30 748 687 A

Operation Manual
Multi-parameter Transmitter
M400 2-Wire –
M400 2(X)H Type 2 and Type 3

METTLER TOLEDO

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Content

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1 Introduction

Statement of Intended Use – The M400 2-wire multi-parameter transmitter is a single-channel on-line process instrument with HART® communication capabilities for measuring various properties of fluids and gases. These include Conductivity, Dissolved Oxygen, and pH/ORP. The M400 is available in two different levels. The level indicates the supported measurment parameters which can be covered. The parameters are indicated on the label on the back of the system.

The M400 offers a mixed mode and pure ISM mode transmitter which can handle conventional sensors (analog) or ISM sensors (digital).

M400 2-wire parameter fit guide

	M400 2(X)H Type2		**M400 2(X)H Type3**	
	Analog	**ISM**	**Analog**	**ISM**
pH/ORP	•	•	•	•
pH/pNa	–	•	–	•
Conductivity 2-e	•	–	•	–
Conductivity 4-e	•	•	•	•
Amp. O_2 ppm/ppb/trace	•/•/•	•/•/•	•/•/•	•/•/•
Amp. O_2 gas ppm/ppb/trace	–	–	•/•/•	•/•/•
Opt. O_2 ppm/ppb	•/•	•/•	•/•	•/•
Dissolved carbon dioxide (pharma)	–	•	–	•

A large black and white screen conveys measuring data and setup information. The menu structure allows the operator to modify all operational parameters by using keys on the front panel. A menu-lockout feature, with password protection, is available to prevent the un-authorized use of the meter. The M400 Multi-parameter transmitter can be configured to use its two analog and/or two open collector (OC) outputs for process control.

This description corresponds to the firmware release, version 1.0.01 for transmitter M400 2(X)H Type2 and M400 2(X)H Type3. Changes are taking place constantly, without prior notification.

2 Safety Instructions

This manual includes safety information with the following designations and formats.

2.1 Definition of Equipment and Documentation Symbols and Designations

Warning: POTENTIAL FOR PERSONAL INJURY.

Caution: Possible instrument damage or malfunction.

Note: Important operating information.

On the transmitter or in this manual text indicates: Caution and/or other possible hazard including risk of electric shock (refer to accompanying documents).

The following is a list of general safety instructions and warnings. Failure to adhere to these instructions can result in damage to the equipment and/or personal injury to the operator.

- The M400 Transmitter should be installed and operated only by personnel familiar with the transmitter and who are qualified for such work.
- The M400 Transmitter must only be operated under the specified operating conditions (see section 13, "Specifications").
- Repair of the M400 Transmitter must be performed by authorized, trained personnel only.
- With the exception of routine maintenance, cleaning procedures or fuse replacement, as described in this manual, the M400 Transmitter must not be tampered with or altered in any manner.
- METTLER TOLEDO accepts no responsibility for damage caused by unauthorized modifications to the transmitter.
- Follow all warnings, cautions, and instructions indicated on and supplied with this product.
- Install equipment as specified in this instruction manual. Follow appropriate local and national codes.
- Protective covers must be in place at all times during normal operation.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

WARNINGS:
Installation of cable connections and servicing of this product require access to shock hazard voltage levels. Main power and OC contacts wired to separate power source must be disconnected before servicing.

Switch or circuit breaker shall be in close proximity to the equipment and within easy reach of the OPERATOR; it shall be marked as the disconnecting device for the equipment. Main power must employ a switch or circuit breaker as the disconnecting device for the equipment. Electrical installation must be in accordance with the National Electrical Code and/or any other applicable national or local codes.

Note: PROCESS UPSETS
Because process and safety conditions may depend on consistent operation of this transmitter, provide appropriate means to maintain operation during sensor cleaning, replacement or sensor or instrument calibration.

Note: This is a 2-wire-product with two active 4 – 20 mA analog output.

2.2 Correct Disposal of the Unit

When the transmitter is finally removed from service, observe all local environmental regulations for proper disposal.

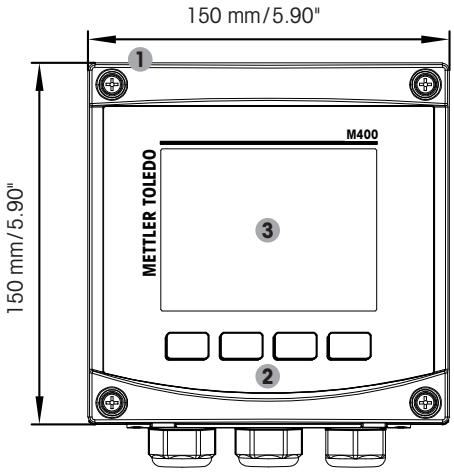
2.3 Ex Classification

Refer to document PN 30715260 for Ex instructions, including IECEx, ATEX, FM, which can be download from "www.mt.com/m400-downloads".

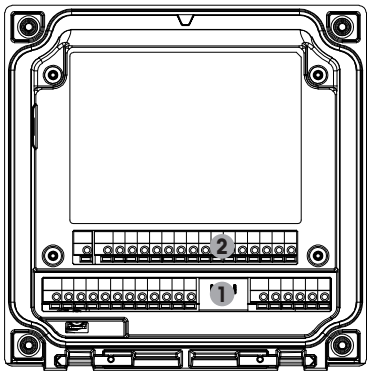
3 Unit Overview

The M400 models are available in ½ DIN case size. The M400 models provide an integral IP66/NEMA4X housing for wall- or pipe mount.

3.1 Overview ½ DIN



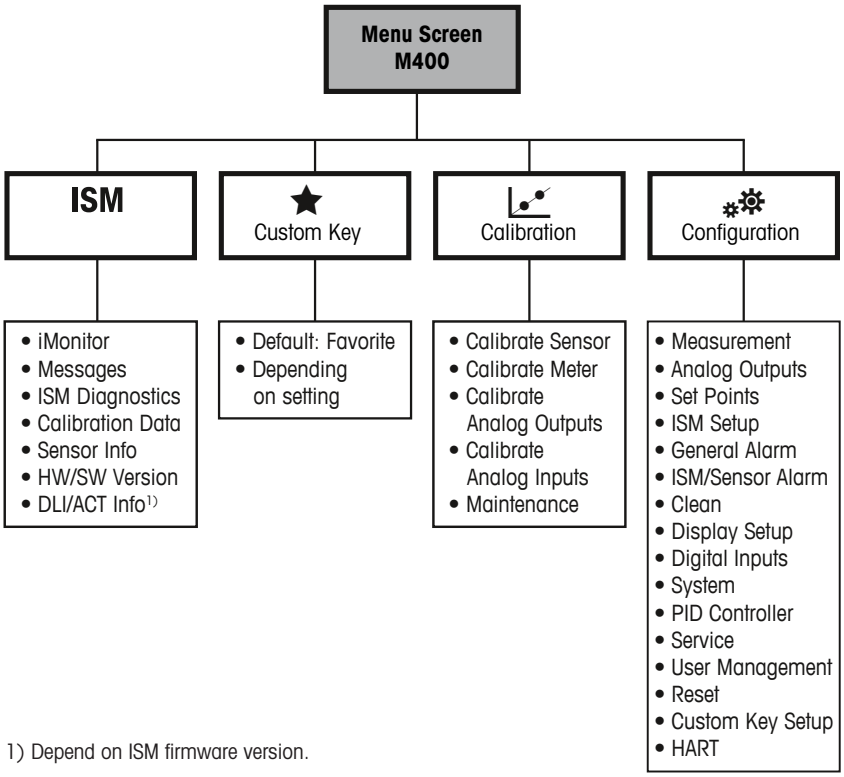
1: Aluminum Alloy Die Castings Case
2: Four Tactile-Feedback Navigation Keys
3: TFT High-Resolution Display



1: TB1 – Input and Output Analog Signal
2: TB2 – Sensor Signal

3.2 Menu Structure

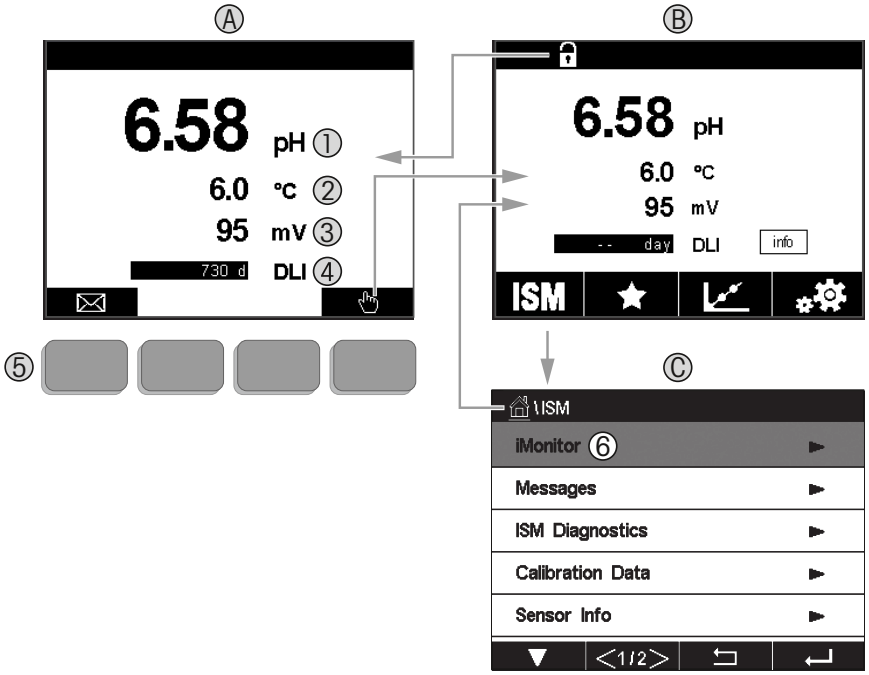
Below is the structure of the M400 menu tree:



1) Depend on ISM firmware version.

Fig. 1: Menu Overview

3.2.1 Display



A. Start screen (example)

1. 1st line, standard configuration
2. 2nd line, standard configuration
3. 3rd line, depends on configuration
4. 4th line, depends on configuration
5. Soft key with indicated functions on the screen
6. Cursor, indicates the current item for soft key operation

B. Menu screen (example)

C. ISM Menu screen

Note: In the event of an alarm or other error conditions the M400 Transmitter will display a symbol in the head line of the display. This head line is blinking until the condition that caused it has been cleared (see chapter 11.7 "Warning- and Alarm Indication" on page 85).

Note: During calibrations, clean, Digital In with Analog Output/OC in HOLD state, a flashing "H" (HOLD) will appear in the upper right corner of the display for the corresponding channel. This symbol will remain for 20 sec., after end of calibration. This symbol will remain for 20 seconds until after the calibration or clean is completed. This symbol will also disappear when Digital In is deactivated.

3.3 Operating Elements

Operating element	Description
	Enter messages menu
	Enter menu screen
	Lock/Unlock Screen
ISM	Enter ISM menu
	Enter favorite menu
	Enter calibration menu
	Enter configuration menu
	Return to menu screen
	Enter next-lower menu level, e.g. iMonitor, Messages or ISM Diagnostics
	Return to next-higher menu level; Long press it to jump return to start screen
	Navigate menu for soft key operation
	Enter selected menu or item for soft key operation

3.4 Entry Data

The M400 displays a keypad for modifying values. Press the ↵ button and the transmitter will store the value. Press the ESC button to exit the keypad without changing data.

Note: For some values, the units can be modified. In this case the keypad shows a button with a U. To select another unit for the entered value on the keypad press the U button. To return again press the 0–9 button.

Note: For some entries letters and/or numbers can be used. In this case the keypad shows a button 'A, a, 0'. Press this button to change between capital letters, small letters and numbers on the keypad.

3.5 Selection Menus

Some menus require a selection of a parameter/data. In this case the transmitter displays a pop up window. Press the according field to select the value. The pop-up window will be closed and the selection will be stored.

3.6 "Save Changes" Dialog

If the M400 brings up the "Save changes" dialog there are the following options. No will discard the entered values, Yes will save changes made and Cancel will bring you back to continue configuring.

3.7 Security Passwords

The M400 Transmitter allows a security lock-out of various menus. If the security lock-out feature of the transmitter has been enabled, a security password must be entered to allow access to the menu. See chapter 7.14 "User Management" on page 72.

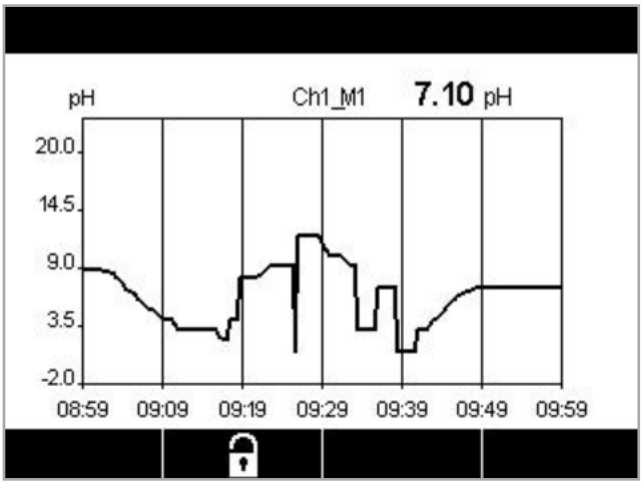
3.8 Graphic Trend Measurement

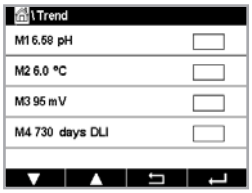
Any single measurement may be displayed as a trend measurement over time. Measurement values will be indicated by a value on the Y-axis and time elapsed on the X-axis of the graph displayed. An actual measurement for the selected value will also be displayed numerically above the graphic trend display. The measurement value is refreshed once per second.

Graphic trending will only display the data within maximum/minimum range. Out of range values or invalid values will not be displayed. Both axes can be configured in terms of range (Y-axis) and resolution (X-axis). Set the range of the Y-axis large enough that all measurements can be displayed. Set the resolution of the X-axis to either "1 hour" or "1 day" to display measurements of the past hour (or day, resp).

Activation Trend Display Screen

While the M400 is displaying the Menu Screen, you can use custom key setup to access this function when operating with tactile keys. PATH:CONFIG\Custom Key Setup\Select "Trend" for option. Save change to Yes. Back to main screen, showing trend curve on second key at the bottom press second soft key, the trend curve will be shown.





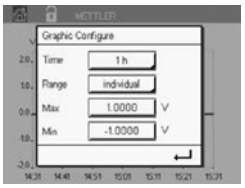
When using custom key setup to access trend display, press the second soft key from the left, after having defined Trend as a custom key.

Use ▼ and ↵ to select the measurement.

When a sensor is disconnected/connected a pop-up window will appear; after closing the window, the display will return to the Menu Screen. The top line will display any message that occurs during trending. "H", "P" will display when this channel is in hold or process.

3.8.1 Settings for Trend Display Screen

For setting configurations, press the fourth button go to the pop-up window of this measurement parameter. Settings are at the default values. However, these settings may be changed when options are available, as needed.



Time: Option button. For graphic display time (X-axis)
1-h (default value)
1-day

Note: 1 h means: 1 meas storage/15 seconds, totally 240 measurements for 1h. 1 day means: 1 meas storage/6 minutes, totally 240 measurements for 1 day;

Range: Option button
Default(default value)
Individual

When "Default" modes are set for the maximum or minimum value, this indicates the full measurement range for this unit. A Max or Min button is not displayed. If setting is selectable, the user can set maximum and minimum settings manually.

Max: Edit button.
Maximum value of this unit on Y-axis. xxxxxx, floating decimal point.

Min: Edit button.
Minimum value of this unit on Y-axis. xxxxxx, floating decimal point.
Max Value > Min Value

Note: Settings for X-and Y-axis and the corresponding measurement values are stored the transmitters memory. A power down returns to default settings.

3.8.2 Deactivation Trend Display Screen

Press ⮌ in activated graphic trend screen to return to Menu Screen.

Note: If a sensor is disconnected/connected a pop-up window come up; after closing the window, it will go back to the Menu Screen.

4 Installation Instruction

4.1 Unpacking and Inspection of Equipment

Inspect the shipping container. If it is damaged, contact the shipper immediately for instructions. Do not discard the box.

If there is no apparent damage, unpack the container. Be sure all items shown on the packing list are present.

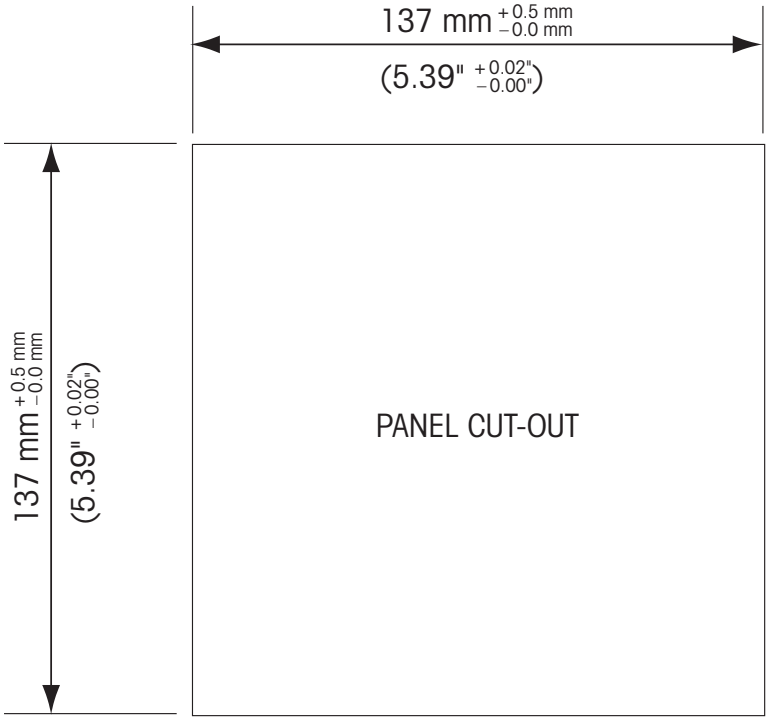
If items are missing, notify METTLER TOLEDO immediately.

4.1.1 Panel Cutout Dimensional Information – ½ DIN Models

½ DIN Model transmitters are designed with an integral rear cover for stand-alone wall mount installation.

The unit may also be wall mounted using the integral rear cover. See installation instructions in section 4.1.2.

Below are cut-out dimensions required by the ½ DIN models when mounted within a flat panel or on a flat enclosure door. This surface must be flat and smooth. Textured or rough surfaces are not recommended and may limit the effectiveness of the gasket seal provided.



Optional hardware accessories are available that allow for panel- or pipe-mount.
Refer to section 15 for ordering information.

4.1.2 Installation Procedure

General:

- Orient the transmitter so that the cable grips face downward.
- Wiring routed through the cable grips shall be suitable for use in wet locations.
- In order provide IP66 enclosure ratings, all cable glands must be in place. Each cable gland must be filled using a cable, or suitable Cable Gland Hole Seal.

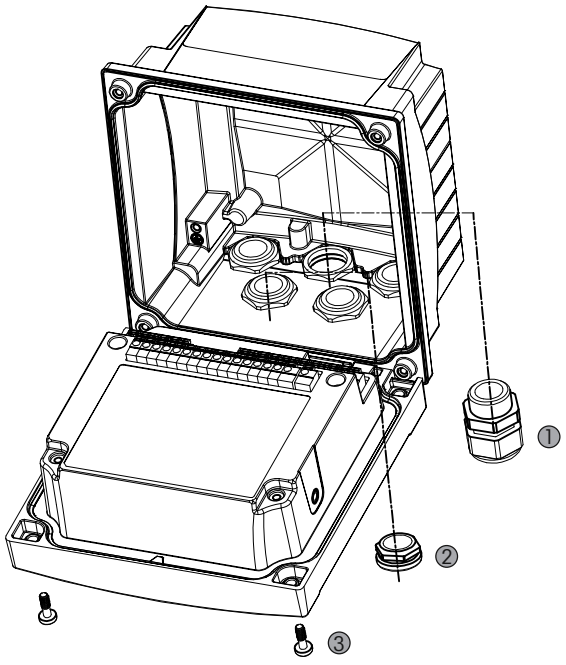
For Wall Mount:

- Remove rear cover from front housing.
- Start by unscrewing the four screws located on the face of the transmitter, in each corner. This allows the front cover to swing away from the rear housing.
- Remove the hinge-pin by squeezing the pin from each end. This allows the front housing to be removed from the rear housing
- Mount rear housing to wall. Secure mounting kit to the M400 according to the supplied instructions. Attach to wall using appropriate mounting hardware for wall surface. Be sure it is level and securely fastened and the installation adheres to any and all clearance dimensions required for transmitter service and maintenance. Orient the transmitter so that the cable grips are facing downward.
- Replace the front housing to the rear housing. Securely tighten the rear-cover screws to ensure that IP66/NEMA4X enclosure environmental rating is maintained. The unit is ready to be wired.

For Pipe Mount:

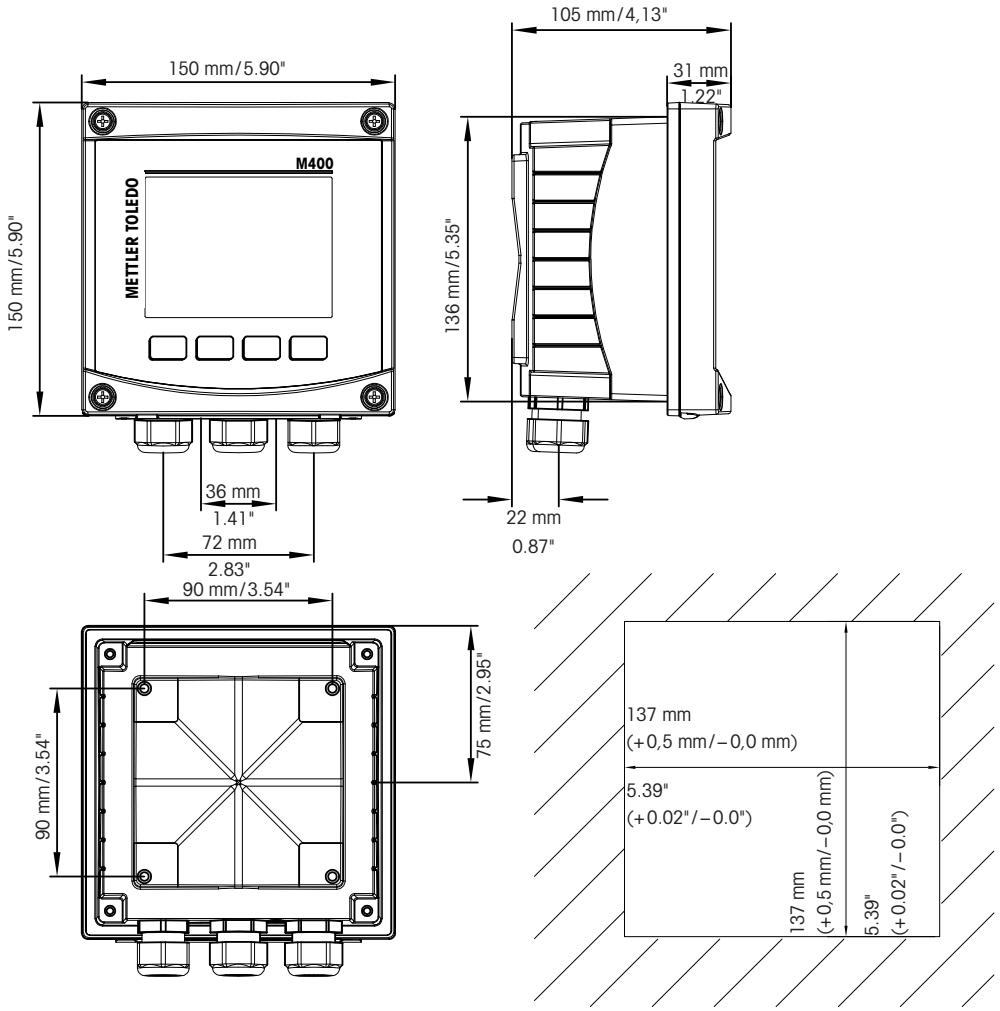
- Use only manufacturer-supplied components for pipe-mounting the M400 transmitter and install per the supplied instructions. See section 15 for ordering information.

4.1.3 Assembly – ½ DIN Version

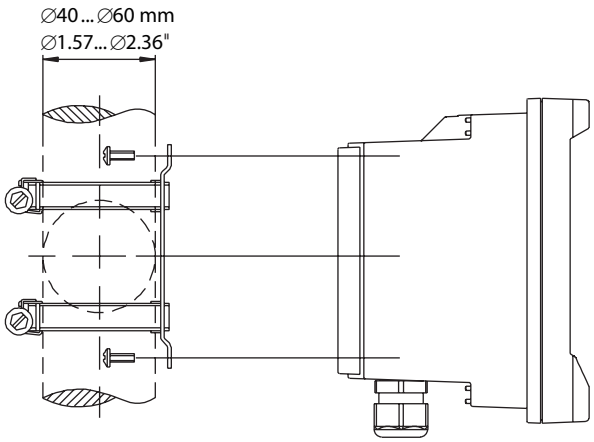


1. 3 M20X1.5 cable glands
2. Plastics plugs
3. 4 screws

4.1.4 ½ DIN Version – Dimension Drawings



4.1.5 ½ DIN Version – Pipe Mounting



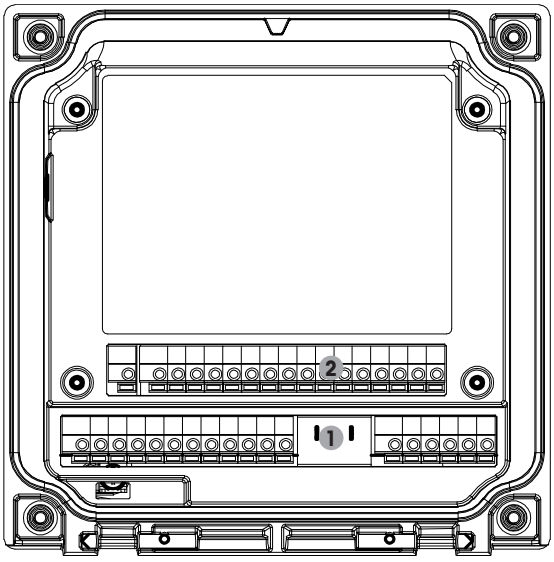
4.2 Connection of Power Supply

All connections to the transmitter are made on the rear panel of all models.

Be sure power to all wires is turned off before proceeding with the installation.

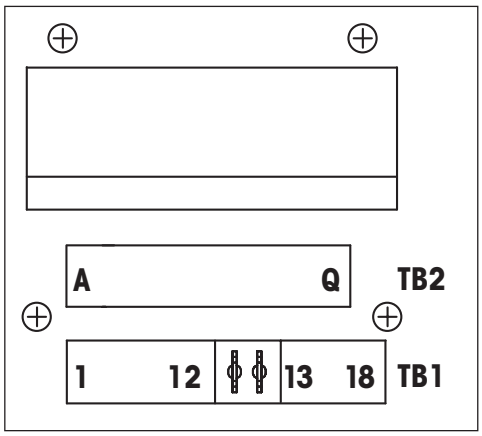
A two-terminal connector on the rear panel of all M400 models is provided for power connection. All M400 models are designed to operate from a 14–30 VDC power source. Refer to specifications for power requirements and ratings and size power wiring accordingly (AWG 16 – 24, wire cross-section 0.2 mm^2 to 1.5 mm^2).

4.2.1 Housing (Wall Mount)



1: TB1 – Input and Output Analog Signal
2: TB2 – Sensor Signal

4.3 Terminal Block (TB) Definitions



Power connections are labeled **A01+/HART** and **A01–/HART** resp. **A02+** and **A02–** for 14 to 30 VDC.

4.4 Terminal Block TB1

Terminal	Designation	Description
1	V_EC	Easy clean
2	GND_EC	
3	485A_EC	
4	485B_EC	
5	DI1+	Digital input1
6	DI1–	
7	DI2+	Digital input2
8	DI2–	
9	OC1+	Open collector output1 (switch)
10	OC1–	
11	OC2+	Open collector output2 (switch)
12	OC2–	
13	AO1+/HART	• Power connection 14 to 30 V DC • Analog output signal 1 • HART signal
14	AO1–/HART	
15	AO2+	• Power connection 14 to 30 V DC • Analog output signal 2
16	AO2–	
17	Not used	–
18	⏚	

4.5 Terminal Block TB2: Analog Sensors

4.5.1 Conductivity (2-e/4-e) Analog Sensors

Terminal	Function	Color
A	Cnd inner1 [1)]	White
B	Cnd outer1 [1)]	White/blue
C	Cnd outer1	–
D	Not used	–
E	Cnd outer2	–
F	Cnd inner2 [2)]	Blue
G	Cnd outer2 (GND) [2)]	Black
H	Not used	–
I	RTD ret/GND	Bare shield
J	RTD sense	Red
K	RTD	Green
L	Not used	–
M	Not used	–
N	Not used	–
O	Not used	–
P	Not used	–
Q	Not used	–

1) For third party Conductivity 2-e sensors a jumper between A and B may be required.

2) For third party Conductivity 2-e sensors a jumper between F and G may be required.

4.5.2 ph and Redox (ORP) Analog Sensors

	pH		Redox (ORP)	
Terminal	**Function**	**Color [1)]**	**Function**	**Color**
A	Glass	Transparent	Platinum	Transparent
B	Not used	–	–	–
C	Not used	–	–	–
D	Not used	–	–	–
E	Reference	Red	Reference	Red
F	Reference [2)]	–	Reference [2)]	–
G	Solution GND [2)]	Blue [3)]	Solution GND [2)]	–
H	Not used	–	–	–
I	RTD ret/GND	White	–	–
J	RTD sense	–	–	–
K	RTD	Green	–	–
L	Not used	–	–	–
M	Shield (GND)	Green/yellow	Shield (GND)	Green/yellow
N	Not used	–	–	–
O	Not used	–	–	–
P	Not used	–	–	–
Q	Not used	–	–	–

1) Grey wire not used.
2) Install jumper between F and G for ORP sensors and pH electrodes without SG.
3) Blue wire for electrode with SG.

4.5.3 Amperometric Oxygen Analog Sensors

		InPro 6800(G)	InPro 6900	InPro 6950
Terminal	**Function**	**Color**	**Color**	**Color**
A	Not used	–	–	–
B	Anode	Red	Red	Red
C	Anode	–[1)]	–[1)]	–
D	Reference	–[1)]	–[1)]	Blue
E	Not used	–	–	–
F	Not used	–	–	–
G	Guard	–	Grey	Grey
H	Cathode	Transparent	Transparent	Transparent
I	NTC ret (GND)	White	White	White
J	Not used	–	–	–
K	NTC	Green	Green	Green
L	Not used	–	–	–
M	Shield (GND)	Green/yellow	Green/yellow	Green/yellow
N	Not used	–	–	–
O	Not used	–	–	–
P	+Ain[2)]	–	–	–
Q	–Ain[2)]	–	–	–

1) Install jumper between C and D for InPro 6800(G) and InPro 6900.

2) 4 to 20 mA signal for pressure compensation

4.6 Terminal Block TB2: ISM Sensors

4.6.1 pH, Amperometric Oxygen, Conductiviy (4-e) and Dissolved Carbon Dioxide ISM Sensors

Terminal	Function	Color
A	Not used	–
B	Not used	–
C	Not used	–
D	Not used	–
E	Not used	–
F	Not used	–
G	Not used	–
H	Not used	–
I	Not used	–
J	Not used	–
K	Not used	–
L	1-wire	Transparent (cable core)
M	GND	Red (shield)
N	RS485-B	–
O	RS485-A	–
P	+Ain[1)]	–
Q	–Ain[1)]	–

1) Only for Oxygen sensors: 4 to 20 mA signal for pressure compensation

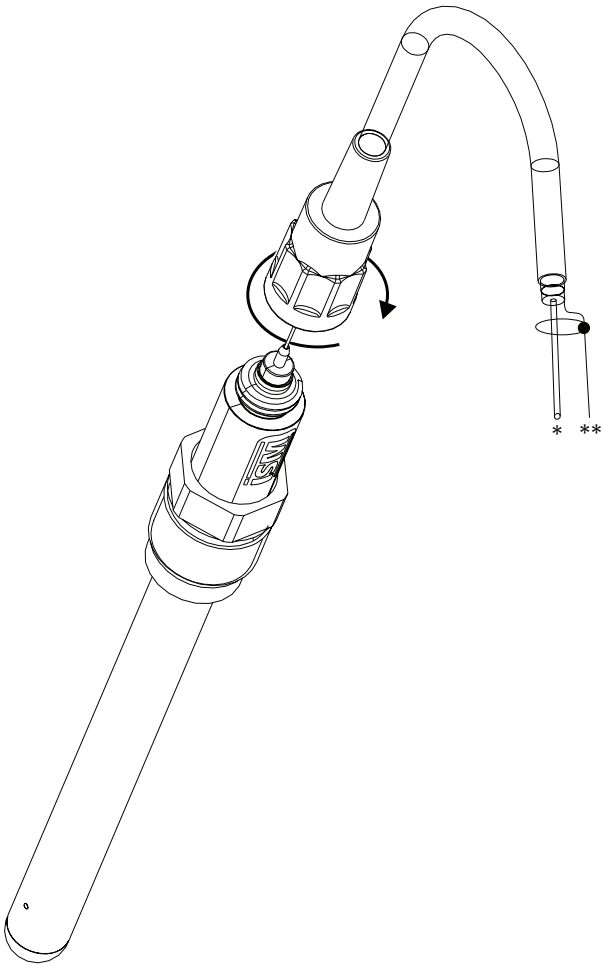
4.6.2 Optical Oxygen ISM Sensors

	Optical Oxygen with VP8 Cable[1]		Optical Oxygen with other Cables[2]	
Terminal	**Function**	**Color**	**Function**	**Color**
A	Not used	–	Not used	–
B	Not used	–	Not used	–
C	Not used	–	Not used	–
D	Not used	–	Not used	–
E	Not used	–	Not used	–
F	Not used	–	Not used	–
G	Not used	–	Not used	–
H	Not used	–	Not used	–
I	Not used	–	D_GND (shield)	Yellow
J	Not used	–	Not used	–
K	Not used	–	Not used	–
L	Not used	–	Not used	–
M	D_GND (shield)	Green/yellow	D_GND (shield)	Grey
N	RS485-B	Brown	RS485-B	Blue
O	RS485-A	Pink	RS485-A	White
P	+Ain[3]	–	+Ain[3]	–
Q	–Ain[3]	–	–Ain[3]	–

1) Connect the grey +24 DC wire and the blue GND_24 V wire of the sensor separately to an external power supply.
2) Connect the brown +24 DC wire and the black GND_24 V wire of the sensor separately.
3) 4 to 20 mA signal for pressure compensation

4.7 Connection of ISM Sensors

4.7.1 Connection of ISM Sensors for pH/ORP, Conductivity 4-e and Amperometric Oxygen Measurement



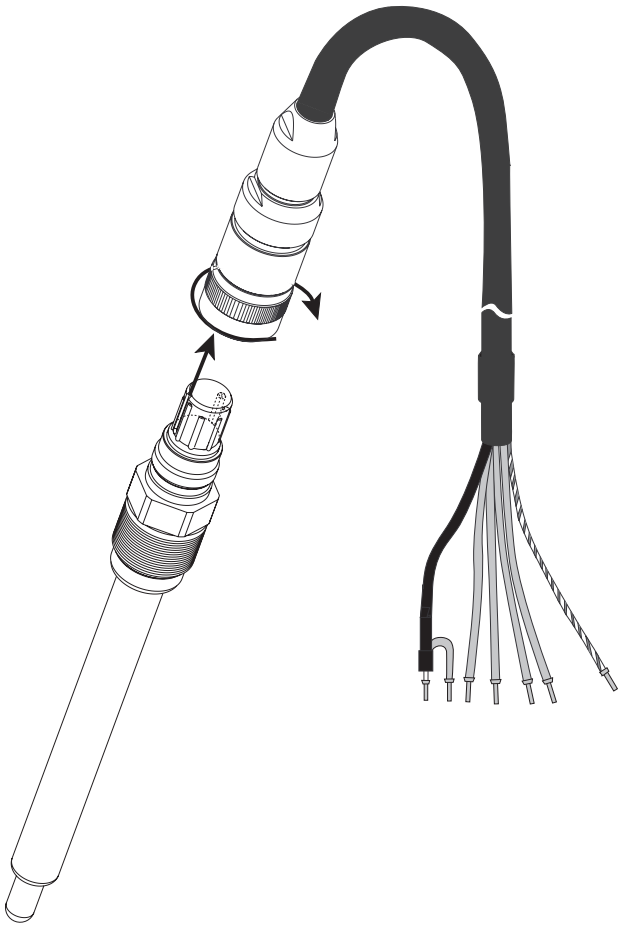
Note: Connect the sensor and screw the plug head clockwise (hand tight).

4.7.2 TB2 – AK9 Cable Assignment

1) 1-wire data (transparent)
2) Ground/shield

4.8 Connection of Analog Sensors

4.8.1 Connection of Analog Sensor for pH/ORP

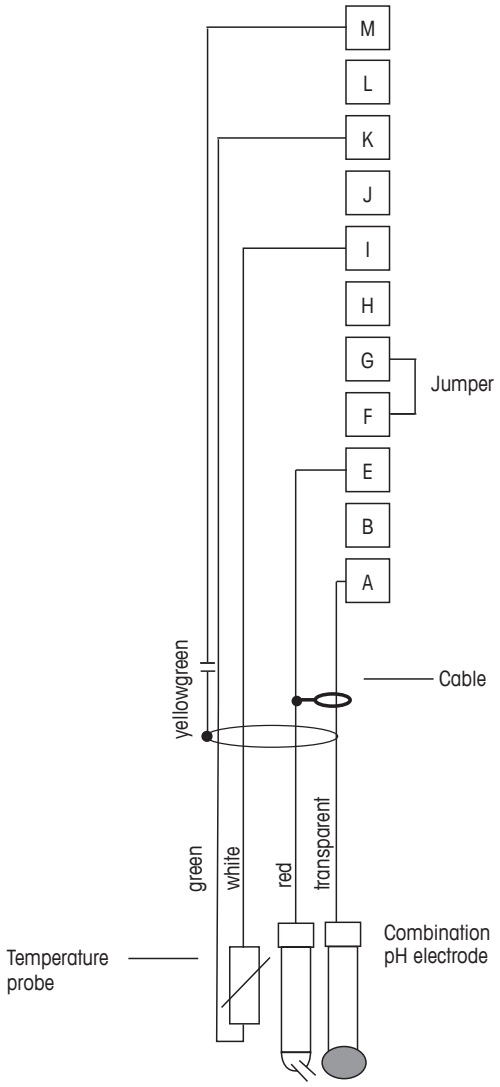


Note: Cable lengths > 20 m can worsen the response during pH measurement. Be sure to observe the sensor instruction manual.

4.8.2 TB2 – Typical Wiring for Analog pH/ORP Sensor

4.8.2.1 Example 1

pH measurement without Solution Ground



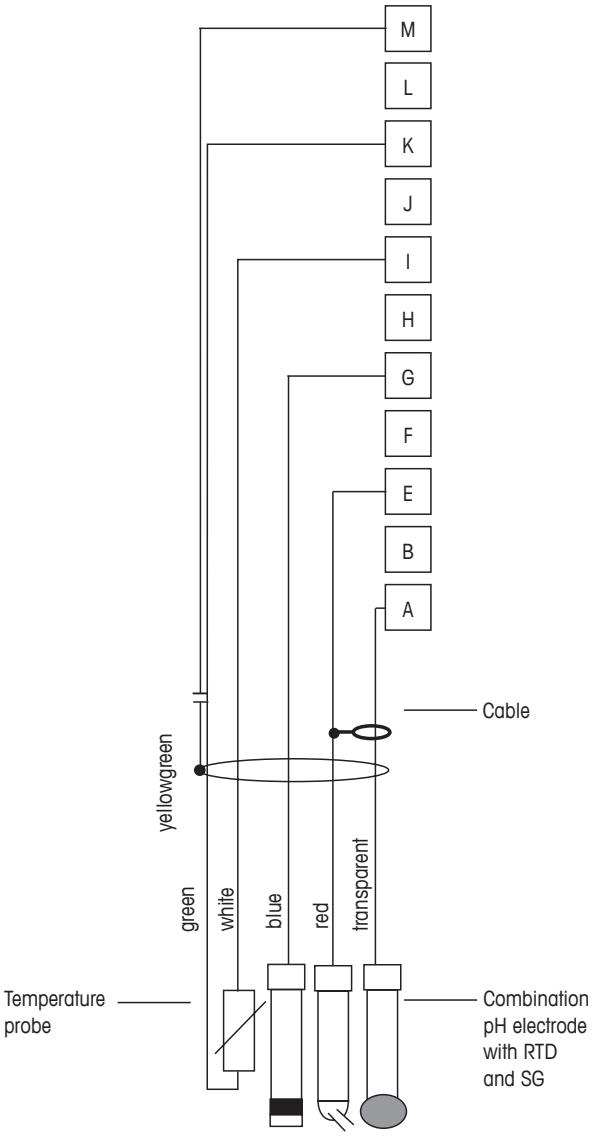
Note: Jumper terminals G and F

Wire Colors only valid for connection with VP caple; blue and grey not connected.

A. Glass
E. Reference
I. RTD ret/GND
K. RTD
M. Shield/GND

4.8.2.2 Example 2

pH measurement with Solution Ground

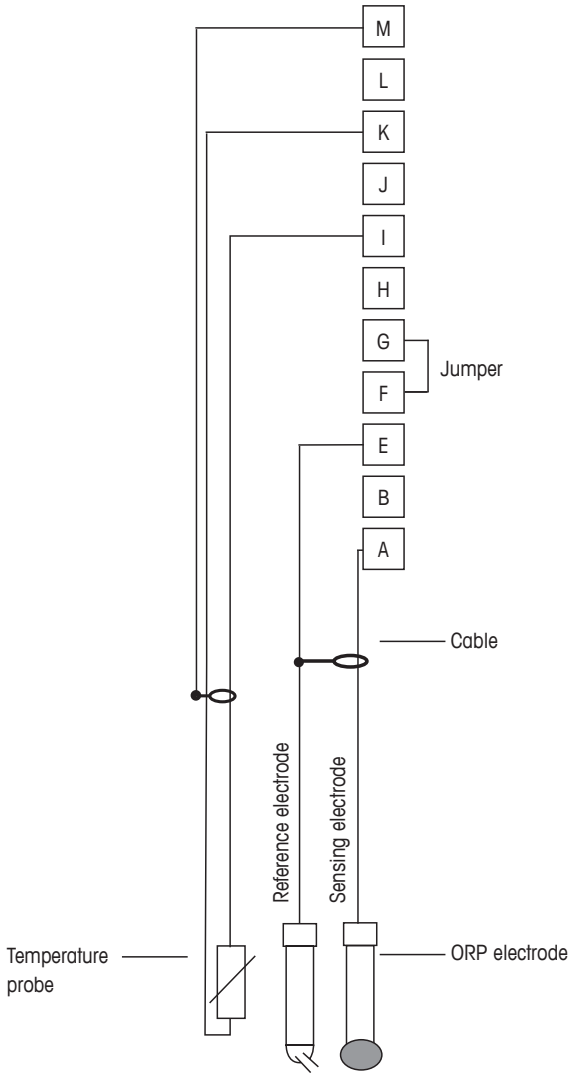


Note: Wire colors only valid for connection with VP cable, grey not connected.

A. Glass
E. Reference
G. Shield/Solution GND
I. GND/RTD ret
K. RTD
M. Shield (GND)

4.8.2.3 Example 3

ORP (redox) measurement (temperature optional)

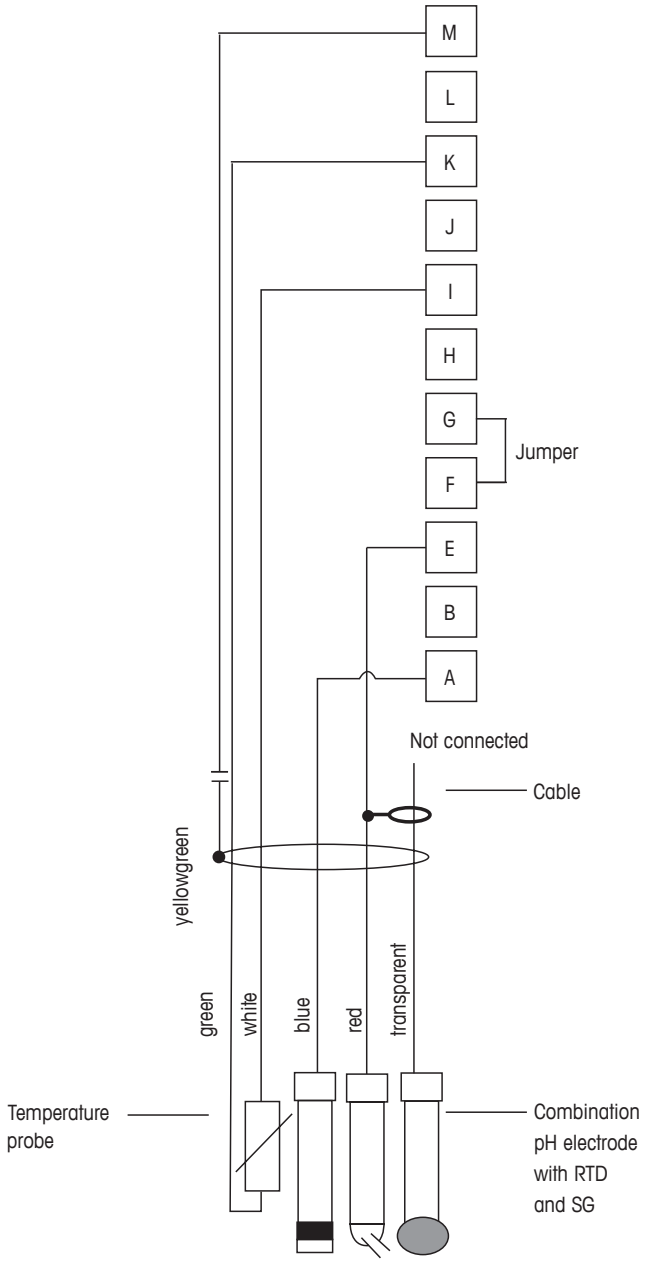


Note: Jumper terminal G and F

A. Platinum
E. Reference
I. RTD ret/GND
K. RTD
M. Shield (GND)

4.8.2.4 Example 4

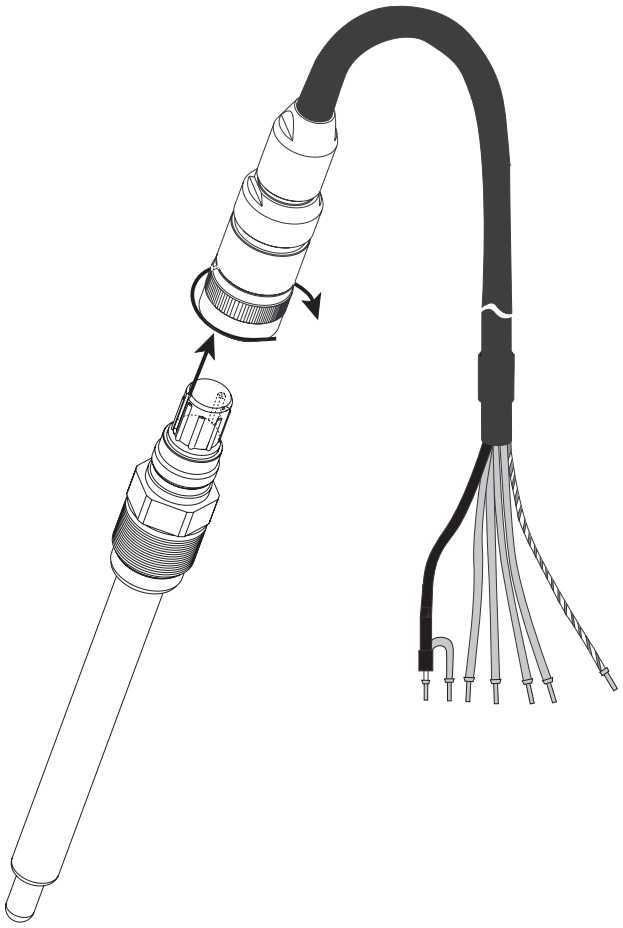
ORP measurement with pH solution ground electrode (e.g. InPro 3250, InPro 4800 SG).



Note: Jumper terminal G and F

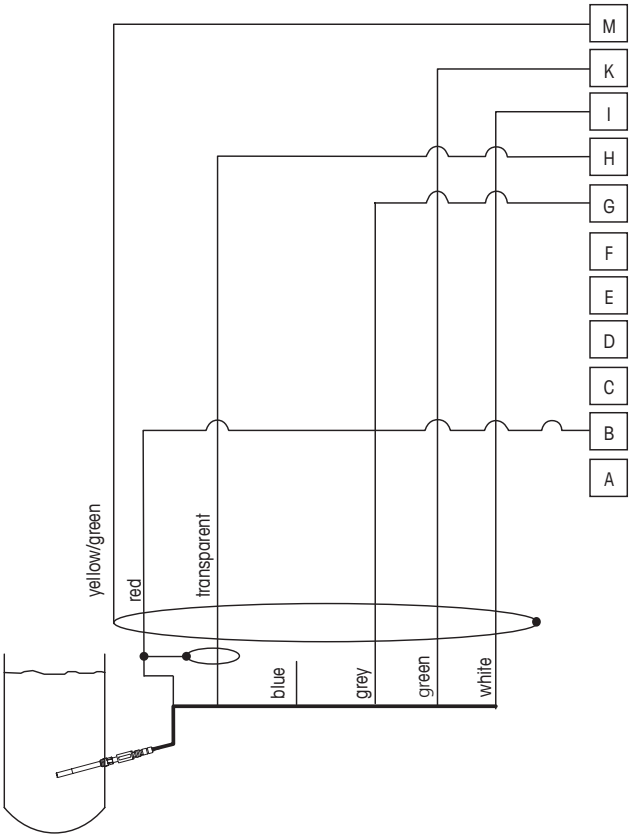
A. Platinum
E. Reference
I. RTD ret/GND
K. RTD
M. Shield (GND)

4.8.3 Connection of Analog Sensor for Amperometric Oxygen Measurement



Note: Be sure to observe the sensor instruction manual.

4.8.4 TB2 – Typical Wiring for Analog Sensor for Amperometric Oxygen Measurement



Note: Wire colors only valid for connection with VP cable, but not connected.

M400 connector:
B. Anode
G. Reference
H. Cathode
I. NTC ret/Guard
K. NTC
M. Shield (GND)

5 Placing Transmitter In, or Out of Service

5.1 Placing Transmitter in Service

After connecting the transmitter to power supply circuit, it will be active as soon as the circuit is powered.

5.2 Placing Transmitter out of Service

First disconnect the unit from the main power source, then disconnect all remaining electrical connections. Remove the unit from the wall/panel. Use the installation instruction in this manual as reference for dis-assembling mounting hardware.

Saved transmitter settings in memory are non volatile.

6 Calibration

PATH: ⌂ \ Cal

Note: During calibration, the outputs for the corresponding channel will default to be held at their current values until 20 seconds after the calibration menu is exited. A flashing H appears in the upper right corner of the display while outputs are held. Refer to chapter 7.3 "Analog Outputs" on page 59 and chapter 7.4 "Set Points" on page 60 to change the HOLD output status.

6.1 Sensor Calibration

PATH: ⌂ \ Cal \ Calibrate Sensor

6.1.1 Select the Desired Sensor Calibration Task

For analog sensors depending on sensor type, the following choices are available:

Analog sensor	Calibration task
pH	pH, mV, Temperature, Edit, Verify
Conductivity	Conductivity, Resistivity, Temperature, Edit, Verify
Amp. Oxygen	Oxygen, Temperature, Edit, Verify

For ISM (digital) sensors depending on sensor type, the following choices are available:

ISM sensor	Calibration task
pH	pH, ORP, Temperature[1)], Verify
Conductivity	Conductivity, Resistivity, Verify
Amp. Oxygen	Oxygen, Verify
Opt. Oxygen	Oxygen, Verify
Carbon Dioxide	Carbon dioxide, Verify

1) Depending on ISM firmware version.

6.1.2 Terminate Sensor Calibration

After every succesful calibration different options are available. If "Adjust", "SaveCal" or "Calibrate" is chosen, the message "Calibration saved successfully!" is displayed. Press "Done" to return to the measuring mode.

Option	Analog sensors	ISM (digital) sensors
Analog sensors: **SaveCal** **ISM sensors:** **Adjust**	Calibration values are stored in the transmitter and used for the measurement. Additionally, the calibration values are stored in the calibration data.	Calibration values are stored in the sensor and used for the measurement. Additionally, the calibration values are stored in the calibration history.
Calibrate	The function "Calibrate" is not applicable for analog sensors.	Calibration values are stored in the calibration history for documentation, but not be used for the measurement. The calibration values from the last valid adjustment are further used for the measurement.
Cancel	Calibration values are discarded.	Calibration values are discarded.

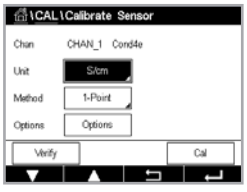
6.2 Calibration of Cond 2e Sensors or Cond 4e Sensors

PATH: ⌂ \ Cal \ Calibrate Sensor

The M400 provides the ability to perform a 1-point, 2-point or process conductivity or resistivity calibration for 2-e-sensors and 4-e-sensors.

Note: When performing calibration on a conductivity sensor, results will vary depending on the method, calibration apparatus and/or quality of reference standards used to perform the calibration.

Note: For measuring tasks the temperature compensation for the application as defined through the parameter settings for conductivity will be considered and not the temperature compensation selected through the calibration procedure (see chapter 7.1.3.1 "Conductivity Settings" on page 54).



The following menus can be called up:

Unit: Between the units for conductivity and resistivity can be chosen.
Method: Select the desired calibration procedure, 1-point, 2-point or process calibration.
Options: The desired compensation mode for the calibration process can be selected. Choices are "None", "Standard", "Light 84", "Std 75 °C". "Linear 25 °C", "Linear 20 °C", "Glycol1", "Cation", "Alcohol" and "Ammonia" **Glycol.5**.

None does not make any compensation of the measured conductivity value. The uncompensated value will be displayed and proceeded.

Standard compensation includes compensation for non-linear purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.

Light 84 compensation matches the high purity water search results of Dr. T. S. Light published in 1984. Use only if your situation has standardized on that work.

Std 75 °C compensation is the **Standard** compensation algorithm referenced to 75 °C. This compensation may be preferred when measuring Ultrapure Water at an elevated temperature (Resistivity of ultrapure water compensated to 75 °C is 2.4818 Mohm-cm).

Linear 25 °C compensation adjusts the reading by a coefficient o factor expressed as %/°C (deviation from 25 °C). Use only if the solution has a well-characterized linear temperature coefficient. The factor default setting is 2.0 %/°C.

Linear 20 °C compensation adjusts the reading by a coefficient or factor expressed as %/°C (deviation from 20 °C). Use only if the solution has a well-characterized linear temperature coefficient. The factory default setting is 2.0 %/°C.

Glycol.5 compensation matches the temperature characteristics of 50 % ethylene glycol in water. Compensated measurements using this solution may go above 18 Mohm-cm.

Glycol 1 compensation matches the temperature characteristics of 100 % ethylene glycol. Compensated measurements may go well above 18 Mohm-cm.

Alcohol compensation provides for the temperature characteristics of a 75 % solution of isopropyl alcohol in pure water. Compensated measurements using this solution may go above 18 Mohm-cm.

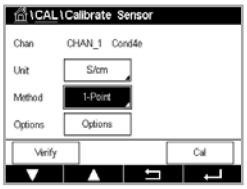
Nat H_2O compensation: includes compensation to 25 °C according to EN27888 for natural water.

Note: If compensation mode "Linear 25 °C" or "Linear 20 °C" has been chosen, the coefficient for the adjustment of the reading can be modified.

The changes are valid until the calibration mode has been exited. After the values defined in the configuration menu are valid again.

6.2.1 One-Point Calibration

With 2-e-sensors or 4-e-sensors a 1-point calibration is always performed as a slope calibration. The following procedure shows the calibration with a 2-e-sensor. The calibration with a 4-e-sensor works respectively.



Press the button Cal for starting calibration.

Place the electrode in the reference solution and press Next button.

Enter the value for the calibration point (**Point 1**).

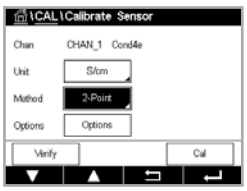
Press the Next button to start the calculation of the calibration results.

The display shows the value for the slope and the offset as the result of the calibration.

For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.2.2 Two-Point Calibration

With 2-e-sensors or 4-e-sensors a 2-point calibration is always performed as an offset and slope calibration. The following procedure shows the calibration with a 2-e-sensor. The calibration with a 4-e-sensor works respectively.



Press the button Cal for starting calibration.

Place the electrode in the first reference solution and press Next button.

Caution: Rinse sensors with a high-purity water solution between calibration points to prevent contamination of the reference solutions.

Enter the value for the first calibration point (**Point 1**).

Press the Next button to go on with the calibration.

Place the electrode in the second reference solution and press Next button.

Enter the value for the second calibration point (**Point 2**).

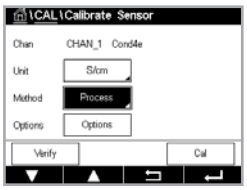
Press the Next button to start the calculation of the calibration results.

The display shows the value for the slope and the offset as the result of the calibration.

For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.2.3 Process Calibration

With 2-e-sensors or 4-e-sensors a process calibration is always performed as a slope calibration. The following procedure shows the calibration with a 2-e-sensor. The calibration with a 4-e-sensor works respectively.



Press the button Cal for starting calibration.

Take a sample and press the Done button to store the current measuring value. To show the ongoing calibration process, P is blinking in the Start and Menu screen if the related channel is selected in the display.

After determining the conductivity value of the sample, press the calibration icon in the Menu Screen again.

Press the input field for **Point 1** and enter the conductivity value of the sample. Press the Next button to start the calculation of the calibration results.

The calibration values are stored in the calibration history. To save (press button SaveCal) or to discard (press button Cancel). Use the Back button to go one step back in the calibration procedure The display shows the value for the slope and the offset as the result of the calibration.

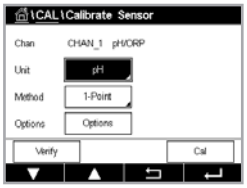
For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.3 pH Calibration

PATH: ⌂ \ Cal \ Calibrate Sensor

For pH sensor the M400 Transmitter features 1-point, 2-point or process calibration with preset buffer sets or manual buffer entry. Buffer values refer to 25 °C. To calibrate the instrument with automatic buffer recognition, you need a standard pH buffer solution that matches one of these values. Please select the correct buffer table before using automatic calibration (see chapter 15 "Buffer Tables" on page 99). The stability of the sensor signal during calibration can be checked by the user or automatically by the transmitter (see chapter 7.1.3.2 "pH Settings" on page 55).

☞ **Note:** For dual membrane pH electrodes (pH/pNa) only buffer Na+ 3.9M is available.

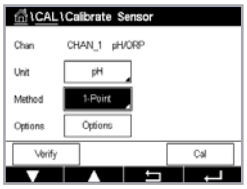


The following menus can be called up:

Unit: Select pH.
Method: Select the desired calibration procedure, 1-point, 2-point or process calibration.
Options: The buffer used for the calibration and the required stability of the sensor signal during the calibration can be selected (see also chapter 7.1.3.2 "pH Settings" on page 55). The changes are valid until the calibration mode has been escaped. After the values defined in the configuration menu are valid again.

6.3.1 One-Point Calibration

With pH sensors a 1-point calibration is always performed as an offset calibration.



Press the button Cal for starting calibration.

Place the electrode in the buffer solution and press the Next button.

The display shows the buffer the transmitter has recognized **Point 1** and the measured value.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

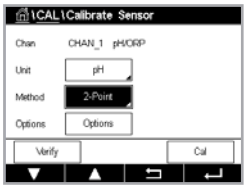
Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

The transmitter shows the value for the slope and the offset as the result of the calibration.

For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.3.2 Two-Point Calibration

With pH sensors a 2-point calibration is always performed as calibration of slope and offset.



Press the Cal button to start calibration.

Place the electrode in buffer solution 1 and press Next button.

The display shows the buffer the transmitter has recognized **Point 1** and the measured value.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

The transmitter prompts you to place the electrode in the second buffer solution.

Press the Next button to proceed with the calibration.

The display shows the buffer the transmitter has recognized **Point 2** and the measured value.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

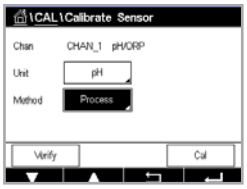
Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

The transmitter shows the value for the slope and the offset as the result of the calibration.

For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.3.3 Process Calibration

With pH sensors a process calibration is always performed as an offset calibration.



Press the Cal button to start calibration.

Take a sample and press the ↵ button to store the current measuring value. To show the ongoing calibration process, P is blinking in the Start and Menu Screen if the related channel is selected in the display.

After determining the pH value of the sample, press the calibration icon in the Menu Screen again.

Enter the pH value of the sample. Press the Next button to start the calculation of the calibration results.

The display shows the value for the slope and the offset as the result of the calibration.

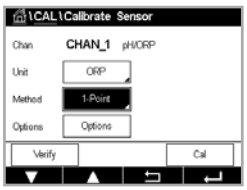
For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.4 ORP Calibration of pH Sensors

PATH: ⌂ \ Cal \ Calibrate Sensor

For pH sensors with solution ground based on ISM technology the M400 Transmitter gives the option to make, in addition to the pH calibration, an ORP calibration.

Note: In case of choosing ORP calibration the parameters defined for pH will not be considered. For pH sensors, the M400 Transmitter features 1-point calibration or process calibration for ORP.



The following menus can be called up:

Unit: Select ORP through pressing the corresponding field.
Options: Select the desired stability, "Manual, Low, Medium, Strict".
Method: 1-Point calibration is displayed or process calibration is displayed.

Press the button Cal for starting calibration.

Enter the value for calibration point 1 (**Point 1**). If select process calibration, jump to next button.

Press the Next button to start the calculation of the calibration results.

The display shows the value for the slope and the offset as the result of the calibration.

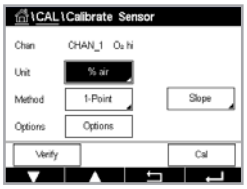
For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.5 Calibration of Amperometric Oxygen Sensors

PATH: ⌂ \ Cal \ Calibrate Sensor

The M400 provides the ability to perform a 1-point or process calibration for amperometric oxygen sensors.

Note: Before air calibration, for highest accuracy, enter the barometric pressure and relative humidity, as described in chapter 7.1.3.3 "Settings for Oxygen Measurement Based on Amperometric Sensors" on page 56.

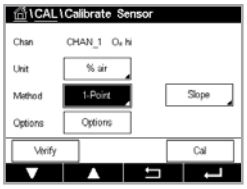


The following menus can be called up:

Unit: Between several units for Dissolved Oxygen can be chosen.
Method: Select the desired calibration procedure, 1-point or process calibration.
Options: In case the method 1-point has been chosen the calibration pressure, relative humidity and - for slope calibration - the stability mode for the sensor signal during the calibration can be selected. For the method Process the values for the process pressure, calibration pressure and the parameter ProcCalPress can be modified. See also chapter 7.1.3.3 "Settings for Oxygen Measurement Based on Amperometric Sensors" on page 56. The changes are valid until the calibration mode has been escaped. After the values defined in the configuration menu are valid again.

6.5.1 One-Point Calibration

A 1-point calibration of oxygen sensors is always either a 1-point slope (i.e. with air) or a zero (offset) calibration. A 1-point slope calibration is done in air and a 1-point offset calibration is done at 0 ppb oxygen. A 1-point zero dissolved oxygen calibration is available but not normally recommended since zero oxygen is very hard to achieve. A zero-point calibration is only recommended if high accuracy at low oxygen level (below 5 % air) is needed.



Choose Slope or Offset calibration through pressing the corresponding field.

Press the button Cal for starting calibration.

Note: If the polarization voltage for the measuring mode and calibration mode is different, the transmitter will wait 120 seconds before starting the calibration. In this case the transmitter will also go after the calibration for 120 seconds to the HOLD Mode, before returning to the measuring mode again.

Place the sensor in air or the calibration gas and press Next button.

Enter the value for the calibration point (**Point 1**).

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

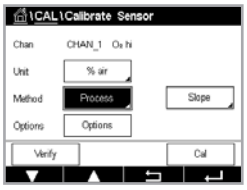
Note: For an offset calibration the Auto mode is not available. If Auto mode has been chosen and afterwards slope calibration has been changed to offset calibration, the transmitter will perform the calibration in Manual mode.

The transmitter shows the value for the slope and the offset as the result of the calibration.

For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.5.2 Process Calibration

A process calibration of oxygen sensors is either a slope or an offset calibration.



Choose Slope or Offset calibration through pressing the corresponding field.

Press the Cal button to start calibration.

Take a sample and press the ↵ button to store the current measuring value. To show the ongoing calibration process, P is blinking in the Start and Menu screen if the related channel is selected in the display.

After determining the oxygen value of the sample, press the calibration icon in the Menu Screen again.

Enter the oxygen value of the sample. Press the Next button to start the calculation of the calibration results.

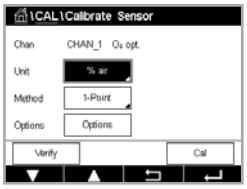
The display shows the value for the slope and the offset as the result of the calibration. For ISM (digital) sensors select "Adjust", "Calibrate" or "Cancel" to finish calibration. For Analog sensors select "SaveCal" or "Cancel" to finish calibration.

6.6 Calibration of Optical Oxygen Sensors

PATH: ⌂ \ Cal \ Calibrate Sensor

Oxygen calibration for optical sensors can be performed as a 2-point, process or, depending on the sensor model connected to the transmitter, also as a 1-point calibration.

Note: Before air calibration, for highest accuracy, enter the barometric pressure and relative humidity, as described in chapter 7.1.3.4 "Settings for Oxygen Measurement Based on Optical Sensors" on page 57.



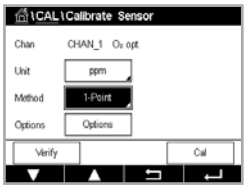
The following menus can be called up:

Unit: Between several units can be chosen. The units are displayed during the calibration.
Method: Select the desired calibration procedure, 1-point, 2-point or process calibration.
Options: In case the method 1-point has been chosen the calibration pressure, relative humidity and the stability mode for the sensor signal during the calibration can be selected. For the method Process the values for the process pressure, calibration pressure, the parameter ProcCalPress and the mode of the process calibration can be modified. See also chapter 7.1.3.4 "Settings for Oxygen Measurement Based on Optical Sensors" on page 57. The changes are valid until the calibration mode has been escaped. After the values defined in the configuration menu are valid again.

6.6.1 One-Point Calibration

Typically a 1-point calibration is done in air. Nevertheless other calibration gases and solutions are possible.

The calibration of an optical sensor is always a calibration of the phase of the fluorescence signal towards the internal reference. During a 1-point calibration the phase in this point is measured and extrapolated over the measuring range.



Press the button Cal for starting calibration.

Place the sensor in air or the calibration gas and press Next button

Enter the value for the calibration point (**Point 1**).

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

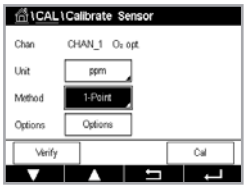
The transmitter shows the value for the phase of the sensor at 100% air (P100) and at 0% air (P0) as the result of the calibration.

Press the Adjust button to perform the calibration and store the calculated values in the sensor. Press the Calibrate button to store the calculated values in the sensor. Calibration is not performed. Press the Cancel button to terminate the calibration.

If "Adjust" or "Calibrate" are chosen, the message "Calibration Saved Successfully!" is displayed. In either case you will see the message "Please re-install sensor".

6.6.2 Two-Point Calibration

The calibration of an optical sensor is always a calibration of the phase of the fluorescence signal towards the internal reference. A 2-point calibration is a combination of first a calibration in air (100%) where a new phase P100 is measured and then a calibration in nitrogen (0%) where a new phase P0 is measured. This calibration routine gives the most accurate calibration curve over the whole measuring range.



Press the Cal button to start calibration.

Place the sensor in air or the calibration gas and press Next button.

Enter the value for the first calibration point (**Point 1**).

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

The transmitter prompts you to change the gas.

Press the Next button to proceed with the calibration.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

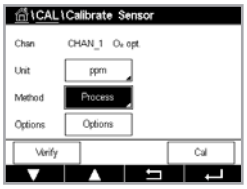
Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

The transmitter shows the value for the phase of the sensor at 100% air (P100) and at 0% air (P0) as the result of the calibration.

Press the Adjust button to perform the calibration and store the calculated values in the sensor. Press the Calibrate button to store the calculated values in the sensor. Calibration is not performed. Press the Cancel button to terminate the calibration.

If "Adjust" or "Calibrate" are chosen, the message "Calibration Saved Successfully!" is displayed. In either case you will see the message "Please re-install sensor".

6.6.3 Process Calibration



Press the Cal button to start calibration.

Take a sample and press the ↵ button to store the current measuring value. To show the ongoing calibration process, P is blinking in the start and Menu Screen if the related channel is selected in the display.

After determining the oxygen value of the sample, press the calibration icon in the Menu Screen.

Enter oxygen value of the sample. Press the Next button to start the calculation of the calibration results.

The display shows now the values for the phase of the sensor at 100% air (P100) and at 0% (P0) air.

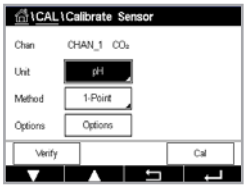
Press the Adjust button to perform the calibration and store the calculated values in the sensor. Press the Calibrate button to store the calculated values in the sensor. Calibration is not performed. Press the Cancel button to terminate the calibration.

Note: If for process calibration Scaling has been chosen (see chapter 7.1.3.4 "Settings for Oxygen Measurement Based on Optical Sensors" on page 57) the calibration values are not stored in the calibration history.

If "Adjust" or "Calibrate" are chosen, the message "Calibration Saved Successfully!" is displayed.

6.7 Calibration of Dissolved Carbon Dioxide Sensors

For dissolved carbon dioxide (CO_2) sensors, the M400 Transmitter features 1-point, 2-point or process calibration. For the 1-point or 2-point calibration the solution with pH = 7.00 and/or pH = 9.21 of the Mettler – 9 standard buffer can be used (see chapter 7.1.3.5 "Dissolved Carbon Dioxide Settings" on page 58) or the buffer value can be entered manually.

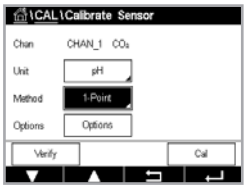


The following menus can be called up:

Unit: Between several units for partial pressure, and dissolved carbon dioxide can be selected.
Method: Select the desired calibration procedure, 1-point or 2-point and process calibration.
Options: The buffer used for the calibration and the required stability of the sensor signal during the calibration can be selected (see chapter 7.1.3.5 "Dissolved Carbon Dioxide Settings" on page 58). The changes are valid until the calibration mode has been escaped. After the values defined in the configuration menu are valid again.

6.7.1 One-Point Calibration

With CO_2 sensors a 1-point calibration is always performed as an offset calibration.



Press the button Cal for starting calibration.

Place the electrode in the buffer solution and press the Next button.

The display shows the buffer the transmitter has recognized Point 1 and the measured value.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If **option** Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

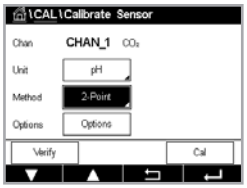
The transmitter shows the value for the slope and the offset as the result of the calibration.

Press the Adjust button to perform the calibration and store the calculated values in the sensor. Press the Calibrate button to store the calculated values in the sensor. Calibration is not performed. Press the Cancel button to terminate the calibration.

If "Adjust" or "Calibrate" are chosen, the message "Calibration Saved Successfully!" is displayed. In either case you will get the message "Please re-install sensor".

6.7.2 Two-Point Calibration

With CO_2 sensors a 2-point calibration is always performed as calibration of slope and offset.



Press the Cal button to start calibration.

Place the electrode in buffer solution 1 and press Next button.

The display shows the buffer the transmitter has recognized **Point 1** and the measured value.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If option Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

The transmitter prompts you to place the electrode in the second buffer solution.

Press the Next button to proceed with the calibration.

The display shows the buffer the transmitter has recognized **Point 2** and the measured value.

The M400 checks the stability of the measuring signal and proceeds as soon as the signal is sufficiently stable.

Note: If option Stability is set to Manual press 'Next' after the measuring signal is stable enough to go on with the calibration.

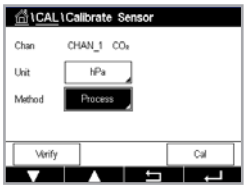
The transmitter shows the value for the slope and the offset as the result of the calibration.

Press the Adjust button to perform the calibration and store the calculated values in the sensor. Press the Calibrate button to store the calculated values in the sensor. Calibration is not performed. Press the Cancel button to terminate the calibration.

If "Adjust" or "Calibrate" are chosen, the message "Calibration Saved Successfully!" is displayed. In either case you will see the message "Please re-install sensor".

6.7.3 Process Calibration

With CO_2 sensors a process calibration is always performed as an offset calibration.



Press the Cal button to start calibration.

Take a sample and press the ↵ button to store the current measuring value. To show the ongoing calibration process, P is blinking in the Start and Menu Screen if the related channel is selected in the display.

After determining the corresponding value of the sample, press the calibration icon in the Menu Screen again.

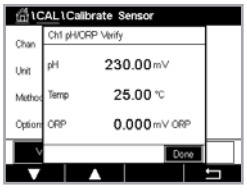
Enter the value of the sample. Press the Next button to start the calculation of the calibration results.

The display shows the value for the slope and the offset as the result of the calibration.

Press the Adjust button to perform the calibration and store the calculated values in the sensor. Press the Calibrate button to store the calculated values in the sensor. Calibration is not performed. Press the Cancel button to terminate the calibration. If "Adjust" or "Calibrate" are chosen, the message "Calibration Saved Successfully!" is displayed.

6.8 Sensor Verification

Enter the menu Calibrate Sensor (see chapter 6.1 "Sensor Calibration" on page 35; PATH: ⌂ \ Cal \ Calibrate Sensor) and choose the desired channel for verification.



Press the Verify button to start verification.

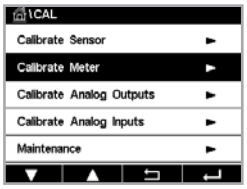
The measured signal of the primary and the secondary measurement in basic (mostly electrical) units are shown. The meter calibration factors are used when calculating these values.

Press the ↵ button and the transmitter returns to the calibration menu.

6.9 Meter Calibration (Analog Sensors Only)

Although it is not normally necessary to perform meter re-calibration unless extreme conditions cause an out of spec operation shown by Calibration Verification, periodic verification/re-calibration may be necessary to meet Q.A. requirements. The frequency calibration requires a 2-point calibration. It is recommended that point one be at the low end of the frequency range and point two at the high end.

Press the Cal button.



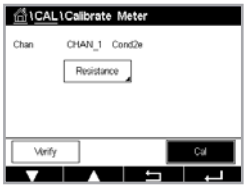
Enter menu Calibrate Meter.

6.9.1 Resistance (Analog Sensors Only)

The meter is equipped with five (5) internal ranges of measurement. Each resistance range and temperature is calibrated separately, with each resistance range consisting of a 2-point calibration.

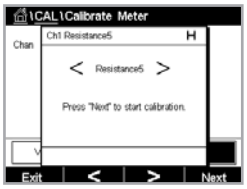
Below is a table showing the resistance values for all calibration ranges.

Range	Point 1	Point 2	Point 4
Resistivity 1	1.0 Mohms	10.0 Mohms	–
Resistivity 2	100.0 Kohms	1.0 Mohms	–
Resistivity 3	10.0 Kohms	100.0 Kohms	–
Resistivity 4	1.0 Kohms	10.0 Kohms	–
Resistivity 5	100 Ohms	1.0 Kohms	–
Temperature	1000 Ohms	3.0 Kohms	66 Kohms

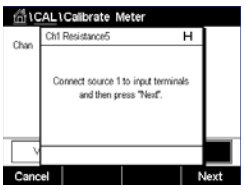


Press the input field in the second line to select Resistance.

Press the Cal button.

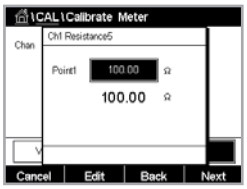


Press the Next button to start the calibration process.



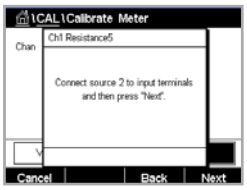
Connect source 1 to input terminals. Each resistance range consists of a 2-point calibration.

Press the Next button to continue.



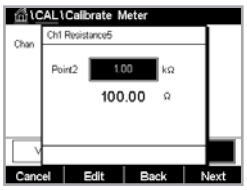
Press input field for Point 1 to enter the calibration point. The M400 displays a keypad for modifying the value. Press the ↵ button and the transmitter will take over the value.

The second line shows the current value.



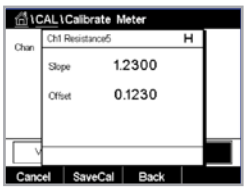
Connect source 2 to input terminals.

Press the Next button to continue.



Press input field for Point 2 to enter the calibration point. The M400 displays a keypad for modifying the value. Press the Edit button to accept the value.

The second line shows the current value.



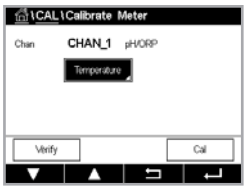
The display shows the value for the slope and the offset as the result of the calibration.

Select "SaveCal" or "Cancel" to finish calibration.

Use the Back button to go one step back in the calibration procedure.

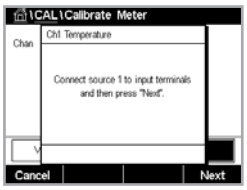
6.9.2 Temperature (for Analog Sensors)

Temperature is performed as a three point calibration. The table in chapter 6.9.1 "Resistance (Analog Sensors Only)" on page 47 shows the resistance values of these three points.

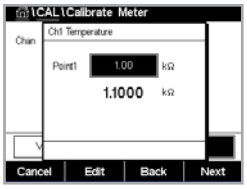


Press the input field in the second line to select Temperature.

Press the Cal button.

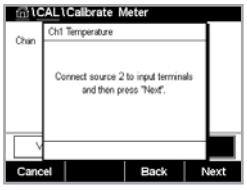


Connect source 1 to input terminals. Press the Next button to start the calibration process.



Press input field for Point 1 to enter the calibration point. The M400 displays a keypad for modifying the value. Press the Edit button and the transmitter will take over the value.

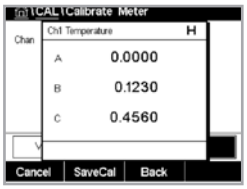
The second line shows the current value.



Connect source 2 to input terminals.

Press the Next button to continue.

Repeat the calibration procedure for Point 2 and Point 3 as for Point 1.



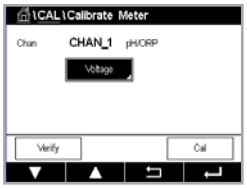
The display shows the result of the calibration.

Select "SaveCal" or "Cancel" to finish calibration. See chapter 6.1.2 "Terminate Sensor Calibration" on page 36.

Use the Back button to go one step back in the calibration procedure.

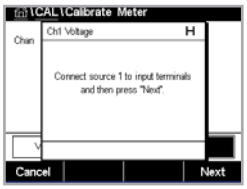
6.9.3 Voltage (Analog Sensors Only)

Voltage calibration is performed as a 2-point calibration.

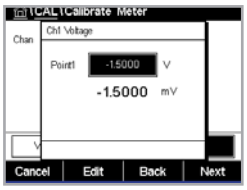


Press the input field in the second line to select Temperature.

Press the Cal button.

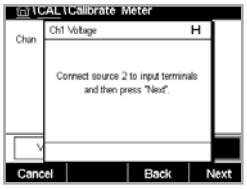


Connect source 1 to input terminals. Press the Next button to start the calibration process.



Press input field for Point 1 to enter the calibration point. The M400 displays a keypad for modifying the value. Press the ↵ button to accept the value.

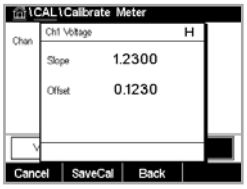
The second line shows the current value.



Connect source 2 to input terminals.

Press the Next button to continue.

Repeat the calibration procedure for Point 2 and Point 3 as for Point 1.



The display shows the result of the calibration.

For Analog sensors select "SaveCal" or "Cancel" to finish calibration. See chapter 6.1.2 "Terminate Sensor Calibration" on page 36.

Use the Back button to go one step back in the calibration procedure.

6.9.4 Current (Analog Sensors Only)

Current calibration is performed as a 2-point calibration.

Perform current calibration according to chapter 6.9.3 "Voltage (Analog Sensors Only)" on page 50.

6.9.5 Rg (Analog Sensors Only)

Rg Diagnostic calibration is performed as a 2-point calibration.

Perform current calibration according to chapter 6.9.3 "Voltage (Analog Sensors Only)" on page 50.

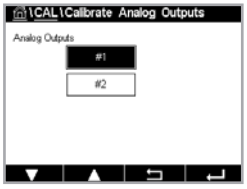
6.9.6 Rr (Analog Sensors Only)

Rr Diagnostic calibration is performed as a 2-point calibration.

Perform current calibration according to chapter 6.9.3 "Voltage (Analog Sensors Only)" on page 50.

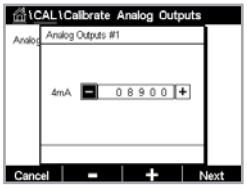
6.10 Analog Output Calibration

PATH: ⌂ \ CAL \ Calibrate Analog Outputs



Each analog output can be calibrated at 4 and 20 mA. Select the desired output signal for calibration by pressing the #1 button for output signal 1, #2 for output signal 2, etc.

Connect an accurate milliamp meter to the analog output terminals and then adjust the 5-digit number in the display until the milliamp meter reads 4.00 mA and repeat for 20.00 mA.



As the 5-digit number is increased the output current increases and as the number is decreased the output current decreases. Long Press + or – can quickly change number.

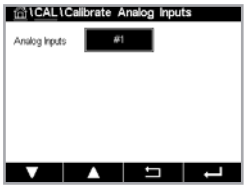
After adjusting both values press the Next button to start the calculation of the calibration results.

The display shows the calibration slope and zero point as the result of the output signal calibration.

Select "SaveCal" or "Cancel" to finish calibration. See chapter 6.1.2 "Terminate Sensor Calibration" on page 36.

6.11 Analog Input Calibration

PATH: ⌂ \ CAL \ Calibrate Analog Inputs



Analog input can be calibrated at 4 and 20 mA by pressing the #1 button.

Connect an 4 mA signal to the analog input terminals. Press the Next button.

Enter the right value for the input signal (**Point 1**).

Press the Next button to go on with the calibration.

Connect an 20 mA signal to the analog input terminals. Press the Next button.

Enter the right value for the input signal (**Point 2**)

Press the Next button to go on with the calibration.

The display shows the calibration slope and zero point as the result of the input signal calibration.

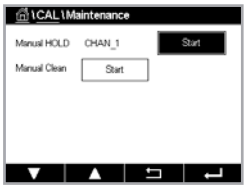
Selecting Cancel will discard the entered values. Pressing SaveCal will making the entered values the current ones.

If "SaveCal" is chosen, "Calibration Saved Successfully" is displayed.

6.12 Maintenance

PATH: ⌂ \ CAL \ Maintenance

The different channels of the M400 Transmitter can be switched manually into HOLD state. Furthermore a cleaning cycle can be started/stopped manually.



Press Start button for **Manual HOLD** to activate the HOLD state for the selected channel. To deactivate the HOLD state again, press the Stop button, which is now displayed instead of the Start button.

Press the Start button for **Manual Clean** to switch the cleaning OC to the state for starting a cleaning cycle. To switch back the OC press the Stop button, which is now displayed instead of the Start button.

If not setup OC in CONFIG\Clean, here it shows a warning "OC not set,cannot start clean."

7 Configuration

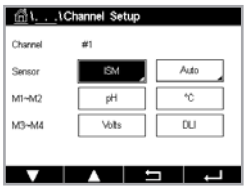
For the menu structure refer to chapter 3.2 "Menu Structure" on page 13.

7.1 Measurement

PATH: ⌂ \ CONFIG \ Meas

7.1.1 Channel Setup

PATH: ⌂ \ CONFIG \ Meas \ Channel Setup



Press the right input field in the line of the setting for **the transmitter**. A parameter for the corresponding channel is chosen through pressing the according field.

If Auto is selected, M400 Transmitter automatically recognizes the ISM sensor type. The channel can also be fixed to a certain measurement parameter, depending on the type of transmitter.

7.1.2 MIX (Analog & ISM) and ISM Transmitter

	M400 2(X)H Type2		**M400 2(X)H Type3**	
	Analog	**ISM**	**Analog**	**ISM**
pH/ORP	•	•	•	•
pH/pNa	–	•	–	•
Conductivity 2-e	•	–	•	–
Conductivity 4-e	•	•	•	•
Amp. O_2 ppm/ppb/trace	•/•/•	•/•/•	•/•/•	•/•/•
Amp. O_2 gas ppm/ppb/trace	–	–	•/•/•	•/•/•
Opt. O_2 ppm/ppb	•/•	•/•	•/•	•/•
Opt. O_2 gas ppm	–	–	•	•
Dissolved carbon dioxide (pharma)	–	•	–	•

Select sensor type Analog or ISM.
Available measurement types depend on transmitter type.

If an ISM sensor is connected, the transmitter automatically (Parameter = Auto) Recognizes the type of sensor. You can also fix the transmitter to a certain measurement parameter e.g."pH", depending on the type of transmitter you have.

Enter the name with a maximum length of 6 characters for the channel through pressing the input field in the line **Descriptor**. The name of the channel will always be displayed. The name will also be displayed on the Start Screen and Menu Screen.

Choose one of the measurements **M1 to M4** (e.g. for measuring value M1 the left button, for measuring M2 the right button in the corresponding line).

Select in the input field for **Measurement** the desired parameter to show.

Note: Beside the parameters pH, O_2, T, etc. also the ISM values DLI, TTM[1)] and ACT can be linked to the measurements.

Choose **Range factor** of the measuring value. Not all parameters allow a modification of the range.

The menu **Resolution** allows the setting of the resolution for the measurement. The accuracy of the measurement is not effected by this setting. Possible setting are 1, 0.1, 0.01, 0.001.

Selected the menu **Filter**. The averaging method (noise filter) for the measurement can be selected. The options are **None**, Low, Medium, High, Special (Default) and Custom.

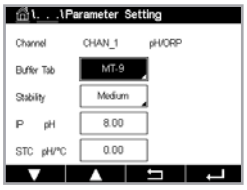
Option	Description
None	No averaging or filtering
Low	Equivalent to a 3 point moving average
Medium	Equivalent to a 6 point moving average
High	Equivalent to a 10 point moving average
Special	Averaging depending on signal change (normally High averaging, but Low averaging for large changes in input signal)
Custom	1 point to 15 points moving average selection

1) TTM availability depends on ISM firmware version

7.1.3 Parameter Related Settings

PATH: ⌂ \ CONFIG \ Meas \ Parameter Setting

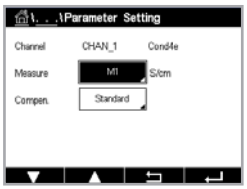
Measuring and calibration parameters can be set for the parameters pH, conductivity and oxygen.



Depending on the selected channel and assigned sensor the measuring and calibration parameters are displayed.

See the following explanation to get more details about the different parameter settings.

7.1.3.1 Conductivity Settings



Select measurement (M1-M4). For more information regarding measurements see chapter 7.1.1 "Channel Setup" on page 52.

If the selected measurement can be temperature compensated, the compensation method may be selected.

Note: During calibration, the compensation method must also be selected.

Press Compen. to select the desired temperature compensation method. Choices are "None", "Standard", "Light 84", "Std 75 °C", "Linear 25 °C", "Linear 20 °C", "Glycol.5", "Glycol1", "Cation", "Alcohol", "Ammonia", "Nat H_2O".

None does not make any compensation of the measured conductivity value. The uncompensated value will be displayed and proceeded.

Standard compensation includes compensation for non-linear high purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.

Light 84 compensation matches the high purity water research results of Dr. T.S. Light published in 1984. Use only if your institution has standardized on that work.

Std 75 °C compensation is the **Standard** compensation algorithm referenced to 75 °C. This compensation may be preferred when measuring Ultrapure Water at an elevated temperature (Resistivity of ultrapure water compensated to 75 °C is 2.4818 Mohm-cm.)

Linear 25 °C compensation adjusts the reading by a coefficient or factor expressed as %/°C (deviation from 25 °C). Use only if the solution has a well-characterized linear temperature coefficient. The factory default setting is 2.0%/°C.

Linear 20 °C compensation adjusts the reading by a coefficient or factor expressed as %/°C (deviation from 20 °C). Use only if the solution has a well-characterized linear temperature coefficient. The factory default setting is 2.0%/°C.

Glycol.5 compensation matches the temperature characteristics of 50% ethylene glycol in water. Compensated measurements using this solution may go above 18 Mohm-cm.

Glycol1 compensation matches the temperature characteristics of 100% ethylene glycol. Compensated measurements may go well above 18 Mohm-cm.

Cation compensation is used in power industry applications measuring the sample after a cation exchanger. It takes into account the effects of temperature on the dissociation of pure water in the presence of acids.

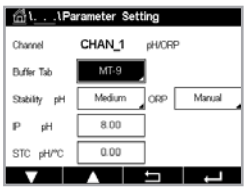
Alcohol compensation provides for the temperature characteristics of a 75% solution of isopropyl alcohol in pure water. Compensated measurements using this solution may go above 18 Mohm-cm.

Ammonia compensation is used in power industry applications for specific conductivity measured on samples using ammonia and/or ETA (ethanolamine) water treatment. It takes into account the effects of temperature on the dissociation of pure water in the presence of these bases.
Nat H_2O compensation: includes compensation to 25 °C according to EN27888 for natural water.

Note: If compensation mode "Linear 25 °C" or "Linear 20 °C" has been chosen, the coefficient for the adjustment of the reading can be modified. In this case an additional input field will be displayed.

Press the input field for **Coef.** and adjust the coefficient or factor for the compensation.

7.1.3.2 pH Settings



If a pH sensor is connected while during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameters Buffer Tab, Stability, IP, STC and calibration temperature as well as the displayed units for slope and/or zero point can be set or adjusted. The same parameters will be displayed if during the channel setup not Auto but pH/ORP has been set.

Select the buffer through the parameter **Buffer Tab**.

For automatic buffer recognition during calibration, select the buffer solution set that will be used: Mettler-9, Mettler-10, NIST Tech, NIST Std = JIS Std, HACH, CIBA, MERCK, WTW, JIS Z 8802 or **None**. See chapter 15 "Buffer Tables" on page 99 for buffer values. If the auto buffer feature will not be used or if the available buffers are different from those above, select **None**.

Note: For dual membrane pH electrodes (pH/pNa) buffer Na+ 3.9M.

Select the required **Stability** of the measuring signal during the calibration procedure. Choose manual if the user will decide when a signal is stable enough to complete the calibration. Select Low, Medium or Strict if an automatic stability control of the sensor signal during calibration through the transmitter should be done.

If the parameter stability is set to medium (default) the signal deviation has to be less than 0.8 mV over a 20 second interval to be recognized by the transmitter as stable. The calibration is done using the last reading. If the criteria is not met within 300 seconds then the calibration times out and the message "Calibration Not Done" is displayed.

Adjust the parameter **IP pH**.

IP is the isothermal point value (Default = 7.000 for most applications). For specific compensation requirements or non standard inner buffer value, this value can be changed.

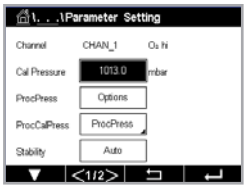
Adjust the value of the parameter **STC pH/°C**.

STC is the solution temperature coefficient in units of pH/°C referenced to the defined temperature. (Default = 0.000 pH/°C for most applications). For pure waters, a setting of −0.016 pH/°C should be used. For low conductivity power plant samples near 9 pH, a setting of −0.033 pH/°C should be used.

If the value for STC is ≠ 0.000 pH/°C an additional input field for the reference temperature will be displayed.

The value for **pH Ref Temperature** indicates to which temperature the solution temperature compensation is referenced. The displayed value and the output signal is referenced to this temperature. Most common reference temperature is 25°C.

7.1.3.3 Settings for Oxygen Measurement Based on Amperometric Sensors



If an amperometric oxygen sensor is connected while during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameters CalPressure, ProcPressure, ProcCalPress, Stability, Salinity, RelHumidity, UpolMeas and UpolCal can be set or adjusted. The same parameters will be displayed if during the channel setup not Auto but O_2 hi, or O_2 lo has been set.

Enter the value for the calibration pressure through the parameter **CalPressure**.

Note: For a modification of the unit for the calibration pressure press U on the displayed keypad.

Press the Option button for the parameter **ProcPressure** and select the how to get applying process pressure through choosing the **Type**.

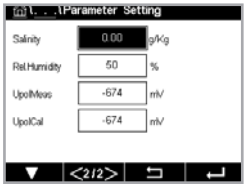
The applied process pressure can be entered by choosing Edit or measured over the analog input of the M400 by choosing Ain_1.

If Edit has been chosen an input field for entering the value manually is displayed on the screen. In case that Ain_1 has been selected two input fields are displayed to enter the start value (4 mA) and the end value (20 mA) of the range for the 4 to 20 mA input signal.

For the algorithm of the process calibration the applied pressure has to be defined. Select the pressure through the parameter **ProcCalPress**. For the process calibration the value of the process pressure (ProcPress) or the calibration pressure (CalPress) can be used.

Select the required **Stability** of the measuring signal during the calibration procedure. Choose Manual if the user will decide when a signal is stable enough to complete the calibration. Select Auto and an automatic stability control of the sensor signal during calibration through the transmitter will be done.

Additional settings can be done by navigating to the next page of the menu.



The **Salinity** of the measured solution can be modified.

In addition the relative humidity (button **Rel.Humidity**) of the calibration gas can also be entered. The allowed values for relative humidity are in the range 0% to 100%. When no humidity measurement is available, use 50% (default value).

The polarization voltage of amperometric oxygen sensors in the measuring mode can be modified through the parameter **UpolMeas**. For entered values 0 mV to – 550 mV the connected sensor will be set to a polarization voltage of – 500mV. If the entered value is less then – 550 mV, the connected sensor will set to a polarization voltage of – 674 mV.

The polarization voltage of amperometric oxygen sensors for calibration can be modified through the parameter **UpolCal**. For entered values 0 mV to – 550 mV the connected sensor will be set to a polarization voltage of – 500mV. If the entered value is less then – 550mV, the connected sensor will set to a polarization voltage of – 674mV.

Note: During a process calibration, the polarization voltage UpolMeas, defined for the measuring mode, will be used.

Note: If a 1-point calibration is executed, the transmitter sends the polarization voltage, valid for the calibration, to the sensor. If the polarization voltage for the measuring mode and calibration mode is different, the transmitter will wait 120 seconds before starting the calibration. In this case the transmitter will also go after the calibration for 120 seconds to the HOLD Mode, before returning to the measuring mode again.

7.1.3.4 Settings for Oxygen Measurement Based on Optical Sensors

If an optical oxygen sensor is connected while during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameters CalPressure, ProcPressure, ProcCalPress, Stability, Salinity, RelHumidity, Sample Rate, LED Mode and Toff can be set or adjusted. The same parameters will be displayed if during the channel setup not Auto but Optical O_2 has been set.

Enter the value for the calibration pressure through the parameter **CalPressure**.

Press the button Option for the parameter **ProcPress** and select the how to get applying process pressure through pressing the according button in the line **Type**.

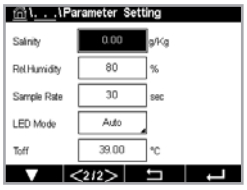
The applied process pressure can be entered by choosing Edit or measured over the analog input of the M400 by choosing AIN_1.

If Edit has been chosen an input field for entering the value manually is displayed on the screen. In case that AIN_1 has been selected two input fields are displayed to enter the start value (4mA) and the end value (20 mA) of the range for the 4 to 20 mA input signal.

For the algorithm of the process calibration the applied pressure has to be defined. Select the pressure through the parameter **ProcCal**. For the process calibration the value of the process pressure (ProcPress) and the value of the calibration pressure (CalPress) can be used. Select between Scaling and Calibration for the process calibration. If Scaling has been chosen, the calibration curve of the sensor will be untouched, but the output signal of the sensor will be scaled. In case of calibration value <1%, the offset of the sensor output signal will be modified during scaling, for value >1% the slope of the sensor output will be adjusted. For further information about scaling refer to the sensor manual.

Selecting the required **Stability** of the measuring signal during the calibration procedure. Choose Manual if the user will decide when a signal is stable enough to complete the calibration. Select Auto and an automatic stability control of the sensor signal during calibration through the transmitter will be done.

Additional settings can be done by navigating to the next page of the menu.



The **Salinity** of the measured solution can be modified.

In addition the relative humidity (button **Rel.Humidity**) of the calibration gas can also be entered. The allowed values for relative humidity are in the range 0% to 100%. When no humidity measurement is available, use 50% (default value).

Adjust the required **Sample Rate** of the optical sensor during measurement. The time interval from one measuring cycle of the sensor to the next can be adjusted i.e. adapted to the application. A higher value will increase the life time of the OptoCap of the sensor.

Select the **LED Mode** of the sensor. There are the following options.
Off: LED is permanently switched off.
On: LED is permanently switched on.

Auto: The LED is switched on as long as the measured media temperature is smaller then Toff (see next value) or switched off through a digital input signal (chapter 7.10 "Digital Inputs" on page 66).

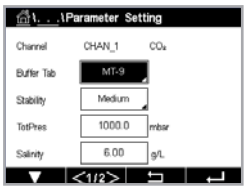
Note: If the LED is switched off, no oxygen measurement is performed.

Enter the limit for the measuring temperature to switch off the LED of the sensor automatically for the M400 through the parameter **Toff**.

If the media temperature is higher then Toff, the LED will switched off. The LED will be switched on as soon as the media temperature falls below Toff – 3 K. This function give the option to increase the lifetime of the OptoCap by switching off the LED during SIP or CIP cycles.

Note: This function is only active if the LED Mode is set to "Auto".

7.1.3.5 Dissolved Carbon Dioxide Settings



If an dissolved carbon dioxide sensor is connected while during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto or CO_2 has been chosen, the buffer used for calibration and the parameters stability, salinity, HCO_3, TotPres can be set resp. adjusted.

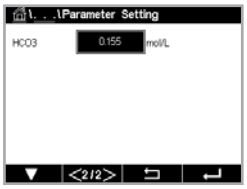
Select the buffer through the parameter **Buffer Tab**. For automatic buffer recognition during calibration, select buffer solution Mettler-9 if it will be used. If the auto buffer feature will not be used or if the available buffer are different from Mettler-9 select **None**.

Select the required **Stability** of the measuring signal during the calibration procedure. Choose manual if the user will decide when a signal is stable enough to complete the calibration. Select Low, Medium or Strict if an automatic stability control of the sensor signal during calibration through the transmitter should be done.

If the unit for the measured dissolved carbon dioxide is %sat, the pressure during the calibration resp. measurement has to be considered. This will be done by setting the parameter **TotPres**. If another unit then %sat has been selected, the result will not be influenced by this parameter.

The **Salinity** describes the total amount of solved salts in the CO_2 electrolyte of the sensor connected to the transmitter. It is a sensor specific parameter. The default value (28.00 g/L) is valid for the InPro 5000i. Do not change this parameter if the InPro 5000 i will be used.

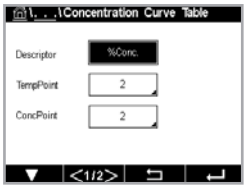
Additional settings can be done by navigating to the next page of the menu.



The parameter **HCO_3** describes the concentration of hydrogen carbonate in the CO_2 electrolyte of the sensor connected to the transmitter. It is also a sensor specific parameter. The default value 0.050 Mol/L is valid for the InPro 5000i. Do not change this parameter if the InPro 5000i will be used.

7.1.4 Concentration Curve Table

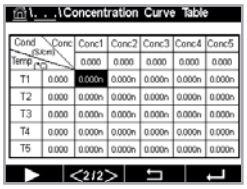
To specify a concentration curve for customer-specific solutions, up to 5 concentration values can be edited in a matrix together with up to 5 temperatures. To do so the desired values are edited under the concentration curve table menu. Beside the temperature values, the conductivity and concentration values for the corresponding temperature are edited. The concentration curve can be selected resp. used in combination with conductivity sensors.



Enter the name with a maximum length of 6 characters for the concentration curve through pressing the input field in the line **Descriptor**.

Enter the amount of desired temperature points (**TempPoint**) and concentration points (**ConcPoint**).

The different values can be entered by navigating to the next page of the menu.



Enter the values for temperature (**T1…T5**), concentration (**Conc1…Conc5**) and the corresponding conductivity through pressing the according input field. The unit for the value of the conductivity can be adjusted as well in the according input field.

Note: The values for the temperature have to increase from T1 to T2 to T3, etc. The values for the concentration have to increase from Conc1 to Conc2 to Conc3, etc.

Note: The conductivity values at the different temperatures have to increase or decrease from Conc1 to Conc2 to Conc3, etc. Maxima and/or minima are not permitted. If the conductivity values at T1 are increasing with the different concentrations, they have to increase also at the other temperatures. If the conductivity values at T1 are decreasing with the different concentrations, they have to decrease also at the other temperatures.

7.2 Temperature Source (Analog Sensors Only)

PATH: ⌂ \ CONFIG \ Meas \ Temperature Source

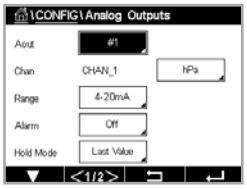
Source: Auto(default), Pt100, Pt1000, NTC22k, Fixed

If select Fixed, the third line shows the related temperature setting. Range: –40 to 200 °C, Default: 25 °C.

7.3 Analog Outputs

PATH: ⌂ \ CONFIG \ Analog Outputs

See the following explanation to get more details about the different settings for the analog outputs.



Press the input field in the line of the setting for **Aout** and select the desired output signal for configuration by pressing button #1 for output signal 1, #2 for output signal 2 etc. Press the related button for the assignment of the channel (**Chan**). Select the channel, which has to be linked to the output signal.

Press the button for the assignment of the measuring parameter – based on the selected channel – that has to be linked to the output signal.

Note: Besides the measurement values pH, O_2, T, etc. also the ISM values DLI, TTM and ACT can be linked to the output signal.

Select the **Range** for the output signal.

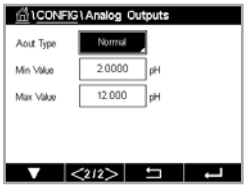
To adjust the value for the analog output signal if an alarm occurs, press the input field in the line for the setting of **Alarm**. Off means, that an alarm has now influence on the output signal.

Note: Not only the alarms occurred on the assigned channel will be considered, but every alarm coming up on the transmitter.

The value for the output signal if the transmitter goes into HOLD mode can be defined. It can be chosen between the last value (i.e. the value before the transmitter switched to the HOLD mode) or an fixed value.

Press the input field in the line for the setting of the **HOLD Mode** and select the value. If a fixed value is chosen, the transmitter shows an additional input field.

Additional settings can be done by navigating to the next page of the menu.



The **Aout Type** can be Normal. The range can be 4 – 20 mA. Normal provides linear scaling between the minimum and maximum scaling limits and is the default setting.

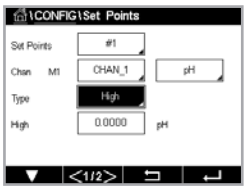
Press the button for the **Min Value**, that corresponds with start point of the analog output range.

Press the button for the **Max Value**, that corresponds with end point of the analog output signal.

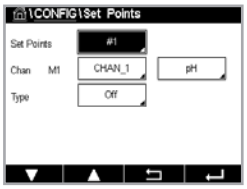
Depending on the chosen Aout type additional values can be entered.

7.4 Set Points

PATH: ⌂ \ CONFIG \ Set Points



See the following explanation to get more details about the different settings for the set points.



Press the input field in the line of the setting for **Set Point** and select the desired set point for configuration through pressing the button #1 for set point 1, #2 for set point 2 etc.

Press the related button for the assignment of the channel (**Chan**). Select the channel, which has to be linked to the set point.

Press the button for the assignment of the measuring parameter – based on the selected channel – that has be linked to the set point.

Mx in the display indicates the measurement assigned to the set point. (chapter 7.1.1 "Channel Setup").

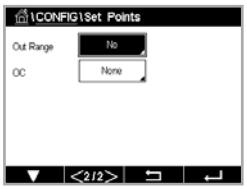
Note: Beside the parameters pH, O_2, T, mS/cm, %EP WFI etc. also the ISM values DLI, TTM and ACT can be linked to the set point.

The **Type** of the setpoint can be High, Low, Between, Outside or Off. An "Outside" setpoint will cause an alarm condition whenever the measurement goes above its high limit or below its low limit. A "Between" setpoint will cause an alarm condition to occur whenever the measurement is between its high and low limits.

Note: If the type of set point is not Off additional settings can be done. See the following description.

According to the selected type of setpoint, value(s) regarding the limit(s) can be entered.

Additional settings can be done by navigating to the next page of the menu.



Once configured an OC could be activated if a sensor Out of Range condition is detected on the assigned input channel.

To select the desired OC that will be activated if the defined conditions are reached press the input field in the line for the setting of **SP OC**. If the chosen OC is used for another task, the transmitter shows the message on the screen that there is a OC Conflict.

The operation mode of the OC can be defined.

OC contacts are in normal mode until the associated setpoint is exceeded, then the OC is activated and the contact states change. Select Inverted to reverse the normal operating state of the OC (i.e. normally open contacts are in a closed state, and normally closed contacts are in an open state, until the setpoint is exceeded).

Enter the **Delay** time in seconds. A time delay requires the setpoint to be exceeded continuously for the specified length of time before activating the OC. If the condition disappears before the delay period is over, the OC will not be activated.

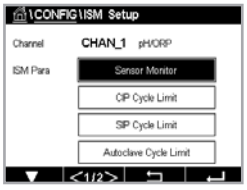
Enter the value for the **Hysteresis**. A hysteresis value requires the measurement to return within the setpoint value by a specified percentage before the OC is deactivated.

For a high setpoint, the measurement must decrease more than the indicated percentage below the setpoint value before the OC is deactivated. With a low setpoint, the measurement must rise at least this percentage above the setpoint value before the OC is deactivated. For example, with a high setpoint of 100, when this value is exceeded, the measurement must fall below 90 before the OC is deactivated.

Enter the OC **HOLD Mode** of "Off", "Last Value" or "On". This is the state of the OC during HOLD status.

7.5 ISM Setup (ISM Sensors Only)

PATH: ⌂ \ CONFIG \ ISM Setup

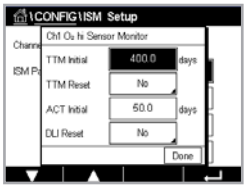


See the following explanation to get more details about the different parameter settings for the ISM Setup.

7.5.1 Sensor Monitor

If an ISM sensor is connected while during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameter Sensor Monitor can be set or adjusted. The menu Sensor Monitor will also be displayed if during the channel setup not Auto but one of the mentioned sensors has been set.

Press the button Sensor Monitor.



Enter the value for the initial Time To Maintenance interval (**TTM Initial**) in days. The initial value for TTM can be modified according to the application experience.

For amperometric oxygen sensors, the time to maintenance indicates a maintenance cycle for the membrane and electrolyte.

Press the input field for **TTM Reset**. Select Yes if Time To Maintenance (TTM) for the sensor should be reset to the initial value.

Time To Maintenance needs to be reset after the following operations.

Oxygen sensor: Manual maintenance cycle on the sensor or exchanging of the membrane of the sensor.

Note: By connecting a sensor, the actual value for TTM of the sensor is read out from the sensor.

Enter the **ACT Initial** value in days. The new value will be loaded down to the sensor after saving the changes.

The Adaptive Calibration Timer (ACT) estimates when the next calibration should be performed to keep the best possible measurement performance. The timer is influenced by significant changes on the DLI parameters. The ACT will be reset to its initial value after a successful calibration. The initial value for the ACT can be modified according to the application experience and loaded down to the sensor.

Note: By connecting a sensor, the actual value for the ACT of the sensor is read out from the sensor.

Press the input field for **DLI Reset**. Select Yes if Dynamic Lifetime Indicator (DLI) for the sensor should be reset to the initial value. The reset will be done after saving the changes.

The DLI allows an estimation, when the pH electrode, the inner body of an amperometric oxygen is at the end of its lifetime, based on the actual stress it is exposed to. The sensor permanently takes the averaged stress of the past days into consideration and is able to increase/decrease the lifetime accordingly.

The following parameters affect the lifetime indicator:

Dynamic parameter
- Temperature
- pH or oxygen value
- Glass impedance (only pH)
- Reference impedance (only pH)

Static parameters
- Calibration history
- Zero and Slope
- CIP/SIP/Autoclaving cycles

The sensor keeps the information stored in the built in electronics and can be retrieved via a transmitter or the iSense asset management suite.

For amperometric oxygen sensors, the DLI is related to the inner-body of the sensor. After exchanging the inner-body perform DLI Reset.

Note: By connecting a sensor, the actual values for the DLI of the sensor are read out from the sensor.

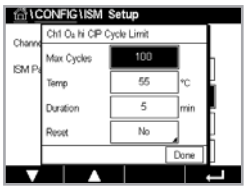
Note: The menu DLI Reset for pH sensors not available. If the actual value for the DLI of a pH sensor is 0 the sensor has to be replaced.

Note: By connecting pH 2.0 sensor, shows ACT Initial, not include TTM Initial, TTM Reset,DLI Reset

7.5.2 CIP Cycle Limit

If a pH/ORP, oxygen or conductivity sensor is connected during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameter CIP Cycle Limit can be set or adjusted. The menu CIP Cycle Limit will also be displayed if during the channel setup not Auto but one of the mentioned sensors has been set.

Press the button CIP Cycle Limit.



Press the button in the input field for the parameter **Max Cycles** and enter the value for the maximum CIP cycles. The new value will be written to the sensor after saving the changes.

The CIP cycles are counted by the transmitter. If the limit (value for Max Cycles) is reached, an alarm can be indicated and set to a certain output OCs.

If the Max Cycles setting is on 0, the counter functionality is turned off.

Press the button in the input field for the parameter **Temp** and enter the temperature, which has to be exceeded, that a CIP cycle will be counted.

CIP Cycles will be automatically recognized by the transmitter. Since CIP cycles will vary in intensity (duration and temperature) for each application the algorithm of the counter recognizes an increase of the measurement temperature above the level defined through the value for Temp. If the temperature does not decrease below the defined temperature level –10 °C within the next 5 minutes after the first temperature was reached, the counter in question will be incremented by one and also locked for the next two hours. In the case the CIP would last longer than two hours the counter would be incremented by one once more.

Press the input field for **Reset.** Select Yes if CIP counter for the sensor should be reset to 0. The reset will be done after saving the changes.

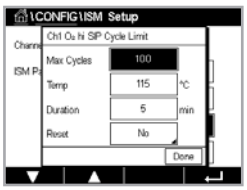
If an oxygen sensor is connected, the reset should be performed after the following operations. amperometric sensor: exchanging of the inner-body of the sensor.

Note: For pH/ORP sensor the menu Reset is not available. A pH/ORP sensor should be replaced if the number for Max Cycles has been exceeded.

7.5.3 SIP Cycle Limit

If a pH/ORP, oxygen or conductivity sensor is connected during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameter SIP Cycle Limit can be set or adjusted. The menu SIP Cycle Limit will also be displayed if during the channel setup not Auto but one of the mentioned sensors has been set.

Press the button SIP Cycle Limit.



Press the button in the input field for the parameter **Max Cycles** and enter the value for the maximum SIP cycles. The new value will be written to the sensor after saving the changes.

The SIP cycles are counted by the transmitter. If the limit (value for Max Cycles) is reached, an alarm can be indicated and set to a certain output OCs.

If the Max Cycles setting is on 0, the counter functionality is turned off.

Press the button in the input field for the parameter Temp and enter the temperature, which has to be exceeded, that the a SIP cycle will be counted.

SIP Cycles will be automatically recognized by the transmitter. Since SIP cycles will vary in intensity (duration and temperature) for each application the algorithm of the counter recognizes an increase of the measurement temperature above the level defined through the value for Temp. If the temperature does not decrease below the defined temperature level –10°C within the next 5 minutes after the first temperature was reached, the counter in question will be incremented by one and also locked for the next two hours. In the case the SIP would last longer than two hours the counter would be incremented by one once more.

Press the input field for **Reset**. Select Yes if SIP counter for the sensor should be reset to 0. The reset will be done after saving the changes.

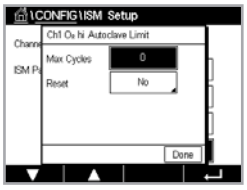
If an oxygen sensor is connected, the reset should be performed after the following operations. Amperometric sensor: exchanging of the inner-body of the sensor.

Note: For pH/ORP sensor the menu Reset is not available. A pH/ORP sensor should be replaced if the number for Max Cycles has been exceeded.

7.5.4 AutoClave Cycle Limit

If a pH/ORP, amperometric oxygen is connected during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameter AutoClave Cycle Limit can be set or adjusted. The menu AutoClave Cycle Limit will also be displayed if during the channel setup not Auto but one of the mentioned sensors has been set.

Press the button AutoClave Cycle Limit.



Press the button in the input field for the parameter **Max Cycles** and enter the value for the maximum AutoClave cycles. The new value will be written to the sensor after saving the changes.

If the Max Cycles setting is on 0, the counter functionality is turned off.

Since during the autoclaving cycle the sensor is not connected to the transmitter, you will be asked after every sensor connection, whether the sensor was autoclaved or not. According to your selection, the counter will be incremented or not. If the limit (value for Max Cycles) is reached, an alarm can be indicated and set to a certain output OC. Press the input field for **Reset**. Select Yes if the AutoClave counter for the sensor should be reset to 0. The reset will be done after saving the changes.

If an oxygen sensor is connected, the reset should be performed after the following operations. Amperometric sensor: exchanging of the inner-body of the sensor.

Note: For pH/ORP sensor the menu Reset is not available. A pH/ORP sensor should be replaced if the number for Max Cycles has been exceeded.

7.5.5 DLI Stress Adjustment

If a pH/ORP is connected during the channel setup (see chapter 7.1.1 "Channel Setup" on page 52) Auto has been chosen the parameter DLI Stress Adjustment can be adjusted. With this setting the user can adjust the sensor sensitivity to the stress of its specific application for the DLI calculation.

Browse to page 2 of "ISM Setup".

Press the button **DLI Stress Adjustment**.

Select between low/medium/high for the **Type** of DLI Stress Adjustment.

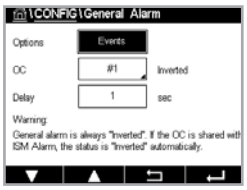
LOW: DLI extended (–30% sensitivity)
MEDIUM: standard DLI (default)
HIGH: DLI reduced (+30% sensitivity)

Press ↵ to accept the setting.

7.6 General Alarm

PATH: ⌂ \ CONFIG \ General Alarm

See the following explanation to get more details about the different settings for General Alarm.



Press the button Event in the line of the settings for **Option** and select the events, that should be considered for an alarm.

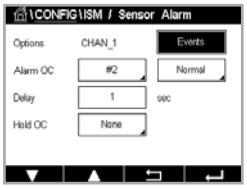
To activate a OC if the defined conditions are reached press the input field in the line for the settings of **OC**. Only OC 1 can be assigned to general alarm. For general alarms the operation mode of the assigned OC is always inverted.

Enter the **Delay** time in seconds. A time delay requires the setpoint to be exceeded continuously for the specified length of time before activating the OC. If the condition disappears before the delay period is over, the OC will not be activated.

7.7 ISM/Sensor Alarm

PATH: ⌂ \ CONFIG \ ISM \ Sensor Alarm

See the following explanation to get more details about the different settings for ISM/Sensor Alarm.



Depending on the assigned sensor the **Events** that will be considered for generating an alarm can be selected. Some alarms will be considered in any case and not have to be selected or deactivated.

To select the desired OC that will be activated if an event has taken place press the input field in the line for the settings for **OC**.

The operation mode of the OC can be defined.

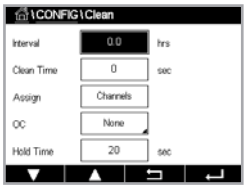
OC contacts are in normal mode until one of the selected events has taken place. Then the OC is activated and the contact states change. Select Inverted to reverse the normal operating state of the OC (i.e. normally open contacts are in a open state, and normally closed contacts are in a closed state if an event has taken place).

Enter the **Delay** time in seconds. A time delay requires the event to be occurred continuously for the specified length of time before activating the OC. If the condition disappears before the delay period is over, the OC will not be activated.

7.8 Clean

PATH: ⌂ \ CONFIG \ Clean

See the following explanation to get more details about the different settings for Clean.



Enter the cleaning **Interval** time in hours. The cleaning interval can be set from 0.000 to 99999 hours. Setting it to 0 turns the clean cycle off.

Enter the **Clean Time** in seconds. The clean time can be 0 to 9999 seconds and must be smaller than the cleaning interval.

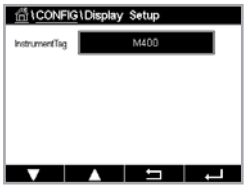
Assign the channel(s) for cleaning cycles. The assigned channels will be in HOLD state during the cleaning cycle.

Choose a **OC**. OC contacts are in normal mode until the cleaning cycle starts, then the OC is activated and the contact states change. Select Inverted to reverse the normal operating state of the OC (i.e. normally open contacts are in a open state, and normally closed contacts are in a closed state when the cleaning cycle starts).

7.9 Display Setup

PATH: ⌂ \ CONFIG \ Display Setup

See the following explanation to get more details about the different settings for Display Setup.



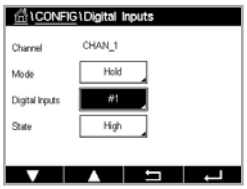
Enter the name for the M400 Transmitter (**Instrument Tag**). The instrument tag will also be displayed on the line at the top of the Start Screen and Menu Screen.

Note: Brightness of backlight is determined by Aout1 automatically.

7.10 Digital Inputs

PATH: ⌂ \ CONFIG \ Digital Inputs

See the following explanation to get more details about the different settings for the digital inputs.



Press the input field in the line of the setting for **Mode** and select the impact of an active digital input signal. Choose 'HOLD' to lead the assigned channel in HOLD state.

Press the related button for the assignment of the **Digital Inputs** (#1 for DI1, #2 for DI2 etc.) and select the digital input signal, which has to be linked to the channel.

An additional setting can be done, it a digital input signal has been selected.

Press the input field in the line for the setting of the **State** and select if the digital input is active at high or low level of the voltage input signal.

7.11 System

PATH: ⌂ \ CONFIG \ System

See the following explanation to get more details about the different settings for the System.

Select the desired Language. The following languages are available: English, French, German, Italian, Spanish, Portuguese, Russian, Chinese, Korean or Japanese.

Enter **Date&Time**.

The automatic change-over from summertime to wintertime and vice-versa frees the users from having to correct the time twice a year.

The winter to summer time-change is carried out automatically using the 12-month clock integrated in the transmitter. The date for the time-change can be set with the parameter **Summer.**

Provided it is a Sunday, the time-change would take place on the day that equates with the value, otherwise on the following Sunday. The winter/summer time-change takes place at 02:00 h.

The summer to winter time-change is carried out automatically using the 12-month clock integrated in the transmitter. The date for the time-change can be set through the parameter **Winter**.

Provided it is a Sunday, the time-change would take place on the day that equates with the value, otherwise on the following Sunday. The winter/summer time-change takes place at 03:00 h.

The number of hours, the clock will be shifted through the winter to summer and summer to winter time-change can be chosen. Press the related button for the setting of the **Shift Hour**.

7.12 PID Controller

PATH: ⌂ \ CONFIG \ PID Controller

PID control is proportional, integral and derivative control action that can provide smooth regulation of a process. Before configuring the transmitter, the following process characteristics must be identified.

Identify the **control direction** of the process:

- **Conductivity:**
  Dilution – direct acting where increasing measurement produces increasing control output such as controlling the feed of low conductivity diluting water to rinse tanks, cooling towers or boilers.

  Concentrating – reverse acting where increasing measurement produces decreasing control output, such as controlling chemical feed to attain a desired concentration.

- **Dissolved Oxygen:**
  Deaeration – direct acting where increasing Dissolved Oxygen concentration produces increasing control output such as controlling the feed of a reducing agent to remove oxygen from boiler feedwater.

  Aeration – reverse acting where increasing Dissolved Oxygen concentration produces decreasing control output, such as controlling an aerator blower speed to maintain a desired Dissolved Oxygen concentration in fermentation or wastewater treatment.

- **pH/ORP:**
  Acid feed only – direct acting where increasing pH produces increasing control output, also for ORP reducing reagent feed.

  Base feed only – reverse acting where increasing pH produces decreasing control output, also for ORP oxidizing reagent feed.

  Both acid and base feed – direct and reverse acting.

Identify the **control output type** based on the control device to be used:

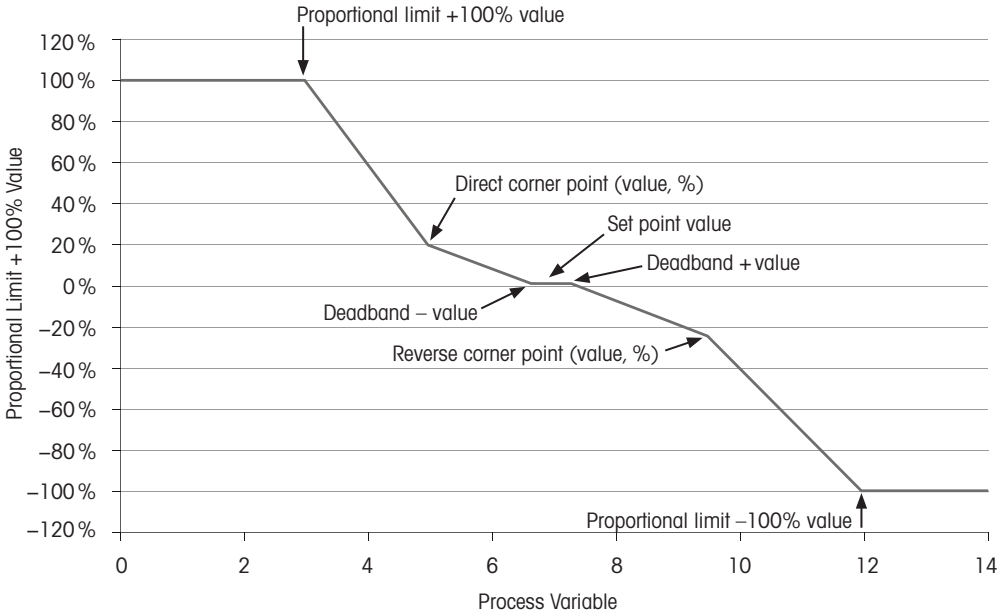
- Pulse frequency – used with pulse input metering pump.
- Pulse length – used with solenoid valve.

Default control settings provide linear control, which is appropriate for conductivity, dissolved oxygen. Therefore, when configuring PID for these parameters (or simple pH control) ignore settings of deadband and corner points in the tuning parameter section below. The non-linear control settings are used for more difficult pH/ORP control situations.

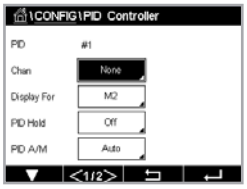
If desired, identify the non-linearity of the pH/ORP process. Improved control can be obtained if the non-linearity is accommodated with an opposing non-linearity in the controller. A titration curve (graph of pH or ORP vs. reagent volume) made on a process sample provides the best information. There is often a very high process gain or sensitivity near the setpoint and decreasing gain further away from the setpoint. To counteract this, the instrument allows for adjustable non-linear control with settings of a deadband around the setpoint, corner points further out and proportional limits at the ends of control as shown in the figure below.

Determine the appropriate settings for each of these control parameters based on the shape of the pH process titration curve.

Controller with Corner Points



See the following explanation to get more details about the different settings for PID Controller.



The M400 provides to one PID controller.

Press the related button for the assignment of the channel (**Chan**). Select the channel, which has to be linked to the PID Controller. To deactivate the PID controller press **None**.

Press the button for the assignment of the measuring parameter – based on the selected channel – that has be linked to the PID controller. Choose the measuring parameter by pressing the according field. Mx in the display indicates the measurement assigned to the PID Controller. (chapter 7.1.1 "Channel Setup").

The M400 offers the display of control output (%PID) of the PID controller in the Start Screen and Menu Screen. Press the related button for **Display For** and select the line, the control output should be displayed by pressing the corresponding field.

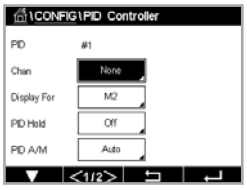
Note: The control output of the PID controller will be displayed instead of the measurement, that has been defined to be shown in the corresponding line (see chapter 7.1.1 "Channel Setup" on page 52).

Select with the parameter **PID HOLD** the state of the control output for the PID controller if the M400 Transmitter is in HOLD mode. Off means that the control output will be 0%PID if the transmitter is in HOLD mode. If Last Value has been chosen, the value for the control output signal before the transmitter went into HOLD mode will be used.

The parameter **PID A/M** allows selection of auto or manual operation for the PID controller. If auto has been chosen, the transmitter calculates the output signal based on the measured value and the settings of the parameters for the PID controller. In the case of manual operation, the transmitter shows in the Menu Screen at the line where the output signal is displayed two additional arrow buttons. Press the arrows buttons to increase or decrease the PID output signal.

Note: If Manual has been chosen the values for the time constants, gain, corner points, proportional limits, setpoint and deadband do not have any influence on the output signal.

Additional settings can be done by navigating to the next page of the menu.



The PID Mode assigns a OC for PID control action. Based on the control device being used, select one of the three options OC PL, OC PF.

OC PL: If using a solenoid valve, select OC PL (Pulse Length).
OC PF: If using a pulse input metering pump, select OC PF (Pulse Frequency).

Link the output signal Out1,2 of the PID controller to the desired output of the transmitter. Press the related button for Out 1 and Out 2 and select the corresponding number for the output through pressing the according field. #1 means OC 1, #2 means OC.

Note: Take care if OCs are linked to the controlling function. The OCs could be used for pulse frequency control devices and light duty applications. The current is limited to 0.1 amps. Do not connect to this OCs higher current devices.

If the PID Mode is set to OC PL, the Puls Length for the output signal of the transmitter can be adjusted. Press the button for **Pulse Length** and the M400 displays a keypad for modifying the value. Enter the new value in the unit seconds according to the table below and press ↵.

Note: A longer pulse length will reduce wear on the solenoid valve. The % "on" time in the cycle is proportional to the control output.

	1st OC Position (Out 1)	2nd OC Position (Out 2)	Pulse Length (PL)
Conductivity	Controlling concentrating reagent feed	Controlling dilution water	Short (PL) provides more uniform feed. Suggested start point = 30 sec
pH/ORP	Feeding base	Feeding acid	Reagent addition cycle: short PL provides more uniform addition of reagent. Suggested start point = 10 sec
Dissolved Oxygen	Reverse control action	Direct acting control action	Feed cycle time: short PL provides more uniform feed. Suggested start point = 30 sec

If the PID Mode is set to OC PF, the Pulse Frequency for the output signal of the transmitter can be adjusted. Press the button for **Pulse Freq** and enter the new value in the unit pulse/minute according to the table below.

Note: Set the pulse frequency to the maximum frequency allowed for the particular pump being used, typically 60 to 100 pulses/minute. Control action will produce this frequency at 100% output.

Caution: Setting the pulse frequency too high may cause the pump to overheat.

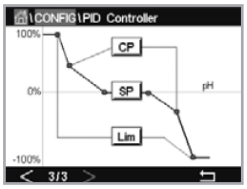
	1st OC Position (Out 1)	2nd OC Position (Out 2)	Pulse Frequency (PF)
Conductivity	Controlling concentrating chemical feed	Controlling dilution water	Max allowed for the pump used (typically 60–100 pulses/minute)
pH/ORP	Feeding base	Feeding acid	Max allowed for the pump used (typically 60–100 pulses/minute)
Dissolved Oxygen	Reverse control action	Direct acting control action	Max allowed for the pump used (typically 60–100 pulses/minute)

Press the input field for the parameter **Gain** to enter the gain of the PID controller as a unitless value. Gain represents the maximum value of the output signal of the PID controller in per cent (value 1 corresponds to 100%).

Press the corresponding input field in the line of **min** to adjust the Parameter integral or reset time **Tr** (left button) and/or rate of derivate time **Td** (right button).

Note: Gain, integral and derivate time are usually adjusted later by trial end error on process response. It is recommended to start with the value Td = 0.

Further settings can be done by navigating to the next page of the menu.



The display shows PID controller curve with input buttons for the corner points, setpoint and proportional limit for 100%.

Press the button **CP** to enter the menu for adjusting the corner points.

Page 1 shows the Corner Limit Low settings. Press the corresponding button to modify the value for the process parameter and the related output signal in %.

Browse to page 2 and the Corner Limit High settings are displayed. Press the corresponding button to modify the value for the process parameter and the related output signal in %.

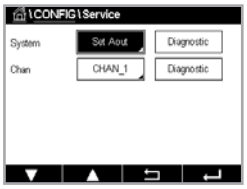
Press the button **SP** to enter the menu for adjusting the setpoint and the dead band.

Press the button **Lim** to enter the menu for adjusting the proportional limit high and the proportional limit low, the range over which control action is required.

7.13 Service

PATH: ⌂ \ CONFIG \ Service

This menu is a valuable tool for troubleshooting and provides diagnostic functionality for the following items: Set Analog Outputs, Read Analog Outputs, Read Analog Inputs, Set OC, Read OC, Read Digital Inputs, Memory, Display and Key Pad.



Select through the parameter **System** the desired item for diagnostic by pressing the according field.

Select through **Chan** the channel for diagnostic information of the sensor. This menu is only displayed if a sensor is connected.

The provided diagnostic functionality can now be called up through pressing the button **Diagnostic**.

Note: Chan option function depends on sensor type.

7.13.1 Set Analog Outputs

The menu enables the user to set all analog outputs to any mA value within the 0–22 mA range. Use the + and – button to adjust the mA output signal. The transmitter will adjust the output signals according to the measurement and configuration of the analog output signals.

7.13.2 Read Analog Outputs

The menu shows the mA value of the analog outputs.

7.13.3 Set OC

The menu allows the user to open or close each OC manually. If the menu is exited, the transmitter will switch the OC according to configuration.

7.13.4 Read OC

The menu shows the state of every OC. On indicates the OC is closed, Off indicates that the OC is open.

7.13.5 Read Digital Inputs

The menu shows the state of the digital input signals.

7.13.6 Memory

If Memory is selected the transmitter will perform a memory test of all connected transmitter boards and ISM sensors.

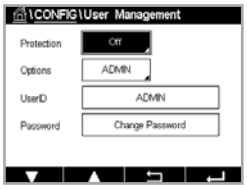
7.13.7 Display

The transmitter shows black white screen every 5 seconds and then go back to service main screen .If within 5 seconds, user can press any botton to go to next screen, if last screen, go to Service man screen.

7.14 User Management

PATH: ⌂ \ CONFIG \ User Management

This menu allows for the configuration of different user and administrator passwords, as well as setting up a list of allowed menus for the different users. The administrator has rights to access all menus. All default passwords for new transmitters are "00000000".



Press the input field in the line of **Protection** and select the desired kind of protection. The following options are available:

Off: No protection
Active: Activation of the Menu Screen (see chapter 3.2.1 "Display") has to be confirmed
Password: Activation of the Menu Screen is only possible with a password

Press the according button for **Option** to select the profile for the administrator (Admin) or one of the users.

☞ **Note:** The administrator always has the rights to access all menus. For different users the access rights can be defined.

Press the input button for **UserID** to enter the name for the user or administrator. The name for the user or administrator will be displayed if the protection via password is selected for activation of the Menu Screen.

For changing the password of the selected user or administrator press the input field for **Password**. Enter the old password in the field Old PW, the new one in the field New PW and confirm it in the field confirm PW. The default password is "00000000" for the administrator and all users.

If the profile for a user has been selected an additional input field to define the access rights will be displayed.

To assign access rights the according button for the menu has to pressed. In case of an assignment of the access rights, ☑ is displayed in the related button.

7.15 Reset

PATH: ⌂ \ CONFIG \ Reset

Depending on the transmitter version and configuration different options for a reset are available.

See the following explanation to get more details about the different option to reset data and/or configurations.

7.15.1 System Reset

This menu option allows the reset of the M400 Transmitter to the factory default settings (set-points off, analog outputs off, passwords, etc.). Furthermore the calibration factors for analog in- and outputs, meter etc. can be set to the last factory values.

Press the input field for **Options** and select System.

Press the input field for **Items** (Configure button) and select the different parts of the configuration that will be reset.

If an item has been selected the Action menu is displayed. Press the Reset button.

7.16 Custom Key Setup

PATH: ⌂ \ CONFIG \ Custom Key Setup

This menu allows to select desired option.

7.17 HART

PATH: ⌂ \ CONFIG \ HART

This menu is always on for HART Mode.

8 ISM

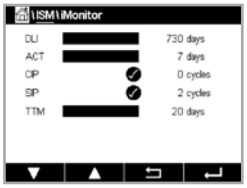
For the menu structure refer to chapter 3.8 "Graphic Trend Measurement".

PATH: ⌂ \ ISM

8.1 iMonitor

PATH: ⌂ \ ISM \ iMonitor

The iMonitor gives an overview of the current state of the complete loop at a glance.



The iMonitor of the first channel is displayed on the screen. To browse through the iMonitor for the different channels press > at the bottom of the display.

The values DLI, TTM and ACT are shown as bar graph.

For Cond 4e sensors the days in operation of the sensor are displayed.

Furthermore SIP-, CIP-, AutoClave-, as well as the values for Rg and Rref can be displayed.61

Rg/pNa Rg/Rref Diagnostics indicator despond on selection in the alarm setting . If selected , each status can be found in iMonitor.

If Rg/pNa Rg/Rref Diagnostics is Off in the alarm setting, these items will be hidden if waning event exist then show "warning" icon, else if alarm event exist then show "alarm" icon, else show "ok" icon.

Depending on the measured parameter (connected sensor) the following data are available in the menu iMonitor:

pH: DLI, TTM(for pH/PNA only), ACT, CIP, AutoClave, SIP[1)], Rg[2)], Rref[2)]
Amperometric O_2: DLI, TTM, ACT, CIP, AutoClave, SIP[1)], Electrolyte[3)]
Conductivity: Days in operation, CIP, SIP

1) If AutoClave has not been activated (see chapter 7.7 "ISM/Sensor Alarm" on page 65)
2) If the alarm for Rg and/or Rref has been activated (see chapter 7.7 "ISM/Sensor Alarm" on page 65)
3) If the alarm for Electrolyte Level Error has been activated (see chapter 7.7 "ISM/Sensor Alarm" on page 65)

8.2 Messages

PATH: ⌂ \ ISM \ Messages

The messages for occurred warnings and alarms are listed in this menu. Up to 100 entries will be listed.

5 messages per page are listed. If more then 5 messages are available additional pages can be accessed.

Unacknowledged alarms or warming will be listed at the beginning. Then the acknowledged but still existing alarm or warning are listed. At the end of the list the already solved warning and alarms are described. Between these groups the messages are listed chronologically.

The state of the warning or alarm is indicated through the following signs:

Symbol	Description	Meaning
	Alarm symbol is blinking	Alarm exists and has not been acknowledged
	Alarm symbol is not blinking	Alarm exists and has been acknowledged
	Warning symbol blinking	Warning exists and has not been acknowledged
	Warning symbol is not blinking	Warning exists and has been acknowledged
	OK symbol is not blinking	Warning or alarm has been solved

An unacknowledged warning or alarm will be acknowledged by pressing the **Info** button in the corresponding line.

For every message the corresponding **Info** button can be pressed. Message information, date and time the warning or alarm has been occurred and the status of the alarm or message are displayed.

If warning or alarm has already been solved the pull up window for the message shows an additional button to clear the message i.e. to delete it from the message list.

8.3 ISM Diagnostics

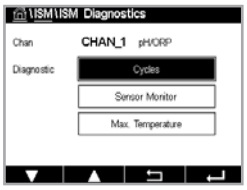
PATH: ⌂ \ ISM \ ISM Diagnostics

The M400 Transmitter provides for all ISM sensors a diagnostic menu. Access the menu Channel and select the channel by pressing the related input field.

Depending on the selected channel and assigned sensor different diagnostic menus are displayed.

See the following explanation to get more details about the different diagnostic menus.

8.3.1 pH/ORP, Oxygen, O_2, Cond 4e Sensors



If an pH/ORP, oxygen, O_2 or Cond 4e sensor is connected, the diagnostic menus cycles, sensor monitor and max. temperature are available.

Press the Cycle button and the information for CIP, SIP and Autoclave cycles of the connected sensor are displayed. The displayed information shows the amount of cycles the sensor has been exposed and the max. limitation for the corresponding cycle as defined in the menu ISM Setup.

Note: For Cond 4e, which are not autoclavable the menu AutoClave Cycles is not displayed.

Press the **Sensor Monitor** button and the information for DLI, TTM and ACT of the connected sensor are displayed. The values DLI, TTM and ACT are shown as bar graph.

Note: For Cond 4e sensors the operating hours are displayed.

Press the **Max. Temperature** button and the information about the maximum temperature, that the connected sensor has ever seen, together with a time stamp of this maximum is displayed. This value is stored on the sensor and cannot be changed. During autoclaving the max. temperature is not recorded.

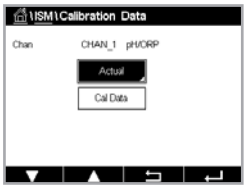
8.4 Calibration Data for All ISM Sensors

PATH: ⌂ \ ISM \ Calibration Data

The M400 Transmitter provides a calibration history for all ISM sensors. Depending on the assigned sensor different data is available for the calibration history.

See the following explanation to get more details about the different data available for the calibration history.

8.4.1 Calibration Data for All ISM Sensors



Actual (Actual adjustment): This is the actual calibration dataset which is used for the measurement. This dataset moves to Cal1 position after the next adjustment.

Factory (Factory calibration): This is the original dataset, determined in the factory. This dataset remains stored in the sensor for reference and cannot be overwritten.

1.Adjust (First adjustment): This is the first adjustment after the factory calibration. This dataset remains stored in the sensor for reference and cannot be overwritten

Cal1 (last calibration/adjustment): This is the last executed calibration/adjustment data set. This dataset moves to Cal2 and then to Cal3 when a new calibration/adjustment is performed. Afterwards, the dataset is not available anymore. Cal2 and Cal3 acting in the same way as Cal1.

Cal2 and **Cal3** and Temp Cal can be chosen. For the selection of the calibration data set press the corresponding field.

☞ **Note:** The amperometric oxygen sensor of THORNTON do not provide the data set Cal1, Cal2, Cal3 and 1.Adjust.

Press the **Cal Data** button and the corresponding calibration data set is displayed. Furthermore the time stamp for the calibration and the User ID is listed.

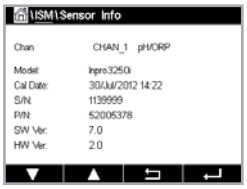
☞ **Note:** This function requires the correct setting of date and time during calibration and/or adjustment tasks.

8.5 Sensor Info

PATH: ⌂ \ ISM \ Sensor Info

The model, hardware and software version, last calibration date as well as the product and serial number of the ISM sensors, that are connected to the M400 Transmitter can be displayed on the screen.

Enter Sensor Info.



The data of the channel, a sensor is connected, are displayed on the screen.

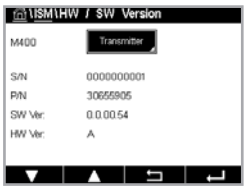
The data Model, Cal Date (date of last adjustment), S/N (serial number), P/N (product number), SW Ver (software version) and HW Ver (hardware version) of the select sensor are displayed.

To exit the menu Sensor Info press ↵. To return to the Menu Screen press ⌂.

8.6 HW/SW Version

PATH: ⌂ \ ISM \ HW/SW Version

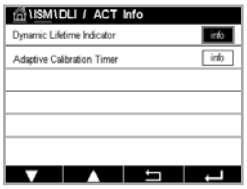
The hardware and software version as well as the product number and serial number of the M400 Transmitter itself or the different boards, that are plugged in can be displayed on the screen.



The data of the transmitter is displayed on the screen. Press the input field in the line of M400. To select the data of the desired board or the transmitter itself press the corresponding field.

The data S/N (serial number), P/N (product number), SW Ver (software version) and HW Ver (hardware version) of the select board or transmitter are displayed.

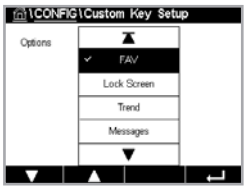
8.7 DLI/ACT Info



The detailed data about DLI and ACT is displayed. This function depends on pH sensor version.

9 Custom Key

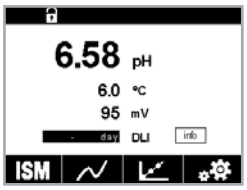
PATH: ⌂ \ Config \ Custom Key Setup



This menu allows the setting of a customize menu to the second left button on the menu screen as a shortcut. The custom key is a convenient option for soft key operation especially when touch-screen is not used.

Options: The "FAV" favorite is the default option. See chapter 9.1 "Set Favorite" for favorite setup.

- "Lock screen" can be selected for locking the screen.
- "Trend" can be selected for graphic trend display.
- "Messages" can be selected for the shortcut to access messages menu.
- "PID" can be selected for manual PID adjustment.
- "Info" can be selected for checking ACT/DLI.



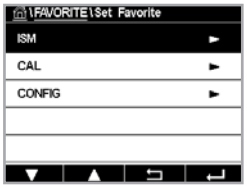
After the custom key setup, the selected custom key will be displayed at the second left button on the menu screen.

Note: The option "PID" will be displayed only if manual PID controller is set.

9.1 Set Favorite

PATH: ⌂ \ FAVORITE \ Set Favorite

The M400 Transmitter allows set up of up to 4 favorites to ensure a quick access for frequently used functions.



The main menus are displayed. Choose the menu, that contains the function, which should be defined as a favorite, e.g. ISM through pressing the corresponding arrow ▶ in the same line.

Choose the function, that should be set as a favorite by activating the option. A function, which is set as a favorite shows ★ icon.

Note: Deactivate the option by pressing on the icon again. The favorite ★ icon is not shown any more.

Access the menu Set Favorites. The favorites defined are listed on this page. Press the corresponding arrow ▶ for the function in the same line.

10 Maintenance

10.1 Front Panel Cleaning

Clean the surfaces with a soft damp cloth and dry the surfaces with a cloth carefully.

11 Troubleshooting

If the equipment is used in a manner not specified by METTLER TOLEDO the protection provided by the equipment may be impaired. Review the table below for possible causes of common problems:

Problem	Possible Cause
Display is blank.	• No power to M400 • Hardware failure
Incorrect measurement readings.	• Sensor improperly installed. • Incorrect units multiplier entered. • Temperature compensation incorrectly set or disabled. • Sensor or transmitter needs calibration. • Sensor or patch cord defective or exceeds recommended maximum length. • Hardware failure.
Measurement readings not stable.	• Sensors or cables installed too close to equipment that generates high level of electrical noise. • Recommended cable length exceeded. • Averaging set too low. • Sensor or patch cord defective.
Alarm ⚠ symbol is shown.	• Setpoint is in alarm condition (setpoint exceeded). • Alarm has been selected (see chapter 7.7 "ISM/Sensor Alarm") and occurred.
Cannot change menu settings.	• User locked out for security reasons.

11.1 Cond (Resistive) Error Messages/Warning- and Alarm List for Analog Sensors

Alarms	Description
Watchdog time-out[1)]	SW/System fault
Dry Sensor	Cell running dry (no measurement solution) or wires are broken
Sensor Shorted[1)]	Short circuit caused by sensor or cable

1) According to the parameterization of the transmitter.

11.2 Cond (Resistive) Error Messages/Warning- and Alarm List for ISM Sensors

Alarms	Description
Watchdog time-out[1)]	SW/System fault
Dry Cond sensor[1)]	Cell running dry (no measurement solution)
Cell deviation[1)]	Multiplier out of tolerance[2)] (depends on sensor model)
Sensor Shorted	Short circuit caused by sensor or cable

1) According to the parameterization of the transmitter (see chapter 7.7 "ISM/Sensor Alarm").
2) For further information refer to the sensor documentation.

11.3 pH Error Messages/Warning- and Alarm List

11.3.1 pH Sensors Except Dual Membrane pH Electrodes

Warnings	Description
Warning pH Slope too high	Slope >102%
Warning pH Slope too low	Slope <90%
Warning pH offset too high	pH ZeroPt>mmmpH
Warning pH offset too low	pH ZeroP<nnnpH
Warning glass resistance low[2)]	Glass elestrode resistance changed by less than factor 0.3
Warning glass resistance high[2)]	Glass electrode resistance changed by more than factor 3
Warning reference resistance low	Reference electrode resistance changed by less than factor 0.3
Warning reference resistance high[2)]	Reference electrode resistance changed by more than factor 3

Alarms	Description
Watchdog time-out	SW/System fault
Error pH Slope too high	Slope >103%
Error pH Slope too low	Slope <80%
Error pH offset too high	pH ZeroPT>xxxpH
Error pH offset too low	ph ZeroPt<yyypH
Error reference resistance high[1)]	Reference electrode resistance >150 KΩ (break)
Error reference resistance low[1)]	Reference electrode resistance >1,000 KΩ (short)
Error glass resistance high[1)]	Glass electrode resistance >2,000 KΩ (break)
Error glass resistance low[1)]	Glass electrode resistance <5 KΩ (short)

1) Activate this function in the transmitter settings (see chapter 7.7 "ISM/Sensor Alarm" on page 65 PATH: Menu \ ISM \ Sensor Alarm).

11.3.2 Dual Membrane pH Electrodes (pH/pNa)

Warnings	Description
Warning pH Slope too high	Slope >102%
Warning pH Slope too low	Slope <90%
Warning pH offset too high	pH ZeroPt>mmmpH
Warning pH offset too low	pH ZeroP<nnnpH
Warning pNa glass resistance low	Glass elestrode resistance changed by less than factor 0.3
Warning pNa glass resistance high	Glass electrode resistance changed by more than factor 3

Alarms	Description
Watchdog time-out	SW/System fault
Error pH Slope too high	Slope >103%
Error pH Slope too low	Slope <80%
Error pH offset too high	pH ZeroPT>xxxpH
Error pH offset too low	ph ZeroPt<yyypH
Error pNa glass resistance high	Glass electrode resistance >2,000 KΩ (break)
Error pNa glass resistance low	Glass electrode resistance <5 KΩ (short)

1) Activate this function in the transmitter settings (see chapter 7.7 "ISM/Sensor Alarm" on page 65 PATH: Menu \ ISM \ Sensor Alarm).

11.3.3 ORP Messages

Warnings[1)]	Description
Warning ORP offset too high	ORP offset close to specified limit
Warning ORP offset too low	ORP offset close to specified limit

Alarms[1)]	Description
Error ORP offset too high	ORP offset exceeds specified limit
Error ORP offset too low	ORP offset below specified limit

1) ISM sensors only.

11.3.4 ISM 2.0 pH Message

Alarms	Description
Error process temp too low	Temperature at the tip of the electrode below specified limit
Error process temp too high	Temperature at the tip of the electrode exceeds specified limit
Error replace sensor	Sensor electronics have detected an unrecoverable internal fault
Error measurement out of range	Sensor measuring circuit saturated, unable to compute reliable pH/ORP/temperature values
Error sensor elec temp too high	Temperature of sensor electrnics exceeds specified limit

Warnings	Description
Warning shelf life expired	Shelf life has expired (only applicable for sensors with specified life time)
Warning measurement out of range	Sensors measuring circuit nearly saturated, potentially unable to compute reliable ph/ORP/temperature values
Warning sensor elec temp too high	Temperature of sensor electronics close to specified limit
Warning replace glass membrane	Glass membrane has reached its expected lifetime and must be replaced (only applicable for sensors with respective detecntion circuit)
Warning replace reference	Reference has reached its expected lifetime and must be replaced (only applicable for sensors with respective detection circuit)
Warning process temp too low	Temperature at the tip of the electrode close to specified limit
Warning process temp too high	Temperature at the tip of the electrode close to specified limit

11.3.5 ISM Sensor Common Alarm Messages

For ISM sensor common alarm messages:

1: Not connected	
2: Sensor calibration required	ACT <= 0
3: a) Sensor lifetime expired	DLI <= 0 (pH, pH/pNa, O_2 hi, O_2 Low, O_2 Trace, CO_2)
b) Change spot	DLI <= 0 (0 pt O_2)
4: Maint required	TTM <= 0 (opt O_2 and pH not use it)
5: Change sensor	for all sensors connect no configured sensor, following are the condition to show this message: a) Unknown sensor connect b) Not accepted sensor connect c) Sensor CheckSum error d) Sensor De-activated e) Old O_2 optical sensor FW <2.13 f) User select "No" when in the following situation: 1) Different module number, same parameter sensor connect; 2) Different paramenter sensor connect
6: CIP Counter Expired	CIP >= CIP max limit
7: SIP Counter Expired	SIP >= SIP max limit
8: AutoClave Counter Expired	AutoClave >= AutoClave max limit

11.4 Amperometric O_2 Error Messages/Warning- and Alarm List

11.4.1 High Level Oxygen Sensors

Warnings	Description
Warning O_2 hi Slope < –90 nA	Slope too small
Warning O_2 hi Slope > –35 nA	Slope too big
Warning O_2 hi Slope > 0.3 nA	Zero offset too big
Warning O_2 hi Slope < –0.3 nA	Zero offset too small

Alarms	Description
Watchdog time-out[1)]	SW/System fault
Error O_2 hi Slope < –110 nA	Slope too small
Error O_2 hi Slope > –30 nA	Slope too big
Error O_2 hi Slope > 0.6 nA	Zero offset too big
Error O_2 hi Slope < –0.6 nA	Zero offset too small
Error Electrolyte level	Too low level of electrolyte

1) ISM sensors only.

11.4.2 Low Level Oxygen Sensors

Warnings	Description
Warning O_2 lo Slope < – 460 nA	Slope too small
Warning O_2 lo Slope > – 250 nA	Slope too big
Warning O_2 lo Offset > 0.5 nA	Zero offset too big
Chx Warning O_2 lo Offset < – 0.5 nA	Zero offset too small

Alarms	Description
Watchdog time-out[1)]	SW/System fault
Error O_2 lo Slope < – 525 nA	Slope too small
Error O_2 lo Slope > – 220 nA	Slope too big
Error O_2 lo Offset > 1.0 nA	Zero offset too big
Error O_2 lo Offset < – 1.0 nA	Zero offset too small
Error Electrolyte level	Too low level of electrolyte

1) ISM sensors only.

11.4.3 Trace Oxygen Sensors

Warnings	Description
Warning O_2 Trace Slope < – 5 uA	Slope too small
Warning O_2 Trace Slope > – 3 uA	Slope too big
Warning O_2 Trace Offset > 0.5 nA	Zero offset too big
Warning O_2 Trace Offset < – 0.5nA	Zero offset too small

Alarms	Description
Watchdog time-out	SW/System fault
Error O_2 Trace Slope < – 6,000 nA	Slope too small
Error O_2 Trace Slope > – 2,000 nA	Slope too big
Error O_2 Trace Offset > 1.0 nA	Zero offset too big
Error O_2 Trace Offset < – 1.0 nA	Zero offset too small
Error Electrolyte level	Too low level of electrolyte

11.5 Optical O_2 Error Messages/Warning- and Alarm List

Warnings	Description
LED Off	

Alarms	Description
Sensor calibration required	ACT = 0 or measured values out of range
Change Spot	DLI < = 0
CIP Counter Expired	Limit of CIP cycles reached
SIP Counter Expired	Limit of SIP cycles reached
Autoclave Counter Expired	Limit of autoclaving cycles reached
Watchdog time-out	SW/System fault

Signal error	Signal or value for temperature out of range
Shaft error	Temperature bad or stray light too high (e.g. becausea glass is fiber broken) or shaft has been removed
Hardware error	Electronic components fail
Not connected	
Change Sensor	For all sensors connect no configured sensor,following are the condition to show this message:
	a) Unknown sensor connect b) Not accepted sensor connect c) Sensor CheckSum error d) Sensor De-activated e) Old O_2 Optical Sensor FW < 2.13 f) User select "No" when in the following situation: 1) Different module number, same parameter sensor connect. 2) Different parameter sensor connect.

1) If this warning is displayed, you will find more information about the cause for the warning in Menu/Service/Diagnostics/O_2 optical.

If an alarm has occurred, you will find more information about the cause for the alarm in Menu/Service/Diagnostics/O_2 optical.

11.6 Dissolved Carbon Dioxide Error Messages/Warningand Alarm List

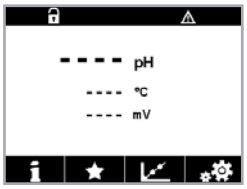
Warnings	Description
Warning reference resistance low	pHGls change < 0.3 (only for analog)
Warning glass resistance high	pHGls change > 3 (only for analog)
Warning pH slope too high	pH slope > 102 %
Warning pH slope too low	pH slope < 90 %
Warning pH offset too high	pH ZeroPt > mmmpH
Warning pH offset too low	pH ZeroPt < nnnpH

Alarms	Description
Watchdog time-out[1)]	SW/System fault
Error glass resistance high	pH Gls Res >2000 MΩ (only for analog)
Error glass resistance low	pH Gls Res <5 MΩ (only for analog)
Error pH slope too high	pH slope >103 %
Error pH slope too low	pH slope < 80 %
Error pH offset too high	pH ZeroPt > xxx pH
Error pH offset too low	pH ZeroPt < yyy pH

1) According to the parameterization of the transmitter (see chapter 7.7 "ISM/Sensor Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm).

11.7 Warning- and Alarm Indication

11.7.1 Warning Indication



Warnings are indicated by a warning symbol ⚠ in the head line of the display. A warning message will be recorded and can be selected through the menu Messages (PATH: ⌂ \ ISM \ Messages).

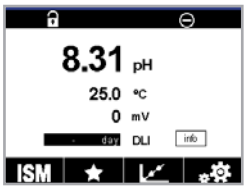
Note: If the warning has not been acknowledged, the head line of the display will blink. If the warning has already been acknowledged, the head line will displayed continuously. See also chapter 8.2 "Messages". In the case of an unacknowledged warning or alarm the transmitter screen will not be dimmed or switched off even if the light time has been elapsed (see chapter 7.9 "Display Setup" on page 66).

Note: If at the same time a channel has born an alarm and a warning indicated, the indication of the alarm will have higher priority. The alarm will be indicated (see chapter 11.7 "Warning- and Alarm Indication" on page 85) on the Menu Screen or Start Screen, while the warning will not be shown.

Pressing the head line on the Menu Screen will lead to the Messages. Refer to chapter 8.2 "Messages" for the description of the functionality for this menu.

Note: The detection of some warnings can be activated/deactivated through (de)activating the corresponding alarm. Refer to chapter 7.7 "ISM/Sensor Alarm".

11.7.2 Alarm Indication



Alarms are indicated by an alarm symbol in the head line of the display. An alarm message will be recorded and can be selected through the menu Messages (PATH: ⌂ \ ISM \ Messages).

Note: If the alarm has not been acknowledged, the head line of the display will blink. If the alarm has already been acknowledged, the head line will be displayed continuously. See also chapter 8.2 "Messages". In the case of an unacknowledged warning or alarm the transmitter screen will not be dimmed or switched off even if the light time has been elapsed (see chapter 7.9 "Display Setup").

Note: If at the same time a channel has born an alarm and a warning indicated, the indication of the alarm will have higher priority. The alarm will be indicated on the Menu Screen or Start Screen, while the warning will not be shown.

Pressing the head line on the Menu Screen will lead to the Messages. Refer to chapter 8.2 "Messages" for the description of the functionality for this menu.

Note: The detection of some alarms can be activated/deactivated. Refer therefore to chapter 7.7 "ISM/Sensor Alarm".

Note: Alarms which are caused by a violation of the limitation of a setpoint or the range (PATH: ⌂ \ CONFIG \ Set Points; see also chapter 7.4 "Set Points") will also be indicated on the display and recorded through the menu Messages (PATH: ⌂ \ ISM \ Messages; see also chapter 8.2 "Messages").

12 Ordering Information, Accessories and Spare Parts

Please contact your local METTLER TOLEDO sales office or representative for details for Additional accessories and spare parts.

Description	Order No.
Pipe mounting kit for ½ DIN for pipe diameter 40 to 60 mm (1.57 to 2.36")	30 300 480
Panel Mount Kit for ½ DIN models	30 300 481
Protective Hood for ½ DIN models	30 073 328
Wall mounting kit for ½ DIN	30 300 482

Transmitter	Order No.
M400 2XH Type2	30 655 901
M400 2H Type2	30 655 902
M400 2XH Type2 ISM	30 655 903
M400 2H Type2 ISM	30 655 904
M400 2XH Type3	30 655 905
M400 2XH Type3 ISM	30 655 908

13 Specifications

13.1 General Specifications

Conductivity 2-e/4-e

Measurement parameters	Conductivity/resistivity and temperature	
Conductivity ranges 2-electrode sensor		0.02 to 2,000 µS/cm (500 Ω×cm to 50 MΩ×cm)
	C = 0.01	0.002 to 200µS/cm (5,000 Ω×cm to 500 MΩ×cm)
	C = 0.1	0.02 to 2,000 µS/cm (500 Ω×cm to 50 MΩ×cm)
	C = 1	15 to 4,000 µS/cm
	C = 3	15 to 12,000 µS/cm
	C = 10	10 to 40,000 µS/cm (25 Ω×cm to 100 kΩ×cm)
Conductivity ranges 4-electrode sensor	0.01 to 650 mS/cm (1.54 Ω×cm to 0.1 MΩ×cm)	
Display range for 2-e sensor	0 to 40,000 mS/cm (25 Ω×cm to 100 MΩ×cm)	
Display range for 4-e sensor	0.01 to 650 mS/cm (1.54×cm to 0.1 MΩ×cm)	
Chemical concentration curves	• NaCl:	0–26 % @ 0 °C to 0–28 % @+100 °C
	• NaOH:	0–12 % @ 0 °C to 0–16 % @+40 °C to 0–6 % @+100 °C
	• HCl:	0–18 %@–20 °C to 0–18 % @ 0 °C to 0–5 % @+50 °C
	• HNO_3:	0–30 % @–20 °C to 0–30 % @ 0 °C to 0–8 % @+50 °C
	• H_2SO_4:	0–26 % @–12 °C to 0–26 % @+5 °C to 0–9 % @+100 °C
	• H_3PO_4:	0–35 % @+5 °C to+80 °C
	• User-defi ned concentration table (5×5 matrix)	
TDS ranges	NaCl, $CaCO_3$	
Cond/Res accuracy[1)]	Analog: ±0.5 % of reading or 0.25 Ω, whichever is greater, up to 10 MΩ-cm	
Cond/Res repeatability[1)]	Analog: ±0.25 % of reading or 0.25 Ω, whichever is greater	
Cond/Res resolution	Auto/0.001/0.01/0.1/1 (can be selected)	
Temperature input	Pt1000/Pt100/NTC22K	
Temperature measuring range	–40 to +200 °C (–40 to +392 °F)	
Temperature resolution	Auto/0.001/0.01/0.1/1 (can be selected)	
Temperature accuracy	• ISM:	±1 digit
	• Analog:	±0.25 °C (±32.5 °F) within –30 to +150 °C (–22 to +302 °F); ±0.50 °C (±32.9 °F) outside
Temperature repeatability[1)]	±0.13 °C (±32.2 °F)	
Max. sensor cable length	• ISM:	80 m (260 ft)
	• Analog:	61 m (200 ft); with 4-e sensors:15 m (50 ft)
Calibration	1-point, 2-point or process	

1) ISM input signal causes no additional error.

pH/ORP

Measurement parameters	pH, mV and temperature
pH display range	–2.00 to +20.00 pH
pH resolution	Auto/0.001/0.01/0.1/1 (can be selected)
pH accuracy[1)]	Analog: ±0.02 pH
mV range	–1,500 to +1,500 mV
mV resolution	Auto/0.001/0.01/0.1/1 mV (can be selected)
mV accuracy[1)]	Analog: ±1 mV
Temperature input[2)]	Pt1000/Pt100/NTC30K
Temperature measuring range	–30 to 130 °C (–22 to 266 °F)
Temperature resolution	Auto/0.001/0.01/0.1/1 (can be selected)
Temperature accuracy[1)]	Analog: ±0.25 °C in the range of –10 to +150 °C (±32.5 °F in the range of + 14 to+176 °F)
Temperature repeatability[1)]	±0.13 °C (±32.2 °F)
Temperature compensation	Automatic/Manual
Max. sensor cable length	• Analog: 10 to 20 m (33 to 65 ft) depending on sensor
	• ISM: 80 m (260 ft)
Calibration	pH: 1-point (offset) or 2-point (slope and offset) or process (offset) ORP: 1-point (offset) or process (offset) Temperature[3)]: 1-point (offset)

1) ISM input signal causes no additional error.
2) Not required on ISM sensors.
3) Applied on ISM 2.0 pH.

Available Buffer Sets

Standard buffers	MT-9 buffers, MT-10 buffers, NIST Technical Buffers, NIST Standard Buffers (DIN 19266:2000–01), JIS Z 8802 buffers, Hach buffers, CIBA (94) buffers, Merck Titrisols-Reidel Fixanals, WTW buffers
Dual menbrane electrode pH buffers (pH/pNa)	Mettler-pH/pNa buffers (Na+ 3.9M)

Amperometric Oxygen

Measurement parameters	• Dissolved oxygen: Saturation or concentration and temperature
	• Oxygen in gas: Concentration and temperature
Current range	Analog: 0 to –7,000 nA
Oxygen measuring ranges, dissolved oygen	• Saturation: 0 to 500 % air, 0 to 200 % O_2
	• Concentration: 0 ppb (µg/L) to 50.00 ppm (mg/L)
Oxygen measuring ranges, oxygen in gas	0 to 9,999 ppm O_2 gas, 0 to 100 vol % O_2
Oxygen accuracy, dissolved oxgen[1)]	• Saturation: ±0.5 % of the measured value or ±0.5 %, depending on which is larger
	• Concentration at high values: ±0.5 % of the measured value or ±0.050 ppm/±0.050 mg/L, depending on which is larger
	• Concentration at low values: ±0.5 % of the measured value or ±0.001 ppm/±0.001 mg/L, depending on which is larger
	• Concentration at traces values: ±0.5 % of the measured value or ±0.100 ppb/±0.1 µg/L, depending on which is larger
Oxygen accuracy, oxygen in gas[1)]	• ±0.5 % of the measured value or ±5 ppb, depending on which is larger for ppm O_2 gas
	• ±0.5 % of the measured value or ±0.01 %, depending on which is larger for vol % O_2
Resolution current[1)]	Analog: 6 pA
Polarization voltage	• Analog: –1,000 to 0 mV
	• ISM: –550 mV or –674 mV (configurable)
Temperature input	NTC 22 kΩ, Pt1000, Pt100
Temperature compensation	Automatic
Temperature measuring range	–10 to +80 °C (+14 to +176 °F)
Temperature accuracy	±0.25 K in the range of –10 to +80 °C (+14 to +176 °F)
Max. sensor cable length	• Analog: 20 m (65 ft)
	• ISM: 80 m (260 ft)
Calibration	1-point (slope and offset) or process (slope and offset)

1) ISM input signal causes no additional error.

Optical Oxygen

Measurement parameters	DO saturation or concentration and temperature
DO concentration range	0.1 ppb (µg/L) to 50.00 ppm (mg/L)
DO saturation range	0 to 500 % air, 0 to 100 % O_2
DO resolution	Auto/0.001/0.01/0.1/1 (can be selected)
DO accuracy	±1 digit
Temperature measuring range	–30 to +150 °C (–22 to +302 °F)
Temperature resolution	Auto/0.001/0.01/0.1/1 (can be selected)
Temperature accuracy	±1 digit
Temperature repeatability	±1 digit
Temperature compensation	Automatic
Max. sensor cable length	15 m (50 ft)
Calibration	1-point (depending on sensor model), 2-point, process

Dissolved Carbon Dioxide

Measurement parameters	Dissolved carbon dioxide and temperature
CO_2 measuring ranges	• 0 to 5,000 mg/L
	• 0 to 200 %sat
	• 0 to 1,500 mm Hg
	• 0 to 2,000 mbar
	• 0 to 2,000 hPa
CO_2 accuracy	±1 digit
CO_2 resolution	Auto/0.001/0.01/0.1/1 (can be selected)
mV range	–1,500 to +1,500 mV
mV resolution	Auto/0.01/0.1/1 mV
mV accuracy	±1 digit
Total pressure range (TotPres)	0 to 4,000 mbar
Temperature input	Pt1000/NTC22K
Temperature measuring range	0 to +60 °C (–32 to +140 °F)
Temperature resolution	Auto/0.001/0.01/0.1/1 (can be selected)
Temperature accuracy	±1 digit
Temperature repeatability	±1 digit
Max. sensor cable length	80 m (260 ft)
Calibration	1-point (offset), 2-point (slope or offset) or process (offset)

Available Buffer Sets

Buffer	MT-9 buffers with solution pH = 7.00 and pH = s9.21 @ 25 °C

13.2 Electrical Specifications

13.2.1 General Electrical Specifications

User interface	TFT 4.4" • Black and white • Resolution: ¼ VGA (320 pixel 3 240 pixel)
Running capacity	Ca. 4 days
Keypad	• 4 tactile feedback keys
Languages	10 (English, German, French, Italian, Spanish, Portuguese, Russian, Japanese, Korean and Chinese)
Connection terminals	Spring cage terminals, appropriate for wire cross section 0.2 to 1.5 mm2 (AWG 16–24)
Analog input	4 to 20 mA (for pressure compensation)

13.2.2 4 to 20 mA (with HART)

Supply voltage	14 to 30 V DC
Number of outputs (analog)	2
Current outputs	Loop current 4…20 mA, galvanically isolated up to 60 V from input and from earth/ground, protected against wrong polarity, feeding voltage14 to 30 V DC
Measurement error through analog outputs	< ± 0.05 mA over 1 to 20 mA range
Analog output configuration	Linear
PID process controller	Pulse length, pulse frequency
Hold input/Alarm contact	Yes/Yes (alarm delay 0 to 999 s)
Digital outputs	2 open collector (OC), 30 V DC, 100 mA, 0.8 W
Digital input	2, galvanically isolated up to 60 V from output, analog input and ground/earth with switching limits 0.00 V DC to 1.00 V DC inactive 2.30 V DC to 30.00 V DC active
Alarm output delay	0 to 999 s

13.3 Mechanical Specifications

Dimensions	Housing – Height × Width × Depth	150×150×105 mm (5.9×5.9×4.1 inch)
	Max. depth – panel mounted	74 mm
Weight		1.50 kg (3.3 lb)
Material		Aluminum die cast
Enclosure rating		IP66/NEMA4X

13.4 Environmental Specifications

Storage temperature	–40 to +70 °C (–40 to +158 °F)
Ambient temperature operating range	–20 to +60 °C (–4 to +140 °F)
Relative humidity	0 to 95 % non-condensing
EMC	According to EN 61326-1 (general requirements) Emission: Class B, Immunity: Class A
Approvals and certificates	M400 2H • cCSAus/FM Class I, Division 2, Groups A, B, C, D T4A • cCSAus/FM Class I, Zone 2, Groups IIC T4
	M400 2XH • ATEX/IECEx Zone 1 Ex ib [ia Ga] IIC T4 Gb • ATEX/IECEx Zone 21 Ex ib [ia Da] IIIC T80 °C Db IP66 • cCSAus/FM Class I, Division 1, Groups A, B, C, D T4A • cCSAus/FM Class II, Division 1, Groups E, F, G • cCSAus/FM Class III • cCSAus/FM Class I, Zone 0, AEx ia IIC T4 Ga
CE mark	The measuring system is in conformity with the statutory requirements of the EC Directives. METTLER TOLEDO confirms successful testing of the device by affixing to it the CE mark.
Specific detail certificates information reference to document	Ex instructions (PN 30715260)

13.5 Control Drawings

Detailed contents refer to document PN 30715260 for Ex instructions.

13.6 Default Table

Common

Parameter	Sub Parameter	Value	Unit
General Alarm	OC	1	
	Delay	1	
	Hysterseis	0	
	State inverted	Inverted	
	Power failure	Yes	
	Software tailure	Yes	
ISM/Sensor Alarm	OC	2	
Clean	OC	None	
	Hold time	20	
	Interval	0	
	Clean time	0	
	Assign channel	None	
Hold outputs		Yes	
DigitalIn		Off	
Lockout		No	
ISM monitor	Lifetime indicator	Yes	Alarm No
	Time to maint	Yes	Alarm No
	Adapt Cal timer	Yes	Alarm No
	CIP cycle counter	100	Alarm No
	SIP cycle counter	100	Alarm No
	Autoclave cycle counter	0	Alarm No
	OC	None	
Language		English	
Passwords	Administrator	00000000	
	Operator	00000000	
All OCs	Delay	1	sec
	Hysteresis	0	For measurement unit pH, mV, ˚C, the same unit. For other measurement unit, is 5 %.
	State	OC#1 is interted, OC#2 is normal	
	Hold mode	Last Value	
All analog out	Mode	4 – 20 mA	
	Type	Normal	
	Alarm	Off	
	Hold mode	Last value	

pH

Parameter	Sub Parameter	Value	Unit
Channel X	M1	pH	pH
	M2	Temperature	°C
	M3	Voltage	Volts
	M4	DLI (None for analog sensor)	DLI
Temperature soure (analog sensor)		Auto	
pH buffer		Mettler-9	
Drift Control		Medium	
IP		7.0 (ISM sensor reading from sensor)	pH
STC		0.000	pH/°C
Fix CalTemp		No	
Cal constants (for Analog sensor)		S=100.0 %,Z=7.000pH	
	Temperature	M=1.0, A=0.0	
Cal constants (for ISM sensor)		Read from sensor	
Resolution	pH	0.01	pH
	Temperature Volts DLI	0.1 1.0 1.0	°C mV day
Analog outputs	1	M1	
	2	M2	
pH	Value 4 mA	2	pH
	Value 20 mA	12	pH
Temperature	Value 4 mA	0	°C
	Value 20 mA	100	°C
Set point 1	Measurement	M1	
	Type	Off	
	OC	None	
Set point 2	Measurement	M2	
	Type	Off	
	OC	None	
Alarm	Rg diagnostics	No	
	Rr diagnostics	No	

pH/pNa

Parameter	Sub Parameter	Value	Unit
Channel X	M1	pH	pH
	M2	Temperature	°C
	M3	Voltage	Volts
	M4	DLI (None for analog sensor)	DLI
Temperature soure (analog sensor)		Auto	
pH buffer		Na+ 3.9M	
Drift Control		Medium	
IP		Reading from sensor	pH
STC		0.000	pH/°C
Fix CalTemp		No	
Cal constants		Read from sensor	
Resolution	pH	0.01	pH
	Temperature Volts DLI	0.1 1.0 1.0	°C mV day
Analog outputs	1	M1	
	2	M2	
pH	Value 4 mA	2	pH
	Value 20 mA	12	pH
Temperature	Value 4 mA	0	°C
	Value 20 mA	100	°C
Set point 1	Measurement	M1	
	Type	Off	
	OC	None	
Set point 2	Measurement	M2	
	Type	Off	
Alarm	OC	None	
	Rg diagnostics	No	

Oxygen

Parameter	Sub Parameter	Value	Unit
Channel X	M1	O_2	%Air (O_2 low:ppb)
	M2	Temperature	°C
	M3	DLI(None for analog sensor)	DLI
	M4	TTM (None for analog sensor)	TTM
Temperature soure (analog sensor)		Auto	
CalPres		1,013	mbar
ProcPres		1,013	mbar
ProcCalPres		ProcPres	
Drift control		Auto	
Salinity		0.0	g/Kg
Humidity		50	%
Umeaspol		Read form sensor	
Ucalpol		−674	mV
Cal constants (for analog sensor)	O_2 high:	S = −70.00 nA, Z=0.00 nA	
	O_2 Trace O_2 low	S = −4000 nA, Z = 0.00 nA S=−350.00 nA, Z=0.00 nA	
Cal constants (for ISM sensor)		Read from sensor	
Resolution	O_2	0.1	%Air
		1	ppb
	Temperature	0.1	°C
Analog outputs	1	M1	
	2	M2	
O_2	Value 4 mA	0	%Air (O_2 low:ppb)
	Value 20 mA	100 (O_2 low: 20)	%Air (O_2 low:ppb)
Temperature	Value 4 mA	0	°C
	Value 20 mA	100	°C
Set point 1	Measurement	M1	
	Type	Off	
	OC	None	
Set point 2	Measurement	M2	
	Type	Off	
	OC	None	
Alarm	Electrolyte low (ISM sensor)	No	

Resistivity/Conductivity

Parameter	Sub Parameter	Value	Unit
Channel X	M1	Conductivity	S/cm
	M2	Temperature	°C
	M3	Resistance	Ω-cm
	M4	Temperature	°F
Temperature soure (analog sensor)		Auto	
Compension		Standard	
Cal constants (for analog sensor)	Cond/Res	M=0.1, A=0.0	
	Temperature	M=1.0, A=0.0	
Cal constants (for ISM sensor)		Read from sensor	
Resolution	Resisitivity	0.01	Ω-cm
	Temperature	0.1	°C
	Conductivity	0.01	Ω-cm
	Temperature	0.1	°F
Analog outputs	1	M1	
	2	M2	
Conductivity	Value 4 mA	100 nS/cm	
	Value 20 mA	10 µS/cm	
Temperature	Value 4 mA	0	°C
	Value 20 mA	100	°C
Set point 1	Measurement	M1	
	Type	Off	
	OC	None	
Set point 2	Measurement	M2	
	Type	Off	
	OC	None	
Alarm	Cond sensor shorted	No	
	Dry cond sensor	No	
	Cond Cell Constant Deviataion (ISM sensor)	No	

CO_2

Parameter	Sub Parameter	Value	Unit
Channel X	M1	Pressure	hPa
	M2	Temperature	°C
	M3	mV	Volts (Auto)
	M4	DLI	
pH buffer		Mettler-9	
Drift Control		Medium	
Salinity		28.00	g/L
HCO_3		0.050	mol/L
TotPres		1000	mbar
Cal constants	CO_2	Read from sensor	
Resolution	hPa	1	hPa
	Temperature	0.1	°C
	Voltage	1.0	mV
	DLI	1	day

Please note:It only support ISM CO_2.

14 Warranty

METTLER TOLEDO warrants this product to be free from significant deviations in material and workmanship for a period of one year from the date of purchase. If repair is necessary and no the result of abuse or misuse within the warranty period, please return by freight pre-paid and amendment will be made without any charge. METTLER TOLEDO's Customer Service Dept. will determine if the product problem is due to deviations or customer abuse. Out-of-warranty products will be repaired on an exchange basis at cost.

The above warranty is the only warranty made by METTLER TOLEDO and is lieu of all other warranties, expressed or implied, including, without limitation, implied warranties of merchantability and fitness for a particular purpose. METTLER TOLEDO shall not be liable for any loss, claim, expense or damage caused by, contributed to or arising out of the acts or omissions of the Buyer or Third Parties, whether negligent or otherwise. In no event shall METTLER TOLEDO's liability for any cause of action whatsoever exceed the cost of the item giving rise to the claim, whether based in contract, warranty, indemnity, or tort (including negligence).

15 Buffer Tables

M400 transmitters have the ability to do automatic pH buffer recognition. The following tables show different standard buffers that are automatically recognized.

15.1 Standard pH Buffers

15.1.1 Mettler-9

Temp (°C)	pH of Buffer Solutions			
0	2.03	4.01	7.12	9.52
5	2.02	4.01	7.09	9.45
10	2.01	4.00	7.06	9.38
15	2.00	4.00	7.04	9.32
20	2.00	4.00	7.02	9.26
25	2.00	4.01	7.00	9.21
30	1.99	4.01	6.99	9.16
35	1.99	4.02	6.98	9.11
40	1.98	4.03	6.97	9.06
45	1.98	4.04	6.97	9.03
50	1.98	4.06	6.97	8.99
55	1.98	4.08	6.98	8.96
60	1.98	4.10	6.98	8.93
65	1.98	4.13	6.99	8.90
70	1.99	4.16	7.00	8.88
75	1.99	4.19	7.02	8.85
80	2.00	4.22	7.04	8.83
85	2.00	4.26	7.06	8.81
90	2.00	4.30	7.09	8.79
95	2.00	4.35	7.12	8.77

15.1.2 Mettler-10

Temp (°C)	pH of Buffer Solutions			
0	2.03	4.01	7.12	10.65
5	2.02	4.01	7.09	10.52
10	2.01	4.00	7.06	10.39
15	2.00	4.00	7.04	10.26
20	2.00	4.00	7.02	10.13
25	2.00	4.01	7.00	10.00
30	1.99	4.01	6.99	9.87
35	1.99	4.02	6.98	9.74
40	1.98	4.03	6.97	9.61
45	1.98	4.04	6.97	9.48
50	1.98	4.06	6.97	9.35
55	1.98	4.08	6.98	
60	1.98	4.10	6.98	
65	1.99	4.13	6.99	
70	1.98	4.16	7.00	
75	1.99	4.19	7.02	
80	2.00	4.22	7.04	
85	2.00	4.26	7.06	
90	2.00	4.30	7.09	
95	2.00	4.35	7.12	

15.1.3 NIST Technical Buffers

Temp (°C)	pH of Buffer Solutions				
0	1.67	4.00	7.115	10.32	13.42
5	1.67	4.00	7.085	10.25	13.21
10	1.67	4.00	7.06	10.18	13.01
15	1.67	4.00	7.04	10.12	12.80
20	1.675	4.00	7.015	10.07	12.64
25	1.68	4.005	7.00	10.01	12.46
30	1.68	4.015	6.985	9.97	12.30
35	1.69	4.025	6.98	9.93	12.13
40	1.69	4.03	6.975	9.89	11.99
45	1.70	4.045	6.975	9.86	11.84
50	1.705	4.06	6.97	9.83	11.71
55	1.715	4.075	6.97		11.57
60	1.72	4.085	6.97		11.45
65	1.73	4.10	6.98		
70	1.74	4.13	6.99		
75	1.75	4.14	7.01		
80	1.765	4.16	7.03		
85	1.78	4.18	7.05		
90	1.79	4.21	7.08		
95	1.805	4.23	7.11		

15.1.4 NIST Standard Buffers (DIN and JIS 19266: 2000–01)

Temp (°C)	pH of Buffer Solutions			
0				
5	1.668	4.004	6.950	9.392
10	1.670	4.001	6.922	9.331
15	1.672	4.001	6.900	9.277
20	1.676	4.003	6.880	9.228
25	1.680	4.008	6.865	9.184
30	1.685	4.015	6.853	9.144
37	1.694	4.028	6.841	9.095
40	1.697	4.036	6.837	9.076
45	1.704	4.049	6.834	9.046
50	1.712	4.064	6.833	9.018
55	1.715	4.075	6.834	8.985
60	1.723	4.091	6.836	8.962
70	1.743	4.126	6.845	8.921
80	1.766	4.164	6.859	8.885
90	1.792	4.205	6.877	8.850
95	1.806	4.227	6.886	8.833

Note: The pH(S) values of the individual charges of the secondary reference materials are documented in a certificate of an accredited laboratory. This certificate is supplied with the respective buffer materials. Only these pH(S) values shall be used as standard values for the secondary reference buffer materials. Correspondingly, this standard does not include a table with standard pH values for practical use. The table above only provides examples of pH(PS) values for orientation.

15.1.5 Hach Buffers

Buffer values up to 60 °C as specified by Bergmann & Beving Process AB.

Temp (°C)	pH of Buffer Solutions		
0	4.00	7.14	10.30
5	4.00	7.10	10.23
10	4.00	7.04	10.11
15	4.00	7.04	10.11
20	4.00	7.02	10.05
25	4.01	7.00	10.00
30	4.01	6.99	9.96
35	4.02	6.98	9.92
40	4.03	6.98	9.88
45	4.05	6.98	9.85
50	4.06	6.98	9.82
55	4.07	6.98	9.79
60	4.09	6.99	9.76

15.1.6 Ciba (94) Buffers

Temp (°C)	pH of Buffer Solutions			
0	2.04	4.00	7.10	10.30
5	2.09	4.02	7.08	10.21
10	2.07	4.00	7.05	10.14
15	2.08	4.00	7.02	10.06
20	2.09	4.01	6.98	9.99
25	2.08	4.02	6.98	9.95
30	2.06	4.00	6.96	9.89
35	2.06	4.01	6.95	9.85
40	2.07	4.02	6.94	9.81
45	2.06	4.03	6.93	9.77
50	2.06	4.04	6.93	9.73
55	2.05	4.05	6.91	9.68
60	2.08	4.10	6.93	9.66
65	2.07[1)]	4.10[1)]	6.92[1)]	9.61[1)]
70	2.07	4.11	6.92	9.57
75	2.04[1)]	4.13[1)]	6.92[1)]	9.54[1)]
80	2.02	4.15	6.93	9.52
85	2.03[1)]	4.17[1)]	6.95[1)]	9.47[1)]
90	2.04	4.20	6.97	9.43
95	2.05[1)]	4.22[1)]	6.99[1)]	9.38[1)]

1) Extrapolated.

15.1.7 Merck Titrisole, Riedel-de-Haën Fixanale

Temp (°C)	pH of Buffer Solutions			
0	2.01	4.05	7.13	12.58
5	2.01	4.05	7.07	12.41
10	2.01	4.02	7.05	12.26
15	2.00	4.01	7.02	12.10
20	2.00	4.00	7.00	12.00
25	2.00	4.01	6.98	11.88
30	2.00	4.01	6.98	11.72
35	2.00	4.01	6.96	11.67
40	2.00	4.01	6.95	11.54
45	2.00	4.01	6.95	11.44
50	2.00	4.00	6.95	11.33
55	2.00	4.00	6.95	11.19
60	2.00	4.00	6.96	11.04
65	2.00	4.00	6.95	10.97
70	2.01	4.00	6.95	10.90
75	2.01	4.00	6.95	10.80
80	2.01	4.00	6.97	10.70
85	2.01	4.00	6.98	10.59
90	2.01	4.00	7.00	10.48
95	2.01	4.00	7.02	10.37

15.1.8 WTW Buffers

Temp (°C)	pH of Buffer Solutions			
0	2.03	4.01	7.12	10.65
5	2.02	4.01	7.09	10.52
10	2.01	4.00	7.06	10.39
15	2.00	4.00	7.04	10.26
20	2.00	4.00	7.02	10.13
25	2.00	4.01	7.00	10.00
30	1.99	4.01	6.99	9.87
35	1.99	4.02	6.98	9.74
40	1.98	4.03	6.97	9.61
45	1.98	4.04	6.97	9.48
50	1.98	4.06	6.97	9.35
55	1.98	4.08	6.98	
60	1.98	4.10	6.98	
65	1.99	4.13	6.99	
70		4.16	7.00	
75		4.19	7.02	
80		4.22	7.04	
85		4.26	7.06	
90		4.30	7.09	
95		4.35	7.12	

15.1.9 JIS Z 8802 Buffers

Temp (°C)	pH of Buffer Solutions			
0	1.666	4.003	6.984	9.464
5	1.668	3.999	6.951	9.395
10	1.670	3.998	6.923	9.332
15	1.672	3.999	6.900	9.276
20	1.675	4.002	6.881	9.225
25	1.679	4.008	6.865	9.180
30	1.683	4.015	6.853	9.139
35	1.688	4.024	6.844	9.102
38	1.691	4.030	6.840	9.081
40	1.694	4.035	6.838	9.068
45	1.700	4.047	6.834	9.038
50	1.707	4.060	6.833	9.011
55	1.715	4.075	6.834	8.985
60	1.723	4.091	6.836	8.962
70	1.743	4.126	6.845	8.921
80	1.766	4.164	6.859	8.885
90	1.792	4.205	6.877	8.850
95	1.806	4.227	6.886	8.833

15.2 Dual Membrane pH Electrode Buffers

15.2.1 Mettler-pH/pNa Buffers (Na+ 3.9M)

Temp (°C)	pH of Buffer Solutions			
0	1.98	3.99	7.01	9.51
5	1.98	3.99	7.00	9.43
10	1.99	3.99	7.00	9.36
15	1.99	3.99	6.99	9.30
20	1.99	4.00	7.00	9.25
25	2.00	4.01	7.00	9.21
30	2.00	4.02	7.01	9.18
35	2.01	4.04	7.01	9.15
40	2.01	4.05	7.02	9.12
45	2.02	4.07	7.03	9.11
50	2.02	4.09	7.04	9.10

Notes

Notes

Notes

For addresses of METTLER TOLEDO
Market Organizations please go to:
www.mt.com/contacts

METTLER TOLEDO Group
Process Analytics
Local contact: www.mt.com/pro-MOs

www.mt.com/pro

For more information