

Ph-Amp MB7 Version 2.0

# Operating instructions

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## 1 Hardware description

### 1.1 Getting started

Before switching on the instrument, the sensor should be plugged into the socket located on the front panel of the instrument. If the sensor is equipped with a thermostat an additional socket is beside the sensor input.

Please connect the instrument with the wall plug transformer. The host computer must be connected via serial interface or USB. The connectors are found on the rear of the instrument.

It's important to connect the amplifier to ground.

Now the instrument may be switched on. The green LED on the front of the instrument indicates an existing voltage. During initialization process the red status LED is flashing. If it is finished correctly, the LED is off. The instrument is now ready to receive commands.

A short flashing of the red led during measure indicates an over-range.

A blinking red led (ca. 1Hz) indicates an internal error. You can read and clear the error by command (3.3.2).

### 1.2 Principle of A/D-conversion

The device contains a high precision photocurrent to voltage converter which produces a maximum of 10 volts. It is connected to a voltage to frequency converter which is driven by a frequency of 1MHz. The integrated microcontroller counts the frequency of the converter during the adjusted integration time period. This means you will get a bit-resolution dependant on the integration time. When an integration time of 20ms is selected a maximum pulse count of 20.000 can be obtained which is equivalent to 14 bit. An integration time of 100ms will lead to a bit resolution of 16.

Please make sure that you select an integration time which is a multiple of the signal periodic time, e.g. if you measure a lamp which operates at 50 Hz, the minimum integration time will be 20ms (or multiples of 20ms), otherwise the sampled values will be wrong.

### 1.3 Under-range / Over-range Conditions

Under-range: average voltage is lower than 0,66V.

Over-range: average voltage is greater than 9,5V or the analog comparator has detected a spike at the comparator threshold (9,5V)

### 1.4 Trigger

There are different kinds of trigger.

- Internal
- External Trigger if a command received
- External Trigger input
- Internal automatic trigger (time, count)

They will be described as follows (3.2.1).

## 2 Interface description

The photocurrent amplifier can be equipped with the following interfaces:

- RS232
- RS485
- USB

All interfaces have the same command set. With them you can control the amplifier, make readings and update the firmware. All instructions will be sent as an ASCII-string.

The serial RS232/RS485 port is set to the following parameters (19200 8 N 1) by default. You can change the baud rate by software command (3.3.6).

The answering time of the device depends on the command. For a simple query of parameters a minimum reaction time of 10ms is preadjusted.

For measurement commands the device will need the integration time plus ca. 6 ms processing time.

All commands have to be terminated by Carriage Return [CR = 0x0D].

### 2.1 Serial RS232 Interface

To connect the RS232 serial interface you have to use a DSUB-9 standard cable (without crossover). A hardware handshake is supported. When the instrument is ready to receive commands, the RTS-Line is set.

### 2.2 RS485

Pin 2 and 3 of the DB9-connector are the pins used for RS485 data transmission.  
(Pin3 RS485A, Pin2 RS485 B, Pin5 GND)

Please keep this in mind when using a RS485 adapter, which does not automatically switch between transmit- and receive line.

#### 2.2.1 Card addressing

The RS485 connection allows multiple (up to 13) devices parallel connected to a 2 wire bus. (0x00 ... 0x0C)

Please note that the bus connection has to be a twisted pair cable to avoid disturbance from other electronic devices.

The amplifier might be addressed by a HEX-switch. Usually this switch is in position 0, so the card will answer for address 0.

The integrated software allows sending the card-address before the command to talk only to a single card. If this card address is not sent, all cards will be addressed automatically.

This allows a common trigger for all cards connected to the bus. The measured signals may be queried separately.

When using addressing mode, the first byte of the answer contains the address of the amplifier.

Example:

[Address][Command]

[0x01]M? → card 1 samples a measurement and answers with that value.

Example for common trigger

4 cards connected to a bus

T1	ext. Trigger
X1	set cards into ,answering by query'-mode
F0	set output format for photocurrent
(R[0..6]	set range(s))

M?	trigger a measurement for all cards
[0x01]Q?	card 1 delivers its sampled value
[0x02]Q?	card 2 delivers its sampled value
[0x03]Q?	card 3 delivers its sampled value
[0x04]Q?	card 4 delivers its sampled value

## 2.3 Acknowledge and error handling

In Mode 'X0' (Device will answer immediately after processing a command) every command produces an answer. If a command doesn't reply a parameter, e.g. by setting parameters, an OK will be sent if no error occurred. Otherwise an ERROR (3.3.2) will be sent. In Mode 'X1' no answer will be sent. If an error occurred it will be stored internal. You can ask for it by instruction.

## 2.4 Firmware update

If a software update is required, it can be done with a PC-program by serial interface or USB.

## 2.5 Interface compatibility

You switch the Amplifier to be compatible with PhAmp Version V1. The Version 1 doesn't generate an acknowledge after every command. This is useful for existing PC-Software.

### 3 Command Set

#### 3.1 Overview

##### Measurement Commands

Command	Parameter	Answer	Acknowledge	Short description	chapter	Store Cmd	Store direct	Only V2
T[0..3]	x	-	x	Set Trigger Mode	3.2.1	x	-	*
T?	-	x	-	Get Trigger Mode		-	-	-
TRGPARM[...]	x	-	x	Set trigger parameter		x	-	X
TRGPARM?	-	x	-	Get trigger parameter		-	-	X
M?	-	x	-	measure	3.2.2	-	-	-
C?	-	x	-	Get counts	3.2.3	-	-	-
F[0..3]	x	-	x	Set readings format	3.2.4	x	-	*
F?	-	x	-	Get readings format		-	-	-
R	x	-	x	Set Range	3.2.5	-	-	-
R?	-	x	-	Get Range		-	-	-
RA	-	-	x	Enable Autorange	3.2.6	x	-	-
RA?	-	x	-	Get Autorange Status		-	-	-
RM	-	-	x	Disable Autorange		x	-	-
TIME[0/1]	x	-	x	Enable/disable timestamp	3.2.7	x	-	X
TIME?	-	x	-	Get timestamp status		-	-	X
Q?	-	x	-	Sends the current transmit buffer	3.2.8	-	-	-
E[x.xxxE-y]	x	-	x	Set Calibration Factor	3.2.9	x	-	*
E?	-	x	-	Get Calibration Factor		-	-	*
RUNDCCOMP	-	-	x	Run dark current compensation	3.2.10	x	-	X
CLRDCOMP	-	-	x	Clear dark current compensation		x	-	X
GETDCOMP	-	x	-	Get dark current compensation		-	-	X
I[10..400]	x	-	x	Set integration Time	3.2.10	x	-	-
I?	-	x	-	Get integration Time		-	-	-

## Common Functions

Command	Parameter	Answer	Acknowledge	Short description	chapter	Store Cmd	Store direct	Only V2
TICKS?	-	x	-	Get internal time	3.3.1	-	-	X
TICKS0	-	-	x	clear internal time		-	-	X
GETERR	-	x	-	Get error code	3.3.2	-	-	X
X[0/1]	x	-	x	Set answer mode	3.3.3	x	-	-
X?	-	x	-	Get answer mode		-	-	-
V? VER	-	x	-	Query the firmware version	3.3.4	-	-	-
SN?	-	x	-	Get serial number	3.3.5	-	-	X
BAUDRATE[.]	x	-	x	Set baud rate	3.3.6	-	X	X
CMDSET	x	-	x	Select Command Set [1..2]	3.3.7	-	X	X
SAVE	-	-	x	Save parameters	3.3.8	-	X	X
CLREE	-	-	-	Reset EEprom and load factory settings	3.3.9	-	X	X
RES RST	-	-	X	Device reset	3.3.10	-	-	-
INVERT [0/1]	x	x	-	Invert input value  <b>optional Hardware feature</b>		x	-	x

## 3.2 Measurement

### 3.2.1 Trigger

	<b>Position</b>	123456789012345678
		000000000111111111
<b>Set</b>	<b>Command</b>	Tx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	T?
	<b>Answer</b>	Tx
<b>Content</b>		
x		Trigger mode [0..5]

As described before there are four different trigger-modes implemented:

- 0: Internal trigger  
The device measures continuously. When sending the command measure (M?) you get the last valid reading.
- 1: External software trigger (by command)  
The device is in standby. When the Command measure (3.2.2) received, the device starts measuring. When finished the reading will be send or stored in the transmit buffer. Note that you have to set the valid range before execute the trigger. If auto-range is enabled and the current range is not valid, the auto-range routine will switch the range after every trigger until a valid range was found.
- 2: External hardware trigger (edge)(optional)  
If the device is equipped with an external trigger-input (opto-coupler or difference signal) you can use this mode to make synchronous measurements. The device is in standby. When detecting a hardware trigger, the device starts measuring. When finished the reading will be send or stored in the transmit buffer. You can control the external interrupt sense (trailing, rising edge). Note that you have to set the valid range before execute the trigger. If auto-range is enabled and the current range valid, the auto-range routine will switch the range after every trigger. The minimum delay between two triggers is the integration time plus processing time (2).

Trigger parameter Mode 2:

	<b>Position</b>	123456789012345678
		000000000111111111
<b>Set</b>	<b>Command</b>	TRGEDGEx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	TRGEDGE?
	<b>Answer</b>	TRGEDGEx
<b>Content</b>		
x		Sense control (0-falling,1-rising edge)

- 3: Intern automatically  
You have to set with the command TRGPARM a delay between the single measurements and the number of measurements. To start the measuring procedure you have to send the command M? once. After this you have to read the measured values continuously until all values were received.  
Note that the amplifier is not able to handle commands until measurement is finished. You have to switch the best range for the whole measurement or enable the auto-range.



If the auto-range is enabled the amplifier switches into the valid range automatically. When an over-range or under-range during a measurement occurred, the current reading will be marked (under-range / over-range (see format settings 3.2.4), and the range will be changed.

Trigger parameter Mode 3:

	<b>Position</b>	123456789012345678 000000001111111111
<b>Set</b>	<b>Command</b>	TRGPARM s.ms nnn
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	TRGPARM?
	<b>Answer</b>	TRGPARM s.ms nnn
<b>Content</b>		
s.ms		Delay between trigger [s.ms] e.g. 15ms → [0.015]
nnn		number of measurements

The minimal delay between two automatic measurements is the integration time with a resolution of 1ms.

- 4: External software trigger (by group command)  
This mode is to trigger multiple amplifiers on one bus (only RS485). The amplifiers take a measure and store the result in a result buffer. If single addressed the answer contains a "OK", if group addressed no answer will be sent.  
You get the reading with the command:

Trigger parameter Mode 3:

	<b>Position</b>	123456789012345678 000000001111111111
<b>Get</b>	<b>Command</b>	VAL?
	<b>Answer</b>	a.aaaaE-n /Error
<b>Content</b>		
a.aaaaE-n		Reading (formatting depends on the mea format)

If no trigger before get the reading you will get an error.

- 5: <sup>1</sup>External hardware trigger (level) (optional)  
If the device is equipped with an external trigger-input (opto-coupler or difference signal) you can use this mode to make continuous measurements. The device is in standby. When detecting a hardware trigger, the device starts measuring. When finished the reading will be send and the next measure will start immediately. You can control the external input level sense (high active, low active). Note that you have to set the valid range before execute the trigger. If auto-range is enabled and the current range valid, the auto-range routine will switch the range after every trigger. The minimum delay between two triggers is the integration time plus processing time (2).

Trigger parameter Mode 5:

	<b>Position</b>	123456789012345678 000000001111111111
<b>Set</b>	<b>Command</b>	TRGLEVELx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	TRGLEVEL?
	<b>Answer</b>	TRGLEVELx
<b>Content</b>		
x		Sense control (0-low active,1-high active)

---

<sup>1</sup> since firmware version 2.35

### 3.2.2 Measure

Depending on trigger mode there are different modes for measurements. In trigger modes 0, 1 and 2 you will get one single reading. It will be sent immediately to the Host-PC or it will be stored in the transmit buffer.

In trigger mode 3 you start the automatic measurement, receive the readings continuously until measure is finished. This mode is not useful by RS485 interface if you use addressing mode with two or more amplifiers on the same bus.

	<b>Position</b>	123456789012345678 000000000111111111
<b>Get</b>	<b>Command</b>	M?
	<b>Answer</b>	depends on format settings and trigger mode

	<b>Content</b>
x.xxx	reading
yy	Exponent
CC	unit
z	Over-range flag

### 3.2.3 Get Counts

The function is useful to test the A/D-Conversion (mostly used for testing purpose).

	<b>Position</b>	123456789012345678 000000000111111111
<b>Get</b>	<b>Command</b>	C?
	<b>Answer</b>	xxxxxx

  

	<b>Content</b>
xxxxxx	Unformatted reading of A/D-Conversion

### 3.2.4 Format of Readings

The format of readings depends on the format settings. In any settings the dark current compensation will be subtracted (see 3.2.10).

	<b>Position</b>	123456789012345678 000000000111111111
<b>Set</b>	<b>Command</b>	Fx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	F?
	<b>Answer</b>	Fx

  

	<b>Content</b>
x	Format

  

<b>x</b>	<b>Get</b>	M? (3.2.2)
<b>0</b>	<b>Photo Current</b>	x.yyyyE-zzA n s.ms
<b>1</b>	<b>Counts</b>	cccc r n s.ms
<b>2</b>	<b>Lux</b>	x.yyyyE+zzlx n s.ms
<b>3</b>	<b>Voltage</b>	x.yyyyE+zzV r n s.ms

	<b>Content</b>
x.yyyy	value
zz	Exponent
n	Range status (U-Underrange, O-Overrange, RA-Autorange, RM-manual range (valid))
s.ms	Timestamp (if enabled)
cccc	Counts
r	Range

The number of positions after decimal point depends on the amplitude of the amplifier and the integration time.

### 3.2.5 Set / Get Range

You can set the range by yourself from range 0 (most insensitive) up to range 6 (most sensitive). This command will disable the auto range.

	<b>Position</b>	123456789012345678
		000000000111111111
<b>Set</b>	<b>Command</b>	Rx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	R?
	<b>Answer</b>	Rx

	<b>Content</b>
x	Range [0..6]

### 3.2.6 Auto range

Enable this mode for handling the best range setting automatically. If an over range during measurement occurred and the current range is higher than the minimum range, the range will be decreased. If an under range occurred and the current range is lower than the most sensitive range, the range will be increased.

	<b>Position</b>	123456789012345678 000000000111111111
<b>Enable</b>	<b>Command</b>	RA
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	RA?
	<b>Answer</b>	RAx
<b>Disable</b>	<b>Command</b>	RM
	<b>Answer</b>	OK / Error
	<b>Content</b>	
x		Auto range Status (0-disabled; 1-enabled)

### 3.2.7 Timestamp

You can mark the reading with a timestamp, which indicates the time of starting the measurement. The time will be added to the formatted reading (3.2.4).

	<b>Position</b>	123456789012345678 000000000111111111
<b>Enable</b>	<b>Command</b>	TIMEx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	TIME?
	<b>Answer</b>	TIMEx
	<b>Content</b>	
x		Timestamp Status (0-disabled; 1-enabled)

### 3.2.8 Query Transmit Buffer

If the answer mode (s. 3.3.3) set to "X0" you can receive the answer immediately after sending the command.

If the answer mode set to "X1" the answer will be stored in the transmit buffer. You can ask for the last answer by query the transmit buffer.

	<b>Position</b>	123456789012345678 000000000111111111
<b>Get</b>	<b>Command</b>	Q?
	<b>Answer</b>	Last transmit content

### 3.2.9 Set Factor

You can set a calibration factor in unit A/lx to get the illuminance (lx) in format mode 3 (3.2.9).

	<b>Position</b>	123456789012345678 000000000111111111
<b>Set</b>	<b>Command</b>	Ex.yyyyE±z
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	E?
	<b>Answer</b>	Ex.yyyyE±z

	<b>Content</b>
x.yyyy	Factor
z	Exponent

### 3.2.10 Dark Current Compensation

To compensate the dark current of the connected photometer head you have cover it with the black cap. After running the dark current compensation the amplifier measures the offset counts in all ranges. This offset will be subtracted automatically if the measurement running in photo current or illuminance mode (s. 3.2.4). In mode counts and voltage this offset compensation has no influence to the measured values.

	<b>Position</b>	123456789012345678 000000000111111111
<b>Run</b>	<b>Command</b>	RUNDCCOMP
	<b>Answer</b>	OK / Error
<b>Clear</b>	<b>Command</b>	CLRDCOMP
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	GETDCOMP
	<b>Answer</b>	CLRDCOMP d0 d1 d2 d3 d4 d5 d6

	<b>Content</b>
d0 .. d6	Dark Current Offset (Counts) [Range]

### 3.2.11 Integration Time

You can set and get the integration time with the following command (1.2).

	<b>Position</b>	123456789012345678 000000000111111111
<b>Set</b>	<b>Command</b>	Ixxx
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	I?
	<b>Answer</b>	Ixxx

	<b>Content</b>
xxx	Integration time [ms] (10..400ms)

### 3.2.12 Inverting the polarity of the analog input

You can invert the input polarity with this command to measure negative input signals.

To use this feature an optional hardware is needed.

	<b>Position</b>	123456789012345678
		000000000111111111
<b>Set</b>	<b>Command</b>	INVERT xxxxx
	<b>Answer</b>	OK / Error

	<b>Content</b>
xxxxxx	INVERT (0 - positive, 1 - negative)

To configure the polarity permanently, the setting should be saved with the command "SAVE".

### 3.3 Common functions

#### 3.3.1 Internal Clock

If the device was switched on or the command "clear time" was sent, the timer increases continuous with a resolution of 1 ms up to 2<sup>32</sup> ms. If the upper border was reached the timer begins at 0 ms.

<b>Position</b>	123456789012345678
	000000000111111111
<b>Clear Command</b>	TICKS0
<b>Answer</b>	OK / Error
<b>Get Command</b>	TICKS?
<b>Answer</b>	TICKS s.ms

	<b>Content</b>
s.ms	seconds, milliseconds

#### 3.3.2 Get Error

A flashing read status led indicated an error. To get the last error you can send this command. By reading the error it will be cleared.

<b>Position</b>	123456789012345678
	000000000111111111
<b>Get+ Command</b>	GETERR
<b>Clear Answer</b>	GETERR xxx

	<b>Content</b>
xxx	Error Code

No	Description
0	No Error
1	Parameter out of range
2	Invalid parameter
3	Invalid trigger parameter
4	Memory error
5	Unknown command received
6	Error EEprom
7	Com error
8	Rx timeout
9	Invalid card address
10	Command not yet implemented
11	Receive buffer overflow
12	Crc error
13	No valid trigger
14	Not calibrated mode
15	Last command not handled

### 3.3.3 Answer Mode

With this command you can set the answer behaviour of the amplifier:

	<b>Position</b>	123456789012345678 000000000111111111
<b>Set</b>	<b>Command</b>	Xn
	<b>Answer</b>	OK / Error
<b>Get</b>	<b>Command</b>	X?
	<b>Answer</b>	Xn

	<b>Content</b>
n	Answer Mode (0 or 1)

X0: Device will answer immediately after processing a command

X1: Device will send the answer only after query by Q?

### 3.3.4 Query the firmware version

<b>Position</b>	1234567890123 0000000001111
<b>Command</b>	V?
<b>..or</b>	VER
<b>Answer</b>	C&G PhAmp µP Vx.x mm dd yyyy hh:mm:ss

	<b>Content</b>
mm dd yyyy	Date of compilation
hh:mm:ss	Time of compilation
x.x	Version number

### 3.3.5 Get Serial Number

<b>Position</b>	1234567890123 0000000001111
<b>Befehl</b>	SN?
<b>Antwort</b>	SN abc0815

	<b>Content</b>
abc0815	Serial Number

### 3.3.6 Baud rate Settings

The default baud rate is 19200. You can change it by command. If a valid baud rate was received it will be changed and stored directly in the EEprom. If you don't know which baud rate is stored, you have to try all possible baud rates until you get an answer (e.g. ask for version (3.3.4)).

	<b>Position</b>	123456789012345678 000000000111111111
<b>Set</b>	<b>Command</b>	BAUDRATExxxxxx
	<b>Answer</b>	OK / Error
	<b>Content</b>	
xxxxxx	Baudrate (9600,19200,38400,57600,115200)	



### 3.3.7 Commando Set

To be compatible with the PhAmp V1 you can switch the mode. No acknowledge will be sent and the readings have another overrange / underrange indication.

```

          Position      123456789012345678
                          0000000001111111111
Set      Command      CMDSETn
          Answer      OK / Error
Get      Command      CMDSET?
          Answer      CMDSETn
          Content
n        Command Set (1-V1, 2-V2)
    
```

### 3.3.8 Save Parameter

The following parameters will be saved internal after executing the SAVE-Command.

- o Integration time
- o Format of readings
- o Auto range enabled
- o Answer Mode
- o Baud rate
- o Trigger mode
- o Extern trigger sense / level control
- o Enable Timestamp
- o Command Set
- o Invert
  
- o Calibration Factor
- o Dark Current Offsets

```

          Position      123456789012345678
                          0000000001111111111
save     Command      SAVE
          Answer      OK / Error
    
```

### 3.3.9 Clear EEPROM

This command erases the EEprom and writes the default values. After it the device will be restarted.

**ATTENTION: this command will erase the calibration factor too !!!**

```

          Position      123456789012345678
                          0000000001111111111
Set      Command      CLREE
          Answer      OK / Error
    
```

### 3.3.10 Reset

```

          Position      123456789012345678
                          0000000001111111111
Reset   Command      RES
          Answer      OK / Error
    
```

## 4 Notes

Date	comments	Docu version	Current firmware
12.12.2005	Rev 1.0		
17.06.2008	2.03e: Command "Invert" added		2.29a
17.09.2008	Documentation error: "Set factor" factor is A/lx	2.04e	
01.12.2008	New Triggermode T4, T5	2.05e	2.35

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