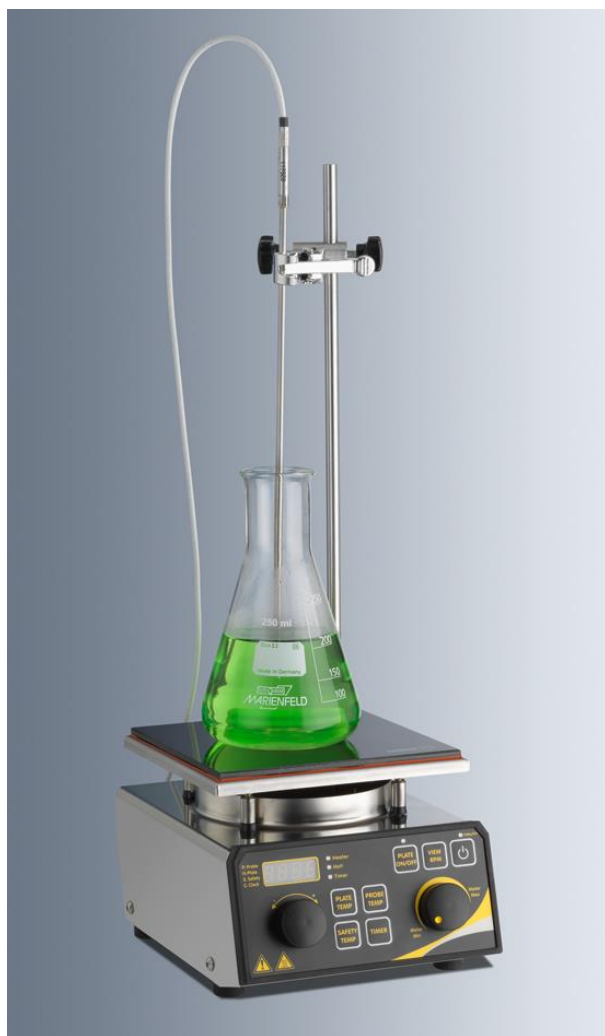SUPE◊RIOR
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Instruction Manual
Magnetic Stirrers with hot plate
M21 and M23

4-digit LED display

Temperature control by optional Pt100 probe

Display of set and actual values

User friendly control panel

PID algorithms for accurate temperature and motor control

Minimal overshoot and high temperature stability

Motor soft-start

Programmable heating plate limit

Programmable safety temperature

Programmable liquid temperature in Pt100 mode

Timer shut-off function

Over temperature protection

Automatic shut-off by error detection mechanisms

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Content

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1. Scope of delivery

Unpack the contents carefully and check to see that nothing appears physically damaged or is missing. Your delivery should contain the following:

1 Magnetic stirrer M21, 230V – Marienfeld Cat. No. 7204124 resp.
1 Magnetic stirrer M21, 115V – Marienfeld Cat. No. 7214124 resp.
1 Magnetic stirrer M23, 230V – Marienfeld Cat. No. 7204125 resp.
1 Magnetic stirrer M23, 115V – Marienfeld Cat. No. 7214125
1 Instruction manual

optionally available:

Cat. No. 7205220 Pt100 temperature probe
Cat. No. 7205221 Stand rod
Cat. No. 7205222 Cross clamp
Cat. No. 7205223 Probe clamp
Cat. No. 7205231 RS485-RS232 Adapter for RS485 communication
Cat. No. 7205232 Connection cord for connection of different devices via RS485
Cat. No. 7205233 RS232 to USB adapter
Cat. No. 7205234 9 pin Sub-D extension cable

2. General information

Our magnetic hotplate stirrers are designed according to the protection class 1. They were manufactured and tested according to DIN EN 61010. According to these regulations, the units are designed to meet the requirements for safe and correct operations. To ensure the proper safety and operational functions of the instrument, the user should follow the instructions and safety guidelines in this manual.

2.1. Unpacking the instrument

Unpack the instrument carefully and check to see that it is not damaged. It is important that any damage incurred during transport be recognized at the time of unpacking. Notify your carrier or forwarding agent immediately in case of such damage.

☞ **Note:**
If the instrument is not damaged and all parts are complete, you may start to operate the device after reading the instruction manual.

☞ **Important note:**
Read this instruction manual carefully before operating the instrument. Please store the manual in a place easily accessible for every user. Should there be any further questions after reading the manual concerning the setup, operation or warranty, please contact:

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97922 Lauda-Königshofen, Deutschland

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E-mail: info@marienfeld-superior.com
Internet: www.marienfeld-superior.com

A SCHUKO plug (DIN 49441, 16 A, 250 V) is normally shipped with our instruments.

When operating the instruments in countries with different AC plug systems, use an approved adapter or have a qualified electrician replace the AC plug with an approved model suitable for the country of operation. Ensure that your local supply voltage matches the indication on the instrument's specification plate!

The instrument is earthed. When replacing the original AC plug, ensure that the earth conductor is connected to the new plug!

3. Safety instructions

3.1. Description of safety symbols on the instrument

Warning against general danger: This symbol indicates that it is imperative to read and understand the instruction manual prior to operating the instrument. Please highlight points which require special attention in your field of application so they are not overlooked. Disregard of warnings may result in impairment of serviceability as well as in physical harm to the user.

Warning against hot surfaces: This symbol indicates hot surfaces on the device. It refers to the hotplate of the magnetic stirrer which can reach up to 500 °C during operation causing a hazard resulting in serious burns. Avoid contact with the hotplate, vessel and heating medium. Also avoid storage of flammable substances near the instrument.

Caution!
Beware of the effect of the magnetic field on cardiac pacemakers and data storage media.

3.2. Description of safety symbols in the instruction manual

This symbol distinguishes notices which have to be strictly observed by the user. Disregard of warnings may result in the impairment of serviceability as well as in physical harm to the user.

Caution
Danger for fire or explosion!

Warning against hot surfaces: This symbol indicates hot surfaces on the device. It refers to the hotplate of the magnetic stirrer which can reach up to 500 °C during operation causing a hazard resulting in serious burns. Avoid contact with the hotplate, vessel and heating medium. Also avoid storage of flammable substances near the instrument.

Note regarding repair or maintenance

Note regarding mains cable connection

Caution
Note regarding mains voltage

This symbol distinguishes notices which have to be strictly observed by the user to ensure safe operation of the unit.

3.3. General safety instructions

Caution:
Please comply with all safety and accident-prevention regulations applicable to laboratory work.

Caution:
Please do not use this instrument in insecure environment especially not in explosive ambience. Danger of life!

Caution:
Instructed users only may operate the instrument.

Caution:
When connecting the instrument to an AC power outlet, ensure that your local supply voltage corresponds to the specifications indicated on the instrument.

Caution:
Please act with caution when working in the vicinity of flammable or explosive substances and observe safety data sheets. This instrument is not explosion-proof.

The On/Off switch does not disconnect the instrument from the power source. Remove the plug from the AC power outlet to disconnect the instrument from the mains supply entirely.

Note:
Make sure that all safety information on the instrument is clearly visible during operation.

Attention:
Do not open the instrument. Repairs are only to be carried out by trained service technicians.

Connect the instrument to an earthed AC power outlet only.

Attention:
When using flammable substances set the temperature to at least 25 °C lower than the flashpoint of the sample.

Make sure the unit is standing on a solid and horizontal surface.

4. **Intended use**

These magnetic stirrers are mainly to be used to heat and stir hydrous solutions and oil not containing inflammable parts in glass vessels. They are designed for use in chemical and biological laboratories or industrial enterprises, universities and pharmacies.

To ensure maximum service life, observe the specified ambient conditions (temperature and humidity) and ensure that the instrument is not exposed to a corrosive atmosphere.

It is under the responsibility of the user to find out whether the device is suitable for his application. If in doubt, clarify this with your dealer or with Paul Marienfeld GmbH & Co. KG directly.

5. **Setting up the instrument**

5.1. **Setup**

Please place the unit on a fire-proof horizontal and even surface. A minimum distance of 50 cm to inflammable materials should always be observed.

⚠	**Caution:** The power cable may not come in contact with the hot plate
⚠	**Caution:** The instrument may not be operated in explosion-prone areas.
⚠	**Caution:** The unit is not to be used without supervision.
⚠	**Caution:** When connecting the instrument to an AC power outlet, make sure that your local supply voltage matches the indication on the instrument.
⚠	**Caution:** Beware of the effect of the magnetic field on cardiac pacemakers and data storage media.

5.2. Rear connections

External Pt100   Extension connector

(rear view of the magnetic stirrer)

5.3. Mains connection

Connect the mains power cable to the mains power connector. Make sure your local supply voltage matches the indication on the instrument.

5.4. Connection of the Pt100 probe

A DIN connector on the rear of the instrument is intended for the connection of a Pt100 temperature probe (Marienfeld Cat. No. 7205220). Pt1000 probes are not suitable for this instrument!

Connection of a Pt100 probe:
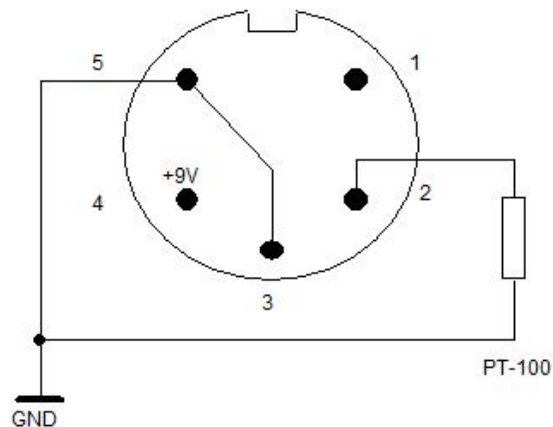
Note:
Please use Pt100 probes with electrically isolated tips only. Probes that allow for an electrical connection to the metal chassis of the unit may distort temperature measurement.

Make sure that the Pt100 probe tip is submersed to a depth of at least 50 mm in the heating medium to allow for accurate measurement.

Caution:
Make sure that the cable of the Pt100 probe does not come into contact with the heating plate.

5.5. Probe stand

Use the M6 thread on the instrument to fasten the optional stand rod (Marienfeld Cat. No. 7205221)

Stand rod

M6 thread
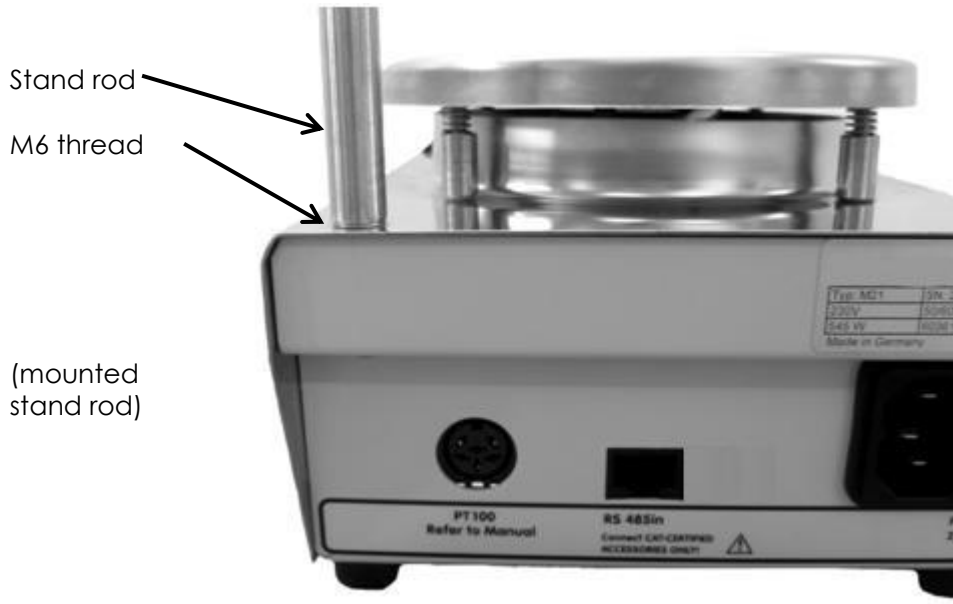
(mounted stand rod)

5.6. Extension connectors

These are for connection of external modules or RS485-RS232 adapters for RS485 communication to a Personal Computer. Please contact your supplier for more information and order numbers.

> ⚠ Please note that no cables (such as network cables) or adapters from other manufacturers should be attached to these connections as this may damage the device and other connected electronics.

6. Control panel

The control wheel on the left is used for changing set values. Any values and messages to be displayed are shown on the 4-digit 7-segment display. The turning knob on the right is used for setting speed of the stirring motor. When switching on the unit, the set motor speed will be displayed on the LED.
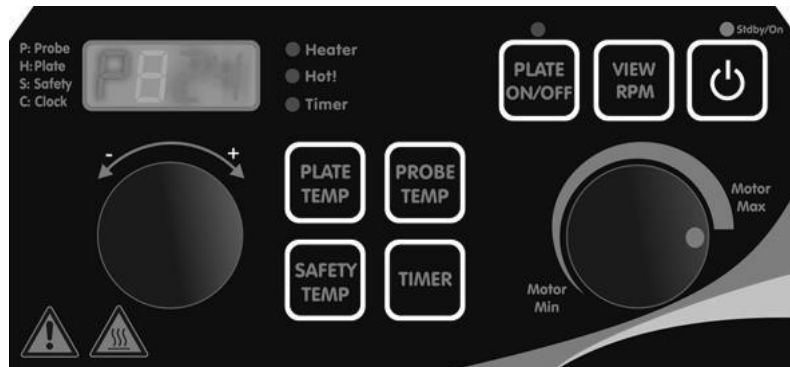
(control panel of the magnetic stirrer)

6.1. Description of the control panel functions

7-segment LED display
This LED display is showing different values and messages
(temperature, motor speed, timer and error messages)

Standby/On button
Switches the device on or off (standby). Switching the unit off all
set temperature values will be stored internally.

Button: „Plate On/Off"
To switch on the heating plate after entering the desired set-values
this button needs to be pressed. Switching the plate off is also
done by pressing this button.

Button: „View RPM"
Shows the actual set motor speed

Button: „Plate Temp"
Display the actual plate temperature or press again for setting the
set point temperature. When used with Pt100 probe: display the
actual plate temperature or press again for setting the plate limit.

Button: „Safety Temp"
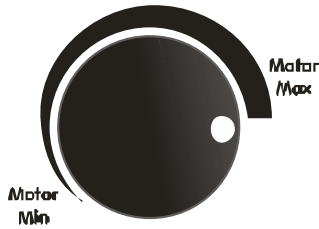Display or set the safety temperature.

Button: „Probe Temp"
Display or set the probe temperature (Pt100)

Button: „Timer"
Display or set the remaining timer minutes

Motor speed wheel
This wheel is sued to set the speed of the stirring motor. The set speed is displayed on the LED display white this wheel is turned (optoelectronic speed control).
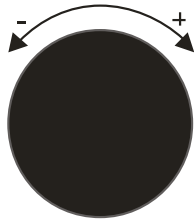
Encoder wheel with push button
This encoder wheel is used to change different set values. Turning clockwise will increment values while turning anti-clockwise will decrement. Pressing the encoder wheel push button will confirm a set value. Any error messages displayed at start can also be reset by pressing the encoder wheel push button.

Status LED „Plate On/Off"
This LED is lit when the hotplate is in service. It indicates that the unit is trying to reach or keep the entered set temperature for hotplate or probe.

Status LED „Heater"
This LED indicates that the hotplate is currently being exposed to an energy pulse.

Status LED „Hot"
This LED lights up when the temperature of the hotplate exceeds 60 °C.

Status LED „Timer"
The LED lights up when the timer is activated

7. **Heating**

The magnetic stirrers M21 und M23 can be used in two different modes of operation:

- heating with external Pt100 temperature probe control (recommended)
- heating control with hotplate only (no Pt100 connected)

We recommend to use an external Pt100 probe for exact temperature control.

Caution: The device will remain hot after switching off the instrument!

If the power cable is connected and the unit is turned off (standby) the display will show the message **hot** as long as the hot plate exceeds 60 °C.

Always switch off the device after use!

7.1. Temperature control with external Pt100 probe

We recommend to use a Pt100 temperature probe (Marienfeld Cat. no. 7205220) to allow for accurate temperature control of the heating medium.

- Connect the Pt100 temperature probe with the DIN connector on the rear of the M21 resp. M23 unit
- Place the Pt100 probe in the vessel (minimum 5 cm submersion)

Press **Power On/Off** to switch on the instrument
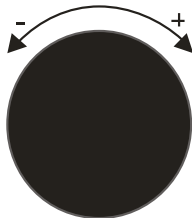
When Ḥ (Amount) is shown as the first digit in the display, turn the **encoder wheel** until the desired volume of the heating medium is shown. Press the **encoder wheel** to confirm the volume in the vessel.

Press **Probe Temp** (P starts to blink). Set the desired setpoint temperature value by turning the encoder wheel. Press **Probe Temp** again or the **encoder** wheel or wait for 3 seconds.

Press **Plate On/Off** to switch on the hot plate (status LED above the button will now light up)

When a Pt100 probe is connected, the value set with "Plate Temp" does not refer to the set point of the hot plate but to the plate limit (plate limit – see section 7.3).

Normally, when using a Pt100 probe, the plate limit should be set to its maximum value (M21: 380 °C, M23: 500 °C) to ensure optimal temperature control.

If the Pt100 probe is connected, the desired temperature of the pt100 probe is set automatically to 0 °C for safety reasons and the heating plate, if switched on is switched off. The plate limit temperature (plate limit see 7.3) will be set to its maximum value.

Caution:
Please ensure that the cable of the Pt100 probe does not come in contact with the hot plate.

7.2. Temperature control without Pt100 probe (hot plate control)

For certain applications it could be necessary to control the hotplate temperature instead the probe temperature. This is only possible if no Pt100 probe is connected to the device.

Press **Power On/Off** to switch on the instrument. Any error messages displayed now can be reset by pressing the encoder wheel button.

Press **Plate Temp** (H starts to blink). Set the desired setpoint temperature value of the hot plate by turning the encoder wheel. To confirm the set value, press **Plate Temp** again or press the encoder wheel or wait for 3 seconds.

Press **Plate On/Off** to switch on the hot plate (status LED above the button will light up).

As soon as the Pt100 sensor is unplugged, the set temperature of the hotplate is automatically set to 0 °C.

7.3. Plate Limit (when heating with Pt100 probe)

When tempering liquid with the Pt100-probe connected, the maximum heating plate temperature can be limited. The instrument now heats up to reach the set temperature of the liquid (Probe Set) with the proviso that the heating plate does not exceed the set maximal temperature (Plate Limit). If the plate limit is set too low, the liquid might not reach the required temperature (Probe Set) or it takes too long to heat-up. To avoid this, the temperature of the heating plate (Plate Limit) should be set to its maximum value, provided there is no safety risk. This allows the microprocessor to freely select the optimum hotplate temperature to reach the set probe temperature as fast as possible. Take care when working with flammable liquids!

If the setpoint of the external Pt100-probe is changed, the plate limit temperature will automatically be set to its maximum value. The new value appears in the display and can be changed to the desired value directly by using the encoder wheel.

To set the hotplate temperature when Pt100 is connected:

Press **Plate Temp** (H starts to blink) Set the desired plate limited by turning the **encoder wheel.** Press the **Plate Temp** key again to confirm the set value or press the encoder wheel or wait 3 seconds.

7.4. Safety temperature (Safety Temp)

A safety temperature can be set to shut down the device in case of an error or to prevent an unexpected heat up of the medium.

The safety temperature is set automatically by the instrument in case that the Pt100 or the hot plate set point temperature is changed. When having connected the Pt100-probe, the safety temperature is automatically set 15 °C above the temperature of the liquid (Probe Temperature). Using the instrument without the external probe, the safety temperature is set automatically to 15 °C higher than the hot plate temperature. If the instrument changes the safety temperature automatically, the new value is shown in the display for a short time.

SAFETY TEMP   Press **Safety Temp** (the symbol ⌐ starts blinking). Set the desired safety temperature by turning the encoder wheel. Press **Safety Temp** again to confirm the set value or press the encoder wheel or wait 3 seconds. The set value will be effective until set point of *Probe Temp* or *Plate Temp* are changed and the *Safety Temp* is set automatically.

☞ If a Pt100 probe is used, the safety temperature refers to the temperature measured by the Pt100 probe. Otherwise, the safety temperature refers to the hot plate.

☞ In safety critical applications the proper use of the safety temperature should be observed. Whenever the set point temperature of the external probe Pt100 is changed, the current safety temperature is automatically set higher than the set Probe Temp value. To set the safety temp as close as possible to the set Probe Temp, set the probe temperature first before changing the safety temperature value.

8. Stirring

Make sure that the vessel used is permeable to magnet field lines (e.g. glass, ceramics or stainless steel)
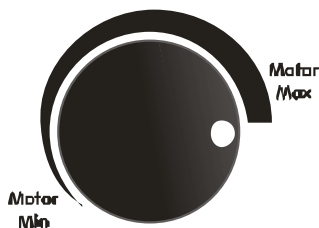
Set the motor speed by turning the motor speed wheel

The set motor speed is shown on the LED display while turning the motor speed wheel. Turn the wheel entirely to the left to switch off the motor.

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> **Note:**
> Optimal magnetic coupling is achieved when using stirring bars with a length of 30-60 mm.

> ⚠ **Caution:**
> Use a suitable vessel and beware of high stirring speeds and high liquid levels to avoid splashing. Make sure to war suitable protective clothing and eyewear.

9. Fahrenheit-Celsius setting

This magnetic hot plate stirrer can show temperature values in degrees Celsius as well as Fahrenheit. When the instrument is switched on in Celsius mode, message ⁻On⁻ will be displayed.

In Fahrenheit mode, the message FAHr will be displayed additionally after switching on the instrument.

You can change between Celsius and Fahrenheit mode as follows:

⏻   Press **Power On/Off** to switch on the instrument.

PROBE TEMP   Shortly **after** switching the instrument on, press **Probe Temp** key and hold.
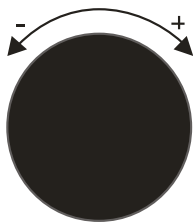
The display now shows a flashing U and you can change between the settings CELC (for Celsius) and FAHr (for Fahrenheit). Choose the desired mode by turning the encoder wheel. Press the encoder wheel to confirm the selected temperature mode. The instrument will remember the selected temperature mode until it is changed again by the user.

10. Timer controlled operation

This device has an internal timer function. The timer allows for automatic switching off. A set time of 10 minutes will cause the shut-off of the unit after 10 minutes. Turning the encoder wheel will increase or decrease the timer period in steps of 1 minute. The switch off time can be selected as follows:

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TIMER	Press the key *Timer* (the symbol ⌐ starts blinking). Turn the ***encoder wheel*** to select the desired switch off time (remaining on-time in minutes). Press the *Timer* key again or wait 3 seconds to confirm.

minimum time until switch off: 1 minute
maximum time until switch off: 999 minutes (16 hours and 39 minutes)

11. **Additional safety functions**

The following safety functions provide additional protection from uncontrolled heating. If a safety problem is detected, the device turns off automatically. The reason for the shutdown is displayed on the LED-display. When switching on the instrument next time, you have to confirm the displayed safety problem by pressing the encoder wheel button.

11.1.   **Differential Alarm**

Breakage of the vessel could create a hazardous situation. To monitor this problem, this instrument has a differential alarm feature. This alarm switches off the unit if the probe has fallen out of the liquid (e.g. breakage of glass). The differential alarm operates as soon as a decrease of temperature detected by the Pt100 exceeds the internal differential alarm sensitivity. The unit then switches off.

11.2.   **Out of liquid check**

The unit monitors whether the Pt100 tip is immersed in the liquid in the vessel on the hotplate. The microprocessor checks whether the probe temperature changes in relation to the temperature changes of the hotplate. If the microprocessor detects no increase in the liquid temperature over a certain time although the hotplate temperature is rising, a warning message is shown on the display and the unit shuts down.

Note:
This safety check is active only if the set temperature is at least 10 °C higher than the currently measured temperature.

The Out of Liquid sensitivity of the instrument can be changed easily via the front panel:

⏻	Press *Power On/Off* to switch on the instrument.

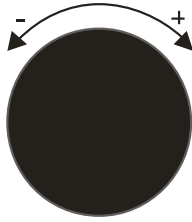| PLATE TEMP	Shortly **after** switching the instrument on, press **Plate Temp** key and hold.

The display now shows a flashing ⏀ and the actual Out of Liquid sensitivity. By turning the encoder wheel you can change the value (0 … 100, standard M21: 20 and standard M23: 15). Smaller values decrease the sensitivity. If the value 0 is selected, the Out of Liquid function is disabled. Press the encoder wheel to confirm the selected sensitivity. The unit will remember the selected value until it is changed again by the user.

11.3.   Failure of the external Pt100 probe

In case of disconnection or failure of the external Pt100 probe the instrument will switch off automatically. When switched on again, the display of the instrument will show the reason for the failure.

11.4.   Internal overheating monitoring

The temperature inside the device is constantly monitored. A safety mechanism will switch off the instrument in case that the internal temperature exceeds a safe value.

12. Error messages

This unit has an on-board self-diagnostic program that detects possible failures. In case of an error message the program switches off the instrument. To enable the user to prevent the problem from re-occurring, the unit will display any of the following error messages as soon as it is switched on again:

LED display:	Error name:	Description/reasons:
HErr	hotplate failure	The hotplate temperature exceeded its maximum value. The hotplate temperature sensor might be broken.
OFEr	Off Error	The device was not switched off via the power button. Disconnecting the power cable or mains power failure might be the reason.
H4AF	Plate > Safety	The measured hot plate temperature was higher than the safety temperature for the hotplate (Safety Temp)
P4AF	Probe > Safety	The measured probe temperature was higher than the set safety temperature for the Pt100 probe (Safety Temp).
CLOC	TIMER expired	The unit switched off after timer expired (→ no mistake, for user information only)
dIFF	Differential Alarm	The differential alarm was triggered after the temperature of the connected probe dropped too fast.

PFAI	Probe failure	This message shows that the Pt100 probe is broken or damaged. The same message is shown if the probe was disconnected during operation.
trIA	Triac failure	The output stage of the heating plate is damaged.
HFAI	Plate SensorFail	The hotplate sensor is damaged.
HOU4	Housing overtemp	The internal temperature exceeded its maximum safe value.
nLI9	Out Of Liquid	The external temperature probe is not inserted into the medium.
COnt	Contact Thermometer Error	The contact thermometer is damaged or was disconnected during operation.
UdtO	Watchdog Timer Off	The internal Watch Dog Timer was trigged.
ICEF	Internal Communication Error Front	There repeatedly was an error in the communication between the printed circuit boards inside the unit.
ICEm	Internal Communication Error Motor	There repeatedly was an error in the communication between the printed circuit boards inside the unit.

12.1. Other messages

LED display:	Error name:	Description/Reasons:
FAHr	Fahrenheit	Fahrenheit Mode
OFF	OFF	The instrument was switched off by ON/OFF key.
4850	RS485 Off	The instrument was switched off by RS232/RS485 PC command
HOt	Hotplate is still hot	The instrument was switched off but the hotplate still exceeds 60°C

13. **Serial RS485 Interface**

The RS485 interface of the magnetic stirrers M21 and M23 allows remote access of all functions as well as readout and change of all system parameters (e.g. hotplate temperature, motor speed etc.).
Multiple units may be connected parallel on a RS232 port of a PC with the adapter RS485 to RS232 (Cat. No. 7205231) and connection cords for connection of different instruments via RS485 (Cat. no. 7205232).
To connect various instruments it is necessary to address these units. Every unit has a so-called slave address between 1 and 255 (default: 1) for parallel operation. Each unit needs its own address to avoid data clashes.

13.1.   **Settings of the RS485 Interface**

The parameters of interface (default settings: 9600, 8 N, 1):

Baudrate:	1200 Baud 2400 Baud 4800 Baud 9600 Baud (default setting)
Databits:	8 Bit
Parity:	none
Stopbits:	1
Slave Address:	1 … 255 (1 = default setting)

13.2.   **Pin assignment of the RS485 Interface**

The serial port is a RS485 4-wire system with 2 differential inputs (A and B) and 2 differential outputs (Y and Z). The RS485 connector on the back of the unit has the following pin assignment:
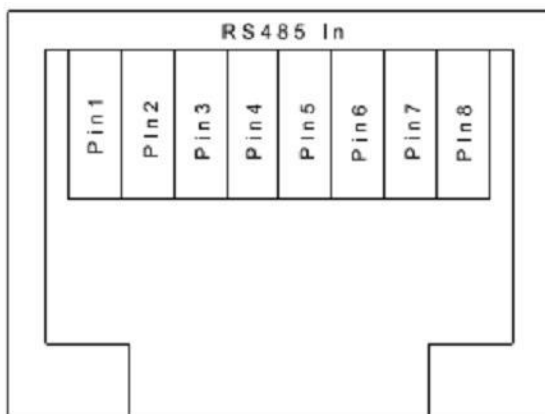

```
Pin 1: RS485 B
Pin 2: RS485 A
Pin 3: GND
Pin 4: reserviert
Pin 5: reserviert
Pin 6: +5V (maximal 100mA)
Pin 7: RS485 Z
Pin 8: RS485 Y
```

(RS485 Pin assignment)

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	Caution:
⚠	Never connect the RJ45 jack with a network jack of a PC, router, switch or something like that. Only connect original accessories to the "RS485 In" jack. Any other use may result in damage of the device or damage to third party devices!

13.3.   Connection between PC and the instrument

To connect the unit with a PC a separate RS485 to RS232 adapter (Cat. no. 7205231) is needed. The RJ45 plug of this adapter has to be connected with the "RS485 In" jack of the instrument. The 9-pin Sub-D connector of the adapter is for the connection to the PC and has the following pin assignment:

Pin	Description
2	transmit data TxD
3	receive data RxD
5	ground, GND

9-pin D-sub connector (female) of the RS485 to RS232 adapter (view on socket)
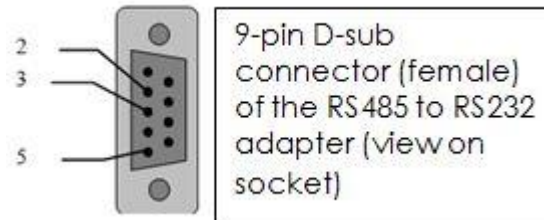
For the extension of the cable you can use a standard 9-pin cable (pins not crossed, Cat. no. 7205234. If your PC has no RS232 port, you can use additionally an USB to RS232 converter (Cat. no. 7205233).

Connection between PC and the stirring unit::

	Caution:
⚠	Never connect the RJ45 jack with a network jack of a PC, router, switch or something like that. Only connect original accessories to the "RS485 In" jack! Any other use may result in damage of the device or damage to third party devices.

13.4.   Addressing the device

To use several units on a bus-system, every unit needs its own address number. This address number is used to send the commands to the unit. No address number must occur twice in the bus system to avoid data collision. For the address numbers you can choose between 1 and 255. The default setting is 1 for all units. There are two methods to change the address number:

Addressing via front panel

You can change the actual RS485 address of the unit easily via the front panel. For changing the address please

Press **Power On/Off** to switch on the instrument

Shortly **after** switching on the instrument press the **Timer** key and hold.
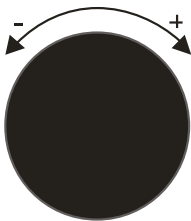
The display now shows a flashing ⌐ and the actual RS485 address. Now you can change the address by turning the encoder wheel. Press the encoder wheel to confirm the selected address. The unit will remember the selected address until it is changed again by the user.

Addressing via RS485 command

Alternatively you can change the slave address with the command WSA:

1. Switch on the instrument
2. Set the new slave address with the RS485 command WSA (example for changing the slave address from 1 to 12: 1,WSA,12<CR>).
3. Switch off the unit
4. The new address is stored even if the instrument is switched off and on

☞ **Important notice:**
Make sure that the old and the new address is not the same as the slave address of any other units in the bus system to avoid data collisions. We recommend that only one instrument is connected with the master during the change of an address.

13.5.   RS485 Data transfer

Every data transfer is started from the Master (normally the PC). The Master sends a command to the instrument (slave). The Slave sends an answer back: a. repeat of the command and the handshake.

13.6.   Format of a RS485 command:

Every command corresponds to the following format:

ADR,CMCCODE,PARAMETERLIST<CR>

Description:

- **ADR:**   Slave address of the desired unit
- **CMDCODE:**   Command-Code
- **PARAMETERLIST:**   1 to 6 parameters, separated by commas
- **CR:**   The command string must be terminated by Carriage/Return (ASCII code 13)

13.7.   Format of a RS485 Handshakes

When a unit gets a command, it will answer as follows:

- The complete command is sent back.
- The unit sends a handshake:

ADR,"HS",RETCODE,PARAMETERLIST<CR>

Description:

- **ADR:**   Slave address of the desired unit
- **RETCODE:**   Error code (see table 2 below)
- **PARAMETERLIST:**   1 to 6 parameters (see table 1), each parameter is separated by a comma
- **CR:**   The handshake must be terminated by Carriage/Return (ASCII code 13)

Return code	Explanation	Parameter list
OK	command executed, no error	see table 1
UC	unknown command	
PA	wrong parameter number (too few or too many parameters specified)	
NA	command is not allowed in actual operation mode	actual operation mode
PR	at least one parameter is out of range	
PL	at least one parameter is too long	
DF	unkown data format	

Important notice:
The PC must not send the next command until the complete answer is received (repeated command and handshake)!

13.8.   RS485 Commands

Overview of all available RS485 commands:

Command	Function	Parameter Description	Parameter Range	Example	Comment
RTY	Read Type and Version of device	1. Dummy parameter to initiate transfer -> Controller sends in handshake: 1. name/type of device 2. Version number of software 3. On Off counts 4. Total Minutes Operation time	1 text number number number	1,RTY,1	
PON	Switch on Device	1. Security parameter 1234	1234	1,PON,1234	
OFF	Switch off Device	1. Security parameter 1234	1234	1,OFF,1234	
WON	Set Status (ON/OFF control) of - Motor - Plate	1. Motor On/Off (0-> Off, 1-> On) 2. Plate On/Off (0-> Off, 1-> On)	0/1 0/1	1,WON,1,0	
RON	Read status of:	1. Dummy parameter to initiate transfer -> Controller sends in handshake: 1. Motor On/Off (0-> Off, 1-> On) 2. Plate On/Off (0-> Off, 1-> On)	1 0/1 0/1	1,RON,1	
		- Motor - Plate			
RAC	Read actual	1. Dummy parameter to initiate transfer -> Controller sends in handshake 1. actual motor speed 2. actual plate temperature in °C 3. actual probe temperature in °C (if connected, if not 'x' as return value) 4. Parameter reserved 5. last off-Condition	1 0..1600 0..MAX 0..250, x x 100…142* see: table RS485 Offcondition numbers	1,RAC,1	Motor disabled in H30/30D. Device will send 'x' as parameter.
WSE	Write actual set values of: - Motor - Hotplate (plate) - external PT100 sensor (probe)	1. Setpoint of motorspeed in Rpm 2. Setpoint of hotplate temperature in °C 3. Setpoint of probe temperature in °C	0..1600 0..MAX platetemp 0..250	1,WSE,800,340,60	MAX depends on plate-type (Ceramic- 500°C, Aluminium 380°C, Stainless steel 350°C, Heatable Flask Stirrer 450°C) Motor disabled in H30/30D. Device will ignore the value.
RSE	Read actual set values of: - Motor - Hotplate (plate) - external PT100 sensor (probe)	1. Dummy parameter to initiate transfer -> Controller sends in handshake: 1. Setpoint of motorspeed in Rpm 2. Setpoint of hotplate temperature in °C 3. Setpoint of probe temperature in °C	1 0..1600 0.. MAX platetemp 0..250	1,RSE, 1	Motor disabled in H30/30D. Device will send 'x' as parameter.
WTR	Set / Write: -Timer - Ramp - Safety temperature	1. Timer value in seconds. Set this value to 0 to disable the timer. 2. setting of the ramp in °C/h (a value of 450 disables the ramp) 3. Safety temperature in °C	0.. 59940 1.. 450 20.. MAX platetemp+25°C	1,WTR,600,450,160	Ramp disabled in M 21, M 22, M 23 KM16.4, KM16.7 and H30/30D. Device will ignore the value.

Command	Function	Parameter Description	Parameter Range	Example	Comment
RTR	Read settings of:	1. Dummy parameter to initiate transfer	1	1,RTR,1	Ramp disabled in M 21, M 22, M 23 KM16.4, KM16.7 and H30/30D. Device will send 'x' as parameter.
	- Timer	-> Controller sends in handshake: 1. actual setting of the timer in seconds. If the timervalue is 0, the timer is disabled. 2. setting of the ramp in °C/h (a value of 450 signals that the ramp is disabled) 3. Safety temperature in °C	0.. 59940		
	- Ramp		1..450, x		
	- Safety temperature		20.. MAX platetemp+25°C		
WVO	Write/Set volume	1. Volume in ml	100..10000	1,WVO,1000	
RVO	Read volume	1. Dummy parameter to initiate transfer -> Controller sends in handshake: 1. programmed volume in ml	1 100..10000	1,RVO,1	
WSM	Activate serial mode (→ enable/disable setpoint control via frontpanel)	1. Set this value to 0 to disable the motor setpoint control via RS232 comands, set this value to 1 to enable motor setpoint control via RS232 commands and disable the frontpanel control. (only used for units with motor)	0 / 1		
RTU	Read Temperature Units	1. type of units	0=Celsius / 1=Fahrenheit	1,RTU,1	
RSS	Read system status	1. Dummy parameter to initiate transfer -> Controller sends in handshake: 1. Device On/Standby 0 → Standby 1 → On 2. Reserved, device will send 'x' as parameter	0/1 x	1,RSS,1	
WSA	Set RS485 slave address	1. New slave address of controller	0...255	1,WSA,3	
WBD	Set RS485 Baudrate	1. Baudrate	0=1200baud / 1=2400baud / 2=4800baud / 3=9600baud	1,WBD,2	After setting the new baudrate you have to switch off and on the device to store the new value in EEPROM

Table *RS485 Offcondition numbers

Offcondition Number	OffCondition	Description
100	NOOFFCONDITION	Undefined Off condition
101	OFF_USER	Unit was switched off by ON/OFF key
102	OFF_REMOTE	Unit was switched off by RS232/RS485 command
103	TIMER_EXPIRED	Unit switched off after timer expired
106	PROBE_DIFFERENTIALALARM	The differential alarm was triggered. The temperature dropped too fast in the probe.
107	PROBE_OUTOFLIQUID	The external temperature probe is not inserted into the medium.
108	PROBE_SAFETY	the measured probe plate temperature was higher than the set safety temperature for the Pt100 probe (Safety Temp)
113	PROBE_BROKEA	The Pt100 probe is broken or damaged. The probe was disconnected during operation.
117	CONTACTTHERMOMETER_BROKE	The contact thermometer is damaged or was disconnected during operation
118	PLATE_OVERTEMP	The hotplate temperature exceeded its maximum value. The hotplate temperature sensor may be broken.
120	PLATE_SAFETY	the measured hotplate temperature was higher than the set safety temperature for the hotplate (Safety Temp)

Offcondition Number	OffCondition	Description
125	PLATE_BROKEA	The hotplate sensor is broken.
130	PLATE_SHORTEDHOTPLATE	The temperature increased too fast. The heating plate output stage is damaged.
134	DEVICE_INTERNALCOMMUNICATIONERROR _FRONT	There repeatedly was an error in the communication between the printer circuit boards inside the unit.
135	DEVICE_INTERNALCOMMUNICATIONERROR _MOTOR	There repeatedly was an error in the communication between the printed circuit boards inside the unit.
139	DEVICE_INTERNALTEMPERROR	the temperature inside the unit has reached its maximum allowed temperature or the internal temperature sensor is damaged.
140	DEVICE_POWERERROR	The instrument was not switched off with the power button. Disconnecting the power cable or a mains power failure may be the source for the error.
141	DEVICE_WDTERROR	The internal Watch Dog Timer was trigged.

13.9.   RS485 Examples of use

Example 1: Setting of values

Programming of a M21 instrument with the following parameters:

- Hotplate   300 °C (corresponds to plate limit)
  temperature:
- Probe temperature: 50 °C
- Motor speed: 500 rpm

The instrument has the standard slave address 1, a Pt100 sensor is connected.
The following commands must be sent to the instrument, the answers of the M21 are in italic types, they must not be sent to the unit:

- 1,PON,1234<CR>   ;Switch on the instrument
  - 1,PON,1234<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK<CR>   *;Handshake from the instrument, command accepted*

- 1,WSM,1<CR>   ;Deactivating of the front panel, only controlling via
                                                       RS485 (optional)
  - 1,WSM,1<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK<CR>   *; Handshake from the instrument, command accepted*

- 1,WSE,500,300,50<CR>   ;Set values (motor speed, hotplate and probe
                                                       temperature)
  - 1,WSE,500,300,50<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK<CR>   *; Handshake from the instrument, command accepted*

- 1,WON,1,1<CR>   ;Switch on motor and hotplate
  - 1,WON,1,1<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK<CR>   *; Handshake from the instrument, command accepted*

Example 2: Reading of actual values

Reading of the actual values of a M21 instrument:

- Temperature mode
- Hotplate temperature
- Probe temperature
- Motor speed

The instrument has the standard slave address 1, a Pt100 probe is connected.
The following commands must be sent to the instrument, the answers of the M21 are in italic types, they must not be sent to the unit:

- 1,PON,1234<CR>   ;Switch on the unit
  - 1,PON,1234<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK<CR>   *;Handshake from the instrument, command accepted*

- 1,RTU,1<CR>   ;Reading temperature mode
  - 1,RTU,1<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK,0<CR>   *;Handshake from the instrument, command accepted (mode = Celsius)*

- 1,RAC,1<CR>   ;Reading actual values
  - 1,RAC,1<CR>   *;Same command is sent back from the instrument*
  - 1,HS,OK,480,180,50,x,4<CR>   *;Handshake sent from the unit, command accepted (motor speed = 480rpm, hotplate temperature = 180°C, probe temperature = 50°C)*

The actual settings are shown in the parameter lists:

- The temperatures are shown in Celsius (command RTU, parameter 1 = 0)
- The actual motor speed is 480rpm (command RAC, parameter 1 = 480)
- The actual hotplate temperature is 180°C (command RAC, parameter 2 = 180)
- The actual probe temperature is 50°C (command RAC, Parameter 3 = 50)

14. Maintenance and Cleaning

The outer casing is mostly 304 grade stainless steel, the hotplate consists of stainless steel resp. Ceran®. The membrane key-pad is chemically resistant splash-proof and can be easily cleaned with warm water and any proprietary liquid laboratory detergent. Do not use steel wool or any similar plastic wool sponge or any aggressive cleaning agents to clean the instrument.

Crust, limestone and water stains may be cleaned with the usual household detergents. Burned-in carbohydrates (e.g. treacle) destroy the Ceran® hotplate. Please remove remaining detergent thoroughly with a damp cloth or sponge since some of the detergents react caustic with higher temperatures. If soils are already encrusted, use a razorblade scratcher. Plastics, kitchen foil as well as stuff containing sugar must be removed immediately.

The following mechanical tools can be used for cleaning:
razorblade scratchers, non-scratching sponges and non-scratching steel wool.

The instruments M21 und M23 must be opened and repaired only by authorized service personnel. Any work on the electronics in the unit should only be carried out by knowledgeable, trained personnel. Any attempt by the user to repair the unit will immediately render the guarantee null and void. Please contact your local distributor in case of a problem.

In case of malfunction do not attempt to repair the unit. There are no user-serviceable parts in this instrument.

15. **Warranty and liability**

Paul Marienfeld GmbH & Co. KG provides a guarantee for a period of 24 months from date of delivery for the instrument purchased by you. This warranty applies only to defects in material or workmanship. There is no warranty for defects or malfunctions caused by neglect, improper use or improper service.

In case of defects in material or workmanship, the instrument will be repaired or replaced. In case of replacement, the warranty for the new unit will persist for the remaining period of the primary warranty period. Charges for returning the instrument have to be borne by the customer.

Any claims regarding guarantee and liability are limited to professional and proper use of the instrument and observance of the general safety instructions and this instruction manual.

Paul Marienfeld GmbH & Co. KG is not liable for any material or personal damages caused by improper use and does not accept liability for consequential damages.
The warranty expires in case of removal or alteration of the identification label and/or the serial number of the instrument.

Note:
It is under the responsibility of the user to find out whether the device is suitable for his application. If in doubt, clarify this with your dealer or with Paul Marienfeld GmbH & Co. KG directly.

16. **Technical data**

Model M21 and M23	
Mains	115 resp. 230 Volt, 50-60 Hz (see rear panel)
Display	4-digit 7-segment-LED display
Motor	- split-pole, 25 Watt - 60-1600 r.p.m. - softstart, microprocessor controlled
Temperature control	- microprocessor controlled (PID control) - hoteplate adjustable in 1 °C steps up to 350° C (M21) resp. 500 °C (M23) - programmable probe temperature (Pt100) - programmable hot plate temperature - programmable safety temperature
Safety system	detects and protects against the following hazardous situations: - hotplate failure (hotplate exceeds max. allowed temperature) - probe failure (disconnection or damage of Pt100 probe) - triac failure - temperature increasing or dropping extremely in case of out-of-liquid probe or breakage of the vessel - out-of-liquid condition
Timer function:	programmable timer min. period: 1 minute max. period: 999 minutes
Temperature sensors	hot plate: thermoelement external: platinum resistance sensor (Pt100)
Setpoint resolution hotplate	1 °C / 1 K (1 °F in Fahrenheit mode)
Setpoint resolution Pt100 probe	0-100 : 0,2 °C / 0,2 K >100 °C : 1 °C / 1 K (1 °F in Fahrenheit mode)

Model M21 and M23	
Motor speed resolution	10 r.p.m.
Typical temperature stability with Pt100 use*	± 0.3 °C
Temperature range heating medium	up to 250 °C
Recommended magnetic stirring bar	length: 55 mm (30-70 mm) diameter: 10 mm (5-12 mm)
Permissible ambient temperature	5-40 °C
Permissible humidity	80 % RH
Safety class acc. to DIN 40050	IP32
Case dimensions	210 x 145 x 110 mm
Weight	2.3 kg

Model M21	
Hot plate material	V2A
Hot plate dimension	Ø 135 mm circular
Heating power	500 Watt

Model M23	
Hot plate material	Ceran®
Hot plate dimensions	135 mm square
Heating power	600 Watt

*2L H_2O at 60 °C setpoint, ambient: 23 °C, maximum variance during 60 min. test

Damaged and/or waste electric or electronic equipment has to be disposed of at the designated Recycling Depot.