



Anton Paar

Measure,
what is measurable,
and make measurable
that which is not.

Galileo Galilei (1564-1642)

Instruction Manual

Physica MCR Series

Physica MCR 51 / 101 / 301 / 501

Physica Smartpave

Instruction Manual

Physica MCR Series

Physica MCR 51 / 101 / 301 / 501

Physica Smartpave

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1 Introduction

This manual describes the installation and operation of the instruments of the Physica MCR xx1 Series and the Physica Smartpave. Carefully read this manual before installation.

Please contact our local distributor or Anton Paar Germany GmbH directly should you require further information.

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2 Safety Instructions

Make sure you read and understand all the safety instructions given in this section and throughout the manuals before installing and operating the equipment. Follow the instructions in this manual at all times.

The manual contains important notes and warnings. Read them carefully and follow all instructions to avoid personal danger to yourself and others and / or damage to the equipment.

All personnel involved in the operation and / or maintenance of the equipment must be properly instructed in its use.

This manual contains important information on operating and handling the instrument. You are therefore required to keep the manual with the instrument, especially when transferring the instrument to other persons.

General remarks

- Anton Paar Germany GmbH and its suppliers shall not be liable for any damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising from the use or inability to use this Physica product, even if Anton Paar Germany GmbH has been advised of the possibility of such damages. In any case, Anton Paar Germany GmbH's liability shall be limited to the amount actually paid by you for this product. This limitation does not apply to damages which were caused by Anton Paar Germany GmbH with intent or due to gross negligence. Likewise, claims which are based on mandatory legal rules regarding product liability remain unaffected.
- Warranty is granted only if no un-authorized modifications have been made to the hardware, firmware or software.
- Only use spare parts supplied or approved by Anton Paar Germany GmbH. The use of other spare parts may result in damage to the instrument or danger to the user. This annuls the warranty.
- The coating of the instrument is resistant to common detergents. Avoid the use of corrosive fluids or solvents.
- Do not use the equipment for any other purpose than for the measurement of rheological properties. Anton Paar Germany GmbH does not accept any liability for the consequences of inappropriate use of this equipment.

- Due to the nature of the measurement, the measuring results not only depend on the correct use and functioning of the Physica MCR xx1, but may also be influenced by other factors. We therefore recommend that the analysis results are plausibility tested before consequential actions are taken.
- Dispose of the equipment according to the legal requirements specific to your country.

Location and Transport

- Allow the equipment to reach ambient temperature before installation. This is extremely important, if the equipment has been stored or transported at a lower temperature.
- Place the instrument in a clean, dry and vibration-free environment. Keep the equipment dry at all times, it is not drip-proof.
- Only use the equipment in a dust-free environment. In particular, avoid an environment where electrically conductive dust may be present.
- Where necessary, place the equipment at the required distance from other objects to avoid overheating.
- Make sure the instrument and peripheral equipment are placed so that they do not interfere with work procedures or personnel moving around the equipment.
- Make sure the instrument and peripheral equipment are placed so that the switches can be reached easily.
- Do not operate the instrument in strong electric or magnetic fields or hazardous areas.
- The equipment is **not** an explosion-proof instrument and therefore must not be operated in areas where there is a risk of explosion.
- Always pack all equipment that needs to be transported in the original packaging. Use adequate lifting techniques as parts of the equipment are heavy. Do not lift the instrument by the measuring head.
- Clean all equipment before packing and clearly mark equipment that has been used for the measurement of potentially hazardous materials. Equipment containing unidentified material will not be serviced or checked.

Electrical connections

- Make sure that the voltage supply meets the instrument specifications before connecting the equipment.
- Only use a grounded outlet to avoid the risk of electric shock.
- Only use the cabling supplied by Anton Paar Germany.
- Switch off the equipment before you connect or disconnect cables.
- High voltages may be present inside the equipment. Do not open the power supply or remove any of the covers of the equipment.
- If a fuse needs to be replaced, switch off the equipment and disconnect it from the main power supply. Only use fuses with the given specifications.
- Only use the power supply the equipment has been delivered with. Do not use the power supply for any other purpose.

Air bearing (where applicable)

- Only use a clean, dry and oil-free air supply that meets the specifications given in the manual.
- Do not touch or try to move the rotor unless a suitable air supply at the correct pressure is connected to the instrument.
- Do not operate the instrument without air at the correct pressure.
- Do not touch the rotor during measurement.

Temperature

- The equipment or parts of it, as well as the sample, can reach temperatures far above or below room temperature. Touching these areas may cause severe burns. Make sure you are adequately protected when operating the equipment at these temperatures.
- Heated or cooled areas may take considerable time to reach room temperature. Allow these areas to cool down / warm up to room temperature or wear adequate protection.

- Some materials may evaporate during measurement especially at high temperatures. Ensure adequate protection from hazardous gases. The measuring temperature should be selected so that no explosive substances can develop.
- The warning sign 'Hot Surface' on temperature devices is also a warning to the fault condition of uncontrolled heating due to an electronics failure. If this occurs, any flammable material left on the heating surface may lead to a fire outside of the instrument. The instrument has to be switched off by its main switch on the left hand side when left unobserved.

Nitrogen (where applicable)

- Only use nitrogen in a well ventilated location.
- Nitrogen is non-toxic, colourless and non-flammable. It does not support breathing so a high concentration of nitrogen may lead to suffocation, especially in small unventilated areas.
- Nitrogen is heavier than air, so high concentrations of nitrogen gas may develop above floor level. There is a DANGER OF SUFFOCATION.
- The nitrogen exhaust and other outlets must be positioned so that they do not cause injuries or damage to other equipment.
- Liquid nitrogen can cause severe burns. Wear protective clothing (especially gloves and glasses) when handling liquid nitrogen containers.
- When containers for liquid nitrogen are used make sure to observe all instructions in the documentation delivered with those containers.

Temperature control / Cooling with fluids (where applicable)

- Read and observe the instructions given in the liquid circulator manual.
- When operating a temperature cell where a liquid, e.g. water or oil, is used make sure that the liquid stays well below its boiling point / flash point and well above its freezing point.
- Only use fluids specified in the thermostat manual and observe the temperature ranges.
- Do not mix fluids.

- Some fluids may expand considerably with increasing temperature. Do not overfill the bath.

Operation

- When operating, the equipment must be supervised at all times. The instrument has to be switched off by its main switch on the left hand side when left unobserved.
- Do not operate the equipment if a malfunction is suspected.
- Do not operate the equipment if there is a risk of damage to the equipment or the surroundings or a risk of injuries to persons.
- Do not use the equipment for the measurement of explosive or hazardous materials.
- Ensure adequate handling routines such as protective clothing and good ventilation when measuring potentially hazardous or volatile samples. This manual is not intended to cover all the safety issues associated with samples or other materials. It is the user's responsibility to establish appropriate procedures in accordance with local, national or international regulations.
- Flammable materials must not be stored near the equipment. Please note that some materials may develop flammable or explosive gases when heated. Keep the measurement temperature below this point.
- Do not exceed the temperature or pressure range specified for the equipment you are using.
- Instruments with automatic gap setting can apply very high forces with the measuring head or measuring system. Stay clear of the measuring head, especially when it is moving downwards.
- Handle the measuring systems with care and do not use force when removing samples.
- Store the measuring systems in a safe place when not in use and avoid scratches and other damages as this affects your measurement results.

Service and Maintenance

- Maintenance and service may only be carried out by authorized personnel. Anton Paar Germany GmbH shall not be liable for maintenance, repairs or modifications carried out by a third party.

- Maintenance of the equipment should be carried out at least once a year or as agreed on in your service contract unless stated otherwise in the manual. Certain equipment may require more frequent checks.

3 Symbols

The following symbols will be used in this manual and/or on the equipment:



Warning:

A section marked with this sign contains important information. Read it carefully and follow all instructions. Disregarding the information may lead to personal injuries and / or to damage of the equipment.



High voltages:

Dangerous voltages may be present. Do not open any covers unless instructed to do so. Always follow the instructions given in sections marked with this sign. Disregarding the information may cause lethal injuries.



Extreme temperature:

The surface may be very hot or very cold. Make sure you are adequately protected and do not touch parts of the equipment marked with this sign.



Important:

A section marked with this symbol contains important information on the handling of the equipment and the reliability of the measurement results. Disregarding this information may cause damages to the equipment.



Hint:

A section marked with this symbol contains additional information.

4 Installation Requirements

Read chapter 2 and observe the requirements given in this section before installing the instrument.

4.1 Environment

The instrument should be placed in a clean environment on a stable lab bench or table free of vibrations. The following environmental conditions should be met.

Temperature range: 15 °C ... 35 °C (operation)
recommended: 23 °C ± 3 °C

Humidity: 20 % ... 60 % non-condensing
up to 80 % (non-condensing) only if the instrument is
connected to a suitable air supply

Overload category: II

Degree of pollution: 2

**Warning:**

Do not expose the instrument and peripheral equipment to:

- direct sunlight,
- strong magnetic or electric fields,
- moisture or
- an explosive environment.

The equipment is not drip-proof. Keep the instrument dry at all times.

4.2 Space

The instrument has a footprint of 485 x 603 mm. The maximum height of the instrument is 621 mm (720 mm for the Physica MCR 501). Keep a distance of 200 mm to other equipment on the left-hand side of the instrument.

Make sure you allow sufficient space for any peripheral equipment. The space requirements for the various accessories can be found in the respective accessory manual.

4.3 Electric

The instrument needs to be connected to a voltage supply that meets the specifications below:

Power supply	AC 100 ... 240 V
Frequency	50 ... 60 Hz
Power consumption	850 W



High voltages:

Make sure you connect the power supply for the instrument and any peripheral equipment to grounded outlets to avoid the risk of electric shock.

4.4 Air (air bearing instruments only)

The air bearing instruments require a supply of clean, dry and oil-free air to the instrument at a recommended pressure of 5 bar (maximum 10 bar). The air supply must fulfill the requirements of ISO 8573.1 class 1.2.1.

Particle size:	max. 0.1 μm
Pressure dewpoint:	-15 °C
Oil content:	0.01 mg/m ³

4.5 Computer

A free serial port on the computer or an Ethernet connection (TCP/IP protocol) is required to run the Physica MCR xx1 / Smartpave rheometer. For the requirements of the Physica rheometer software please see the software manual.

5 Unpacking and Supplied Items

5.1 Unpacking

Before unpacking, check the packaging for external damage. If damage is visible, this needs to be documented in case the instrument or other equipment is also damaged. Keep the packaging material for inspection by the transport agency or insurance company.

Unpack all items and compare them to the delivery note. The extent of delivery for the instrument is given below.



Warning:

- The instrument is heavy (approx. 50 kg). Use appropriate lifting techniques to avoid injuries.
- Always lift the instrument at the base plate or at both ends, not by the head alone.
- Do not remove the transport protection of the air bearing before you have connected a suitable air supply.

5.2 Supplied Items

Item	Pcs.	Art. no.
	1	Physica MCR 51 16100
		Physica MCR 101 16101
		Physica MCR 301 16102
		Physica MCR 501 16103
		Physica Smartpave 16104
Water level	1	17205
Tool set	1	
RS 232 cable	1	70429

Ethernet cable (standard cable)	1	
Power cable	1	52112
Air hose MCR (inner Ø 10 mm)	1	
Air hose FMU (inner Ø 10 mm)	1	
Fluid circulator hoses (for the temp. control unit; inner Ø 10 mm)	2	
Physica MCR 501 only: Fluid circulator hoses (for the motor)	2	

6 Description

This chapter contains an overview of the elements of the instrument as well as a more detailed description of the connection panels. Please note that 'Physica MCR xx1 Series' implies all instruments of the series including the Smartpave, unless mentioned otherwise.

6.1 Overview

The figure below shows the Physica MCR 501 as an example. The described elements are identical for all instruments of the Physica MCR xx1 Series.

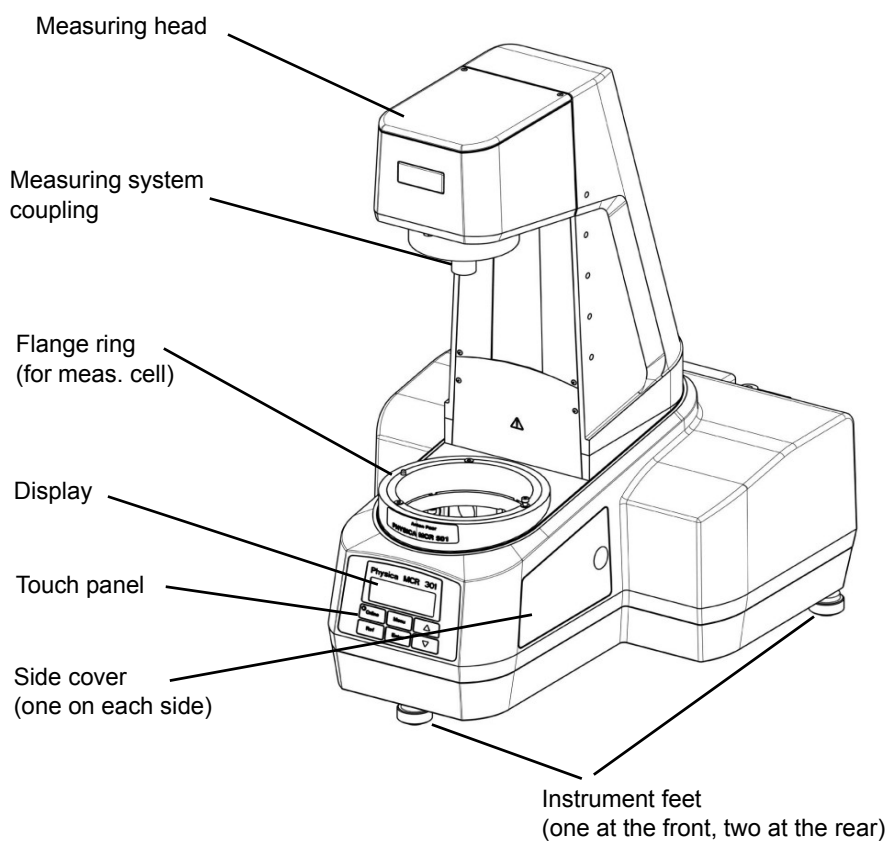


Fig. 6 - 1 Front view - Physica Physica MCR xx1

6.2 Connection Panel (Side)

The side panel on the left hand side of the instrument contains the connectors for power supply, communication and control of external devices.

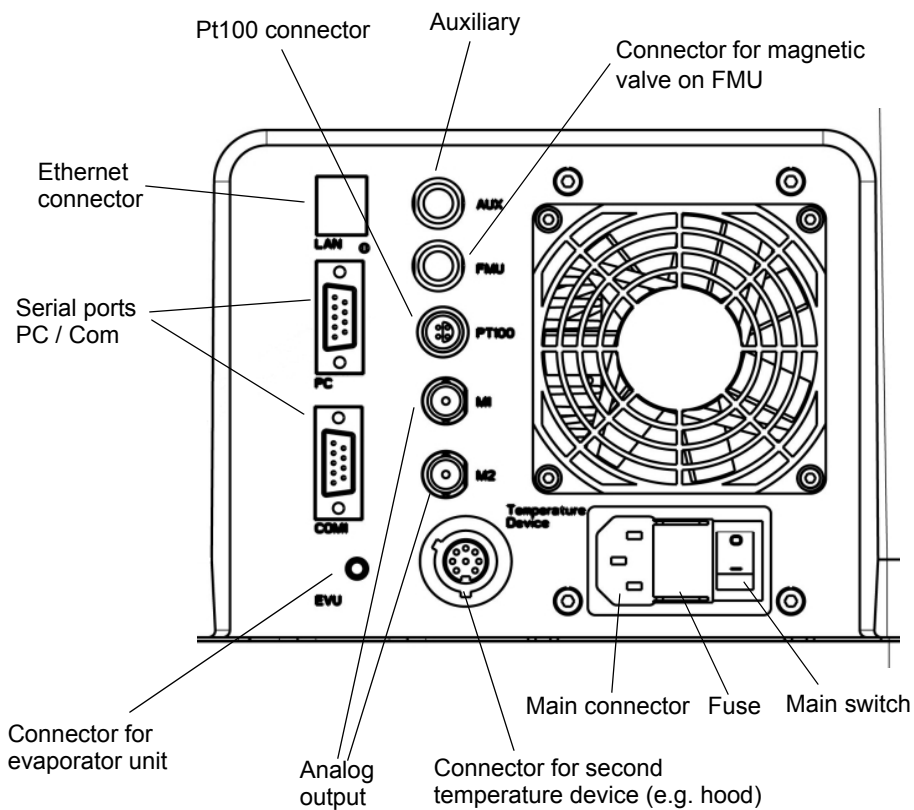


Fig. 6 - 2 Side panel - Physica MCR xx1

The connector for the second temperature accessory allows to connect both Peltier and electrically heated systems.

6.3 Connection Panel (Rear)

The connection panel on the rear of the instrument you find the connectors for air supply and circulator hoses. Also mounted on the rear of the instrument are the handle for carrying the instrument, the flowmeter unit (FMU) and the magnetic valve.

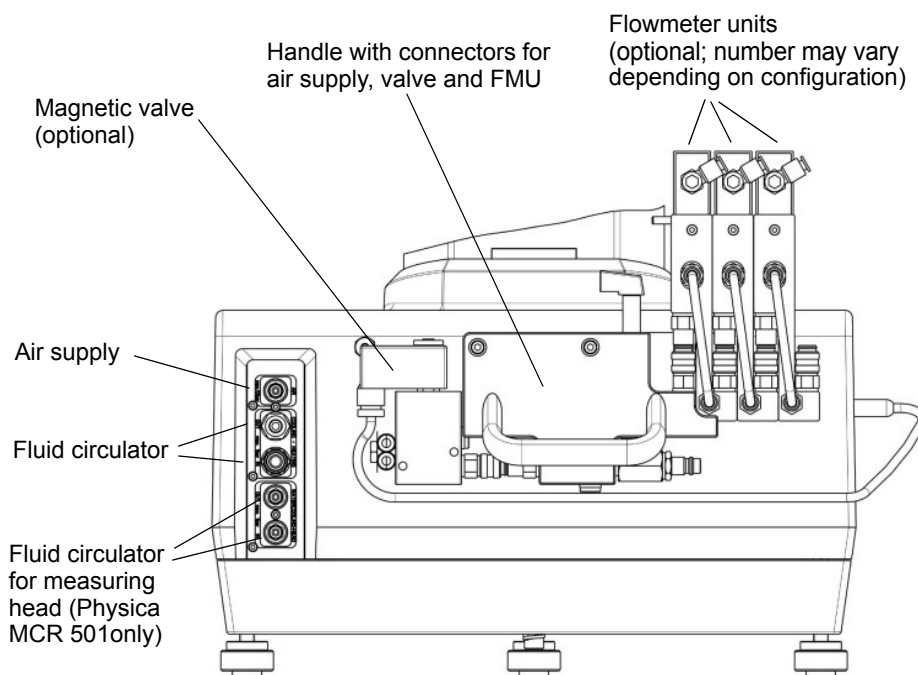


Fig. 6 - 3 Rear panel - Physica MCR xx1

The connector for the air supply is marked in red on both the instrument and the air hose. The air supply connector and both sets of connectors for the fluid circulator are coded to avoid confusing them.



Important:

When exchanging an instrument of the Physica MCR Series make sure to exchange the existing air hose with that supplied with the Physica MCR XX1 before installing the instrument.

The hoses from the fluid circulator also need to be exchanged.

6.4 Touch panel

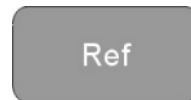
The buttons on the instrument's touch panel can be used to operate the instrument manually and to access the menu with the instrument settings. Please note that the menu contains settings that influence the instruments overall behaviour. Therefore, these may only be changed if you are instructed to do so by Anton Paar Germany GmbH or an authorized person.

The buttons can only be used when the instrument is set to 'offline' mode.



The indicator light shows whether the instrument is online (green indicator light is on) , i. e. can be controlled from the computer, or offline (green indicator light is off) for manual operation.

To switch to 'offline' mode, press the button once. To return to the online mode, press the button again.



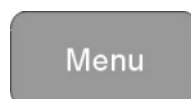
Press this button to start the reference move of the measuring head. The head will move to the maximum position and stop there.



This button can be used to manually move the measuring head upwards. The gap motor speed increases when the button is pressed until it reaches the maximum value. The movement is stopped as soon as the button is released.



This button can be used to manually move the measuring head downwards. The gap motor speed increases when the button is pressed until it reaches the maximum value. The movement is stopped as soon as the button is released.



Press this button to enter the instrument menu. The menu contains general settings for the instrument. These should not be changed unless you are instructed to do so by Anton Paar Germany GmbH or an authorized person. To return to the default display press the 'Menu' button again. The menu structure is described in the appendix.



The 'Enter' button is used to confirm changes that have been made in the instrument menu.

7 Installation

This chapter describes the installation procedure for the instruments of the Physica MCR xx1 series. Please read the whole chapter before starting with the installation. Further, make sure that the intended location meets the installation requirements as stated in chapter 4.

The installation of the accessories is described in the respective accessory manual.

7.1 Mounting the Handle

Use the supplied screws to mount the handle on the middle and left-hand Allen screws on the rear panel of the instrument (see Fig. 7 - 1). The handle can be used to carry the instrument, a second handle is mounted on the base plate at the front of the instrument.

The handle is used to fix the flowmeter unit(s) and the magnetic valve for the flowmeter unit. The magnetic valve and flowmeter unit(s) are part of the respective accessory and may therefore not be part of your delivery.

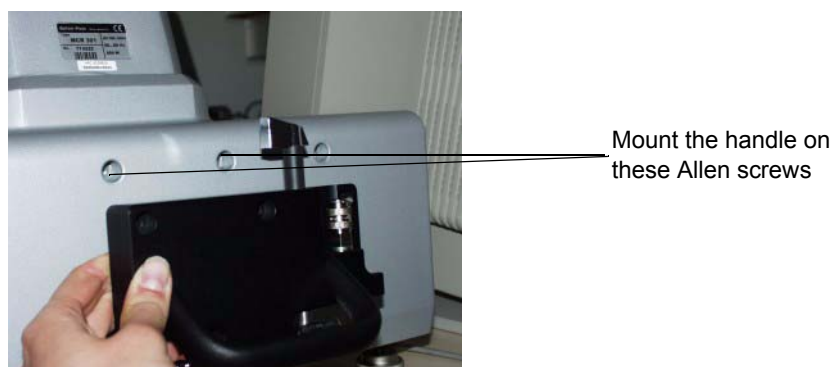


Fig. 7 - 1 Mounting the handle

After mounting the handle, turn the manual valve (on top of the handle) clockwise by 90 degrees.

7.2 Connecting the Air Supply to the Instrument

When installing an air bearing instrument, the air supply must be connected first. This is to avoid damaging the air bearing accidentally during the installation.

**Warning:**

- Before connecting the air supply, make sure that it meets the requirements given in section 4.4.
- Do not touch or try to move the rotor unless a suitable air supply at the correct pressure is connected to the instrument.
- Do not operate the instrument without air at the correct pressure.

1. The air supply hose is delivered with the instrument (transparent hose with one quick connector marked in red and one open connector). Connect the open end of the hose to a suitable air supply. If you are using an air filter/drier unit supplied by Anton Paar Germany GmbH, the connector can be connected directly to the air filter/drier. In that case connect the air supply to the inlet of the filter/drier unit.
2. If you are using a filter/drier unit that requires electrical power make sure you connect it to a voltage supply that meets the specifications of the unit. Always use a grounded outlet to avoid the risk of electric shock. The filter/drier unit should be switched on at all times.
3. Connect the quick connector to the connector marked 'Air' on the rear panel of the instrument. The maximum input pressure is 10 bar, the recommended pressure is 5 bar.

**Hint:**

It is recommended to leave the air supply to the instrument switched on at all times. If the drier unit needs to be switched off or disconnected, disconnect the air supply hose from the instrument to avoid that humid air entering into the air bearing as this may cause corrosion.

If the air supply is disconnected, make sure to protect the air bearing using the transport protection.

7.3 Connecting the Air Supply to the Accessory

This chapter describes the installation of the air supply to the accessory as well as the mounting of the magnetic valve and the flowmeter unit(s).

1. Connect the supplied air hose (transparent hose with one brass quick connector and one open connector) to the connector on the lower right side of the handle. If you are using an air filter/drier unit supplied by Anton Paar Germany GmbH the connector can be connected to the air filter/drier.
2. Connect the magnetic valve to the quick connector on the lower left side of the handle (see Fig. 7 - 2). Then connect the cable to the connector marked 'FMU' on the side panel of the instrument

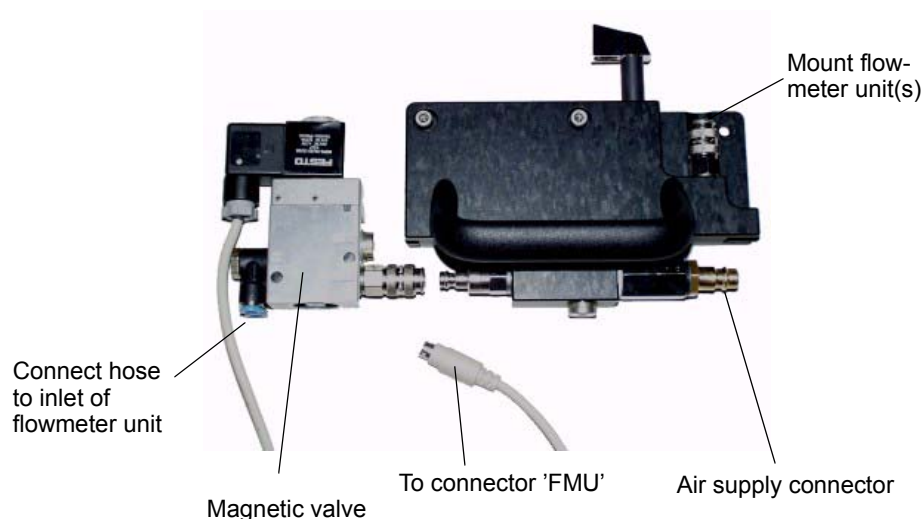


Fig. 7 - 2 Connecting the magnetic valve

3. Connect the flowmeter unit(s) to the quick connector on the upper right side of the handle. The scale should point towards the front of the instrument. If several flowmeter units need to be mounted, they can be connected in series.
4. For the flowmeter marked 'Cooling', remove the short hose between the two lower connectors and connect a hose from the outlet of the magnetic valve to the connector in the middle of the flowmeter unit.
5. Turn the manual valve on top of the handle counter-clockwise by 90 degrees.

7.4 Connecting the Instrument to the Mains

Connect the mains cable to the instrument and to a voltage supply that meets the specifications given on the rear of the instrument.



High voltages:

Only use a grounded outlet to avoid the risk of electric shock. Only use the cabling supplied by Anton Paar Germany GmbH.

Make sure that the voltage supply meets the specifications of the power supply unit (see 4.3).

7.5 Connecting the PC

The instruments of the Physica MCR xx1 Series can either be connected to the computer by an RS232 cable or by Ethernet. The instrument has to be set to one of these options from the instrument menu. The default setting is RS 232.

To install the software, insert the installation CD and follow the instructions on the screen. For information on the installation procedure and on the software, please see the software manuals. The manuals are available on the installation CD.

7.5.1 Selecting the Communication Setting

1. Switch on the instrument and wait for the boot procedure to finish. The instrument is ready, when 'NForce', 'Temp.', 'Pos' and 'Status' are shown on the display.
2. Press the 'Online' button once, then press 'Menu' and 'Enter' to access the 'Select Connection' menu. The active option is marked with an arrow. To change the setting use the arrow buttons on the touch panel.
3. After you have made your selection, press 'Enter' and wait for the instrument to finish storing the new settings. The menu structure is described in detail in Appendix A at the end of this manual.
4. Press 'Menu' to return to the default display.
5. Press 'Online' to return to online mode.
6. Switch off the instrument for the connection of cables.

7.5.2 RS 232

Connect the serial cable (9pin-9pin) to the connector marked 'PC' on the side panel of the instrument and to a free serial port on the computer on which the rheometer software will be installed.

7.5.3 Ethernet

Each instrument is equipped with an Ethernet interface. The MAC address of this interface is given on the instrument. The TCP/IP protocol is used for the communication between software and instrument.

To connect the instrument to the network, use a patch panel connector, a switch or an additional Ethernet board. The included standard patch cable can be used for the direct connection and for most modern switches. For the connection to the additional Ethernet board a crossover patch cable is required.

Connect the patch cable to the connector marked 'LAN' on the side panel of the instrument and to the network connector. For the configuration in the software please see the software manual. For questions regarding the required hardware on the network side and for the configuration in the software, the assistance of your network administrator may be required.

7.6 Connecting the Hoses from a Fluid Circulator

A circulator is required e.g. for counter-cooling or for a temperature unit whose temperature is controlled by the circulator fluid.

Connect the hose from the circulator outlet to the connector marked 'In' and the hose from the circulator inlet to the connector marked 'Out'. Both connectors are found on the rear panel of the instrument; they are marked 'Temperature Device'.

**Warning:**

The fluid temperature must not exceed the range of -20 ° to +70 °C.

For the Physica MCR 501 you can additionally connect a fluid circulator for controlling the temperature of the measuring head. To install the hoses from this circulator, please proceed as described above. The connectors are marked 'Watercooling Head'.



Warning:

The temperature of the fluid for the 'Watercooling-Head' must not exceed the range of +15 ° to +40 °C.

Suitable hoses with quick connectors and an inner diameter of 8 mm are supplied with the instrument.

7.7 Removing the Transport Protection



Important:

For air bearing instruments, make sure that the air supply is switched on and set to the correct pressure.

1. Switch on the the instrument. The main switch is found on the panel on the left hand side of the instrument.
2. Wait for the instrument to boot. The boot sequence is finished when the last line of the display shows 'Status: o.k.'.
3. Press the button marked 'Online' once to switch off the green LED.
4. Press 'Ref'. The measuring head will move to the maximum position.



Warning:

Stay clear of the measuring head while it is moving as it can generate high forces. The warning symbol on the lift cover also indicates the danger of being crushed.

5. Remove the transport protection. Please keep the transport protection in case the instrument needs to be moved or shipped later on.
6. Press the 'Online' button again to switch on the green LED.

7.8 Installing Accessories

The measuring cells are mounted into the instrument's flange ring, aligned to the guide pin and fixed using the three screws. All necessary tools are supplied with the instrument or the accessory.

1. To mount an accessory remove the three screws, guide cables and hoses through the flange ring and insert the accessory into the flange ring aligning it to the guide pin.
2. Insert the long screw opposite the guide pin and tighten it.
3. Insert the remaining two screws and tighten them as well.
4. Open the the side panels of the instrument by pushing on the black area and taking out the panels.
5. On the right hand side you can connect the hoses, if any, from the accessory to the quick connectors inside the instrument. See the figure below.



Fig. 7 - 3 Connecting the fluid circulator hoses from the accessory

6. On the left hand side you can connect the control cable from the accessory. Align the cable connector to the connector inside the instrument and push in the connector.



Fig. 7 - 4 Connecting the accessory cable to the instrument

7. Re-mount both side panels.
8. A hood can be mounted to the thread on the instrument head. The controller cable is connected to the accessory connector on the left hand side of the instrument.

A detailed description of the installation including cabling and hoses can be found in the respective accessory manual.

All accessories for the Physica MCR xx1 Series and the measuring systems are detected automatically by the instrument and installed to the software. A manual selection in the software is not required. Accessories from the Physica MCR Series can be equipped with a cable adapter to be used in the Physica MCR xx1 Series. Measuring systems from the Physica MCR Series cannot be detected automatically.

The accessory should be installed before aligning the instrument (see the next step of the installation) unless it is not possible to place the water level on the lower accessory. In that case, place the water level on the flange ring.

To disconnect the hoses make sure that the fluid circulator is switched off and push back the sleeve of the female connector. To disconnect the cable pull back the sleeve of the cable connector and pull out the connector.

7.9 Leveling the instrument

1. Place the supplied water level on the lower accessory parallel to the back of the instrument and check the alignment.
2. Adjust the alignment using the two rear feet of the instrument until the instrument is levelled. If necessary, adjust the front foot as well.
3. Place the water level at 90 degrees to the initial direction and check the alignment. Adjust using the rear foot and the two front feet until the instrument is levelled.
4. Repeat step 1 to 3 until the instrument is levelled in both directions.

The levelling of the instrument may influence measurements at small torque values. Therefore, it should be checked and repeated if the instrument has been moved.

8 Operating the Physica MCR xx1

For the operation of the instrument, it is required that the installation has been carried out as described in this manual. The accessory or accessories and the rheometer software also have to be installed. Information on the accessories is found in the respective manual, information on the installation and operation of the software is found in the software manuals on the installation CD.

8.1 Start-up and Initialization

1. For air bearing instruments, make sure that the air supply and air drier are connected and working at the correct pressure.
2. To start up the instrument, switch it on. Then wait for the instrument to boot; this takes approx. one minute. The instrument is ready when the display shows 'Status: o.k.' in the last line.
3. Start your computer and the operating system, then start the rheometer software.
4. Switch on the accessory / accessories, for example an external temperature controller or water bath (if applicable).
5. Initialize the instrument from the software to establish communication. During initialization, the measuring head will move to the top position to check the gap sensor. The rotor will perform several revolutions at high speed to check the position sensor.



Important:

If this is the **first start-up** of the instrument you should carry out the motor adjustment and, if necessary, the determination of the moment of inertia for the measuring system you are going to use. Both procedures are described in the device driver manual for the xx1 Series which is part of the software manuals.

6. If this is not the first start-up, you can proceed with the measurement.
7. Send the required temperature to the accessory and mount the measuring system. For cylinder systems go to the measuring position and wait for thermal equilibrium. For measuring systems where a zerogap is required start the zerogap procedure and move to the measuring position after the procedure has been finished. Wait for thermal equilibrium and repeat the zerogap.

8. Set up the measurement parameters as described in the software manual.
9. Move up the instrument head and load the sample.
10. Move to the trimming position (cone-plate and plate-plate systems), trim the sample and then move to the measuring position. For cylinder systems you can go to the measuring position directly.
11. Wait for thermal equilibrium and start the measurement.
12. After the measurement, disconnect the measuring system and move up the instrument head.
13. Remove the sample and clean both upper and lower measuring system.



Extreme temperature:

The measuring system, the sample and parts of the accessory may reach temperature far below or above room temperature. Allow the equipment to reach room temperature or make sure you are protected adequately before touching any of these parts.

Avoid scratching or otherwise damaging the measuring system and / or accessory.

14. Re-mount the measuring system for the next measurement.

The setting of the measurement parameters and the evaluation of the rheological data are very dependent on the sample and the selected measurement type. It would far exceed the scope of this manual to describe the rheological background. For further reading the 'Rheology Handbook' by Thomas Mezger is recommended (ISBN 3-87870-745-2).

8.2 Measuring Systems

To mount the measuring system, push up the sleeve of the coupling and insert the upper end of the measuring system into the coupling. Make sure you align the markers on the measuring system and the coupling. Pull down the sleeve to fix the measuring system. To remove the measuring system, push up the sleeve and take out the system.

Please observe the following when handling the measuring systems:

- Do not bend or drop the measuring system. Even a slight mechanical damage may cause serious measurement errors.

- Keep the coupling of the measuring system clean. Do not oil or grease the coupling.
- Do not use force when removing the measuring system from a sample. Do not scratch the measuring system while cleaning.

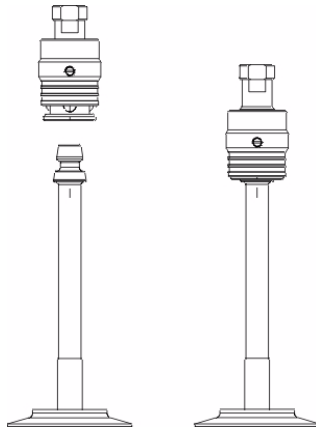


Fig. 8 - 1 Measuring system with open and closed coupling

8.3 Sample Loading

The sample amount and the handling of the sample during loading are two of the most important factors for the correctness and reproducibility of rheological measurement results.

As most materials are sensitive to external forces, it is essential that all samples are treated as similarly as possible before the measurement. They should be applied carefully to the measuring system to avoid influencing the results.

The correct amount of sample for a cone-plate system is shown in the figure below. The same principle applies for a parallel plate system. The sample should be just outside the rim of the measuring system. Ideally, all excess sample is removed at a position just above the measuring position; then the measuring system is moved to the measuring position. Both too much and too little sample will lead to large errors in the measurement data.

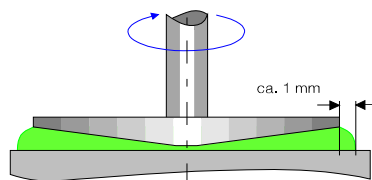


Fig. 8 - 2 Measuring system filling

The volume required for concentric cylinder systems is indicated by a marker in the measuring system cup.

9 Technical Specifications

9.1 Measuring Drive

Drive principle	permanent magnet synchronous drive
Minimum torque	0.1 μNm (Physica MCR 301 / 501) (0.02 μNm with DSO) 0.5 μNm (Physica MCR 101 / Smartpave) 250 μNm (Physica MCR 51)
Maximum torque	125 mNm (Physica MCR 51 / 101 / Smartpave) 200 mNm (Physica MCR 301) 230 mNm (Physica MCR 501)
Torque resolution	< 0.1 μNm (Physica MCR 51) 0.002 μNm (Physica MCR 101 / Smartpave) 0.001 μNm (Physica MCR 301 and 501)
Torque accuracy	max. (0.2 μNm ; 0.5%)
Maximum rise of torque	1500 Nm/s
Speed range CSS	10^{-5} min^{-1} - 3000 min^{-1} (Physica MCR 51) 10^{-6} min^{-1} - 3000 min^{-1} (Physica MCR 101) 10^{-7} min^{-1} - 3000 min^{-1} (Physica MCR 301 and 501)
Speed range CSR	10^{-3} min^{-1} - 3000 min^{-1} (Physica MCR 51) 10^{-4} min^{-1} - 3000 min^{-1} (Physica MCR 101 / Smartpave) 10^{-6} min^{-1} - 3000 min^{-1} (Physica MCR 301 / 501)
Typical adjustment time:	to a speed of 1000 min^{-1} : 150 ms to an angle of 20 mrad: 200 ms
Frequency range	10^{-4} Hz - 100 Hz 10^{-5} Hz - 100 Hz

9.2 Encoder

Measuring principle	optical incremental encoder
Internal digital resolution	0.012 μrad (no oversampling)
Real resolution	< 1 μrad within the range of measurement accuracy

9.3 Power Consumption

Power supply	100 ... 240 VAC
Frequency	50 ... 60 Hz
Maximum power consumption	850 W
Fuses	T10 A H

9.4 Analog Output

Range of output voltage	-9.9 ... 9.9 V
Resolution	0.305 mV
Maximum output current	2 mA
Maximum capacitive load	820 pF
Protection	short circuit protection

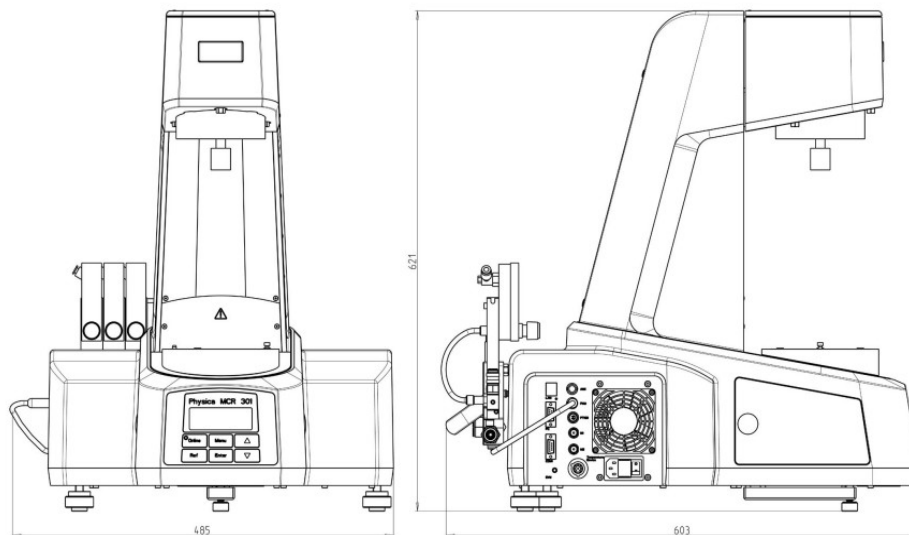
9.5 Temperature Ranges

Connectors for fluid circulators (rear panel)

'Temperature Device':	-20 °C to 70 °C
'Watercooling-Head':	15 °C to 40 °C

9.6 Dimensions

Rheometer



Width x Height x Depth 485 x 621 x 603 mm (Physica MCR 51, 101, 301, Smartpave)

485 x 720 x 603 mm (Physica MCR 501)

Weight 43 kg (Physica MCR 51, 101, 301, Smartpave)

50 kg (Physica MCR 501)

9.7 Pin Assignment

LAN Interface

1	N.C.
2	N.C.
3	N.C.
4	TX+
5	TX-
6	SIRX+
7	SIRX-
8	N.C.
9	GND
10	GND

Serial interface PC

1	N.C.
2	RXD
3	TXD
4	N.C.
5	GND
6	N.C.
7	N.C.
8	N.C.
9	N.C.

Serial interface COM 1 (to accessory with serial interface)

1	N.C.
2	RXD
3	TXD
4	N.C.
5	GND
6	N.C.
7	N.C.
8	N.C.
9	N.C.

EVU

1	N.C.
2	PWM Signal
3	GND

AUX

1	RSW2
2	RGND
3	RSW1
4	R+
5	N.C.
6	+AN_IN
7	-AN_IN
8	GND
9	GND
10	GND

FMU

1	N.C.
2	N.C.
3	LSW2
4	LGND
5	LSW1
6	L+
7	GND
8	GND
9	GND

Pt 100 socket

1	Pt100A
2	Pt100A
3	Pt100B
4	Pt100B

Multi-purpose sockets M1 and M2

In	Analog Out
Out	GND

Temperature device

1	Pt100_1
2	Pt100_3
3	W-
4	Pt100_2
5	Pt100_4
6	-OUT
7	+OUT
8	W+

TruGap connector

1	W-
2	W+
3	I_IN
4	I_OUT
5	U_SEK_A
6	U_SEK_B

9.8 Cable

Serial cable to PC / thermostat / controller

MCR	PC
-----	----

2	3
---	---

3	2
---	---

5	5
---	---

Analog cable to Viscotherm thermostats

MCR	VT
-----	----

In	Out
----	-----

Cable for temperature probes

MCR	Probe
-----	-------

1	A
---	---

2	A
---	---

3	B
---	---

5	B
---	---

9.9 Serial Interfaces

Standard	a) RS232
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b) Ethernet

Protocols	a) Software / none
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b) TCP/IP

Baud rates	9600/19200/38400/57600
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Communication protocols	Julabo MV, MW, MH, Eurotherm 800
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9.10 EMC Specifications

Interference immunity pursuant EN 61326:2001

Interference emission pursuant EN 61326:2001 Class A

European Union RFI Statement: This is a Class A product (EN 61326). In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

9.11 Air Bearing

Type of bearing	diffusion air bearing
Stiffness	7 N/ μ m
Air pressure specifications / purity	SO 8573.1 class 1.2.1 particle size < 0.1 μ m pressure dew point -15 °C oil content < 0.01 mg/m ³
Air consumption	10 NI/min
Instrument input pressure	5 bar (max. 10 bar)

9.12 Normal Force Measurement

Measuring principlecapacitive probe inside air bearing
(patented procedure)

Range	-50 N ... 50 N
Resolution	0.002 N
Accuracy	2.5% of measured value, ± 0.03 N

9.13 Temperature Channel

Type of probe	Pt100 DIN/IEC 751
Resolution	0.01 K
Measuring range	-200 °C ... 650 °C
Accuracy	± 0.03 K (-30...200 °C) otherwise ± 0.06 K

9.14 Ambient Conditions

Temperature range for storage -20 °C ... 50 °C

Temperature range for operation 15 °C ... 35 °C

Recommended temperature range 23 °C $\pm$ 3 °C

Air humidity 20 % ... 60 % non-condensing

If the instrument is connected to the air supply the maximum allowable environmental humidity is 80 % non-condensing.

Conditions for instrument setup temperature drift < $\pm$ 1 K

(measuring position) (air conditioned), no direct sunlight,
no vibration

9.15 Mechanical Specifications

Concentricity of coupling $\pm$ 0.005 mm

Concentricity of coupling $\pm$ 0.01 mm

referenced to centering flange

Concentricity of measuring system $\pm$ 0.01 mm

(measuring cylinder only)

Parallelism of measuring system $\pm$ 0.01 mm

(measuring cone/plate)

Anhang A: Instrument Menu MCR xx1

