

Monitoring and control of disinfectants BAMOPHAR 194



USER MANUAL

BAMO INTERNATIONAL

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Monitoring and control of
disinfectants

BAMOPHAR 194

14-11-2018

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1. DESCRIPTION

BAMOPHAR 194 is designed for measurement and regulation of disinfectants (free chlorine, total chlorine, chlorine dioxide, ozone, hydrogen peroxide, peracetic acid) with specific amperometric sensors (193 series).

It is equipped with a color touch screen for multilingual display of a user-friendly and intuitive menu.

It provides an easy reading of the measurement, temperature and status of the thresholds.

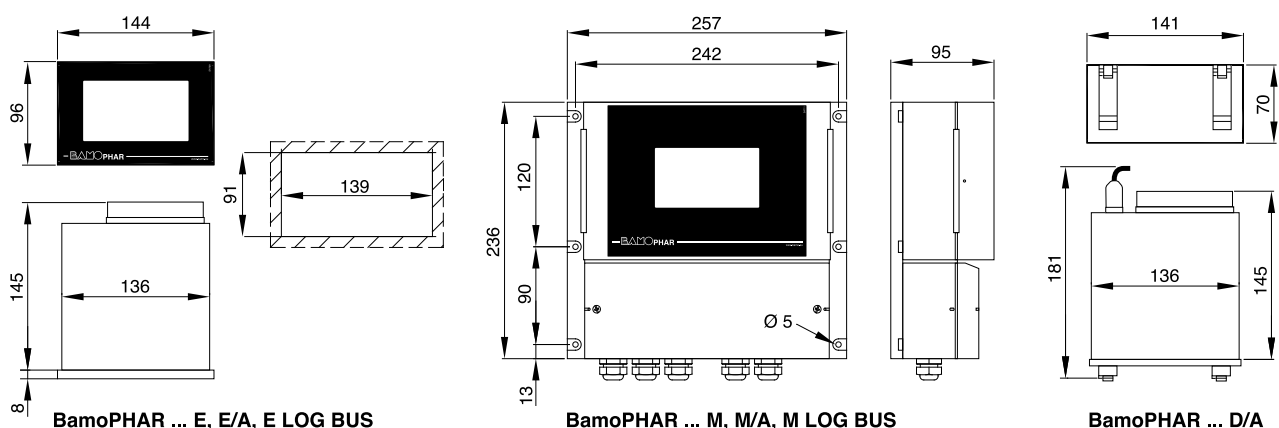
The instrument also displays the menu for setting the analog output, the thresholds and operating mode.

To facilitate commissioning, a programming menu can be used to simulate a measurement, acting on analogue outputs and P.I.D, as well as on thresholds.

2. TECHNICAL FEATURES

End-user interface	Color touch screen 4.3", resolution 480x272 pixels Display of measurements, menus, temperature, relays status Configuration - Keyword protected
Measuring scale	Configuration according to sensor type (from 0.001 to 9999 ppm or g/l)
Accuracy	According to sensor features
Input impedance	$> 10^{13} \Omega$
Sensor signal input	For amperometric sensors, with voltage loop, 4-wire, 0-2 V Or for amperometric sensors, 2-wire, 4-20 mA
Temperature display	0... 100 °C when connecting a temperature probe with Pt 100 Ohm sensor, 3-wire fils Or manual setting (if constant) between 0 and 100 °C
Relay outputs	4 contacts N.O., potential free
Configurable thresholds	2 Thresholds, independent,, to set up for measurement or temperature 1 Threshold, independant assigned or to external contact, or measurement, or temperature 1 Threshold, to set up for alarming function (too long injection, temperature sensor defect)
Contact, initial resistance	100 m Ω max. (voltage drop 6 V DC 1 A)
Switching power	831 VA AC / 3 A / 277 V AC 90 W / 3 A / 30 V DC
Switching capacity (min.)	100 mA, 5 V DC (variable according to switching frequency, environmental conditions, accuracy)
On / Off Regulation	Adjustable cycle time from 0 to 9999 s, High and low proportional bandwidths, high and low dead zones
PID Regulation	Adjustable proportionality from 0 to 200%, Integrant and Derivative: 0 to 999 s
Calibration routine	Relay outputs inhibited; Analogue outputs on standby at latest values
Measurement output	0/4-20 mA (max. 600 Ω) proportional to measurement
Temperature output / PID	0/4-20 mA (max. 600 Ω), scaling between 0 and 100 °C
Operating configuration Test	Simulation through the menu on measurement, temperature, PID and Thresholds
Main power supply	230 V AC / 50-60 Hz (others on request) - Consumption 10 VA
Models	Panel mount, 96x144 mm, Front IP65 - Rear IP40 Wall mount, IP65, cable glands
Temperature limits	-5 °C ... +50 °C; (storage -10 ... +70 °C)
OPTION (RS 422 + Logger)	
Interface	RS422 output, J-BUS link - Binary slave mode - 2400 to 9600 bauds
Data Logger	Record of cycle average measurement; 150 000 records max. on memory card, external card-reader necessary

3. DIMENSIONS



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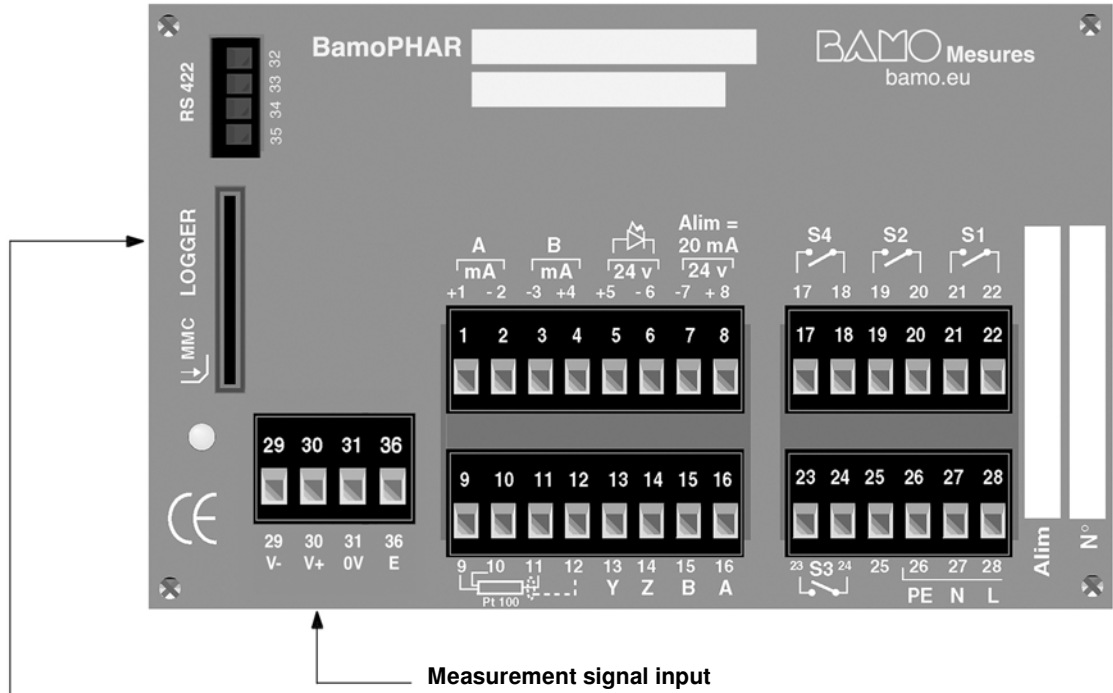
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4. ELECTRICAL CONNECTIONS

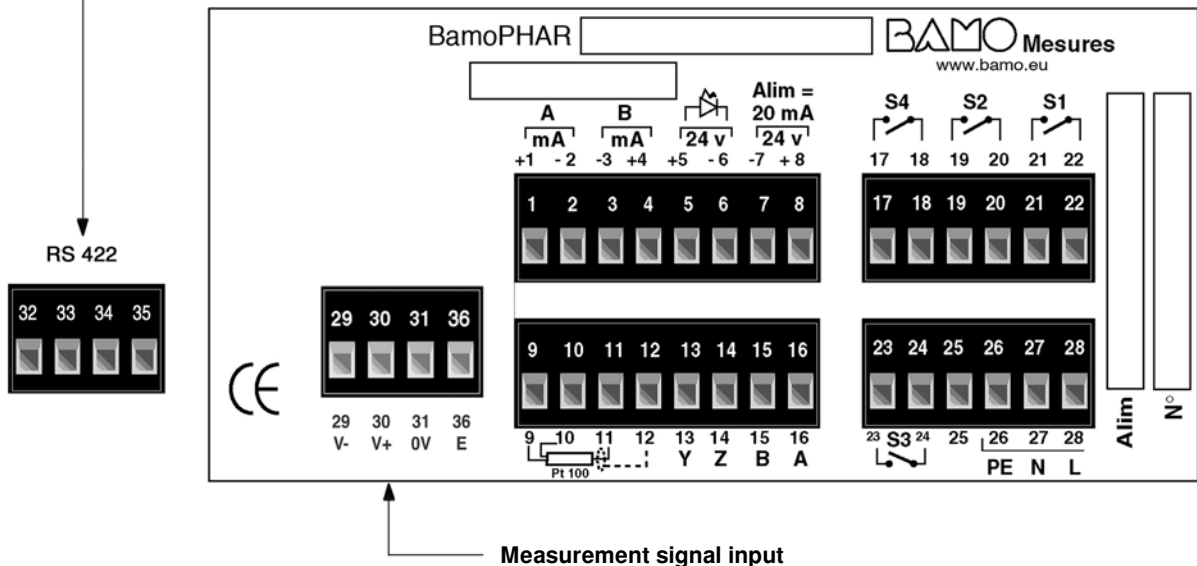
PANEL MOUNT MODEL



OPTION : LOGGER & RS 422

*Wall mounting model:
Access to memory card
by opening the top cover*

WALL MOUNT MODEL



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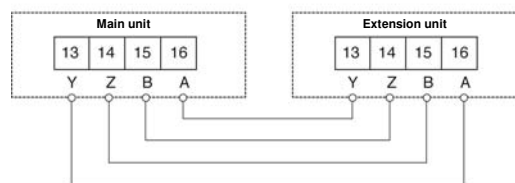
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4.1 VIEWS OF TERMINALS

Description	Terminal	Connection
Output, mA; copy of measurement signal	1	+ mA
	2	- mA
Output, mA; Copy of temperature or PID control signal	3	- mA / PID
	4	- mA / PID
Input E1 (external signal): Flow controller N.C.; NPN sensor <i>When voltage applies between terminals 5 & 6: regulation is blocked (see § 9.2.1)</i>	5	+ 24 V
	6	0V
Supply power to sensor 2-wire, 4-20 mA 2-wire	7	0V
	8	+ 24 V
Input for Pt 100 Ohm sensor, 3-wire	9	+
	10	+
	11	-
	12	Shield
Connections for an extension terminal (blind unit)	13	Y
	14	Z
	15	B
	16	A
Relay S4 (N.O. contact) for Fault alarm/ Regulation/ Cleaning routine	17	S4
	18	
Relay S2 (N.O. contact) for measurement/ temperature	19	S2
	20	
Relay S1 (N.O. contact) for measurement/ temperature	21	S1
	22	
Relay S3 (N.O. contact) for measurement/ temperature May be assigned to the external signal and becomes N.C. contact (see § 9.2.3)	23	S3
	24	
	<i>Not in use</i>	25
Main power supply	26	PE = Earth (equipotential)
	27	N = Neutral
	28	L = Live
Signal input	29	V -
	30	V +
	31	0V
	36	E

Connection of an extension unit



Cable length max.. 500 m

500 m

Cable type

Network cable or 4-wire shielded cable, $\geq 0.25 \text{ mm}^2$

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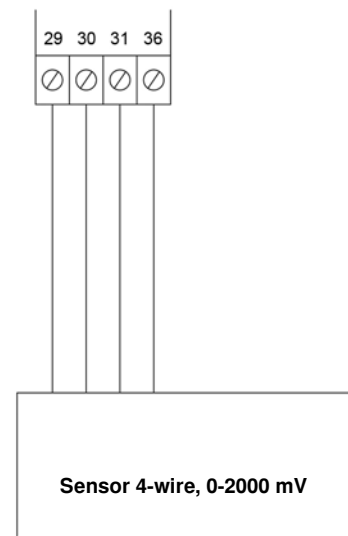
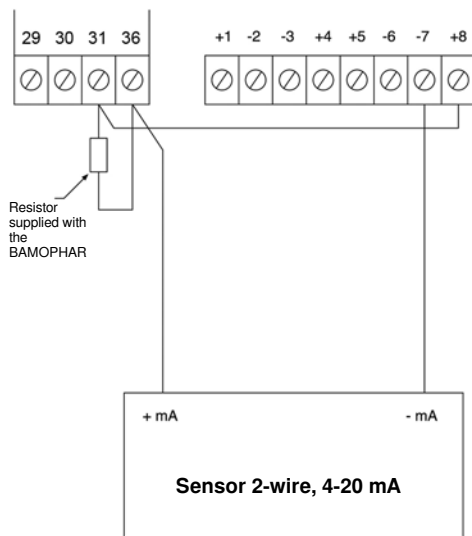
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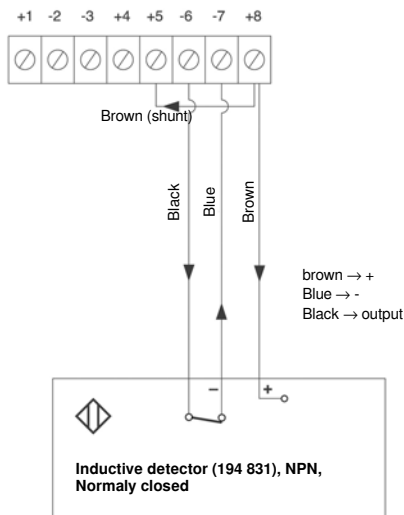
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4.2 Sensors connection

4.2.1 Sensor 4-20 mA (2-wire) or 0-2000 mV (4-wire)



4.2.2 Flow detector, NPN, N.C. (code 194831)



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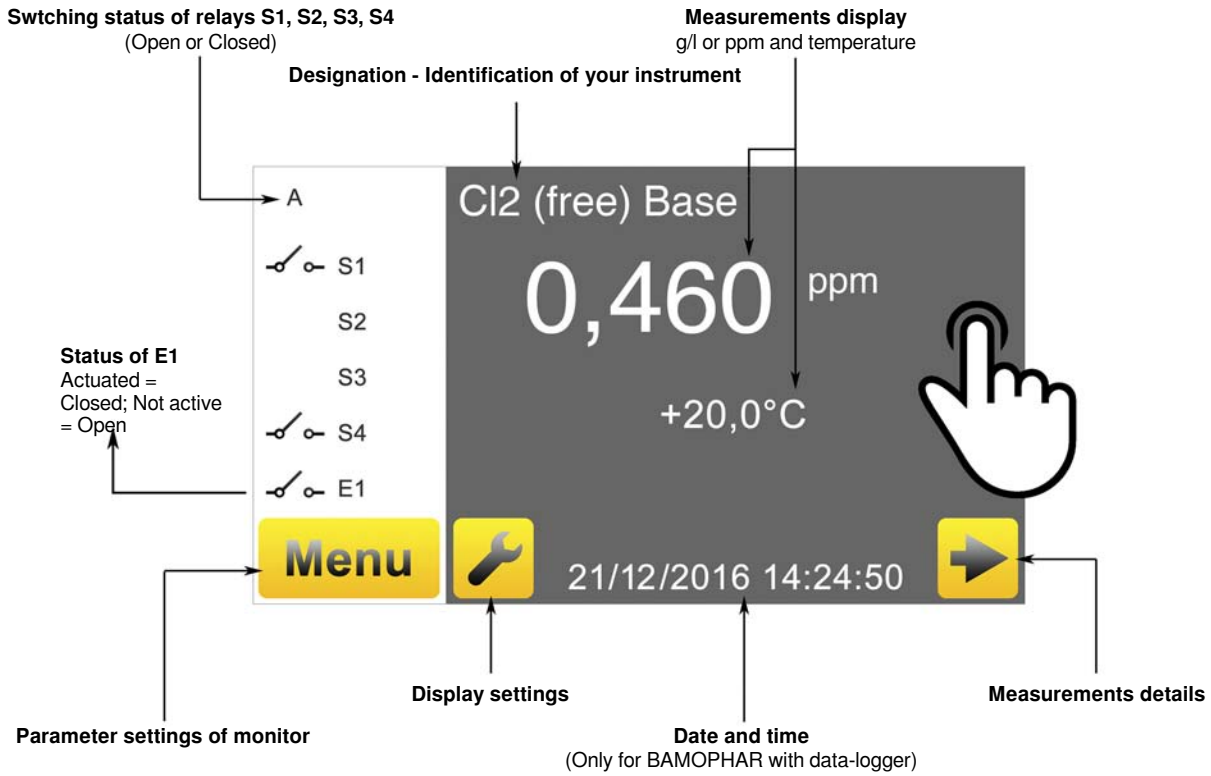
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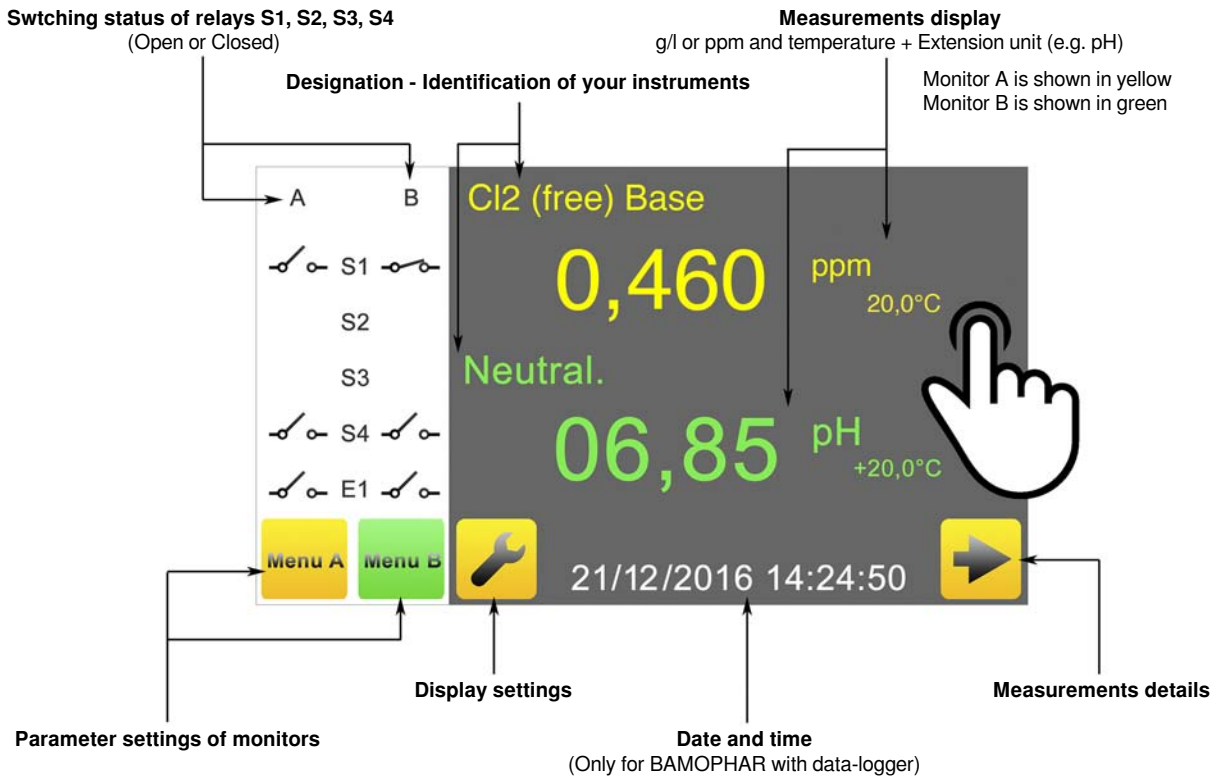
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5. MAIN DISPLAY

5.1 WITHOUT EXTENSION UNIT



5.2 WITH AN EXTENSION UNIT



6. DESCRIPTION OF ICONS

The touch screen allows you to navigate within the menus and to set up the display according your application.
To each yellow icon dedicated to main unit A, corresponds a green icon dedicated to the extension unit B.



HOMEDISPLAY SETTINGS Access to parameters of display (language and identification) of the m

Return to main display
e.g. Green icon for the extension unit



DISPLAY SETTINGS

Access to parameters of display (language and monitor identification)



LANGUAGES

Language selection



MENU

Access to parameter settings of the monitor



INFORMATION

Access to serial number and version of your BAMOPHAR



PADLOCK

Open: Means MODIFICATION mode
Closed: Means CONSULTATION (review) mode



RETURN

To go back to the previous screen



ARROWS

Cursors to navigate within the menus



SELECTION

Scroll through the selection list



CONFIRMATION

Confirm setting ("OK") and go to the next parameter



SAVE

To save the parameters

7. DISPLAY SETTINGS

Note : To access to display settings, BAMOPHAR must be in **MODIFICATION** mode (See § **CONSULTATION/MODIFICATION**).

7.1 SCREEN INFORMATION

Screen identification number and its version are available in this menu.

7.2 SCREEN SAVER

Screen saver brightness is adjusted by moving the cursor: decreased (to the left) or increased (to the right).

7.3 LANGUAGE SELECTION

Select the flag according to your choice.
The display automatically returns to previous view.
Press icon "HOME" to go back to main display.

7.4 DESIGNATION

it is recommended to name each channel (main unit A and Extension unit B) for an easiest reading:

- 1) Press on icon A or B according to the instrument you wish to rename.
- 2°) A keyboard appears, enter the name of your unit.
- 3°) Save the new designation.

8. CONSULTATION / MODIFICATION

CONSULTATION mode let the operator to check out all working parameters.
This mode is represented by the closed padlock icon.

To change the settings of the BAMOPHAR, you need to enter in the **MODIFICATION** mode.
This mode is protected by a password identical to last 4 digits of the serial number.

On the main display, press MENU icon.

Press the padlock icon and type the 4 last digits of Serial Number.
To validate it, press "OK"; Device is now in **MODIFICATION** mode (padlock is open).
If the entered keyword is wrong, **ERROR** message appears: Type again the keyword.

After 30 minutes the mode MODIFICATION switches back to CONSULTATION mode.

Where to find the serial number?

The serial number (SN) is written on the identification label of the device.
It appears as well in MENU, icon "i" (**INFORMATION**).

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9. PARAMETERS SETTINGS OF BAMOPHAR

9.1 MEASUREMENT LOOP CALIBRATION (SENSOR)

Press MENU and choose ADJUST ELECTRODE

(To access to this menu, BAMOPHAR must be in MODIFICATION mode)

These settings allow the calibration of measuring loop (sensor).

In order not to disturb the complete system, the measurement is frozen when entering the calibration menu. This blocking is effective during the whole time of the calibration plus an adjustable delay entered at the end of the menu (DELAY). This delay makes it possible to put back in order the measurement system (sensor connection, flow control, etc.).

Before to proceed a calibration, see the sensor end-user manual and follow the routine.

ZERO ADJUST YES / NO

Selection: NO

Amperometric sensors do not need a calibration of zero (factory calibrated).

Choosing NO set the display on next step: SLOPE ADJUST

Choose NO, then CONFIRM to go to next step.

SLOPE ADJUST YES / NO

Choose YES to calibrate the sensor signal slope

Choosing NO will display the step DELAY

Confirm to go to the next step

STAND. 1.000

Take a sample of liquid from measuring cell.

Find out the disinfectant concentration with a specific photometer or laboratory analysis.

Enter this value in BAMOPHAR for calibration (Caution with the unit in use).

For proper calibration, concentration value should be as close as possible to the full scale of the sensor.

CONFIRM to go to the next step

SLOPE xxx,x %

Display of sensor slope SLOPE xxx,x %

CAUTION: If slope is over 200 % or below 50 %, Do not confirm

In such a case, check out the integrity/ dirtyness of sensor, proceed to its maintenance.

If the slope is correct, confirm to go to the next step or proceed to a second analysis just to confirm the previous one.

DELAY 0015 Sec

Enter the time during which the measurement (and the actions of the mA, relay ... outputs) remains locked at the value preceding the beginning of calibration, then confirm.

To record the settings, press the icon SAVE

Caution - Display of temperature

If a temperature probe Pt 100 is connected, reset the temperature compensation in "AUTO" mode.

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9.2 SET THRESHOLDS S1, S2 AND S3 IN MODE ON/OFF REGULATION

9.2.1 Precautions:

Before setting the thresholds or regulation, the operating mode must be known in details.

BAMOPHAR 194 allows 3 operating modes:

- 1) Mode ON/OFF with relays S1, S2 and/ or S3
- 2) Relay regulation mode with trigger points between bandwidths and dead zones (S1 and S2)
- 3) PID regulation mode through 4-20 mA output signal of BAMOPHAR

Specificity of threshold S3:

It can be assigned to E1, external sensor signal, (e.g. from the flow detector in measuring cell), for blocking the regulation (terminals 5 & 6 on wiring diagram).

In this case, relay S3 becomes normally closed (E1 not active) and it opens when blocking regulation is activated (E1 actuated).

With NPN flow detector N.F. (code 194831) following result is obtained:

- If the flow is normal in the measuring chamber: relay S3 is closed (E1 not active).

In this case, the flow detector NPN NF is not lighting.

- If the flow is very low, S3 opens and blocks the regulation (E1 actuated).

In this case: Flow detector NPN is alight.

Blocking the regulation has consequences:

- In ON/OFF regulation mode, there are no additional effects on S1 and/ or S2. However, it is possible for the operator to serially wire the relays S1 and S3 to secure the injection (if the relay S1 manages the injection of reagent).
- In relay regulation mode, both S1 and S2 become open (not actuated): Regulation is inhibited.
- In PID regulation mode, output signal 4-20 mA is frozen (on ultimate value).

9.2.2 ADJUSTMENT OF THRESHOLDS S1, S2 AND S3 IN MODE ON/OFF REGULATION

Below is a detailed description of the steps for setting threshold S1:

Enter to the menu ADJUST ALARM 1

ALARM 1 ON / OFF	To set up output S1, select ON, then confirm. To disable the relay S1, select OFF, then confirm and save the setting
ALARM 1 MEASURE / TEMP.	In ON mode, threshold S1 can be assigned to MEASURE or TEMPERATURE: MEASURE = threshold dedicated to ppm or g/l TEMP. = threshold dedicated to temperature measurement Select the appropriate parameter, then confirm.
ALARM 1 HIGH / LOW	HIGH = Trigger when measurement rises over threshold S1 LOW = Trigger when measurement decreases below threshold S1 Select the appropriate parameter, then confirm.
ON 1.200 ppm	Enter the value at which relay S1 will actuate (closing), then confirm.
OFF 1.250 ppm	Enter the value at which relay S1 will be back open, then confirm.
DELAY UP ON / OFF	With or without delay to actuate the relay S1.
TIME 0000 Sec	Enter the duration of delay before actuating S1, then confirm.
DELAY DOWN ON / OFF	With or without delay to open relay S1
TIME 0000 Sec	Enter the duration of delay before opening S1, then confirm.
SAVE ?	To record the settings, press the icon SAVE

All settings for S2 and S3 are available respectively in ADJUST ALARM 2 and ADJUST ALARM 3 menus.

9.2.3 ASSIGNMENT OF S3 THRESHOLD TO EXTERNAL SIGNAL

Go to the menu ADJUST ALARM 3

ADJUST ALARM 3 ON / OFF	Select ON to set the relay S3, then confirm.
EXTERN. YES / NO	NO: Settings are the same as for S1 or S2 in ON/ OFF regulation mode YES = External signal (E1) is assigned to relay S3 Relay S3 becomes a normally closed contact (E1 not active) and will open when blocking of regulation operates (E1 active). Confirm the selection.
SAVE ?	To record the settings, press the icon SAVE

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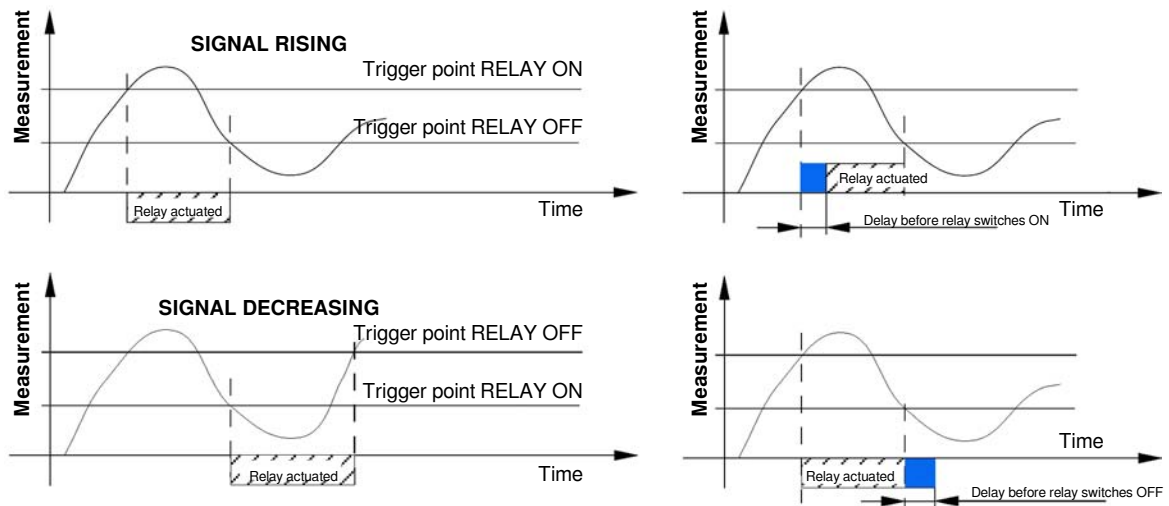
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9.3 SETTING OF TEMPERATURE PARAMETERS

Go to the menu *TEMPERATURE*

MEASURE: AUTO / MANUAL	AUTO: With signal from a sensor Pt 100 Ohm MANUAL: Without sensor Pt 100 Ω; Temperature value is entered manually.
FLUID T. + 020.0 °C	In MANUAL mode enter the temperature value of the liquid, in °C, then confirm.
SAVE ?	To record the settings, press the icon SAVE

9.4 SETTINGS OF ANALOGUE OUTPUT FOR MEASUREMENT

Go to menu *OUTPUT mA MES.*

HIGHER 5.000ppm	Enter the value for 20 mA output signal, then confirm.
LOWER 0.000ppm	Enter the value for 4 mA (or 0 mA) output signal, then confirm.
OUTPUT 4/20 mA or 0/20 mA	Select the right scale 4...20 mA or 0...20 mA for output signal, then confirm.
SAVE ?	To record the settings, press the icon SAVE

9.5 SETTINGS OF ANALOGUE OUTPUT FOR TEMPERATURE

Go to menu *OUTPUT mA TEMP.*

HIGHER +050.0 °C	Enter the value in °C for 20 mA output signal, then confirm.
LOWER +005.0 °C	Enter the value for 4 mA (or 0 mA) output signal, then confirm.
OUTPUT 4/20 mA or 0/20 mA	Select the right scale 4...20 mA or 0...20 mA for output signal, then confirm.
SAVE ?	To record the settings, press the icon SAVE

9.6 TESTING - FORCED RELAY

This menu allows to test manually the relays S1, S2, S3 and S4.
Status of last one (S4) is OFF (non actuated) by default. Test begins with threshold S1.
To test it, press the arrows SELECTION to switch relay to ON status (activated).
Confirm to go to next threshold; Same routine for testing S2, S3 and S4.

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9.7 RELAY REGULATION MODE

Go to the menu RELAY REGULATION

- There is no access to settings of relay regulation mode if relays S1 and/ or S2 are operating; So, go to:

ADJUST ALARM To access to this mode, first go back to menus ADJUST ALARM S1 and S2 to set them in OFF.

- There is no access to relay regulation mode when PID regulation is operating; So go to:

REGUL. PID To access to relay regulation mode, go to to the menu REGUL. PID to switch it OFF.

- Regulation mode is thus accessible if, and only if, the THRESHOLDS and PID modes are deactivated:

REGULATION ON / OFF Select ON mode to set up RELAY REGULATION, then confirm.

SET VAL 0.900ppm Enter the threshold value, then confirm.

T. CYCLE 0060 Sec Enter the cycle time according to the process, then confirm.

HIGH PB 0.300ppm Enter the differential for upper bandwidth, then confirm.

Note: Output S2 is dedicated for upper bandwidth.

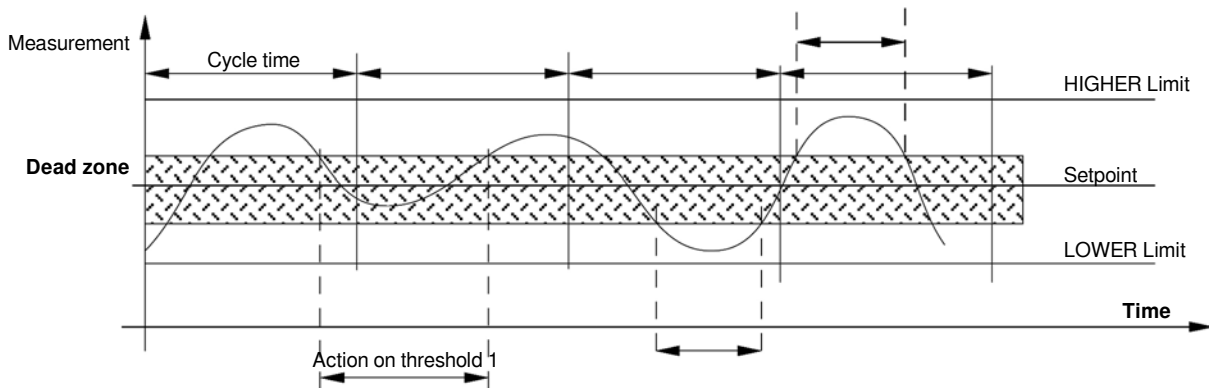
LOW PB 0.200ppm Enter the differential for lower bandwidth, then confirm.

Note: Output S1 is dedicated to lower bandwidth.

HIGH DZ 0.050ppm Enter the differential value for the upper dead zone, then confirm.

LOW DZ 0.040ppm Enter the differential value for the lower dead zone, then confirm.

SAVE ? To record the settings, press the icon SAVE



EXAMPLE :

For settings such as following:

- Set point: 1.5 ppm
- Cycle time: 10 s
- Upper bandwidth: 3.5 ppm (i.e. high limit is 5 ppm)
- Lower bandwidth: 0.5 ppm (i.e. lower limit is 1.0 ppm)
- High dead zone: 0.4 ppm (from 1.5 to 1.9 ppm)
- Lower dead zone: 0.1 ppm (from 1.4 to 1.5 ppm)

Results for operating regulation:

- Above the High limit, over 5 ppm: S2 is activated permanently and contact is closed.
- Below the lower limit, between 0 and 1.0 ppm: S1 is activated permanently, contact is closed.
- Within the Dead zones, between 1.4 and 1.9 ppm: Both S1 and S2 are not actuated, contacts are open.
- When measurement is between Dead zone and High limit (between 1.9 and 5 ppm), or between Dead zone and Low limit (between 1.0 and 1.4 ppm): Both S1 and S2 are actuated during a time proportionnal to the difference between set point and measurement.

Actuation time = Cycle time x (Measurement - Set point) / High or Low bandwidth

CAUTION:

According to the above example, if measurement is 1.42 ppm and cycle time is 10 s then, actuation time is:

$$10 \times (1.5 - 1.42) / 0.4 = 2 \text{ That is 2 seconds}$$

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9.8 OUTPUT S4 SETTINGS

9.8.1 DEFAULT SETTING

- By default, relay S4 is assigned for alarming on measurement or temperature faults:
- The contact closes if the measurement is outside the settled measurement range.
 - The contact closes if the sensor Pt 100 is faulty (broken cable)

9.8.2 SETTING ALARMS

This function activates relay S4 when the switch-on time of relays S1 and S2 is too long.
Go to the menu *ADJUST ALARM*

WITH ALARM / WITHOUT ALARM	Select WITH ALARM to activate the relay S4, then confirm.
TIME S1 0005 Sec	Enter the holding time max. for relay S1, then confirm.
TIME S2 0005 Sec	Enter the holding time max. for relay S2, then confirm.
SAVE ?	To record the settings, press the icon SAVE

9.9 PID REGULATION MODE

Allows setting of a PID regulation through analogue output (0...20 or 4...20 mA) between terminals 3 and 4.
This output is no more assigned to temperature.

Go to the menu *REGUL. PID*

REGULATION ON / OFF	Select ON to set the function PID REGULATION, then confirm.
REGUL. MANU / AUTO	Select AUTO to access to parameters, then confirm.
SET VAL 0.700 ppm	Enter the value of desired trigger point, then confirm.
GAIN: 4.800	Enter the required proportional gain value, then confirm.
T.i : 0050 Sec	Enter the value for integral timer, then confirm.
Td : 0012 Sec	Enter the required value for derivative timer, then confirm.
ACTION DIRECTE / INVERSE	Select the right action, or DIRECT, or REVERSE, then confirm.
OUTPUT 4/20 mA or 0/20 mA	Select the required output scale, then confirm.
SAVE ?	To record the settings, press the icon SAVE

Note: To block the PID regulation, set a voltage of 24V DC between terminals 5 (+) and 6 (0).

METHOD FOR ADJUSTMENT OF PID PARAMETERS:

In order to setup values for start-up on PID, we recommend to use the Ziegler-Nichols open loop method.

Proceed as follows:

- Connect a recorder to the analogue output or write on a list the measurement values, then draw the diagram ppm vs. time.
- Switch the PID regulation mode to MANU.
- Reach and keep the measurement close to the set point by adjusting the PID output.
- Apply a step (ΔCde) of 10 % on the analogue output (e.g. If preset value was 30%, apply 40%).
- Note on the diagram the corresponding time for this event (step of +10%).
- Find out on this diagram both times t and T :
 - t = delay of response
 - T = Time corresponding to a variation Δm of measurement equal to percentage of variation ΔCde of output ($\Delta m = \Delta Cde$)
 - This value may be found out from the slope at the beginning of measurements.
- Set up the PID parameters with the values from the following table:

Regulation	Gain	Ti(s)	Td(s)
PID	$1.2 \times T/t$	$2 \times t$	$0.5 \times t$
PI	$0.9 \times T/t$	$3.3 \times t$	00
P	T/t	9999	00

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Monitoring and control of
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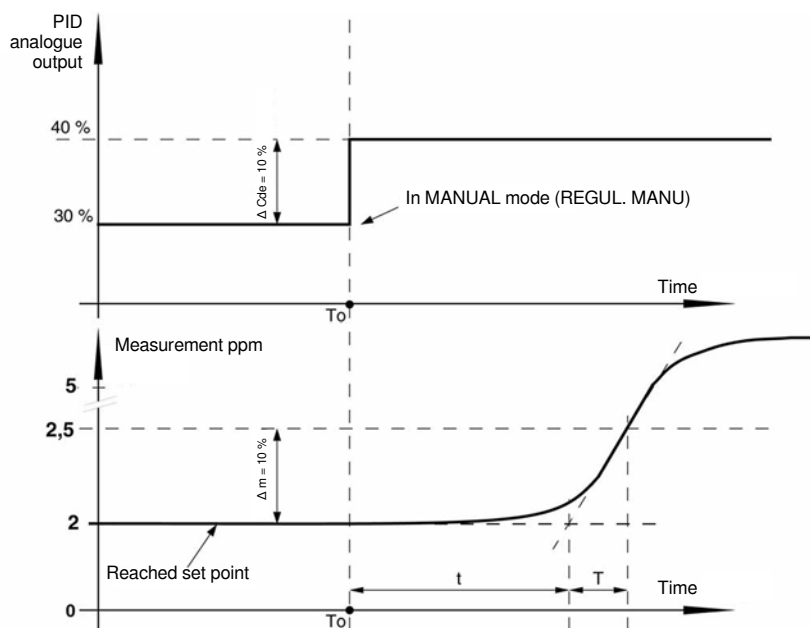
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9.10 SETTING OF MEASUREMENT

Go to the menu *MEASURE DATA*

Name of disinfectant	Select the corresponding sensor to: Free chlorine; Total chlorine; Chlorine dioxide; Ozone, Hydrogen peoxide; Peracetic acid; Then confirm.
UNIT ppm / g/l	Select the unit: ppm or g/l, Then confirm.
x-x,xxx ppm	Select the decimal point position, then confirm
ECHELLE	For "Range", confirm to go to the next step (to set parameters: see the sensors features)
MAXI : 5.000ppm	Select the value max. of sensor measuring range (full scale) then confirm
SENSOR mA / mV	Select the output signal type, then confirm
SAVE ?	To record the settings, press the icon SAVE

9.11 MEASUREMENT SIMULATION

Go to the menu *FORCED MEASURE*

It is possible to force the measurement or the PID.
The first line shows the real time measurement.
Confirm to open keyboard.
Enter the value you need to simulate.

Note: The value is immediately considered by BAMOPHAR (thresholds, regulation, 4-20mA outputs ...)

To exit this menu, press icon RETURN KEY.

**Note : It is possible to force the output 4-20 mA for PID when PID regulation is in manual mode (REGUL. MANU).
If PID regulation is operating, the display of analogue output is in %.**

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