STEIEL

Microprocessor-Based pH & ORP Controllers

S503-pH/ORP/T

TECHNICAL MANUAL

CE

STEIEL Elettronica S.r.l. – Viale Europa, 24 – 35020 Ponte San Nicolò – PADOVA ITALY
Tel. +39 049.8961488 – Fax +39 049.8960184 – www.steiel.it – info@steiel.it

Certified Company, according to UNI EN ISO 9001 standards

WARNINGS

This manual is dedicated to the technical personnel responsible of the installation, management and maintenance of the plants. The manufacturer assumes no responsibility for damages or malfunctions occurring after intervention by non-authorized personnel, or not compliant with the prescribed instructions.

Before performing any maintenance or repair action, ensure that the system is electrically and hydraulically insulated.

Dispose of waste material and consumables accordingly with local regulations.

The manufacturer can modify the instrument or the technical manual without advanced notice.

WARRANTY

All our products are warranted for a period of 12 months from the delivery date.
Warranty is not valid if all instructions of installation, maintenance and use, are not strictly followed by the user. Local regulations and applicable standards have also to be followed.

TABLE OF CONTENTS

PACKING LIST

1) Instrument
2) Technical manual
3) Mounting brackets (2 pcs.) for panel installation
4) Ferrites (2 pcs. – part no. 5062.0020)

INTRODUCTION AND PRINCIPLE OF OPERATION

The S503 instruments are microprocessor-based digital devices, designed for panel installation.
All models feature 2 relay outputs (settable as set-points or alarm thresholds), one current output completely configurable and galvanically insulated.
All outputs may be temporary deactivated (e.g. during maintenance) through the ON button.
Alarms and errors are shown directly on the display, and calibration and configuration data are saved into the non-volatile memory for at least 10 years.

The S503 series includes several models, for measuring the following parameters:

- ✓ **pH** / **ORP (redox)** / **Temperature**
- ✓ Conductivity
- ✓ Indicator (model with standardized input)

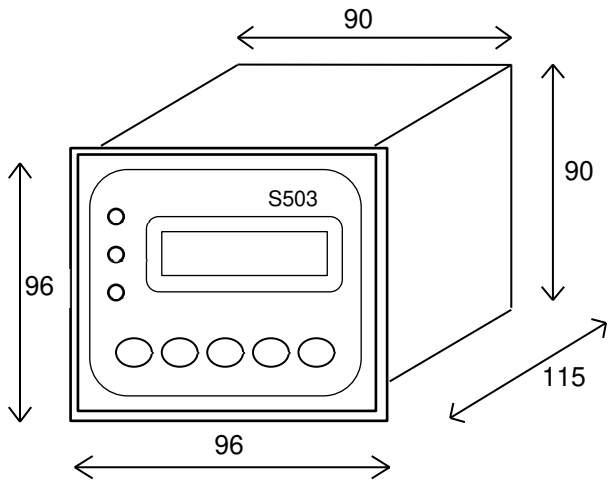
All models feature a temperature input for Pt100 sensor, for temperature measurement and compensation of the pH and conductivity.

TECHNICAL DATA

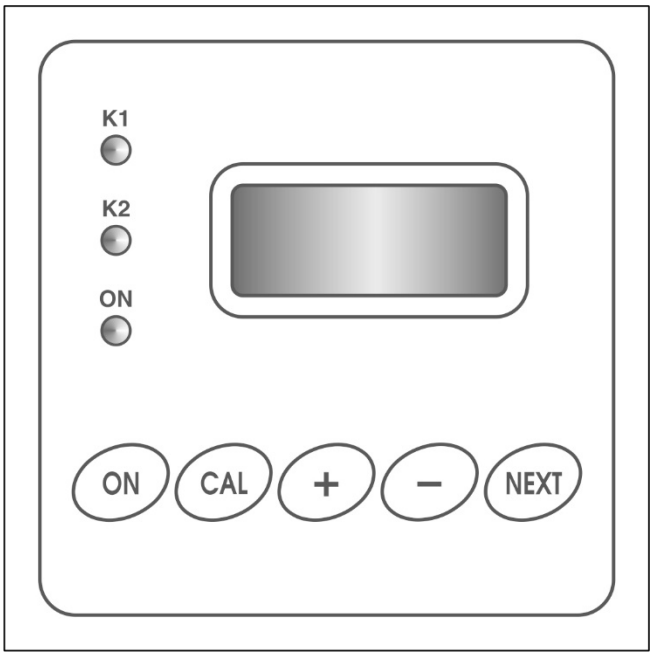
pH / ORP Input	removable, 3-pole terminal block (coaxial cable + reference); input impedance > 10^12 Ω **pH range: 0…14.00 pH** **ORP range: -1000 ….+1000 mV**	
Temperature Input	removable, 2-pole terminal block, for connection of Pt100 sensor **range: -100 … +200 °C**	
Analogic Inputs	precision better than 0.3% FS / repeatability better than 0.2% FS (electronics only)	
Power supply	100-240 V~ 50/60 Hz (24V~, 24V- upon request)	
Power Consumption	5 VA max	
Protection	5x20 fuse that can be accessed from the rear panel, 24 V~ ⇒ F 250 mA; 100-240 V~ ⇒ F 100 mA	
Display	2-row, alphanumeric LCD (8 digits per row), with backlight	
Relay Outputs	2 independent outputs, available on removable, 5-pole terminal block; contact max load: 250 V~, 3 A resistive	
Current Output	0/4-20 mA (selectable through software), 600 Ω max load, 0.5% FS max error; galvanically isolated from inputs	
Environment	storage temperature	-20 to +60 °C
	operating temperature	-10 to +50 °C
	RH	max 90% no condensing
Casing	NORYL body, polyester front panel; designed for panel installation with supplied mounting brackets	
Protection rate	IP42, panel-mounted without front protection; IP54 with optional cover (upon request: version with IP65 housing)	
Dimensions	instrument: DIN 96 x 96 x 115 mm; drilling template: 90 x 90 mm	
Weight	approx. 400 g	

MECHANICAL DIMENSIONS

Note: all dimensions are in mm.



DESCRIPTION OF THE FRONT PANEL



ON key	Enable / disable output relays
CAL key	Allow to enter configuration and calibration modes
[+] key	While in normal mode, show the "GAIN" value (amplification factor); in calibration mode increase the displayed value
[-] key	While in normal mode, show the "OFFSET" value (deviation from zero); in calibration mode decrease the displayed value
NEXT key	While in normal mode, toggle between main measure and temperature readings; in calibration mode exit without saving the new calibration data
LED K1	LED ON = K1 relay ON = contact closed
LED K2	LED ON = K2 relay ON = contact closed
LED ON	Light ON (fix) means instrument ON and no anomalies; blinking light indicates malfunction or outputs disabled through the ON button

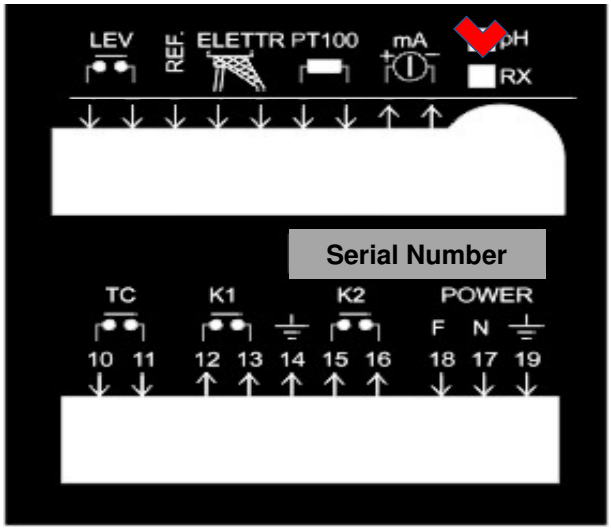
Display — The below figures show typical displays, depending on the meter configuration:

7.00 pH (25 °C)	0 mV (25 °C)	70.0 °C
pH / T	ORP / T	T

The temperature value is shown within brackets if corresponding to a value entered during configuration (parameter Work Temp). Otherwise, if a Pt100 probe is connected, the measured temperature is displayed without brackets.

ELECTRICAL CONNECTIONS

For correct electrical connections always refer to the rear panel pad printing.



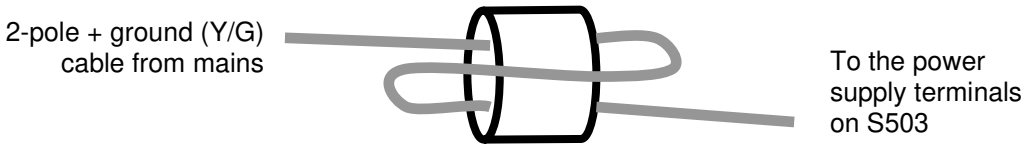
- ✓ POWER: connect to these terminals (17, 18 19) the external power supply, accordingly with voltage technical specifications indicated on the instrument label; max tolerance ±10% ; in case of DC power supply, N=negative and F=positive
- ✓ K1: relay output: voltage-free contact, terminals 12 and 13
- ✓ K2: relay output: voltage-free contact, terminals 15 and 16
- ✓ TC: not used
- ✓ LEV: digital input (terminals 1 and 2); accept voltage-free contact; when the contact is closed, after a proper delay, the outputs are disabled and the status is shown on the display
- ✓ mA: current output, terminals 8 (positive) and 9 (negative)
- ✓ ELETTR. : measure input, terminals 4 and 5; maximum cable length for pH or ORP (RX) electrode is 20 m; perform wiring while keeping signal and power cables separated; if using shielded cable, connect the shield to the REF terminal (never short-circuit the grounding with REF terminal!)
- ✓ PT100: temperature input (terminals 6 & 7); connect a Pt100 sensor for temperature measurement and pH reading thermo-compensation; if a probe with cable longer than 5 meters is required, it is recommended to use a shielded cable and connect the shield to terminal 3 (REF)

Warning! Before performing any connection, check that the meter is not powered!

Notes:

- *The maximum load for relay outputs is 3 A and 250 Vac resistive; with inductive load the maximum current is 1 A (with a 230 Vac power supply voltage it is possible to directly drive pumps or solenoid valves up to 200 VA).*
- *The output relay contacts are not protected: insert a fuse or other protection system appropriate for the load.*
- *In case of inductive load, the output should be protected with appropriate system for arc and interference suppression (RC nets or varistors in AC, diodes or varistors in DC).*

For a correct functioning of the device even in bad interference conditions, it is recommended to proceed as follows:
a) insert one of the supplied ferrites on the power supply cable as shown in the below picture
b) connect the shield of the signal cable to the grounding or to the REF terminal
c) insert the second supplied ferrite on the input signal cable as shown in the below picture
d) connect RC suppressors (or similar) in parallel with the load (properly dimensioned)
e) check the correct grounding connection of the electric cabin that contains the instrument
f) if the cable connected to the current output is longer than 20 meters, use shielded cable



Ferrite (part number 5062.0020)

Make one or two turns (depending on the cable section) around the ferrite.

Note: *The instrument is supplied with two ferrites, one for the power cable and one for the input signal cable. In the case of a second input (temperature) with separate cable from that of the main input, order a third ferrite.*

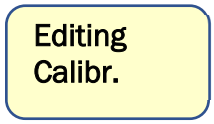
START-UP

At start-up S503 performs a quick test of the display switching on all the segments, then shows the instrument/software version code, checks the memory status, and displays error or advice codes (if present). For details, see “ERRORS” section.
After completing the start-up operations, the device enters the normal operating mode, displays main measurement and temperature, and updates accordingly the current and relay outputs.
If at start-up the [+] and [-] keys are pressed simultaneously, the device runs a simulation program: “0” is displayed and the LED ON blinks. This value simulates the measurement and can be adjusted with the [+] and [-] keys, for testing the functioning and configuration of the current and relay outputs. To exit the simulation mode, press NEXT.

CONFIGURATION

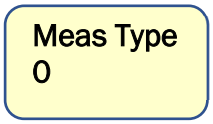
This section describes the operating procedure for configuring editable parameters from the keyboard.

1) Press and hold the CAL key for at least 2 seconds to enter configuration (Editing) / calibration mode

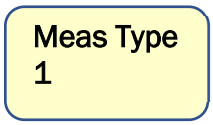


2) Press NEXT to start the configuration

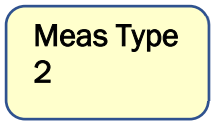
3) Release the button and the display will show the first editable parameter



pH



ORP



Temperature

4) Use the [+] keys to go to the next parameter, or press CAL to move the cursor on the parameter value; modify the value with the [+] and [-] keys
5) Press CAL to confirm the modification or NEXT to proceed without saving
6) Now the display shows the next parameter
7) Proceed as explained at the previous steps for setting all the parameters
8) To exit the configuration mode, press NEXT
9) If no key is pressed, after a few seconds the instrument will automatically quit the configuration mode

List of Parameters

It is recommended to fill the last column with the values set for your application.

Parameter	Description	Min value	Max value	Default value	Set value
Meas Type	Measure type	0	2	0	
	Reserved	0.00	4.00	0.00	
	Reserved	0	1	0	
Work Temp	Working temperature	0	100	25 °C	
K1 Type	Working mode for K1	0	2	1	
K1 Min	Minimum threshold for K1 relay	-1000	2000	6.00 pH	
K1 Max	Maximum threshold for K1 relay	-1000	2000	6.30 pH	
K1 Del ON	Energizing delay for K1 relay	0	120	0 sec	
K1 Del OFF	De-energizing delay for K1 relay	0	120	0 sec	
K2 Type	Working mode for K2	0	5	1	
K2 Min	Minimum threshold for K2 relay	-1000	2000	6.50 pH	
K2 Max	Maximum threshold for K2 relay	-1000	2000	6.80 pH	
K2 Del ON	Energizing delay for K2 relay	0	120	0 sec	
K2 Del OFF	De-energizing relay for K2 relay	0	120	0 sec	
Start Del	Starting delay	0	60	0 min	
mA Type	mA output type	0	1	1	
mA Start	Starting value for mA output	-1000	2000	0.00 pH	
mA Full	Full scale value for mA output	-1000	2000	14.00 pH	
mA Err	Fault mA value	0.0	21.0	21.0 mA	
PASSWORD	Password	0	999	0	
Autoset	Auto-set	0	100	0	

Meaning of Parameters

Meas Type
0

MEASURE TYPE

This model is configured and calibrated for pH, ORP (redox) or temperature measurements;
can be set as follows: 0 = pH-meter, 1 = ORP meter, 2 = thermometer.

Reserved
0

RESERVED

Parameter reserved for future use.

Reserved
0

RESERVED

Parameter reserved for future use.

Work Temp
25 °C

WORKING TEMPERATURE

All the S503 models are designed for measuring temperature and use this value for temperature compensation (when required). If no temperature probe is connected, the working temperature value can be manually entered. In this case the set value is displayed within brackets.

K1 Type
1

WORKING MODE OF RELAY K1

The K1 relay output can work in 3 different modes:
0 = Relay output is disabled.
1 = Relay contact is closed when the set thresholds are exceeded; this mode is used for acidifying (pH-meter version) or lowering de ORP value.
2 = Contact is open when the set thresholds are exceeded; this mode is use for increasing the pH value or chlorinating (ORP meter).

To activate the new setting of the working mode, turn the instrument off and on again.

K1 Min
6.00 pH

K1 Min
600 mV

MIN THRESHOLD FOR RELAY K1

Minimum threshold value for relay K1 action.

K1 Max
6.30 pH

K1 Max
630 mV

MAX THRESHOLD FOR RELAY K1

Maximum threshold value for relay K1 action.

K1 Del ON
0 sec

ENERGIZING DELAY FOR RELAY K1

This parameter allows to enter a delay time (in seconds) for energizing relay K1, if it is configured with working type option 1 or 2. Entering zero will skip delay and the relay is activated immediately.

K1 Del OFF
0 sec

DE-ENERGIZING DELAY FOR RELAY K1

This parameter allows to enter a delay time (in seconds) for de-energizing relay K1, if it is configured with working type option 1 or 2. Entering zero will skip delay and the relay is de-activated immediately.

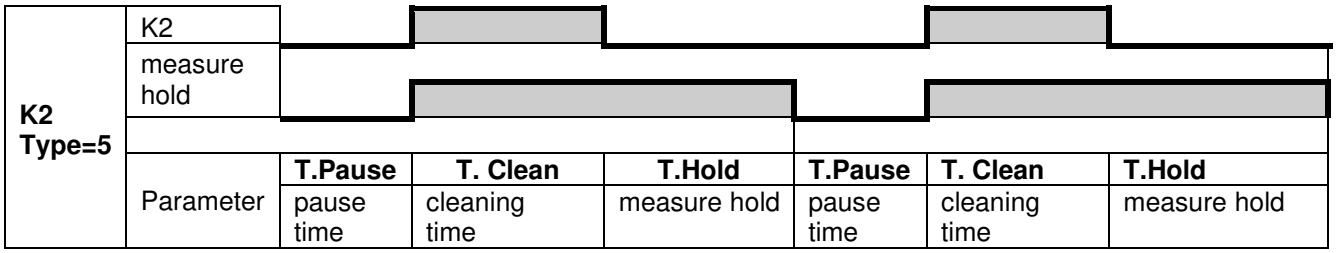
K2 Type
1

WORKING MODE OF RELAY K2

The K2 relay output can work in 6 different modes:
0 = Relay disabled.
1 = Contact is closed when the set thresholds are exceeded.
2 = Contact is open when the set thresholds are exceeded.
3 = NC (normally closed) alarm, i.e. K2 contact is closed when measurement is within the set thresholds.
4 = NO (normally open) alarm, i.e. K2 contact is open when measurement is within the set thresholds.
5* = Automatic cleaning cycle: at set time intervals, the instrument freezes measurement and the relay K2 closes.
For example: Pause time = 1-2 hours = 60-120 minutes,
Cleaning = 10 seconds;
Measure hold = 60 seconds (time needed to discharge the dirty water and return to correct measurement).

To activate the new setting of the working mode, turn the instrument off and on again.

*The below diagram shows the functioning of the automatic cleaning mode.



K2 Min
6.50 pH

K2 Min
650 mV

MIN THRESHOLD FOR RELAY K2

Minimum threshold value for relay K2 action. If K2 Type=5 (cleaning cycle), this parameter is used to set the pause time (minutes) between two subsequent cleaning cycles.

K2 Max
6.80 pH

K2 Max
680 mV

MAX THRESHOLD FOR RELAY K2

Maximum threshold value for relay K2 action. If K2 Type=5 (cleaning cycle), this parameter is used to set the cleaning time (seconds).

K2 Del ON
0 sec

ENERGIZING DELAY FOR RELAY K2

Energizing delay for relay K2 (seconds). If K2 Type=5 (cleaning cycle), this parameter is used to set the time (seconds) with frozen measurement after the cleaning cycle has been completed, before returning to normal operations.

K2 Del OFF
0 sec

DE-ENERGIZING DELAY FOR RELAY K2

De-energizing delay for relay K2 (seconds).

Start Del
0 min

STARTING DELAY

The sensor connected to the measure input may require a stabilization time before measuring reliable values, but anyway outputs are activated accordingly with readings. This parameter allows to enter a proper time delay (minutes), for waiting for sensor stabilization. Setting the parameter to zero means disabling this function.

mA Type
1

CURRENT OUTPUT TYPE

This parameter allows to choose the current output range:
0 = 0-20 mA; 1 = 4-20 mA.
***Note**: The precision for the current output refers to values greater than 0.3 mA (approx.). Note that the low values for the 0-20 mA output are quite approximate.*

mA Start
0.00 pH

mA Start
0 mV

STARTING VALUE FOR CURRENT OUTPUT

Measure value corresponding to the starting value of the current output (0 or 4 mA).

mA Full
14.00 pH

mA Full
1400 mV

FULL SCALE VALUE FOR CURRENT OUTPUT

Measure value corresponding to the full scale of the current output (20 mA).

mA Err.
21.0 mA

FAULT CURRENT OUTPUT

This parameter is used to enter the output current value when an error occurs (e.g. reading out of range, measurement disabled, etc.).

PASSWORD
0

PASSWORD

The user can enter a protection password to avoid intervention by non-authorized personnel.
Warning! If the password is forgotten, the instrument has to be sent back to the factory for a complete re-configuration!

Autoset
0

AUTOSET

This parameter allows to restore the factory settings. Enter “12” and the display will show the “Autoset Done ! “ message for 3 seconds, then the device returns to normal operating mode.

TEMPERATURE COMPENSATION

The temperature compensation (for pH readings only) is calculated using the temperature value measured through the dedicated input. If this input is not connected, the S503 controller will use the working temperature value set in the parameter Work Temp.

ADDITIONAL VISUALIZATIONS

Pressing the [+] and [-] keys while in normal mode, the following values are displayed:

pH meter	key [+]	gain factor (0.667 to 1.428)
	key [-]	offset, pH units at 25°C (-1.50 to 1.50)
ORP meter	key [+]	gain factor (1.000 – fix)
	key [-]	offset (-150 to 150 mV)
thermometer	key [+]	gain factor (0.900 to 1.100)
	key [-]	offset (-5.0 to +5.0°C)

***Note**: The first calibration settings are OFFSET = 0, GAIN = 1.000.*

CONTROL EXAMPLES

This section includes some configuration examples of control parameters.

1) Acidification control to have approximately pH 7.40
   Meas Type - MEASURE TYPE = 0 (pH meter)
   K1 Type - WORKING MODE FOR K1 = 1 (closed when thresholds are exceeded)

   It is recommended to set a narrow threshold window, e.g.:
   K1 Min - MIN THRESHOLD = 7.30 pH
   K1 Max - MAX THRESHOLD = 7.50 pH

   The relay K1 starts acidification when the pH level is greater than 7.50 and de-activates as soon as the pH level falls below the 7.30 threshold.

   The relay K2 can be configured as alarm:
   K2 Type - WORKING MODE FOR K2 = 3 (NC alarm)
   K2 Min - MIN THRESHOLD = 6.50 pH
   K2 Max - MAX THRESHOLD = 8.50 pH

2) Control of the swimming pool chlorination using a redox electrode, to have an approximate free chlorine level of 0.80 ppm. Using a photometer, analyze the water to obtain the redox value of the water when the free chlorine concentration is 0.80 ppm; for example redox=696 mV:

   Meas Type - MEASURE TYPE = 1 (redox-meter)
   K1 Type - WORKING MODE FOR K1 = 2 (open when thresholds are exceeded)
   K1 Min - MIN THRESHOLD = 675 mV
   K1 Max - MAX THRESHOLD = 695 mV

   In these conditions, the relay K1 activates when the redox potential level falls below 675 mV, and deactivates for values greater than 695 mV.

pH INPUT SPECIFICATIONS

Electrical Connections for pH-Meter

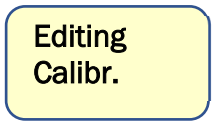
The signal comes from the electrode through a coaxial cable, with maximum recommended length of 20 meters (for longer cables, please contact the manufacturer).
The electrode input is available on removable terminal block: connect the coaxial cable core to terminal 4, and the shield to terminal 5 (***Note**: remove any black conductive plastic between the core and shield of the cable*).
If two separate electrodes are used for measurement and reference, connect the reference electrode to terminal 3 (REF).
The Pt100 temperature sensor (for pH readings thermo compensation and temperature measurement) should be connected to terminals 6 and 7. If no sensor is connected, the instrument uses a constant temperature of 25.0°C. If a Pt100 probe is used, immerse it into the liquid to be tested, close to the electrode or anyway at the same temperature. If a 3-wire Pt100 sensor is used, connect the 2 wires of the same colour at the same terminal (wires are internally short circuited).
It is recommended to keep signal cables away from power cables.

Electrochemical Calibration

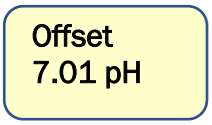
Before starting this procedure, ensure to have fresh buffer solutions (not expired). If temperature compensation is requested, immerse the Pt100 probe into the buffer solution near the pH electrode.

1) Rinse the electrode with distilled water, dry it and then immerse in pH 7.01 buffer solution

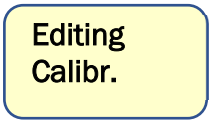
2) Press and hold the CAL key for at least 2 seconds to enter configuration (Editing) / calibration mode



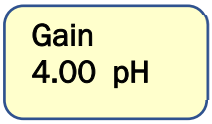
3) Press [-] and the "OFFSET" message is displayed, followed by the pH value of the automatically recognized buffer solution
4) If necessary, adjust this value using the [+] and [-] keys
5) Press the CAL key to confirm calibration, or NEXT to exit without saving (previous calibration data are kept)



6) Rinse the electrode with distilled water, dry it and then immerse in pH 4.01 (or pH 9.01) buffer
7) Press and hold the CAL key for at least 2 seconds to enter configuration (Editing) / calibration mode



8) Press the [+] key and the "GAIN" message is displayed, followed by the pH value of the automatically recognized buffer solution
9) If necessary, adjust this value with the [+] and [-] keys
10) Press the CAL key to confirm calibration, or NEXT to exit without saving (previous calibration data are kept)



The instrument does not automatically recognizes the buffer pH values whenever:
a) The buffer solution is contaminated dirty or expired
b) The electrode is not working properly or it is exhausted
c) The electrode connection cable is damaged

***Note:** If you attempt to calibrate the offset at a pH value too different from pH 7, or to calibrate the gain with a buffer solution too close to pH neutrality, the instrument shows the "CALIBRATION ERROR!" message and does not save the calibration data.*

ORP INPUT SPECIFICATIONS

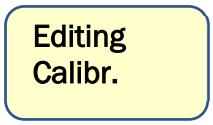
Electrical Connections for ORP-Meter

The signal comes from the electrode through a coaxial cable, with maximum recommended length of 20 meters (for longer cables, please contact the manufacturer).
The electrode input is on removable terminal block: connect the coaxial cable core to terminal 4, and the shield to terminal 5 (***Note****: remove any black conductive plastic between the core and shield of the cable*). If two separate electrodes are used for measure and reference, connect the reference electrode to terminal 3 (REF).
If temperature measurement is also required, connect a Pt100 temperature sensor to terminals 6 and 7. If a 3-wire Pt100 sensor is used, connect the 2 wires of the same colour at the same terminal (the wires are internally short circuited).
It is recommended to keep signal cables away from power cables.

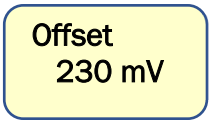
Electrochemical Calibration

Before starting the procedure, check to have a fresh calibration solution (not expired).

1) Rinse the electrode with distilled water, dry it and then immerse it into the calibration solution (e.g. 230 mV)
2) Press and hold the CAL key for at least 2 seconds to enter configuration (Editing) / calibration mode



3) Press [-] and the "OFFSET" message is displayed, followed by current reading
4) If necessary, use the [+] and [-] keys to adjust this value to that of calibration solution
5) Press the CAL key to confirm calibration, or NEXT to exit without saving (previous calibration data are kept)



After performing the calibration, the meter does not display the standard solution value whenever:
a) The calibration solution is contaminated dirty or expired
b) The electrode is not working properly or it is exhausted
c) The electrode connection cable is damaged

Note: *If you attempt to calibrate the offset at a value too different from the internal one, the instrument shows the "CALIBRATION ERROR!" message and does not save the calibration data.*

ORP calibration is a single point procedure (offset)!

TEMPERATURE INPUT SPECIFICATIONS

Electrical Connections for Thermometer

The signal comes from a Pt100 sensor through a 2 or 3-wire cable, that has to be shielded if longer than 15 meters. Connections are made on removable terminal block, at pins 6 and 7.
If a sensor with 3-wire cable is used, connect to the same terminal the two wires of the same colour (internally short-circuited). If a shielded cable is used, connect the shield to terminal 3 (REF).

Thermometer Calibration

The electronic calibration of the instrument and the accuracy class of the Pt100 sensor ensure a maximum error of ±0.3°C at 0°C and ±0.8°C at 100°C (Pt100 class B, according to IEC 751 standard). Therefore, no user calibration is required.

Note*: Factory calibration is performed with a sensor with 2 m cable. Using a probe with a cable longer than 2 meters could introduce a greater reading error.*

ERRORS

When an error is detected, the LED ON starts blinking, the mA output provides the fault current value set in “mA Error”, and the display shows the corresponding error message, as listed here below:

WARNING 1 - RELAY K1 DISABLED
No working mode has been configured for K1 output, but the instrument works normally.

WARNING 2 - RELAY K2 DISABLED
No working mode has been configured for K2 output, but the instrument works normally.

ERR. 2 CURRENT OUTPUT
The maximum and minimum values for the mA output (mA Start and mA Full) are too close. The output will not work correctly. Enter new values for parameters.

OFF LEV FLOW
Missing consent at the LEV input (terminals 1 and 2). When the contact closes, an alarm condition is generated.

CALIBRATION ERROR!
The requested calibration cannot be performed. Check probe and connection cable; repeat the procedure.

UR/OR
Under Range / Over Range: the input signal is greater than the full scale value, or lower than the minimum value of the measurement range. Check sensor and cable. When this error occurs, the instrument outputs are disabled.

Auto Clean
This is not an error message, but an indication that the automatic cleaning is in progress; while this message is displayed, measurement is frozen at the value read before the cycle start.