User's Manual

Aqua4Trans

R2, Dec 2023

Forbes Marshall Pvt. Ltd.

B-85, Phase-II, Chakan Industrial Area
Sawardari, Chakan
Tal: Khed, District: Pune
Maharashtra, India - 410501
Tel: +91-21-35393400
Website: www.forbesmarshall.com

Contents

1. General information

 This User Manual describes the Aqua4Trans – 4 Wire Dual Channel / Multi parameter Transmitter, designed and manufactured by Forbes Marshall Pvt. Ltd. (FMPL). FMPL reserves the right to make changes to the transmitter specifications, the transmitter and the manual at any time without prior notice. FMPL is not liable for any direct, indirect or consequential damages resulting from any errors or omissions in this manual.

1.1 Safety

Please read this manual completely before proceeding with installation. Pay particular attention to all the caution and danger statements. Employ personnel who are trained to install, connect, power-up and operate the sensors and the transmitter. Install and use the transmitter only in the manner specified in this manual.

No unauthorized modifications to the transmitter are allowed. FMPL accepts no responsibility for damage caused by unauthorized modifications. The risk is borne entirely by the user.

1.2 Making electrical connections

Before connecting any high voltage/current cables:

- Ensure that the power is off at the source and that the cables are not live.
- Connect the power Live, Neutral & Earth ground to the AC power plug.
- Connect the protective earth cable to the extreme right side Earth screw and use other three Earth screws for terminating the shields of sensors and communication cable.
- All the terminal connectors are pluggable and should be removed to insert and fasten the wires.
- Ensure that the routing of the sensor cables till the Transmitter prevents exposure to high Electromagnetic fields (e.g. Transmitters, motors and switching equipment). Exposure to these fields can cause inaccurate results.

1.3 Hazard info

 This indicates that a high risk of electrocution exists and will result in death if due care is not taken.

 This indicates that a high risk of electrical shock exists and could result in death or serious injury if due care is not taken.

 This indicates the presence of electrical potential and could result in serious injury if due care is not taken.

 This indicates that a certain action is prohibited. The user must take precaution to prevent damage to the transmitter, degradation in the transmitter's performance and/or injury to self.

 This indicates that the user must disconnect mains power to the transmitter before performing further actions.

1.4 Other info

 This indicates the presence of modules with electronic devices that are susceptible to electrostatic discharge. Hence caution - do not touch the devices!

 This indicates that the user must read an important note and / or observe the instruction during installation, connection and/ or use of the transmitter.

 This indicates that you must use only the recommended tools or tools appropriate for the immediate task.

1.5 Removal of transmitter from service

- Disconnect the cable wiring from the transmitter terminals.
- Remove the transmitter from the mounting hardware.

1.6 E-waste disposal

 This mark indicates that the disposal of the transmitter and/or its accessories must conform to the **e-wastes (Management and Handling) Rules**, published by the Government of India. Do not dispose of in domestic/municipal waste. This also applies to countries outside India as per their specific requirements.

2. Overview

Aqua4Trans is a 4 Wire Dual Channel / Multi parameter Transmitter that accepts process sensor inputs and displays the measured values. It transmits standard analog current outputs and drives internal relay outputs. As an option, it communicates digitally with external devices. A digital input is used to control internal functions.

2.1 Sensor inputs

Aqua4Trans accepts up to two sensor modules with one sensor connected to each module. The modules installed can be any combination of the available types.

2.2 Analog outputs

Aqua4Trans drives up to four active 0/4 ~ 20 mA current outputs. Each output is freely assignable to any of the measured parameters and can be configured for a selectable output characteristic.

2.3 Relay outputs

Aqua4Trans drives up to six internal relays. The relays can be assigned to various functions. Their potential-free contacts to operate external devices are configurable as normally open or normally closed.

2.4 Digital input

Aqua4Trans detects an external potential-free contact closure as an event to trigger the internal timer function.

2.5 HART® Interface (option):

Aqua4Trans communicates digitally with external smart devices via HART® protocol. This interface is provided on the CPU module on Iout1.

2.6 Digital communication (option)

2.6.1 Modbus RS485:

Aqua4Trans communicates digitally with external smart devices via Modbus over RS485.

2.6.2 User interface

Aqua4Trans has a large backlit alphanumeric display panel, minimal number of keys and an easy to understand menu structure, making it simple to operate.

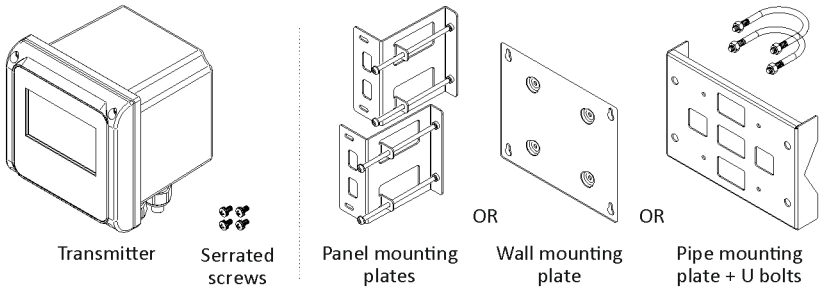
2.7 Mounting

Aqua4Trans is housed in an IP66-rated enclosure. Depending on the installation requirement it can be panel-mounted, wall-mounted or pipe-mounted using the accessories provided.

3. Installation

3.1 After unpacking

Confirm that the unit received is with attached cable glands and one of the mounting accessories as ordered.



Inspect all parts for any visible in-transit damage. Report any missing or damaged items immediately to FMPL support.

3.2 Tools required

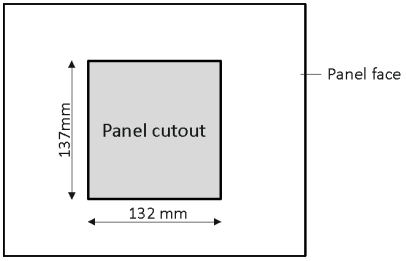
3.2.1 Screw drivers

- Standard Phillips tip for M3 | M4 screws: enclosure lid, mounting and Earth connections
- Standard flat tip 0.4x1.6 to 04.x2.5 mm blade: terminal connectors

3.2.2 Side spanners

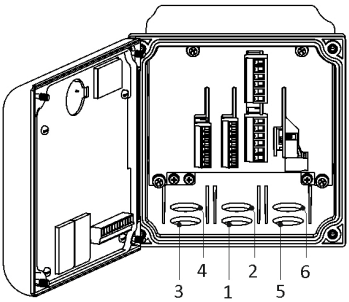
- Size 24: cable glands
- M8 spanner size 13: U-bolt hex nuts

3.3 Panel cut-out



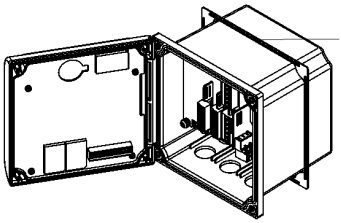
3.4 Cable gland sequence

Ensure that the mounting face of the panel has a cut-out as stated in the Specifications. Once mounted onto the panel, follow the sequence shown below when fixing the cable glands.

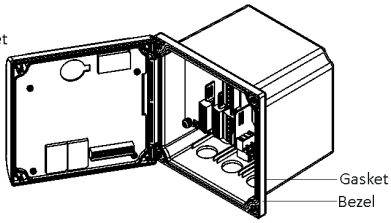


Cable glands fixing sequence

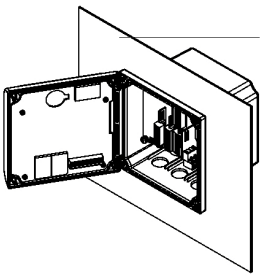
3.5 Panel Mounting



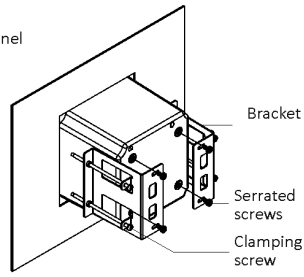
1. Slide gasket around Transmitter.



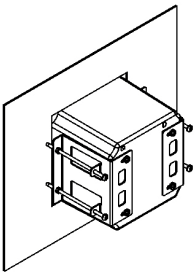
2. Let gasket mate with bezel.



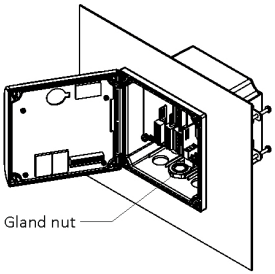
3. Slide Transmitter into cutout until its bezel touches panel.



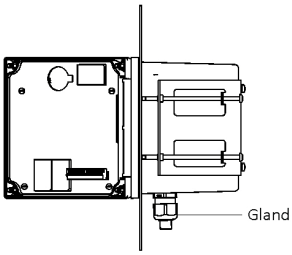
4. Keeping clamping screws loose, fix brackets using serrated screws.



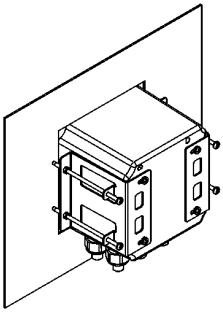
5. Tighten serrated screws followed by clamping screws.



6. Hold gland nut through front open lid.

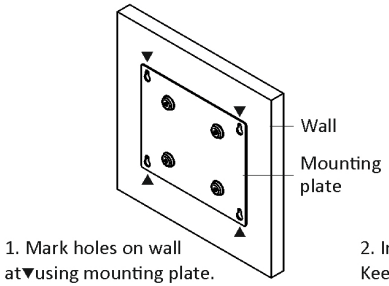


7. Thread-in gland into gland nut from rear of panel.

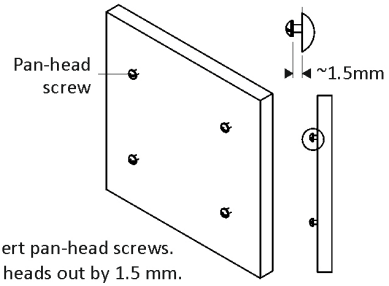


8. Fix all glands following indicated sequence.

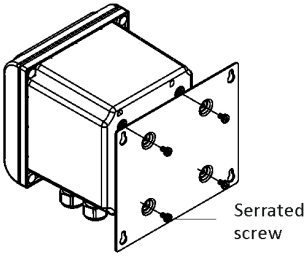
3.6 Wall mounting



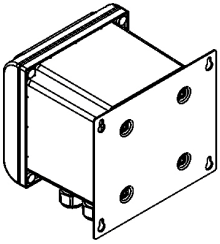
1. Mark holes on wall at▼using mounting plate.



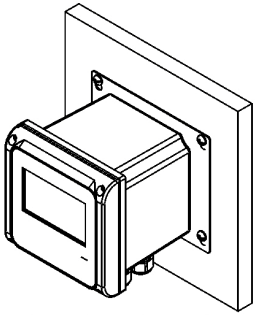
2. Insert pan-head screws. Keep heads out by 1.5 mm.



3. Fix plate to equipment using serrated screws.

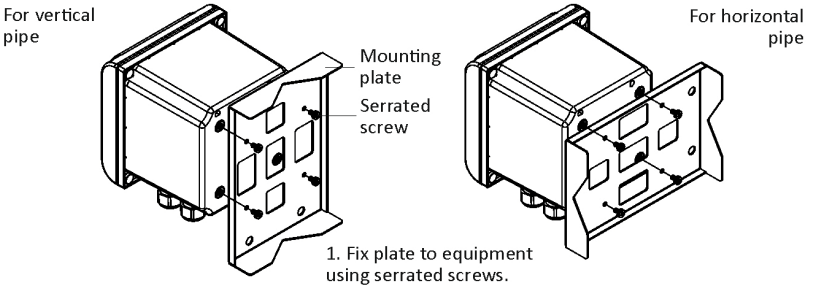


4. Tighten serrated screws.

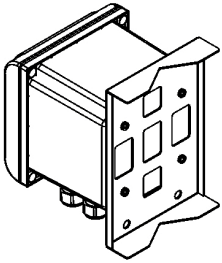


5. Mount through keyholes. Tighten pan-head screws.

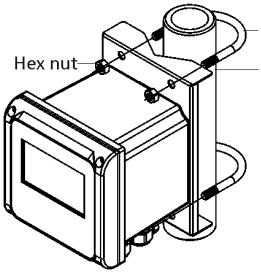
3.7 Pipe mounting



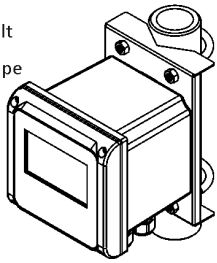
1. Fix plate to equipment using serrated screws.



2. Tighten serrated screws.



3. Fix plate using U bolts and hex nuts.



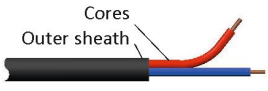
4. Tighten hex nuts.

4. Electrical connections

Before making any connections, switch off power and disconnect the mains supply if already connected to the Transmitter.

4.1 Recommended cable preparation practices

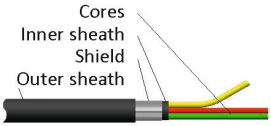
Unshielded cables



Without damaging inner cores:
>Strip off the outer sheath
>Strip off the insulation of each core
Repeat for all cores

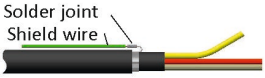
Slide in a Ferrule
Crimp a pin Lug
Repeat for all cores

Shielded cables

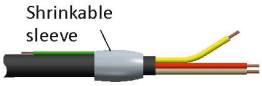


Without damaging shield and cores:
>Strip off outermost sheath
>Strip off inner sheath
This exposes the shield and the cores

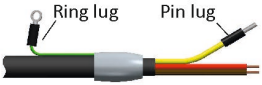
Separate out the shield braid
Tie together the shield strands
Fold backwards



Tin the shield end with solder gun
Solder a length of wire to the shield



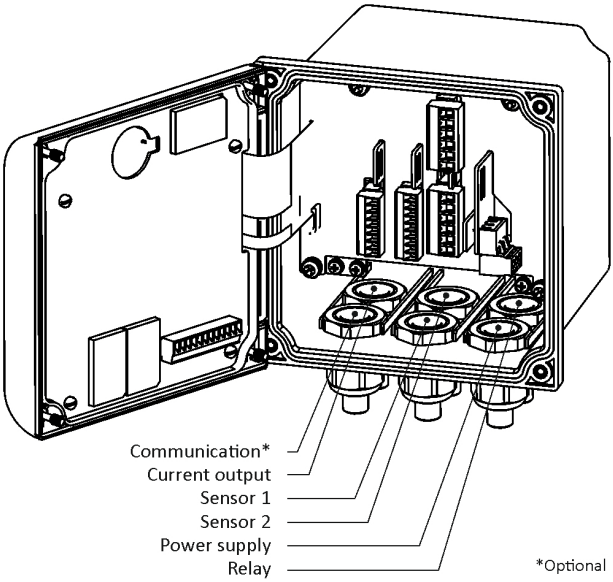
Strip off the insulation of the cores
Slide a heat-shrinkable sleeve over solder joint
Shrink the sleeve completely



Crimp a pin Lug to the core
Repeat for all cores
Crimp a ring Lug to the shield wire

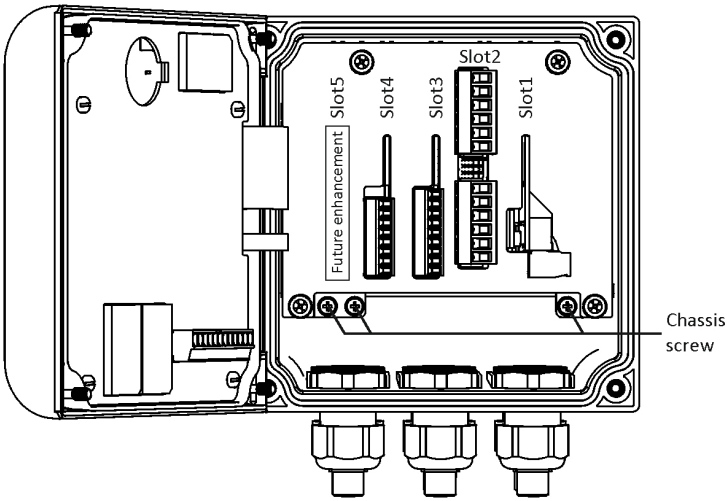
Terminate the shields of the various signal cables onto the chassis screws using ring type crimp lugs.

4.2 Cable gland allocation



Run the prepared cables through the indicated cable glands. Detach the plug from its module. Insert and connect the respective wires according to the termination chart. Plug in. Pull back any extra cable length within the Transmitter and tighten the cable gland nuts.

4.3 Slot locations | Chassis screws



The slot locations for plug-in modules types are:

- Slot1: Power Supply module
- Slot2: Relay module
- Slot3: Channel A Sensor Modules*
- Slot4: Channel B Sensor Modules*

  *Sensor Module types:

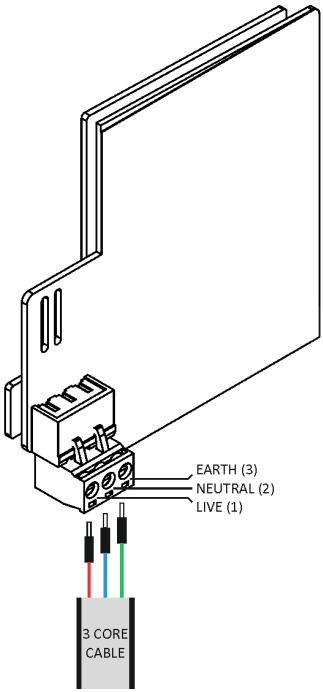
  - Conductivity / TDS **Note1**
  - pH / ORP(Redox)
  - Turbidity / TSS Module
  - 4 ~ 20mA Module **Notes 2,3**
  - DO (Dissolved Oxygen) module
- Slot5: Communication (optional): Modbus RS485 module

Note1: Math functions are available **only** when both Channels A and B have Conductivity / TDS modules inserted.

Note 2: Any sensor that has a 4 ~ 20mA output can be connected to this module.

Note 3: If a chlorine sensor is connected to this module, the user is provided with an option in the configuration menu of this module to enable pH compensation in Manual or Auto. If Auto is selected, it is necessary to connect a pH sensor to a pH module in Channel A / B as the case may be.

4.4 Power Supply connections



Recommendation

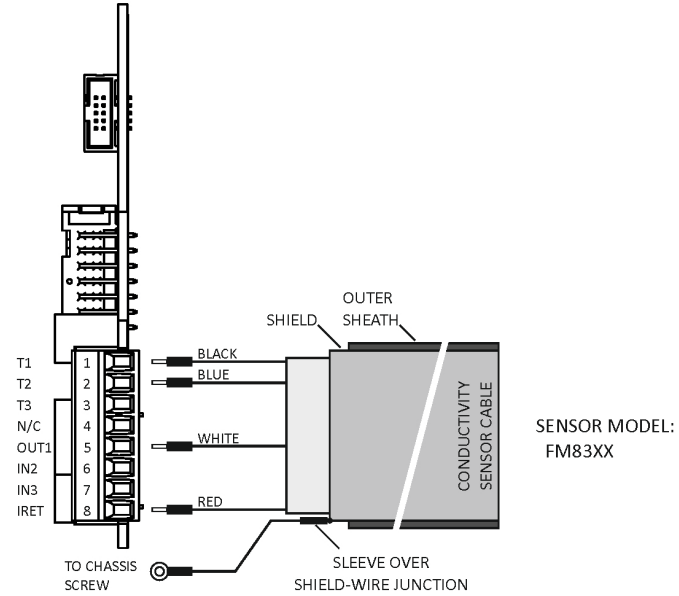
Use a single 3-core cable with individual core colours of red (LIVE), blue or back (NEUTRAL) and green or yellow/green (EARTH). As an example, use a 3 core cable, 1.0 mm^2 core cross section.

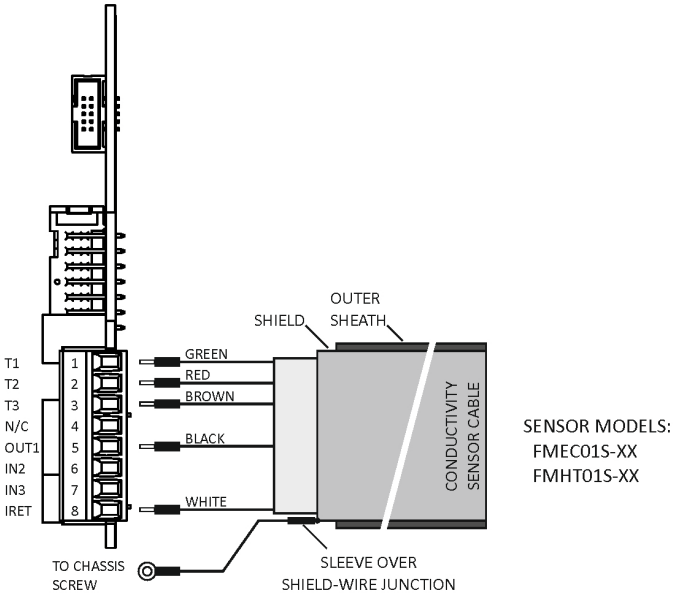
4.5 Sensor connections

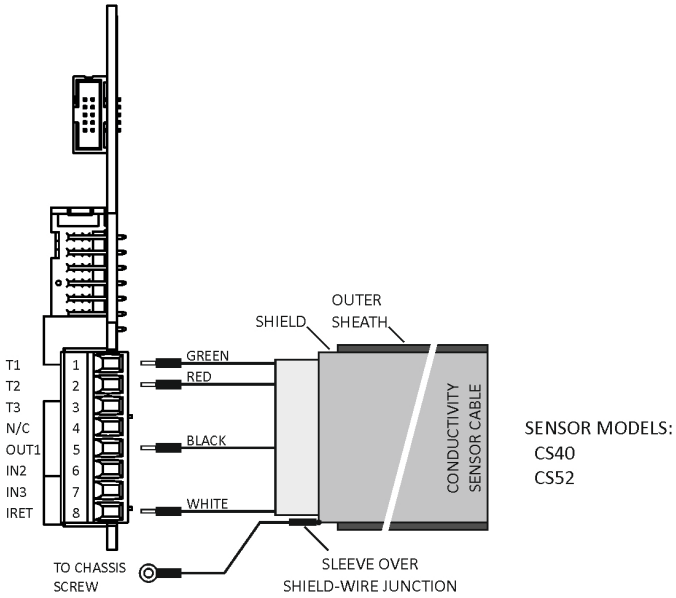
The cable consists of a screw cap at one end which fits to the sensor end. In some cases the cable could be integral to the sensor at its end. The four conductors at the other end must be connected to the terminal plugs of the appropriate sensor module, and the shield to the chassis screws within the transmitter.

Do not terminate the shield directly without lug. Use a sleeve over the shield and a ring-type lug before terminating. This lug must always be terminated to the chassis screw.

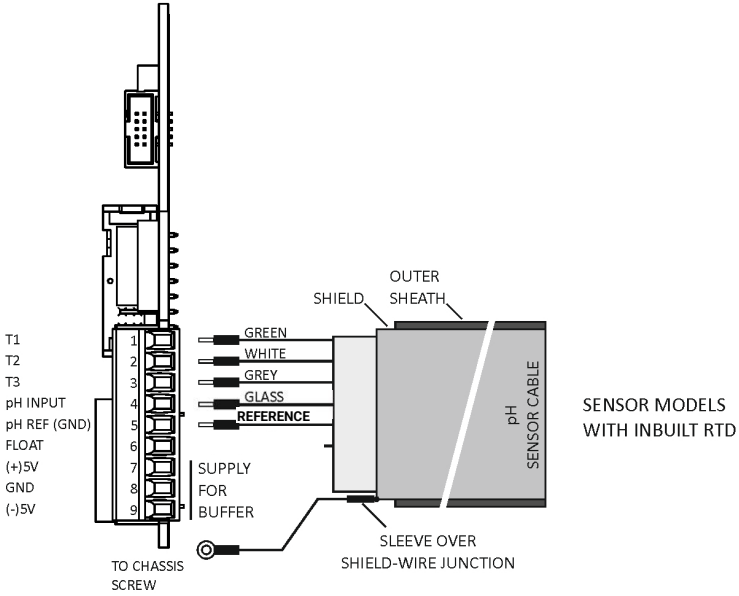
4.5.1 Conductivity sensors

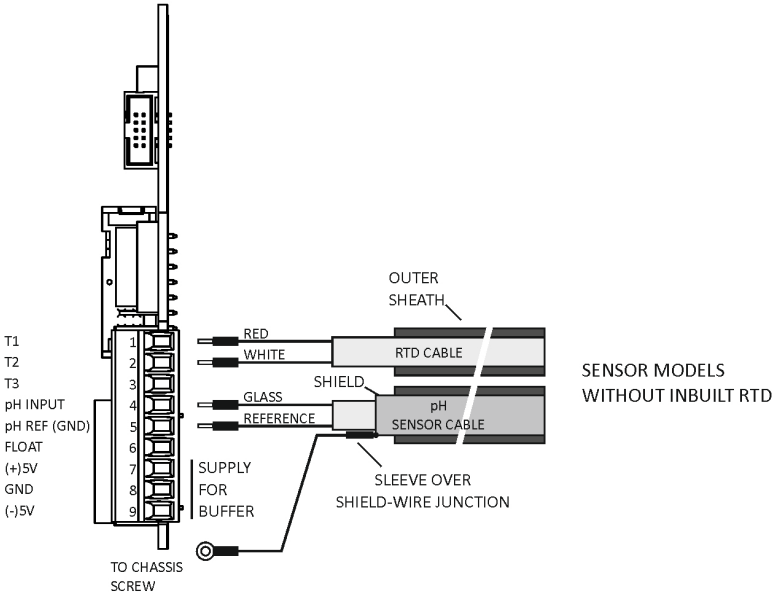






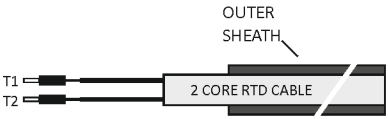
4.5.2 pH sensors





4.5.3 Temperature sensor (2 –wire Pt100)

Not applicable if using conductivity or pH sensors with inbuilt temperature sensing element. It is necessary to use a temperature sensor for auto compensation of the measured conductivity value. A typical cable for the RTD sensor is shown below.



The temperature input is used during conductivity sensor calibration with a standard solution. Insert the temperature sensor also into the solution when calibrating the conductivity sensor.

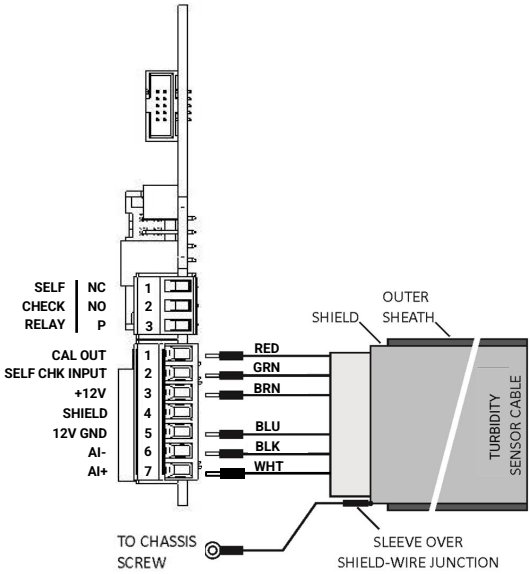
4.5.4 Terminating lugs

Use pin type lugs suitable for 0.5-1.0 mm^2 conductor with pin length of 6-8 mm.

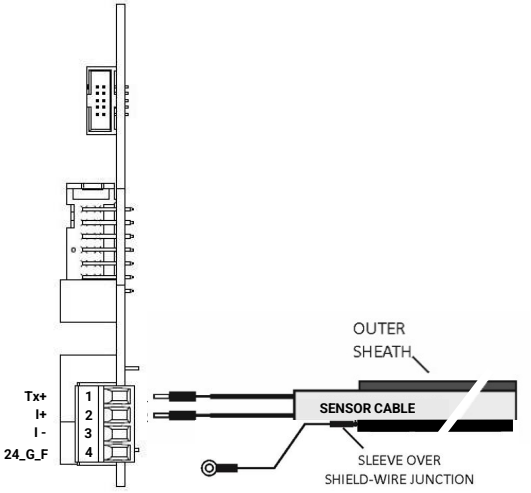
4.5.3 pH sensor connection details

Electrode	Cable	Glass – TER 6	Ref. – TER 5	PT1 - TER 1	PT2 - TER (2+3)
FM1104	AS7	Transparent core	Black/Shield		
FM1106	Special	HI	LO	White	Red
Inchtrode	VP6	Black - Transparent	Red	White	Green
Inchtrode with VP8	VP8	Core Coax Black	Shield Coax Black	White	Green
Jackotrode	VP6	Black - Transparent	Red	White	Green
Deltatrode	VP6	Black - Transparent	Grey	White	Green
Ploylite pro 120	AS7	Transparent core	Black/Shield		
Polylite Pro VP120	VP6	Black - Transparent	Red	White	Green
2GE P	AS7	Transparent core	Black/Shield		
EASYPHERM BIO 120	AS7	Transparent core	Black/Shield		
EASYPHERM BIO VP 120	VP6	Black - Transparent	Red	White	Green
EASYPHERM PLUS PHI VP120	VP6	Black - Transparent	Red	White	Green
EASYPHERM PLUS PHI 120	AS7	Transparent core	Black/Shield		
INOTRODE	AS7	Transparent core	Black/Shield		
FM1108	VP6	Black - Transparent	Red	White	Green
LIQ GLASS PG	S8	Transparent core	Black/Shield		
MECOTRODE	AS7	Transparent core	Black/Shield		
MECOTRODE VP	VP6	Black - Transparent	Red	White	Green
POLILYTE PLUS	S8	Transparent core	Black/Shield		
POLYLITE PLUS VP	VP6	Black - Transparent	Red	White	Green
INCHTRODE (N75FC10 cable)	Special	Core Black	Core Red	White	Green & yellow
OPTISENSE 8390	Special	Core Transparent	Inner shield black	White	Red

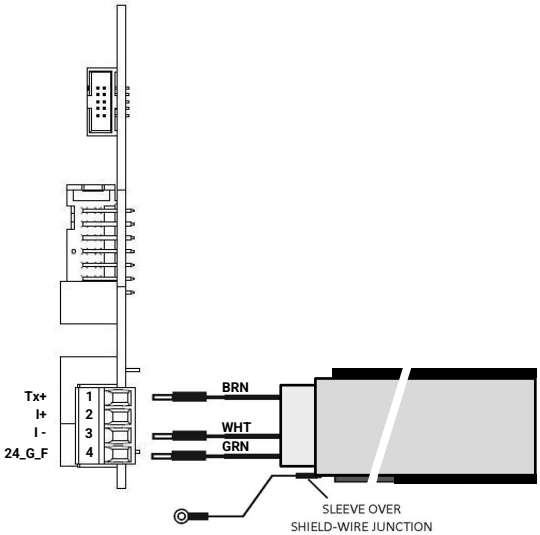
4.6 Turbidity / TSS module:



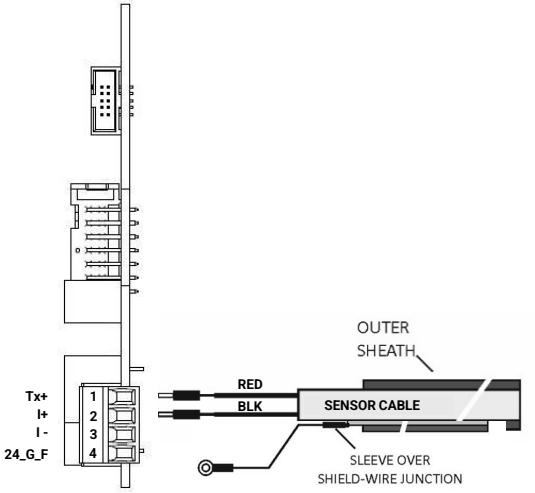
4.7 4 ~ 20 mA Module connections:



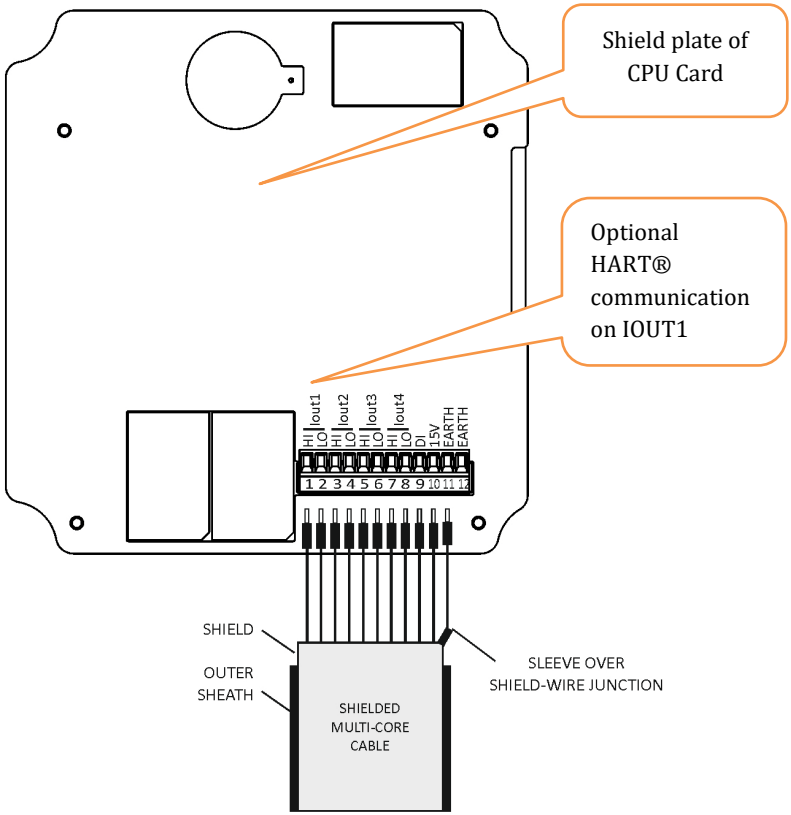
4.7.1 DO Sensor Connections



4.7.2 Chlorine Sensor Connections



4.8 CPU Module: Current Output and Digital Input connections



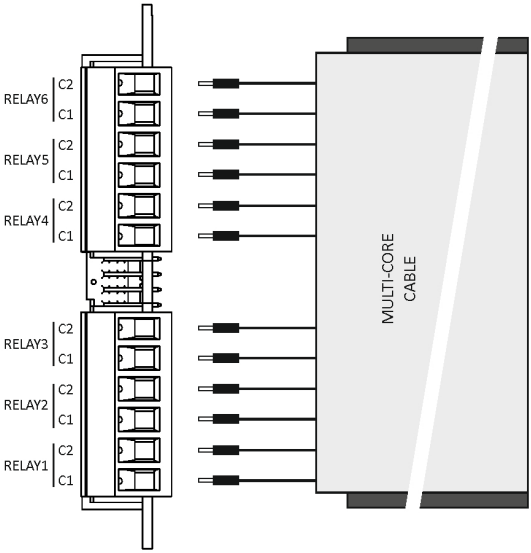
The CPU board has four current outputs: Iout1 ~ Iout4. HART® communication is available as an option on IOUT1

Recommendation

Use a single shielded cable with appropriate number of cores. As an example, to use all the current outputs and the digital input, use a 10 core cable, 0.5 mm^2 with braided shield. Connect the shield to the chassis screw.

You may terminate the other end of the cable onto terminals within an external junction box of suitable IP rating. This will allow you to distribute the connections to the individual output loads as well as the digital input switch, which may be scattered across the wide process area.

4.9 Relay connections



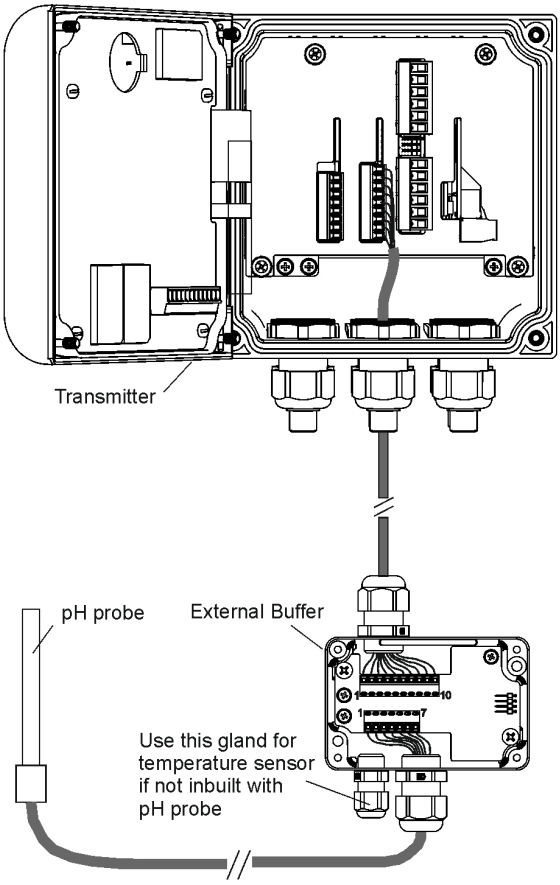
Recommendation

A single cable with appropriate number of cores should be used. As an example, it is recommended that a 12 core cable, 0.5 mm^2 be used for all relay contacts. The other end of the cable should be terminated to terminals within an external junction box of suitable IP rating. This will allow distribution of connections to individual output loads, which may be spread wide across the process area.

4.10 External Buffer connections (pH)

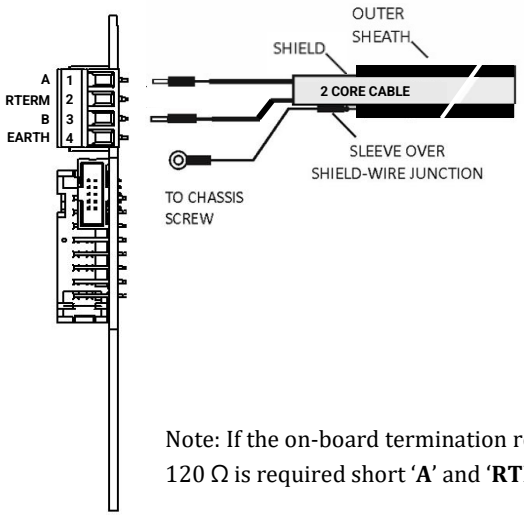
Use an external buffer when the cable length between the pH sensor and the transmitter exceeds 10m.

- Mount the buffer module within 10m cable length of the Transmitter.
- Connect the cable provided as part of the supply, between the buffer output and the Transmitter input.
- Connect the sensor to the buffer input.
- Tighten the cable glands.
- Fix the buffer amplifier cover and tighten its screws.



Buffer Amplifier (IN)		Buffer Amplifier (OUT)		Transmitter pH module	
Terminal	Signal	Terminal	Signal	Terminal	Signal
1	T1	1	T1	1	T1
2	T2	2	T2	2	T2
3	T3	3	T3	3	T3
4	pH_input	4	pH_output	4	pH_input
5	pH_reference	5	GND	5	pH_reference
6	Float	6	NC	6	Float
7	Shield	7	+5V	7	+5V
		8	GND	8	GND
		9	-5V	9	-5V
		10	EARTH		

4.11 Modbus RS485 Comm module connections



Note: If the on-board termination resistor of 120 Ω is required short '**A**' and '**RTERM** '

4.11.1 Terminating lugs

Use pin type lugs suitable for 0.5-1.0 mm^2 conductor with pin length of 6 ~ 8 mm.

4.11.2 Recommended specifications for MODBUS RS485 communication

- Two core twisted pair
- Conductor: 7 strands bare copper wire
- Specific insulation resistance > 5 G Ω
- Mutual capacitance conductor to conductor < 120nF/km
- Mutual capacitance conductor to shield < 160nF/km (at 800 Hz)
- Inductance: 0.65 mH/km
- Characteristic impedance: 100 Ω ± 15 Ω (> 1 MHz)

5. The First Power-up

5.1 Checks before power-up

Unscrew and hinge-open the lid of the transmitter.
Check and confirm that

- only the specified mains power source has been connected
- the required wiring has been correctly done
- no wires are loose
- protective plate is installed
- all the connectors have been properly plugged into their receptacles
- all shields have been firmly connected to the chassis screws

Close and fasten the lid of the transmitter.

5.2 Powering up

Before powering ON, disconnect the power connector and check the incoming AC supply. Confirm the following voltages at the incoming supply:

- **Between Phase and Neutral is between 100 ~ 260VAC**
- **Between Neutral and Earth is < 1.5VAC**

Re-connect the power supply connector and switch on the mains power. The display momentarily shows the sign-on screen followed by a default runtime screen. Read the section **User Interface** for details.

5.3 Quick start: putting into operation

The transmitter is normally dispatched pre-configured with required settings, if provided by the customer when ordering.

Use the  key to scroll through the Runtime screens. These show the measured parameter values (primary and secondary variables), the current output values and the relay status on consecutive screens.

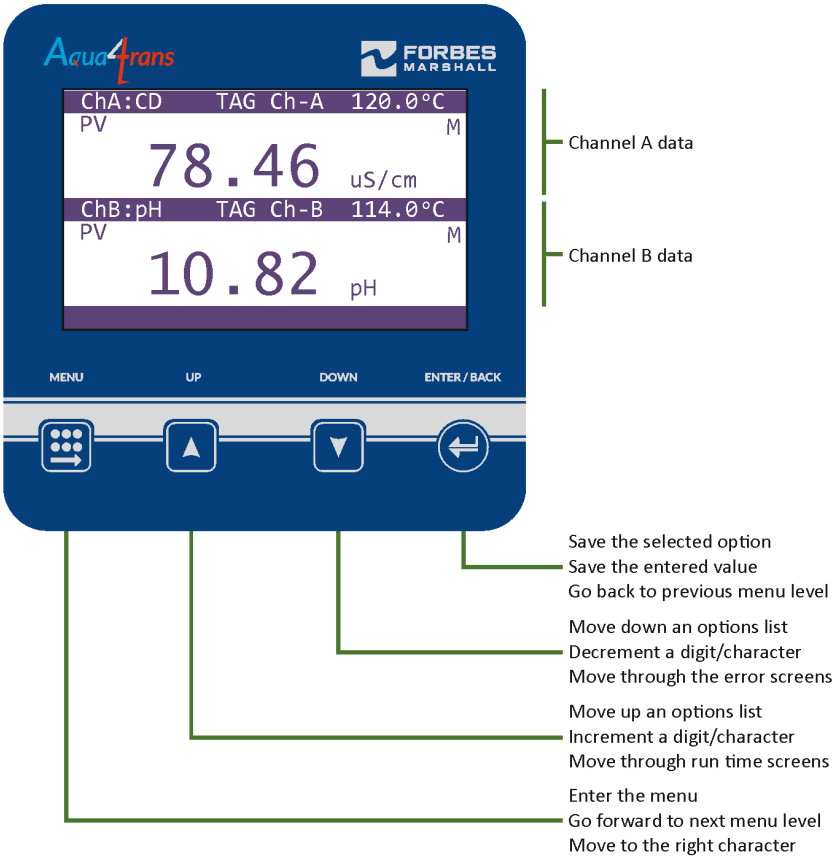
 Note that the values and status displayed will be in line with the actual conditions of the process at that time. At this point in time, a difference may be

observed between the displayed and expected values since the transmitter has not yet been calibrated along with the connected sensors.

In case the required settings have not been provided when ordering, the transmitter is configured with default values; see the section Default Settings. Please read the sections Menu and Configuration and perform the required settings.

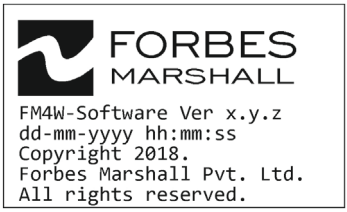
6. User Interface

Aqua4Trans has a large backlit alphanumeric display panel, four tactile keys and an easy to understand menu structure, making it simple to operate. Set the runtime screen to display the data of either both the channels simultaneously or single channel at a time, values of current outputs and status of relays.

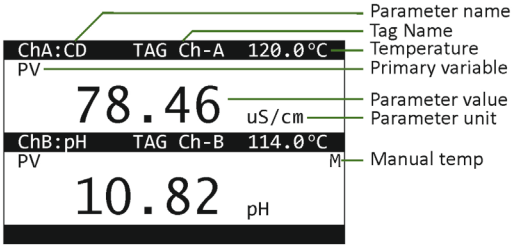


6.1 Runtime screens

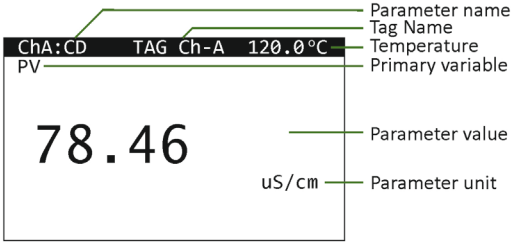
At power up, Aqua4Trans initially displays the FM logo, version details, and date and time.

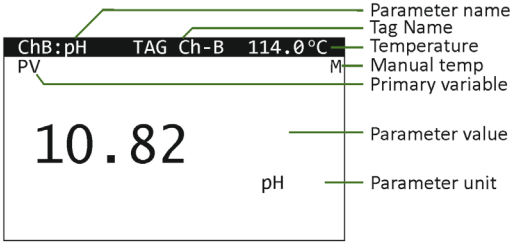


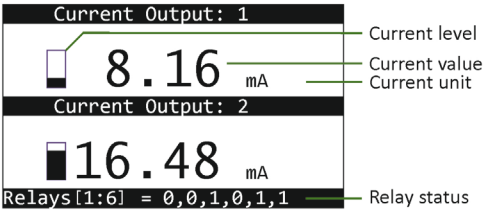
After few seconds, it displays that runtime screen as previously configured.

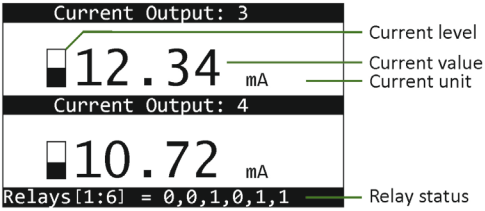


Use the key to scroll through the multiple runtime screens shown below.






Current Output: 1
8.16 mA
Current Output: 2
16.48 mA
Relays[1:6] = 0,0,1,0,1,1
Current level
Current value
Current unit
Relay status


Current Output: 3
12.34 mA
Current Output: 4
10.72 mA
Relays[1:6] = 0,0,1,0,1,1
Current level
Current value
Current unit
Relay status

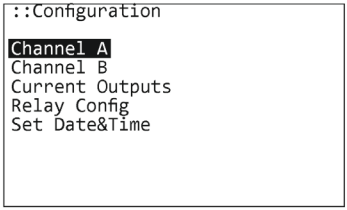
7. Menu: overview

7.1 Menu screens

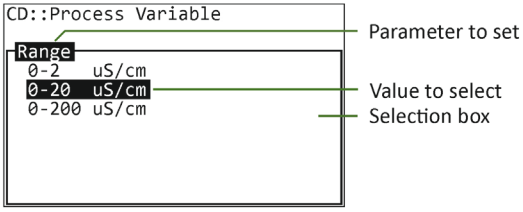
The menu screens have different formats, illustrated as examples below.

7.1.1 Main menu list

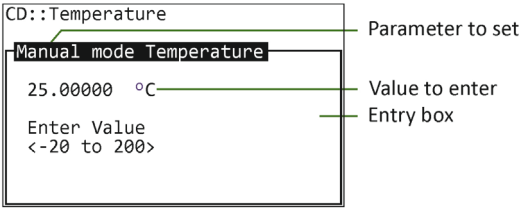
7.1.2 Sub menu list (title prefixed ::)



7.1.3 Selecting an option

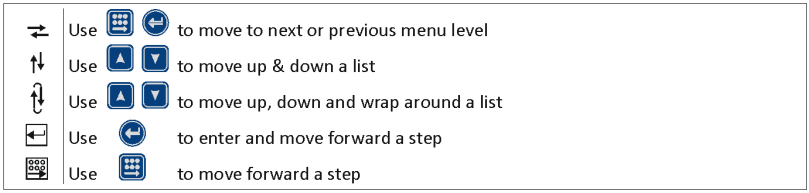


7.1.4 Entering a value



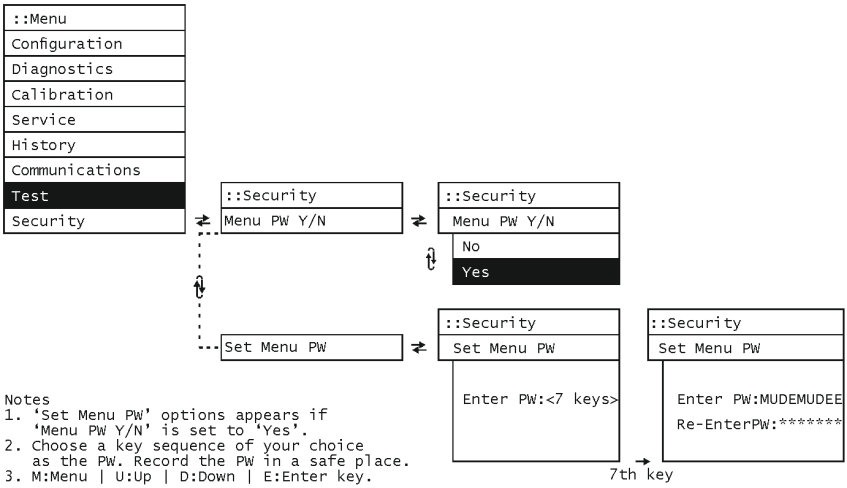
7.2 Navigating the menu

Use the four keys to navigate the menu. For simplicity, these keys have been represented with compact icons in the flow charts, as shown below.



7.3 Security menu

The Transmitter is delivered with the Menu password deactivated. Set a password of your choice. **Once a password is set and saved, all subsequent access to the Menu will require this password.**



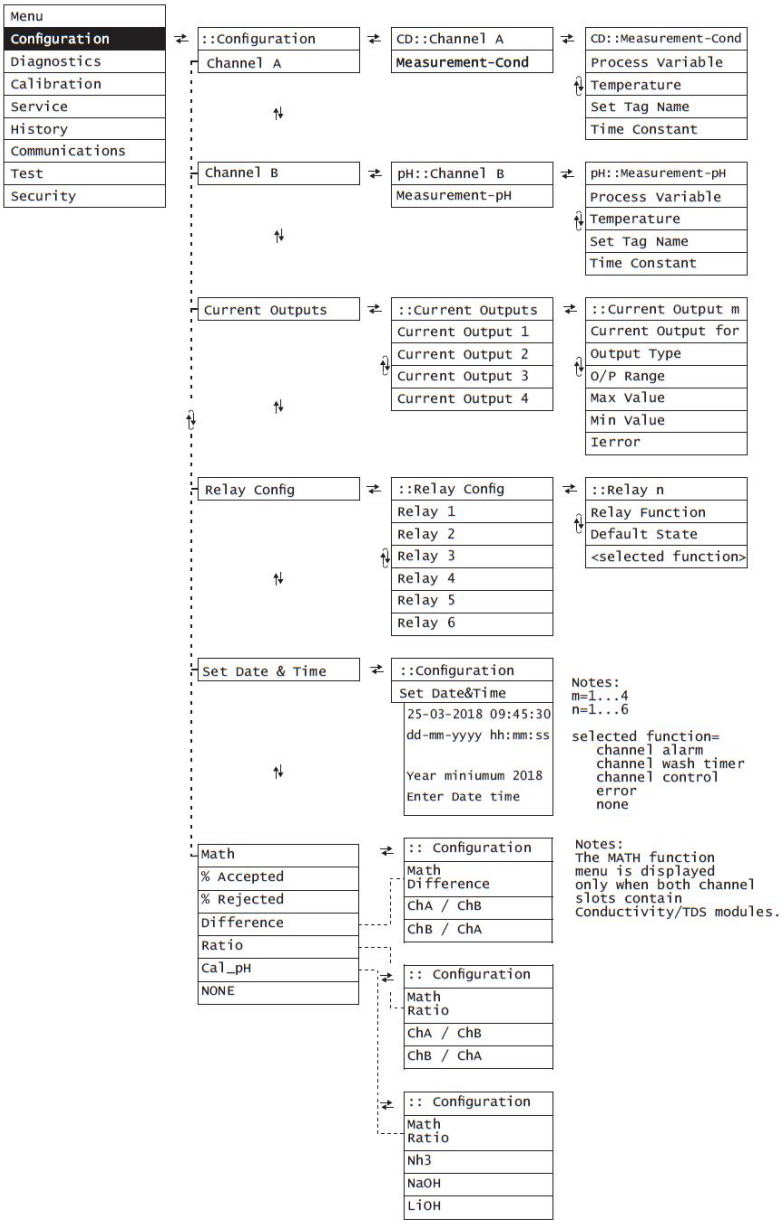
8. Configuration menu

Use this menu to configure various parameters related to the

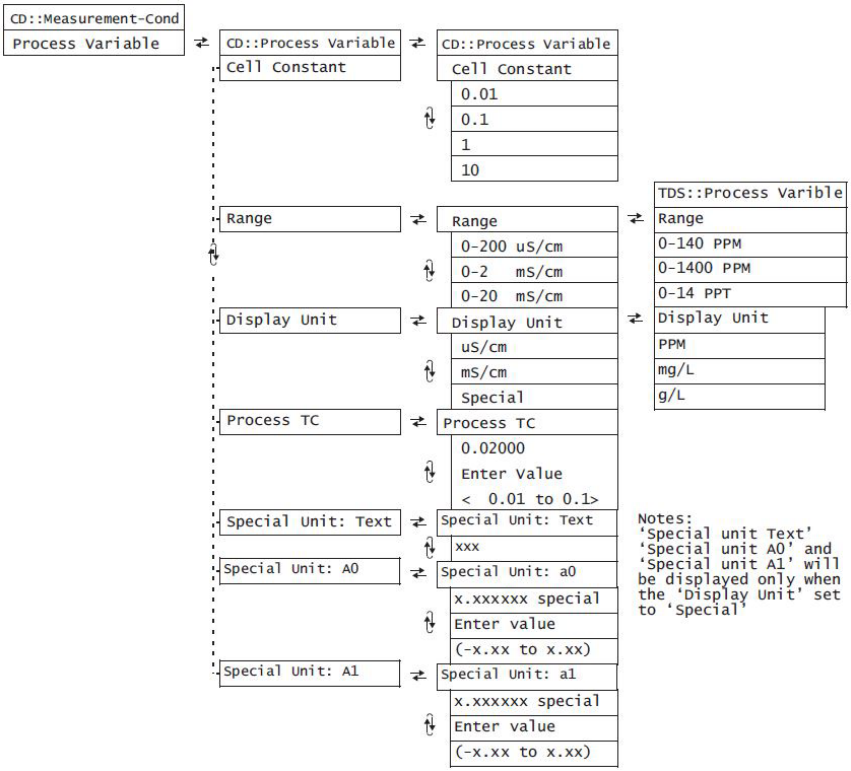
- Sensor inputs of channels A and B depending on the module type inserted
- Four current outputs
- Six relay outputs
- 4 ~ 20mA input module
- Communication via Modbus / HART®
- Date and time

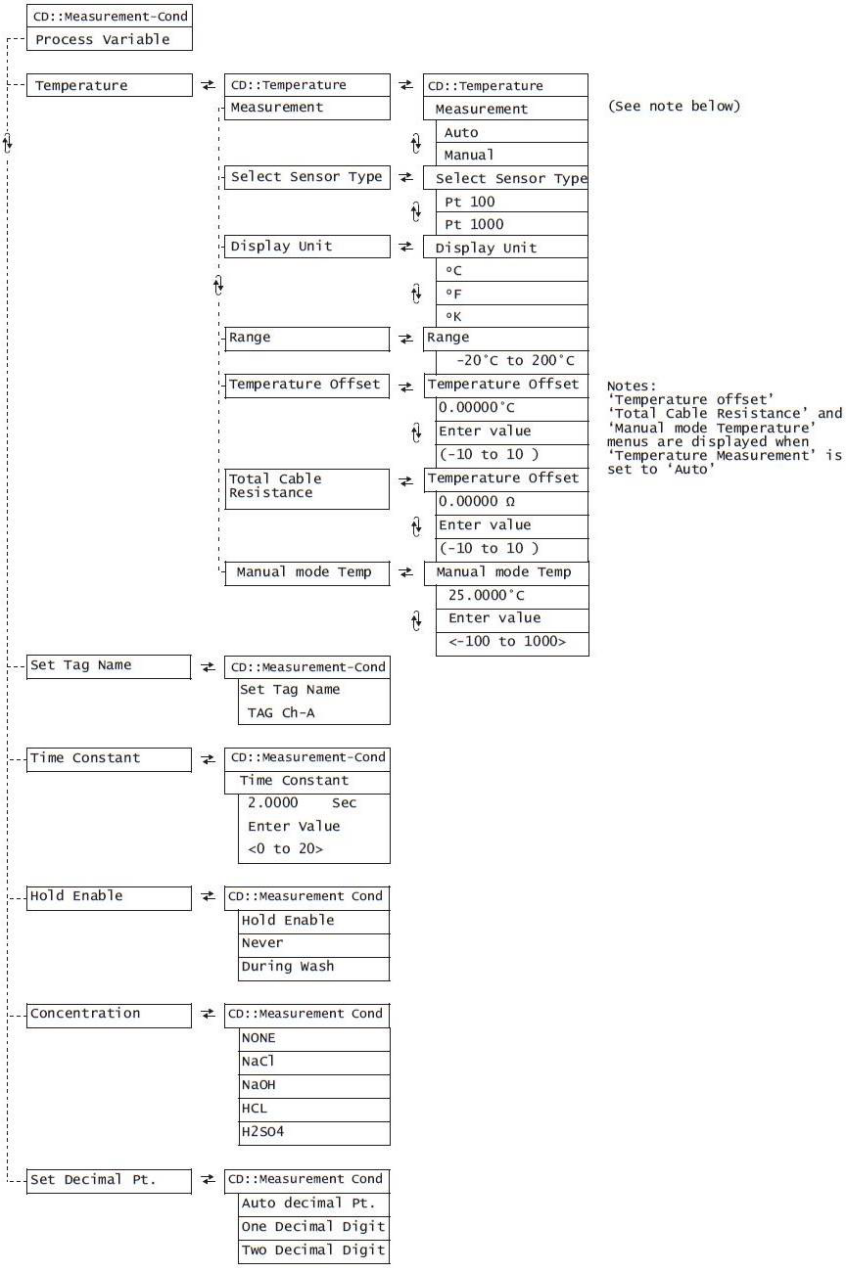
Refer to the following sections for details.

8.1 Top level

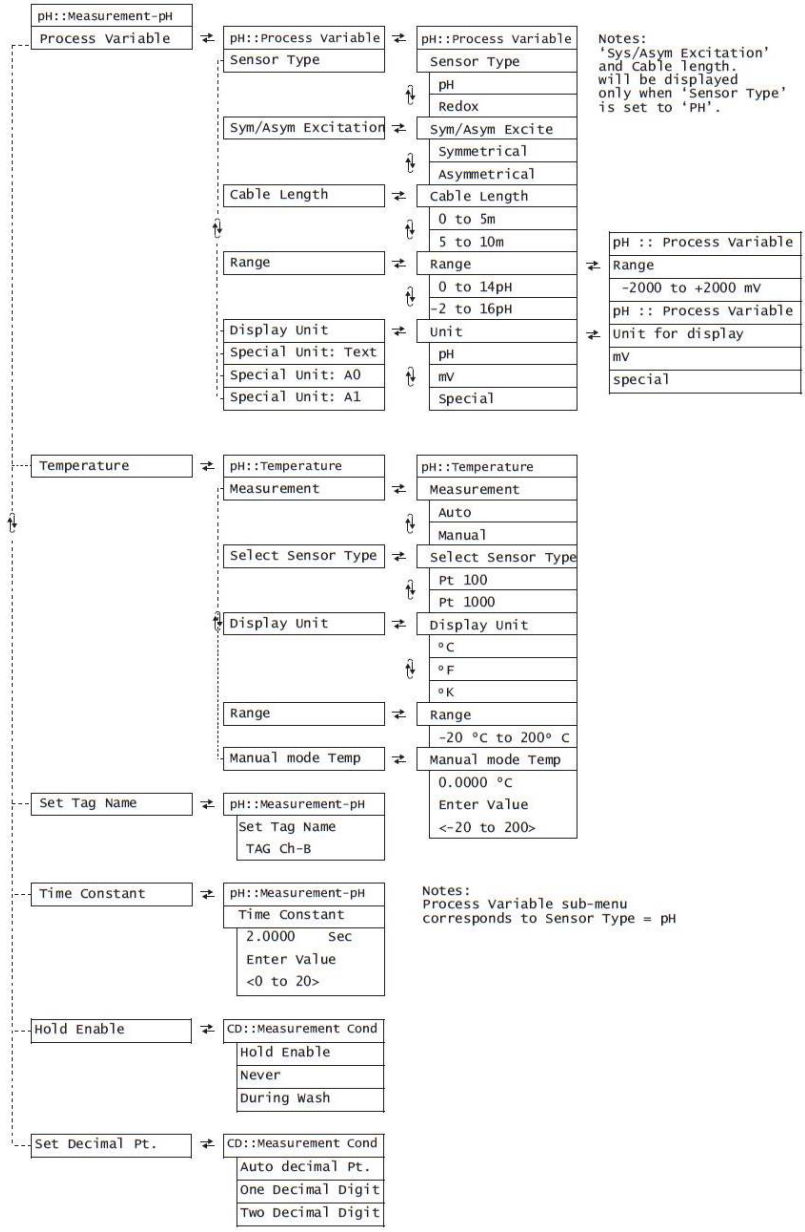

Menu
Configuration
Diagnostics
Calibration
Service
History
Communications
Test
Security
::Configuration
Channel A
Channel B
Current Outputs
Relay Config
Set Date & Time
Math
% Accepted
% Rejected
Difference
Ratio
Cal_pH
NONE
CD::Channel A
Measurement-Cond
pH::Channel B
Measurement-pH
::Current Outputs
Current Output 1
Current Output 2
Current Output 3
Current Output 4
::Relay Config
Relay 1
Relay 2
Relay 3
Relay 4
Relay 5
Relay 6
::Configuration
Set Date&Time
25-03-2018 09:45:30
dd-mm-yyyy hh:mm:ss
Year miniumum 2018
Enter Date time
:: Configuration
Math
Difference
ChA / ChB
ChB / ChA
:: Configuration
Math
Ratio
ChA / ChB
ChB / ChA
:: Configuration
Math
Ratio
Nh3
NaOH
LiOH
CD::Measurement-Cond
Process Variable
Temperature
Set Tag Name
Time Constant
pH::Measurement-pH
Process Variable
Temperature
Set Tag Name
Time Constant
::Current Output m
Current Output for
Output Type
O/P Range
Max Value
Min Value
Ierror
::Relay n
Relay Function
Default State
<selected function>
Notes:
m=1...4
n=1...6
selected function=
channel alarm
channel wash timer
channel control
error
none
Notes:
The MATH function
menu is displayed
only when both channel
slots contain
Conductivity/TDS modules.

8.2 Configuration: Conductivity / TDS Module

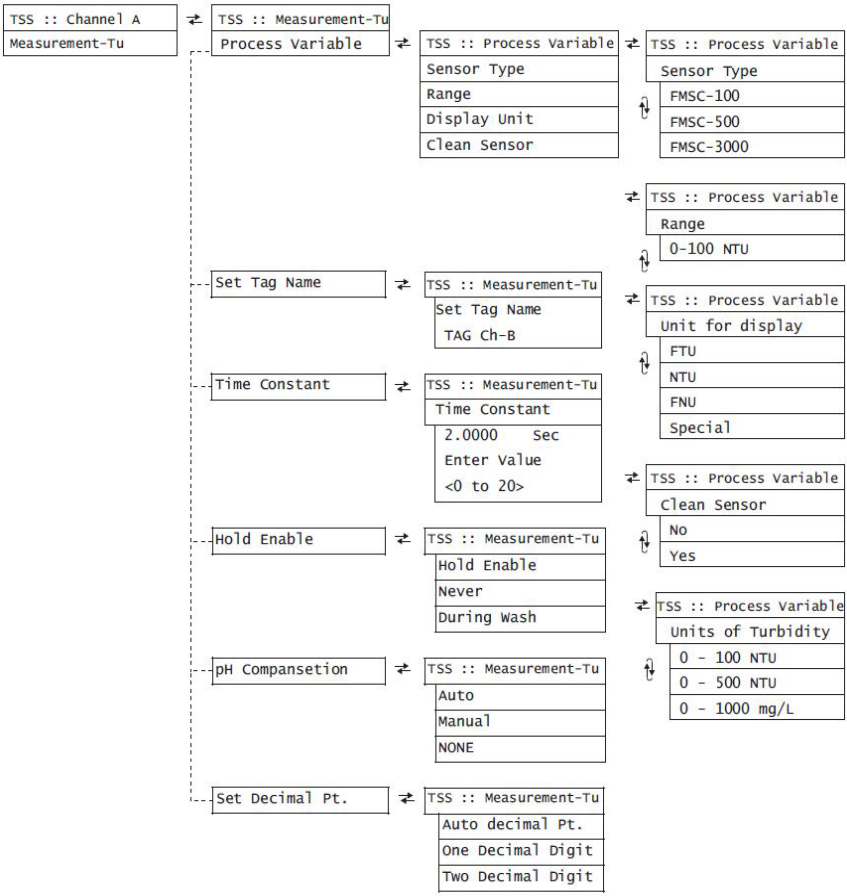



CD::Measurement-Cond
Process Variable
Temperature
CD::Temperature
Measurement
CD::Temperature
Measurement
(See note below)
Auto
Manual
Select Sensor Type
Select Sensor Type
Pt 100
Pt 1000
Display Unit
Display Unit
°C
°F
°K
Range
Range
-20°C to 200°C
Temperature Offset
Temperature Offset
0.00000°C
Enter value
(-10 to 10)
Total Cable Resistance
Temperature Offset
0.00000 Ω
Enter value
(-10 to 10)
Manual mode Temp
Manual mode Temp
25.0000°C
Enter value
<-100 to 1000>
Notes:
'Temperature offset'
'Total Cable Resistance' and
'Manual mode Temperature'
menus are displayed when
'Temperature Measurement' is
set to 'Auto'
Set Tag Name
CD::Measurement-Cond
Set Tag Name
TAG Ch-A
Time Constant
CD::Measurement-Cond
Time Constant
2.0000 Sec
Enter Value
<0 to 20>
Hold Enable
CD::Measurement Cond
Hold Enable
Never
During Wash
Concentration
CD::Measurement Cond
NONE
NaCl
NaOH
HCL
H2SO4
Set Decimal Pt.
CD::Measurement Cond
Auto decimal Pt.
One Decimal Digit
Two Decimal Digit

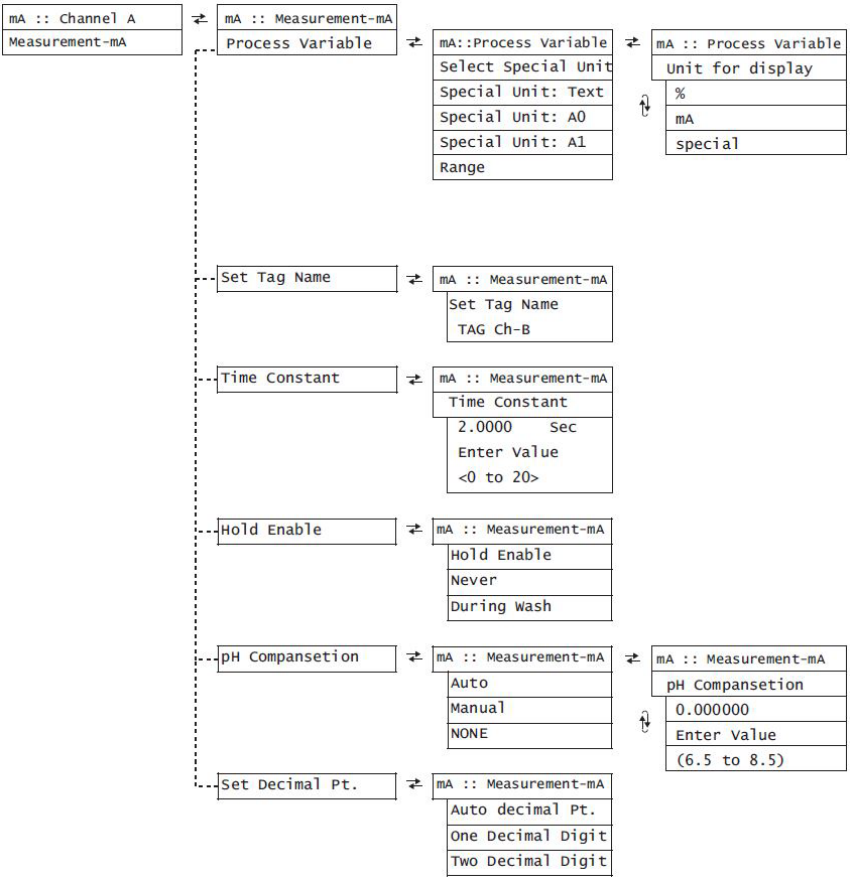
8.3 Configuration: pH / ORP (Redox) Module

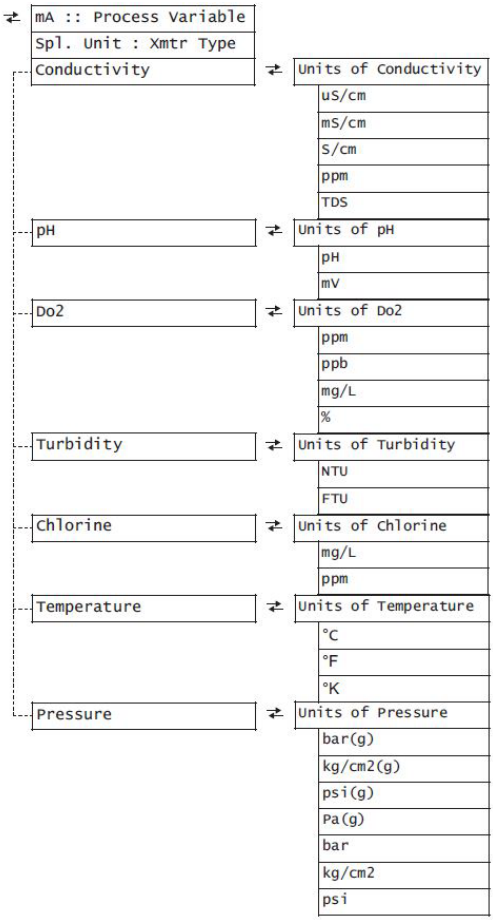


8.4 Configuration: Turbidity / TSS Module



8.5 Configuration: 4 ~ 20mA Module

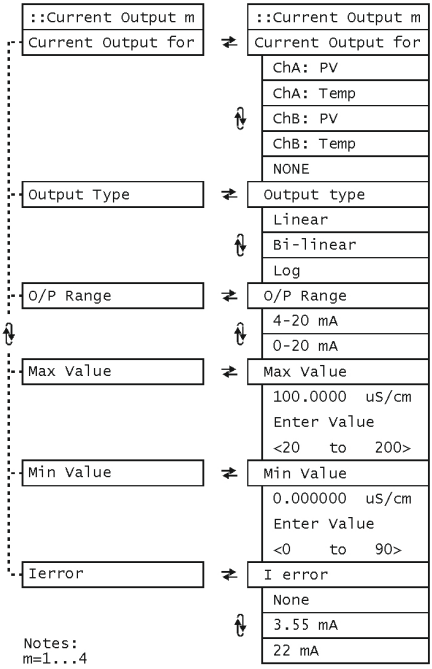



mA :: Process Variable
Spl. Unit : Xmtr Type
Conductivity
Units of Conductivity
uS/cm
mS/cm
S/cm
ppm
TDS
pH
Units of pH
pH
mV
Do2
Units of Do2
ppm
ppb
mg/L
%
Turbidity
Units of Turbidity
NTU
FTU
Chlorine
Units of Chlorine
mg/L
ppm
Temperature
Units of Temperature
°C
°F
°K
Pressure
Units of Pressure
bar(g)
kg/cm2(g)
psi(g)
Pa(g)
bar
kg/cm2
psi

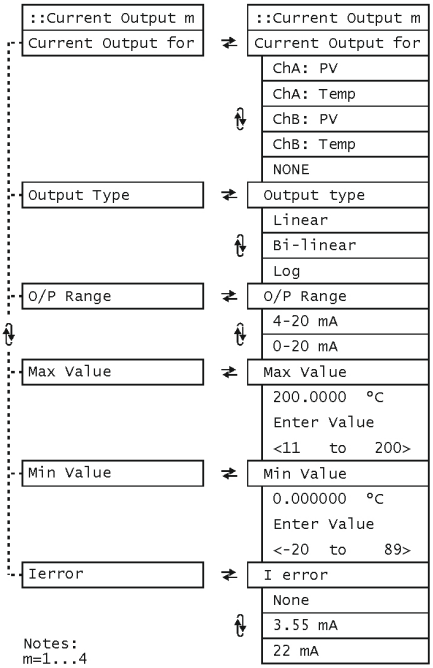
8.6 Configuration: Current Outputs (located on the CPU board)

First assign 1 of 4 Current Outputs to either the Primary Variable (PV) or Temperature of Channel A or B. Then select an output characteristic type for that output. Then set the output range, min and max values and the parked value in case of error. Repeat for multiple outputs as required.

8.5.1 Current Outputs for PV

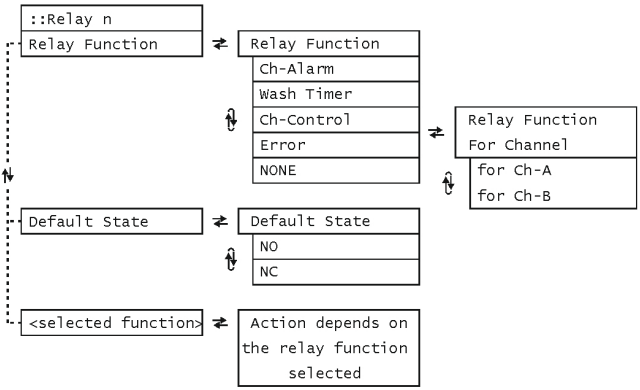


8.5.2 Current Outputs for temperature



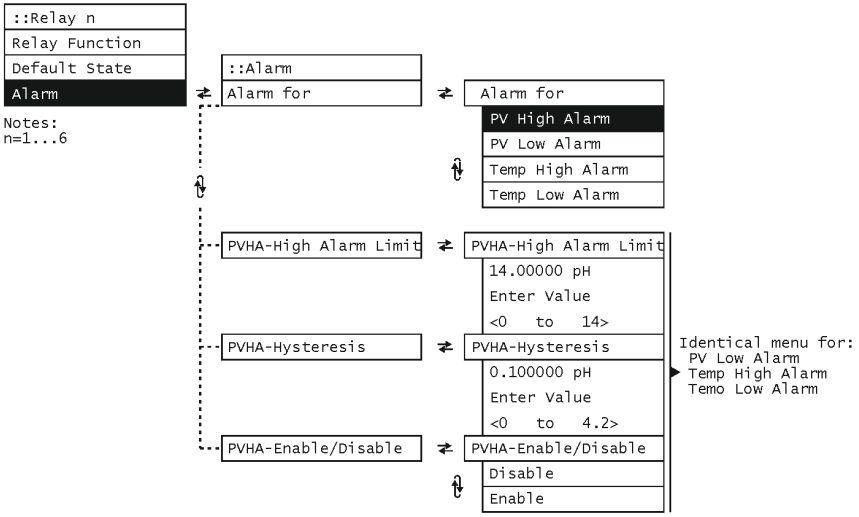
8.6 Configuration: Relay Config (top level)

First assign a function to 1 of 6 relays. Then select its default state – NO or NC. Depending on the function selected, set the related parameters as described in subsequent sections.



8.7 Configuration: Relay Config (Alarm)

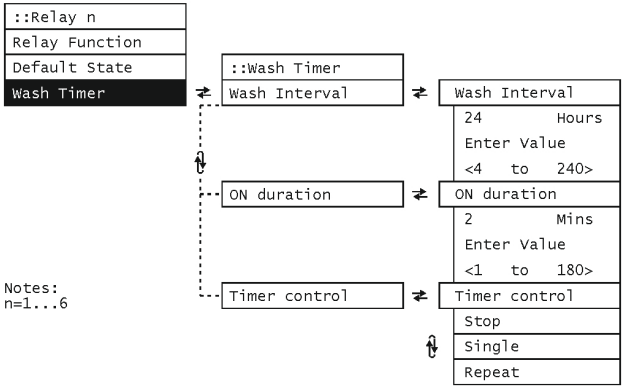
First assign the alarm to either PV or Temperature high or low alarm. Then set the alarm limit and its hysteresis. Keep this alarm either enabled or disabled during operation.



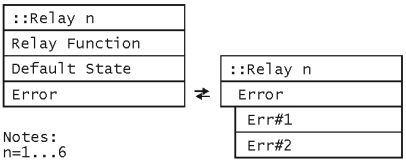
8.8 Configuration: Relay Config (Wash Timer)

First set the interval between two consecutive timer runs if repeat mode is to be selected. Then set the duration of each timer run. Finally select the mode in which the timer will operate:

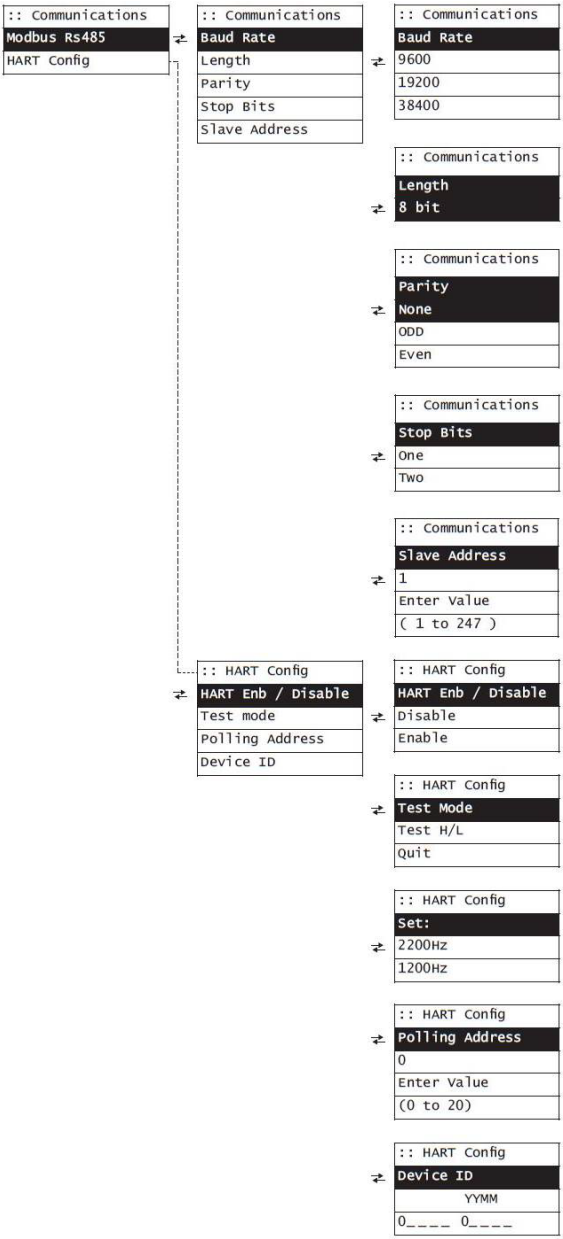
- Stop: Stop the timer when an external digital input is asserted
- Single: Operate the timer once
- Repeat: Repeat the timer action for the number of wash timer set



8.9 Configuration: Relay Config (Error)

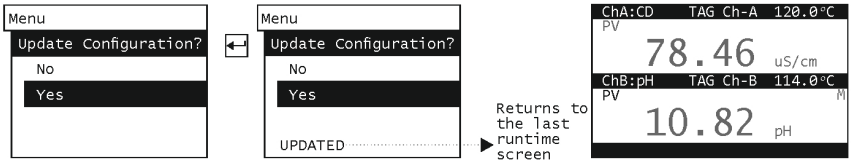


8.10 Configuration: Communications



8.11 Update Configuration

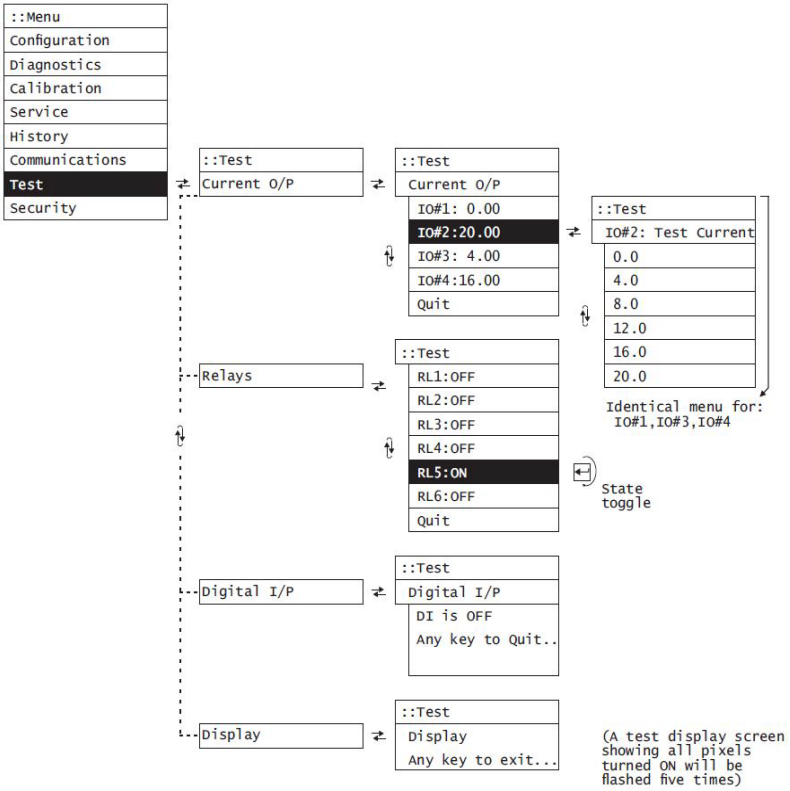
If you have modified any of the configuration parameters, you will be prompted with the following question before exiting the menu to runtime screen. Select 'Yes' or 'No' appropriately.



9. Test menu

Use this menu to test the hardware as follows -

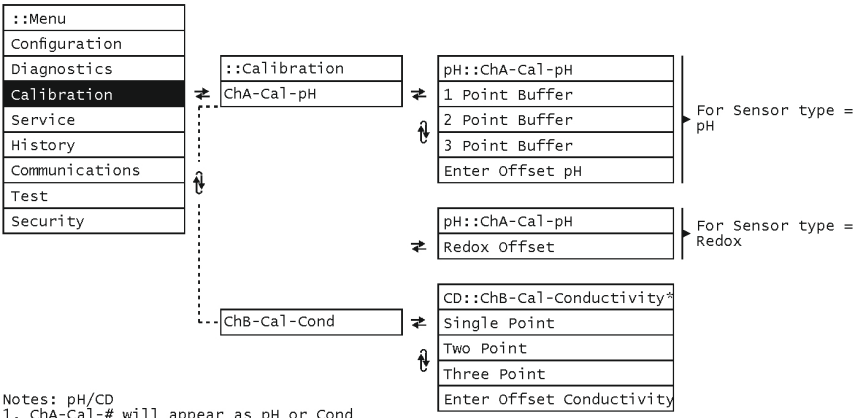
- Current output: Select 1 of 4 outputs. Disconnect its external load. Connect a DMM on 200mA DC range across the respective outputs. Force either of 0/4/8/12/16/20 mA and confirm against the value indicated on the DMM. Quit the test mode.
- Relays: Select 1 of 6 relays. Disconnect its external load. Connect a DMM on resistance range and toggle the state of the respective relay. Confirm against the value indicated on the DMM. It must toggle between open and short. Quit the test mode.
- Digital input: Disconnect the external input. Using a DMM prod or wire, short and open the input terminals pair. The display must toggle between ON and OFF. Quit the test mode.



10. Calibration menu

10.1 Calibration: Top level

Select the channel to be calibrated. The transmitter auto-detects the inserted sensor module type (pH or Conductivity) and prompts you with messages relevant to the sensor type.



Notes: pH/CD
1. ChA-Cal-# will appear as pH or Cond depending on the module type installed in Slot 3(CH A).
2. ChB-Cal-# will appear as pH or Cond depending on the module type installed in Slot 4(CH B).
3. Calibration option will not be displayed for an empty slot.

*Limited by availability of standard solution for selected range

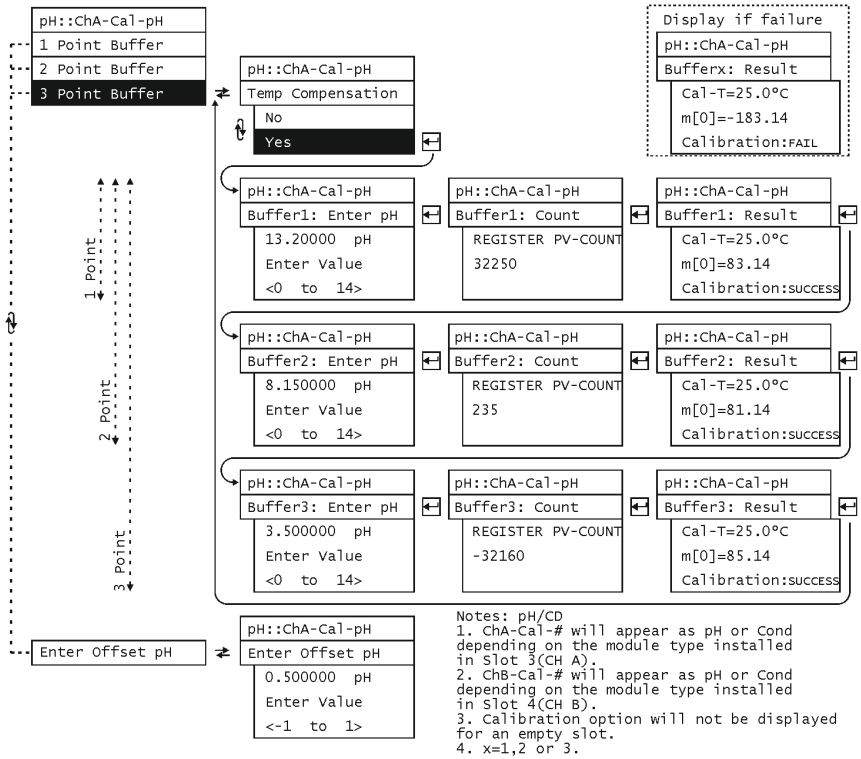
10.2 Calibration: pH

Select between 1/2/3 Point calibration and keep the corresponding buffer solutions ready. If you have enabled temperature compensation ensure that under Configuration-pH you have either

- Set the temperature measurement to Manual and also set the required temperature value OR
- Set the temperature measurement to Auto and the temperature sensor is functional

Immerse the pH sensor and the temperature sensor (if not inbuilt with the pH sensor) into the buffer solution.

Depending on the number of points selected complete the calibration as prompted on the display.



10.3 Calibration: Conductivity

Depending on the number of available standard solutions for the required measurement range, select between 1/2/3 Point calibration and keep the corresponding standard solutions ready. If temperature compensation is enabled ensure that under Configuration-Cond the temperature measurement set the to either

'Manual' and the required temperature value set

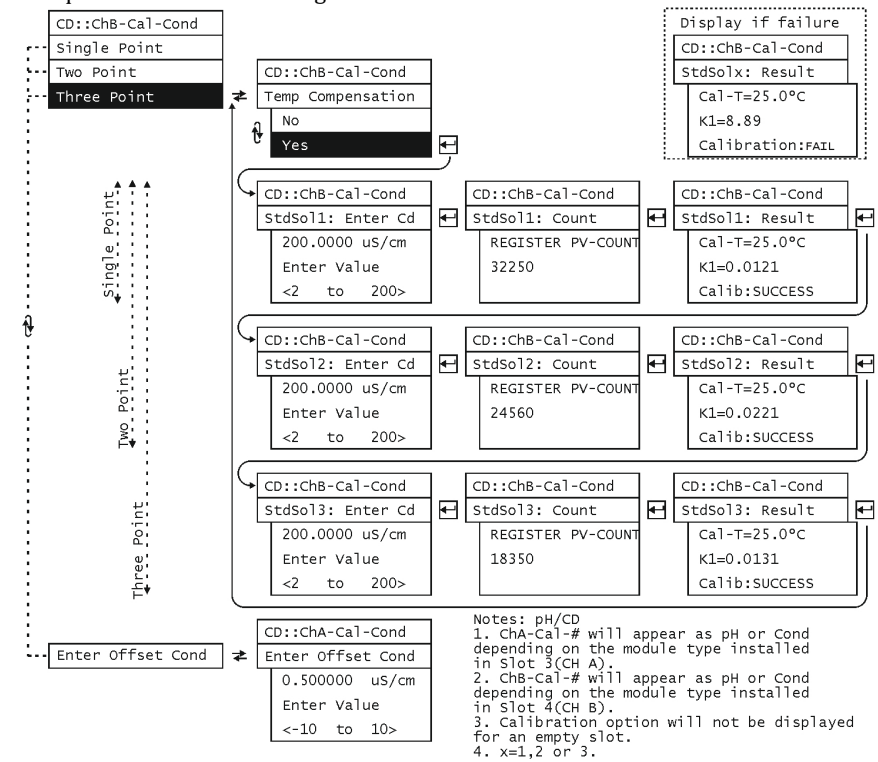
or

'Auto' with a functional temperature sensor

Immerse the conductivity sensor and the temperature sensor (if not inbuilt with the conductivity sensor) into the standard solution.

Depending on the number of points selected complete the calibration as prompted on the display.

The number is limited only by the number of available standard solutions for the required measurement range



10.4 Modbus Map of Parameters

Modbus Address	Measurement Channel	Parameter	Data type	No. of Registers
30001	A	Parameter Value	Float	2
30003	A	Temperature Value	Float	2
30005	B	Parameter Value	Float	2
30007	B	Temperature Value	Float	2
41025	A	Range	Integer (Enumerated)	1
41026	A	Display Unit	Integer (Enumerated)	1
42025	B	Range	Integer (Enumerated)	1
42026	B	Display Unit	Integer (Enumerated)	1

10.5 Ranges

Card type	Range
Conductivity / TDS	**Conductivity:** 0: 0 – 2 µS/cm 1: 0 – 20 µS/cm 2: 0 – 200 µS/cm 3: 0 – 2 mS/cm 4: 0 – 20 mS/cm 5: 0 – 200 mS/cm
pH / Redox	**pH:** 0: (0 to 14pH) 1: (– 2 to 16pH) **Redox:** 0: (– 2000 to 2000mV)
mA	0: 4 – 20 mA
Turbidity / TSS	0: 0 – 100 NTU 1: 0 – 500 NTU 2: 0 – 3000 NTU 3: 0 – 1000 mg/L (TSS)
DO2	0: 0 – 20 ppb 1: 0 – 200 ppb 2: 0 – 2000 ppb 3: 0 – 20 ppm 4: 0 – 50 ppm 5: 0.0 – 200.0 % 6: 200 – 500 %

10.6 Units

Card type	Units
Conductivity / TDS	0: µS/cm, 1: mS/cm 2: Special
pH / Redox	0: pH 1: mV 2: Special
mA	0: % 1: mA 2: Special
Turbidity / TSS	0: FTU 1: NTU 2: FNU 3: mg/L 4: ppm 5: g/L 6: % 7: Special
DO2	0: ppm(gas) 1: pb 2: % 3: mg/L (gas) 4: ppm (DO) 5: mg/L (DO) 6: Special

11. Calibration Procedures

11.1.1 : Conductivity calibration with a conductivity simulator

i) Carry out a single point calibration. The accuracy will be valid throughout the range.

ii) Connect the simulator to the conductivity transmitter.

OR

Connect a 1kΩ ±0.1% resistor. For a 1kΩ resistor,

Cell Constant k	Conductivity
0.01	10 µS/cm
0.1	100 µS/cm
1	1 mS/cm

iii) Calibrate the transmitter keeping the simulator on the high range of the transmitter.

iv) Check the transmitter with different positions of the simulator.

11.1.2: Conductivity calibration with a STD conductivity solution

i) A chart of Temperature vs Conductivity is given on the bottle of the STD conductivity solution.

ii) Measure the temperature of the solution and check the conductivity value based on the measured temperature.

iii) Set the transmitter to Manual mode in the configuration with a temperature at 25°C.

iv) Calibrate the transmitter with the STD solution conductivity value found in step (ii)

v) Repeat steps (i) and (ii) for another STD solution and confirm the value.

vi) Verify this value in the transmitter (keeping the transmitter in Manual temperature mode at 25°C)

vii) Set the transmitter to Auto mode before putting the transmitter into the process.

11.3.1 : pH Calibration with a pH simulator:

i) Ensure 'Two Point Buffer' calibration is set.

ii) Connect the pH Simulator to the pH transmitter

iii) Set the range 0 ~ 14pH on the simulator and calibrate the transmitter.

iv) Check the transmitter by setting various pH values on the simulator

11.3.2 : pH Calibration with a STD pH buffer solution:

i) Ensure 'Two Point Buffer' calibration is set.

ii) Immerse the pH sensor and the temperature sensor (if not inbuilt with the pH sensor) into the buffer solution of 4pH. Enter the buffer value 4 in the transmitter.

iii) Now, immerse the pH sensor in a buffer solution of 7 or 9pH. Enter the buffer value 7 or 9 as applicable in the transmitter

iv) Check the slope and offset value shown by the transmitter. This indicates the health of the sensor. A good electrode a slope > 85% and an offset < ±25mV

Refer 'pH vs mV Table' in Annexures

11.4.1 : ORP Calibration with a ORP simulator:

i) Ensure 'Single Point Buffer' calibration is set.

ii) Calibrate the transmitter by keeping the simulator on high range of the transmitter i.e. ±1000mV

iii) Check the transmitter with different mV values from the simulator.

11.4.2 : ORP Calibration with a STD ORP buffer solution:

i) Ensure 'Single Point Buffer' calibration is set.

ii) A chart of Temperature vs ORP is given on the bottle of the ORP buffer solution

iii) Set the transmitter to Manual mode with 25°C temperature and calibrate the transmitter.

iv) Calibrate the transmitter with a higher value of buffer solution i.e. 475mV

v) Repeat steps (i) and (ii) for the other solution and check the value of the second buffer solution.

vi) Verify this value in the transmitter while keeping it in Manual mode at 25°C temperature

vii) Set the transmitter to Auto mode before putting it into the process.

Refer to the 'pH vs mV Table' in Annexures

12. Maintenance & Troubleshooting: Conductivity

12.1 Sensor care

Conductivity sensors require maintenance at regular intervals. The interval which is typically between 1 and 3 months is decided by the user depending on the process fluid and conditions.


Please check for useful tips on sensor care if provided in the sensor instruction manual.

12.2 Cleaning the sensor

Clean the sensor electrode with isopropyl alcohol IPA and allow it to dry completely before use.

 In case of heavy deposits, keep immersed in IPA overnight, before use. It is recommended to clean the sensor electrode before each sensor calibration.

12.3 Storing a new sensor for long time

While no special care is required for a conductivity sensor, store it in its original packing and in a dry area, avoiding extreme temperature and climatic conditions.

12.4 Storing a sensor after use

Remove the sensor from the process and allow it to dry completely. In case of any surface deposits, clean the sensor electrode with IPA before storing.

 In case of heavy deposits, keep immersed in IPA overnight, before storing.

12.5 Do's and Don'ts for sensor

- Read the instruction manual provided if any with the sensor.
- Before putting the sensor to use, remove any special transportation cover wrapped over it during transportation.
- Clean the sensor electrode under low pressure running water or any cleaning solution recommended in the sensor instruction manual.
- Always calibrate the transmitter along with the sensor as a system. If you change/replace either the transmitter or the sensor, recalibrate as a system.

 Calibrate the sensor at planned regular intervals.

12.6 Error messages

The Aqua4Trans issues messages on the display. User can identify the possible causes of the problems and take corrective actions. The error messages and their meaning are given below.

Error message	Action
ChA:PV-SENSOR FAIL Or ChB:PV-SENSOR FAIL	Check the sensor wires for open or loose connections. Reconnect the wires and check.
	Check the sensor wires for short. If short, replace the sensor.
	Disconnect the cable from the sensor. Check the resistance across the sensor terminals. It should show open. ▪ If it shows a low resistance or a short, remove the sensor from the process, clean, dry, and check again. ▪ If problem persists, replace the sensor.
ChA:T-SENSOR OPEN Or ChB:T-SENSOR OPEN	Check the temperature sensor wires for open or loose connection. Reconnect the wires and check.
	Disconnect the sensor. Check the resistance of the RTD element. It should be: ▪ 109.73 Ω at 25°C for Pt100 ▪ 1097.3 Ω at 25°C for Pt1000 If open, replace the sensor.
ChA:T-SENSOR SHORT Or ChB:T-SENSOR SHORT	Check the temperature sensor wires for a short.
	Disconnect the sensor. Check the resistance of the RTD element. It should be: ▪ 109.73 Ω at 25°C for Pt100 ▪ 1097.3 Ω at 25°C for Pt1000 If found shorted, replace the sensor.

Note: For conductivity sensors with an inbuilt temperature sensor, replace the complete sensor.

12.7 Problems, causes and solutions

Problem	Possible cause	Solution
Incorrect conductivity value	Sensor not calibrated for long time.	Recalibrate the sensor.
	Sensor mechanically damaged.	Replace the sensor.
	Process fluid is dirty.	Clean the sensor as described earlier.
	Sensor improperly dipped into the process fluid.	Ensure that the fluid covers the sensor electrode completely.
	Electrical noise pickup.	Follow proper grounding and shielding procedures described earlier.

12.8 Problem in temperature measurement and calibration

Indicated temperature differs from that of a standard thermometer by more than ±1°C. Check the following:

- Confirm that the standard thermometer, RTD, thermistor that is used as a reference is calibrated and is accurate.
- General purpose liquid in glass thermometers can have large errors.
- Are the measurements done at the same point?
- Is the standard thermometer dipped into the process up to the right level?

 It is necessary to calibrate the temperature sensor during installation and calibration.

12.9 Conductivity reading differs from lab reading

It is normal to see differences in the readings indicated by online instruments and the lab instruments.

This phenomenon is further amplified when measuring ultra pure of conductivity less than 10µS/cm. In practice the two will never match in this application.

The online instrument is subjected to the real process conditions of process temperature, stray voltages, pressure, supply voltage variations, etc.

The lab instrument works under standard controlled conditions. Some impurities are added, the temperature of the lab sample changes and such factors cause the differences to be observed.

12.9.1 How can this difference be minimized?

Check both – the online and lab instruments by using the same buffer solution and comparing their readings.

If the difference is vast, calibrate both the instruments using the same standard solution.

Ensure that both the instruments use cell with the same cell constant; different cell constants exhibit different accuracy levels.

 Use single point calibration method to compare the two readings.

12.9.2 Is the transmitter working satisfactorily?

In case of problems that cannot be easily and confidently attributed to either the sensor or the transmitter, it is necessary to isolate the problem areas.

12.9.3 Simulate the conductivity input

Disconnect the conductivity sensor wires from the transmitter end. Connect standard resistance such as a standard resistance box to the transmitter. If the transmitter is healthy, it will indicate accurate conductivity values. Follow the procedure below.

i. Turn off the transmitter supply. Disconnect the sensor wires from the transmitter end.
ii. Connect the box to the conductivity inputs.
iii. Turn on the transmitter.
iv. Turn off auto temperature compensation and set to 25°C manually.
v. Simulate conductivity using the box and check results.
vi. Note down the cell constant and then set the cell constant as '1.0' via the menu.
vii. Save and exit the menu.
viii. Check the readings as per the table below. These must be within ±0.5%.

Resistance	Reading	Resistance	Reading
1MΩ	1.00 µS/cm	100kΩ	10.00 µS/cm
500kΩ	2.00 µS/cm	50kΩ	20.00 µS/cm
250kΩ	4.00 µS/cm	25kΩ	40.00 µS/cm
125kΩ	8.00 µS/cm	10kΩ	80.00 µS/cm

ix. If the readings are okay, clean and recalibrate the sensor.
x. You can re-enter the cell constant noted down earlier.
xi. Reconnect the sensor wires and continue normal operation.

12.9.4 Simulate temperature input

Disconnect the temperature sensor wires from the transmitter end. Connect standard resistance such as a standard resistance box to the transmitter. If the transmitter is healthy, it will indicate accurate temperature values. Follow the procedure below.

i. Turn off the transmitter supply. Disconnect the sensor wires from the transmitter end.
ii. Connect the box to the conductivity inputs.
iii. Turn on the transmitter.
iv. In case of Pt100 sensor, feed 109.73Ω from the box. (1097.3Ω in case of Pt1000)
v. The secondary display will show 25.0°C. Repeat this for different values of input resistance values.
vi. The indicated temperature may not match the standard RTD table values. This is due to the offset added/subtracted when the temperature sensor was calibrated.

vii. The same offset gets applied when the input is simulated. The transmitter is measuring temperature correctly if the difference between the two table readings and the same two transmitter readings is within ±0.5°C.

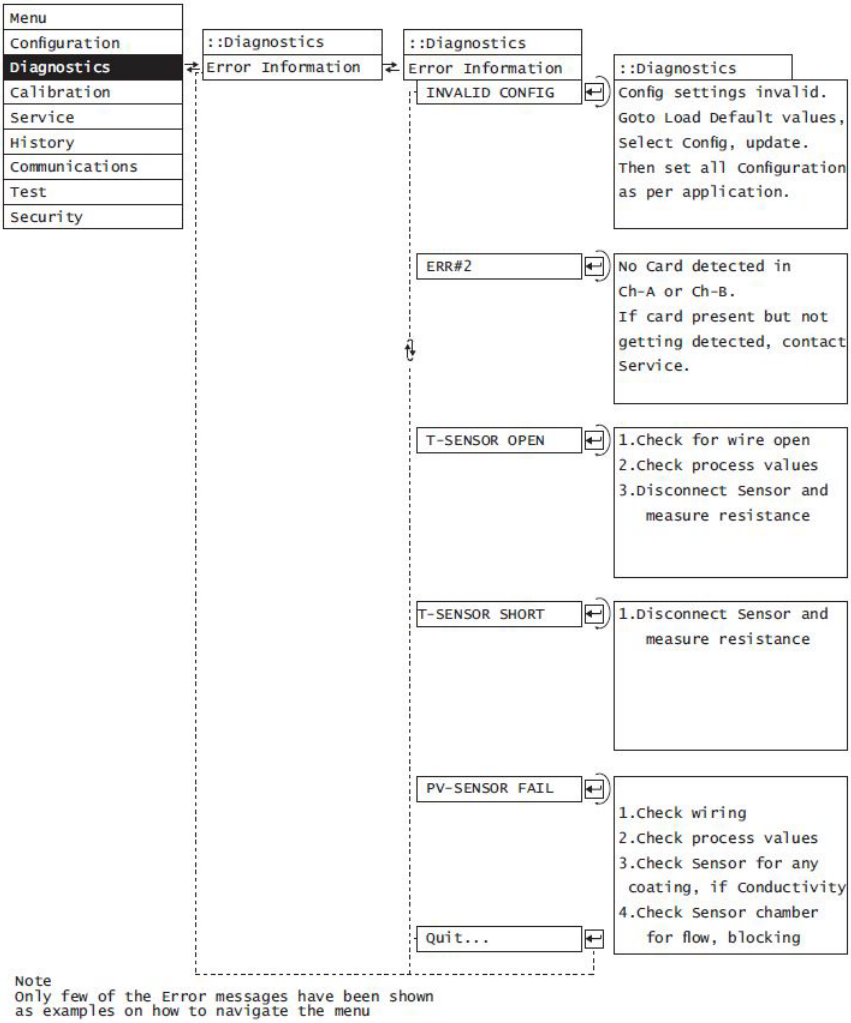
viii. For example, if an offset of 2°C is added during calibration, the transmitter will read the value of 115.54 as 40°C, but display it as 42°C.

Refer annexure for RTD table.

13. Maintenance and troubleshooting: pH

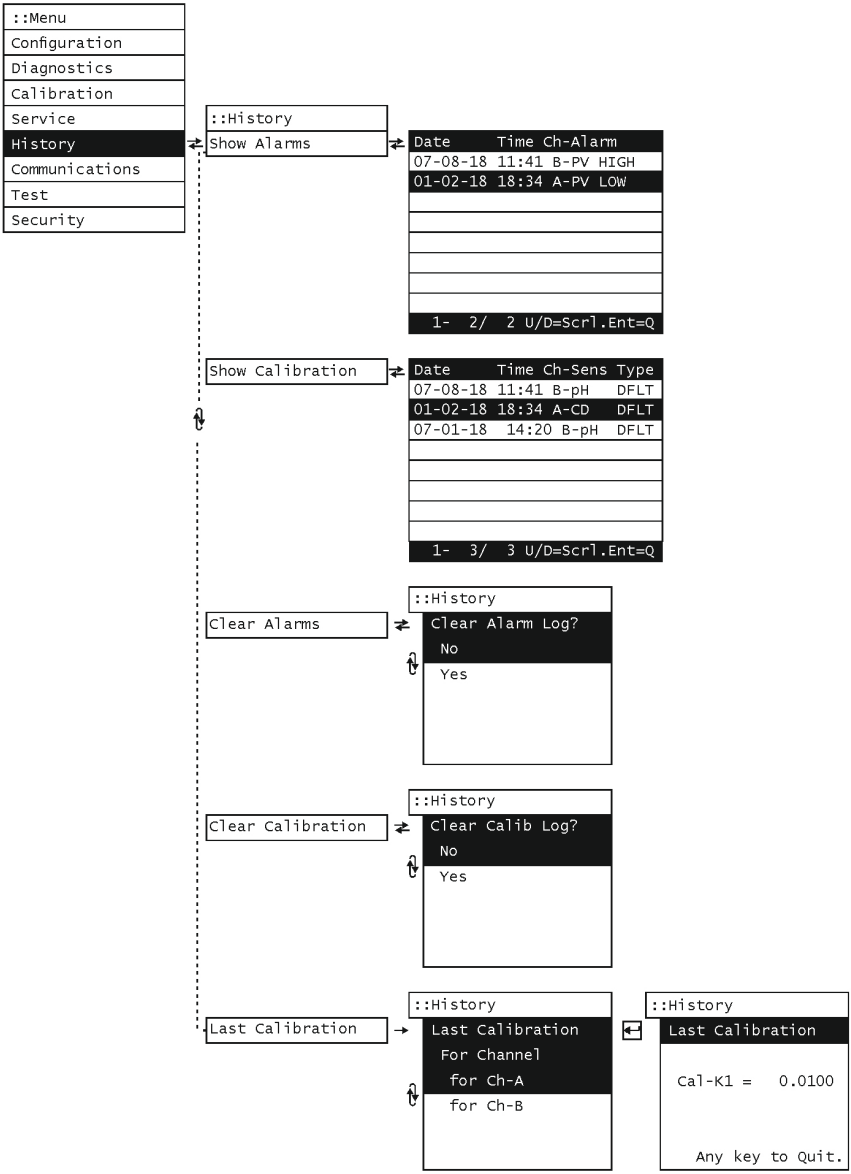
13.1 Diagnostics menu

Use this menu to understand the meaning of the error messages and take appropriate actions.



13.2 History

Use this menu to view past alarms, calibration dates and calibration data. Also use this to clear alarm list and calibration data, if absolutely necessary.



13.3 Sensor care

pH sensors require maintenance at regular intervals. The interval – typically between 1 and 3 months - is decided by the user depending on the process fluid and conditions.

 Please check for useful tips on sensor care if provided in the sensor instruction manual.

13.3.1 Cleaning the sensor

The pH sensor has an electro-chemical electrode. When used, its junction and glass membrane contaminate due to the process fluid. This increases the sensor response time.

13.3.2 Salt deposits

Immerse the electrode in tap water for 10 to 15 minutes until the salt dissolves. Rinse the electrode in distilled water.

13.3.3 Oil/grease film

Use mild detergent and water to gently wash the electrode bulb. Rinse the electrode tip in distilled water.

13.3.4 Protein deposits

Dip the electrode in a solution prepared with 1% pepsin solution in 0.1M of HCl for 10 minutes. Rinse the electrode in distilled water.

13.3.5 Clogged reference junction

Heat diluted KCl solution to 60-80°C. Place the sensing part of the electrode into the heated solution for about 10 minutes. Allow the electrode to cool in unheated KCl solution.

13.3.6 Storing a new sensor for long time

Always the pH bulb wet. Use electrode storage solution recommended by the sensor manufacturer.

Use rubber cap or electrode storage bottle filled with electrode storage solution.

You can use pH 4 buffer solution with 1/100th part of saturated KCl solution.

13.3.7 Storing a sensor after use

Use de-ionized water to rinse the pH electrode and reference junction.

Store the sensor after rinsing it, as described earlier.

Before putting back into service, clean the electrode with de-ionized water and gently pat dry with **clean** tissue paper.

 Never rub or wipe the electrode. This could give rise to electrostatic charges that will increase the response time of the sensor.

13.3.8 Rehydrating the bulb?

If the electrode is stored and cleaned as described earlier, it is always service ready. But because of some reasons the bulb gets dehydrated, follow the procedure below.

- Immerse the electrode in pH 4 buffer solution for 10 to 30 minutes. Rinse the electrode in distilled water. Check the response of the sensor.

 If the procedure fails and the electrode does not respond, consult with the sensor manufacturer.

13.3.9 Do's and Don'ts for sensor

- Read the instruction manual provided if any with the sensor.
- Before putting the sensor to use, remove any special transportation cover wrapped over it during transportation, without damaging the diaphragm.
- Clean the pH electrode under low pressure tap water or any cleaning solution recommended by its manufacturer. Do not touch the diaphragm or the tip of the electrode when cleaning.
- Gently pat dry the tip of the electrode using a **clean and soft** tissue paper. Do not rub the tissue paper on the electrode as it may generate static charges over its surface.
- Calibrate the transmitter with the pH sensor as a system. Use this calibrated system to measure the pH values. If you replace/change the transmitter or the sensor, it is necessary to recalibrate as a system.
- Keep electrode wet when not in use. Dip the electrode in 3M KCl solution, or any storage solution recommended by the sensor manufacturer.

 Calibrate the sensor at planned regular intervals.

13.4 Error messages

The Aqua4Trans issues messages on the display. User can identify the possible causes of the problems and take corrective actions. The error messages and their meaning are given below.

Error message	Action
ChA:PV-SENSOR FAIL Or ChB:PV-SENSOR FAIL	This is displayed during sensor calibration. It implies that the sensor 'zero' or 'slope' is out of the acceptable deviation range.
	Follow the procedure to clean the electrode and rehydrate the bulb. Check again. If the message recurs, replace the sensor.
ChA:T-SENSOR OPEN Or ChB:T-SENSOR OPEN	Check the temperature sensor wires for open or loose connection. Reconnect the wires and check.
	Disconnect the sensor. Check the resistance of the RTD element. It should be: ▪ 109.73Ω at 25°C for Pt100 ▪ 1097.3Ω at 25°C for Pt1000 If open, replace the sensor.
ChA:T-SENSOR SHORT Or ChB:T-SENSOR SHORT	Check the temperature sensor wires for a short.
	Disconnect the sensor. Check the resistance of the RTD element. It should be: ▪ 109.73Ω at 25°C for Pt100 ▪ 1097.3Ω at 25°C for Pt1000 If short, replace the sensor.
PV SENSOR FAIL	1. Check wiring 2. Check process values 3. Check sensor for any coating 4. Check sensor chamber for flow / blockages

Note: For pH sensors with an inbuilt temperature sensor, replace the complete sensor.

13.5 HART Commands

The Aqua4Trans supports the following HART® commands:

13.5.1 Operating Mode

Command	Displayed parameter
Read unique identifier	Travel
Read primary variable	Setpoint
Read loop current and percent of range	Temperature
Read dynamic variable and PV current	Inlet pressure
Read loop configuration	Outlet pressure - 1
Read device variable classification	Outlet pressure - 2
Read device variable with status	Device status
Read unique ID associated with tag	
Read PV Transducer/Sensor Information	
Read Device Information	
Read Unique Identifier associated with Long Tag	

13.5.2 Configuration Mode

Command
Write Polling Address
Read Message
Read Tag, Descriptor, Date
Read Final Assembly Number
Write Message
Write Tag, Descriptor, Date
Write Final Assembly Number
Read Long Tag
Write Long Tag
Reset Configuration Changed Flag
Write PV Damping Value
Write PV Range Values
Read set point source and value
Write set point source and Value
Read sensor type and valve-actuator related data
Write sensor type and valve-actuator related data
Read Type of Pilot-valve
Write type of Pilot-valve
Read Basic Valve Configuration like valve direction and valve flow characteristics.
Write Basic Valve Configuration like valve direction and valve flow characteristics.
Read software limit for actual displacement of valve
Write software limit for actual displacement of valve
Read unit and range of input mA source for split range
Write unit and range of input mA source
Read Partial stroke Data.
Write Partial stroke Data.
Read PID parameters.
Write PID parameters.
Read Configured Positioner features.
Write specific features of positioner to configure the valve performance as per requirement.
Read value of free adjustable characterization of valve
Write value of free adjustable characterization
Read Dynamic variable assignments
Write Device variable unit
Read Device variable information
Write Number of Response Preambles

13.5.3 Device Specific Commands

Command#131 - Channel wise Card identification
Command#132 - Read CHA Temperature Measurement parameters
Command#133 - Read CHB Temperature Measurement parameters
Command#134 - Write CHA Temperature Measurement parameters
Command#135 - Write CHB Temperature Measurement parameters
Command#136 - Read IOut Channel parameters
Command#137 - Write IOut Channel parameters
Command#138 - Read Relay Relay Configuration
Command#139 - Write Relay Relay Configuration
Command#140 - Read CHA Conductivity device parameters
Command#142 - Read CHB Conductivity device parameters
Command#143 - Write CHA Conductivity device parameters
Command#144 - Write CHB Conductivity device parameters
Command#144 - Read CHA Conductivity Range
Command#146 - Read CHB Conductivity Range
Command#145 - Write CHA Conductivity Device parameters
Command#147 - Write CHB Conductivity Device parameters
Command#148 - Read CHA TDS_Range & Factor
Command#150 - Read CHB TDS_Range & Factor
Command#149 - Write CHA TDS_Range & Factor
Command#151 - Write CHB TDS_Range & Factor
Command#152 - Read Math
Command#153 - Write Math
Command#154 - Read CHA PH_RX Cable length & range
Command#156 - Read CHB PH_RX Cable length & range
Command#155 - Write CHA PH_RX Cable length & range
Command#157 - Write CHB PH_RX Cable length & range
Command#158 - Read CHA DO_Sensor_range
Command#160 - Read CHB DO_Sensor_range
Command#159 - Write CHA_DO_Sensor_range

Command#161 - Write CHB_DO_Sensor_range
Command#162 - Read CHA DO_Parameter
Command#164 - Read CHB DO_Parameter
Command#163 - Write CHA DO_Parameter
Command#165 - Write CHB DO_Parameter
Command#166 - Read CHB TU_Sensor_range
Command#168 - Read CHB TU_Sensor_range
Command#167 - Write CHA TU_Sensor_range
Command#167 - Write CHB TU_Sensor_range
Command#170 - Read CHA mA_Parameter_Assignment
Command#172 - Read CHB mA_Parameter_Assignment
Command#171 - Write CHA mA_Parameter_Assignment
Command#173 - Write CHB mA_Parameter_Assignment
Command#174 - ReadSpecialUnit
Command#175 - WriteSpecialUnit

13.5 Problems, causes and solutions

Problem	Cause	Solution
Incorrect pH value	Sensor not calibrated for long time.	Recalibrate the sensor.
	Sensor mechanically damaged.	Replace the sensor.
	Process fluid is dirty.	Clean the sensor as described earlier.
	Sensor improperly dipped into the process fluid.	Ensure that the fluid covers the sensor electrode completely.
	Electrical noise pickup.	Follow proper grounding and shielding procedures described earlier.

13.6 Troubleshooting deviations in temperature measurement and calibration

If the indicated temperature differs from that of a standard thermometer by more than ±1°C, check the following:

- Confirm that the standard thermometer / RTD / thermistor used as a reference is calibrated and is accurate.
- General purpose liquid in glass thermometers can have large errors and hence should not be used.
- Are the measurements done at the same location?
- Is the standard thermometer dipped into the process up to the correct level?


It is necessary to calibrate the temperature sensor during installation before performing pH calibration.

13.7 pH reading differs from lab reading

It is normal to see differences in the readings indicated by online instruments and the lab instruments.

An online instrument is subjected to the real process conditions of process temperature, stray voltages, pressure, supply voltage variations, installation, etc.

A lab instrument works under standard controlled conditions. If some impurities are present and / or the temperature of the lab sample changes, such factors cause deviations in observed values.

13.7.1 How is this difference minimized?

Check both the online and lab instruments by using the same buffer solution and comparing their readings.

If the difference is significantly large, calibrate both the instruments using the same buffer solution.


Use the single point calibration method to compare the two readings.

13.7.2 Is the transmitter working satisfactorily?

In case of problems that cannot be easily and confidently attributed to either the sensor or the transmitter, it is necessary to isolate the problem areas.

13.7.3 Simulate the pH input

Disconnect the pH sensor wires from the transmitter end. Connect a milli-volt source to the transmitter. If the transmitter is healthy, it will indicate accurate pH values. Follow the procedure below:

i. Turn off the transmitter supply. Disconnect the sensor wires from the transmitter end.
ii. Connect the milli-volt source to the pH inputs pH_{IN} and REF.
iii. Turn on the transmitter.
iv. Simulate pH by feeding 118.4mV from the milli-volt source.
v. From Menu select 'Raw mV'.
vi. Display will show 118.4mV.
vii. Display error must be within ±10mV.
viii. Check this over the range -414mV to +414mV.
ix. If all the indicated readings match the simulated milli-volts, the transmitter is working fine.
x. Save and exit the menu.
xi. Reconnect the sensor wires and continue normal operation.

13.7.4 Simulate temperature input

Refer to the related procedure described under the section 'Maintenance and troubleshooting: Conductivity/TDS'.

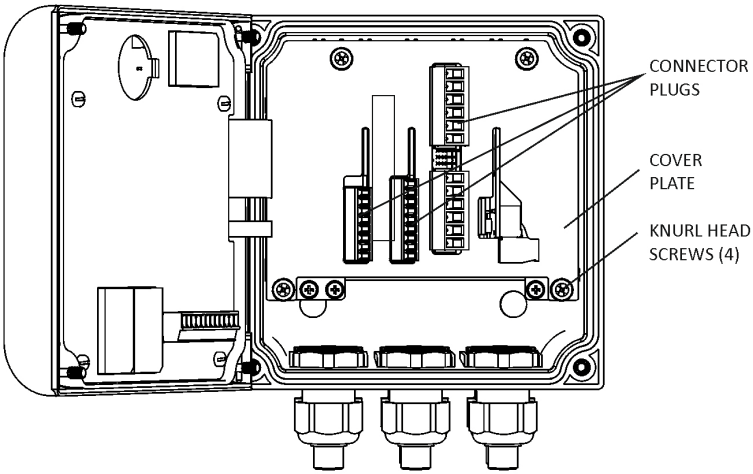
14. Replacing modules

Switch off the mains power to the transmitter before attempting to remove or install any of the modules.

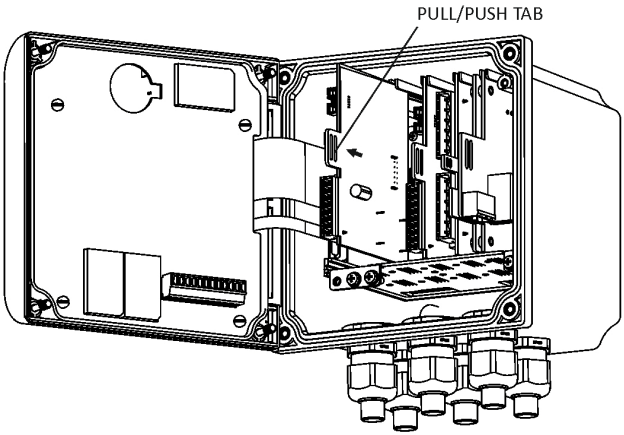
14.1 Replacing a module

14.1.1 Module removal

- Switch off the power supply.
- Open the Lid. Unplug the connector plugs from all the modules.
- Unscrew the knur-headed screws. Remove the cover plate.



Each module has a pull-push tab. Clasp this tab between your thumb and a finger. Pull out with a quick, light jerk. Slide the module out until it fully disengages from its guides.



 Do not touch any of the components on the module. Immediately place the module in an anti-static zip-pouch and seal.

Remove the replacement module from its anti-static zip-pouch only when you are about to insert it.

14.1.2 Module installation

- Orient the module correctly, engage into the correct slot and gently slide it in until it mates completely with the mother board on the rear of the Transmitter.
- Locate and fix the protective plate using the knurl-headed screws.
- Plug in the connectors into their respective receptacles.
- Close and fasten the main lid.
- Switch on the power supply.

14.2 Disposing of module / battery

Observe safe disposal procedures as described at the beginning of this manual.

15. Technical specifications

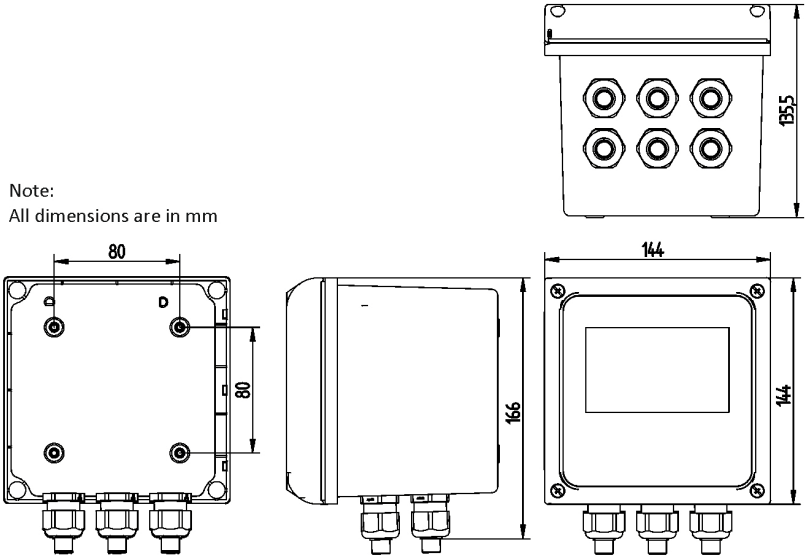
15.1 General specifications

Feature	Details
Display	
Local display	128 x 64 Dot Matrix Liquid Crystal Display with White backlight
Display function	Programmable for continuous or sequential display of measured value, temperature, units and error messages.
Keypad	
Keypad	Four tactile type keys with user friendly menu interface.
Current Outputs	
Type	4 active outputs
	Freely configurable & programmable for two channels measured or calculated parameters of pH or Conductivity - Process Variable (PV) or Temperature or None.
Mode of operation	Linear, Bi-linear or Logarithmic.
Isolation	Galvanic isolation from the Sensor. Output (1 & 2) can be isolated from Output (3&4) or all 4 outputs can be non-isolated.
Error options	3.55mA DC or 22mA DC or NONE
Output ranges	4-20 mA DC or 0-20mA DC
Accuracy	Better than ±0.1mA DC
Load capacity (max)	750Ω resistive
Relay Outputs	
State	Asserted or de-asserted (programmable)
Contact	NO or NC (programmable)
Rating	250 VAC 5A (max) or 24 VDC 5A (max)
Digital Input	
Type	Potential-free contact closure
Function	Trigger internal timer
Power requirement	
Supply	100 ~ 260 VAC | Frequency 50/60 Hz
Consumption	Less than 40 W
Internal RTC	Backed up with 3VDC battery type: CR2032
Mechanical Specifications	
Housing material	Polycarbonate, 10% Glass filled.
Colour	Exterior - Satin Silver, Interior – Conductive Paint.
Dimensions	144(H) x 144(W) x 135.5(D) mm
Connections glands	M20x1.5 – 6 nos. (for Power Supply, 2 Sensors, Current outputs, Relay Contacts, Communication*) * Optional
Weight	1.2kg approximately

Mounting type options	Panel / Wall / 2” Pipe type (vertical and horizontal)
Ingres Protection class	IP 66
Approvals / Certifications - Electromagnetic Compliance as per EMC Directive (2004/108/EEC)	
Emitted Interference/ Electromagnetic Compliance	EN/IEC61326-1, EN/IEC 61000-4-6, EN/IEC 61000-4-2, EN/IEC 61000-4-3, EN/IEC 61000-4-5, EN/IEC 61000-4-4, EN/IEC 61000-4-8, EN/IEC 61000-4-11, EN/IEC 61000-4-12
Vibration	IEC60068-2-6
IP66	IEC60529
Safety	CE/CB (Standard IEC61010-1)
Environmental Conditions	
Ambient temperature operating range	(-)20 to +60°C
Transport / storage temperature range	(-)20 to +70°C
Maximum relative humidity	95% RH, non-condensing at temperature up to 55°C
Salt spray test (Enclosure) compliance	ASTM B 117
Spacing requirements compliance	EN/ IEC61010-1

15.2 Mechanical dimensions

Note:
All dimensions are in mm



15.3 Measurement specifications: pH | ORP

Parameter	Details
pH	
Range	0 to 14 pH (-)2 to 16 pH
Resolution	0.01 pH
Accuracy	±0.01 pH
Span	Range 0 to 14 pH: 2pH (min) to 14pH (max) (programmable) Range (-)2 to 16pH: 0pH (min) to 16pH (max) (programmable)
mV (ORP)	
Range	±2000 mV
Resolution	1 mV
Accuracy	±1 mV
Span	±200mV (min) to ±2000mV (max) programmable
Temperature	
Range	(-)20°C to +200°C
Resolution	0.1°C
Accuracy	±0.5 % of FS ±1°C
Sensor	Pt100 (default) / Pt1000 (programmable)
Compensation	Automatic or Manual (programmable)
Calibration	
pH Sensor slope	70% to 110%
pH sensor zero	±2pH
Method	Single/Dual/Three Point
Diagnostics	
Measurement mode	Temperature sensor open
	Temperature sensor short
Calibration mode	Calibration error

15.4 Measurement specifications: Conductivity

Parameter	Details		
Range	Measuring range	Cell constant K	Resolution
	0 to 2 µS/cm	0.01	0.001 µS/cm
	0 to 20 µS/cm	0.01	0.01 µS/cm
	0 to 200 µS/cm	0.01	0.1 µS/cm
	0 to 20 µS/cm	0.1	0.01 µS/cm
	0 to 200 µS/cm	0.1	0.1 µS/cm
	0 to 2 mS/cm	0.1	0.001 mS/cm
	0 to 200 µS/cm	1	0.1 µS/cm
	0 to 2 mS/cm	1	0.001 mS/cm
	0 to 20 mS/cm	1	0.01 mS/cm
	0 to 2 mS/cm	10	0.001 mS/cm
	0 to 20 mS/cm	10	0.01 mS/cm
	0 to 200 mS/cm	10	0.1 mS/cm
Accuracy	K = 0.01, 1% of measured value OR ± 0.01uS/cm whichever is greater		
	K = 0.1, 1% of measured value OR ± 0.1uS/cm whichever is greater		
	K = 1, 1% of measured value OR ± 1uS/cm whichever is greater		
	K =10, 1% of measured value OR ± 10uS/cm whichever is greater		
Span	5% (min) to 100% (max) of measurement range (programmable)		
Calibration			
Conductivity	Single/Dual/Three point*		
	*Note: Limited by availability of standard conductivity solution in particular range.		
Temperature			
Range	(-)20°C to +200°C		
Resolution	0.1°C		
Accuracy	±0.5% of FS ±1°C		
Sensor	Pt100 (Default) / Pt1000 (programmable)		
Temperature coefficient	0.01 to 1 % (programmable)		
Compensation	Automatic or Manual (programmable)		
Diagnostics			
Measurement mode	Sensor faulty		
	Temperature sensor open		
	Temperature sensor short		

15.5 Measurement specifications: TDS

To activate this option select 'Special Unit' in Conductivity configuration menu.

Parameter	Details		
Range (with Auto ranging feature)	Measuring range*	Cell constant K	Resolution
	0 to 1.4 ppm	0.01	0.001 ppm
	0 to 14 ppm	0.01	0.01 ppm
	0 to 140 ppm	0.01	0.01 ppm
	0 to 1400 ppm	0.1	0.1 ppm
	0 to 14 ppt**	1	0.01 ppt
	0 to 140 ppt	10	0.1 ppt
	*Ranges calculated considering TDS Factor = 0.7 **implies parts per million equivalent to g/L		
TDS factor	0.1 to 1.00 (programmable)		
Accuracy	± 0.5 % of FS		
Temperature			
Range	(-)20°C to +200°C		
Resolution	0.1°C		
Accuracy	±0.5% of FS ±1°C		
Sensor	Pt100 (default) / Pt1000 (programmable)		
Temperature coefficient	0.01 to 1 % (programmable)		
Compensation	Automatic or Manual (programmable)		
Diagnostics			
Measurement mode	Sensor faulty		
	Temperature sensor open		
	Temperature sensor short		

16. Annexure

16.1 Default settings

Feature	Parameter	Sub parameter	Factory default
Conductivity	Process variable	Cell constant	0.01
		Range	0-200 µS/cm
		Display unit	µS/cm
		Special unit (text)	Ppm
		Special unit A0	0
		Special unit A1	0
		Process TC	0.02
	Temperature	Measurement	Manual
		Sensor type	Pt100
		Display unit	°C
		Range	-20°C to +200°C
		Temperature offset	0.00000 °C
		Cable resistance	0.00000 Ω
		Manual mode temperature	25.00000 °C
	Tag name		TAG Ch-A
	Time constant		2.00000 s
pH	Process variable	Sensor type	pH
		Sym/Asym excitation	Symmetrical
		Cable length	Less than 5 m
		Range (pH sensor)	0 to 14 pH
		Range (Redox sensor)	-2000 to +2000 mV
		Unit	pH
	Temperature	Measurement	Manual
		Sensor type	Pt100
		Display unit	°C
		Range	-20°C to +200°C
		Temperature offset	0.00000 °C
		Cable resistance	0.00000 Ω
		Manual mode temperature	25.00000 °C
	Tag name		TAG Ch-B
	Time constant		2.00000 s
Current outputs 1 to 4	Current output for		ChA: PV
	Output type		Linear
	Output range		4-20 mA
	Max value		100.000 mS/cm
	Min value		0.00000 mS/cm
	Ierror		3.55 mA
Relays 1 to 6	Relay function		None

	Default state		Normally open
	Selected function		
Conductivity calibration	Calibration points	One/ Two/ Three point	200.0000 µS/cm
	Offset conductivity		0.0000 µS/cm
pH calibration	Calibration points	One/ Two/ Three point	14.0000 pH
	Offset conductivity		0.0000 pH
Current calibration	Outputs 1 to 4	Current Low	5.0000 mA
		Current High	17.5000 mA
Test current output	Outputs 1 to 4		4 mA
Test relay output	Relay states 1 to 6		OFF

16.2 Conductivity of common aqueous solutions at 25°C

Solution	Conductivity
Ultra pure water	0.055 µS/cm
Power plant boiler water	0.05 - 1.0 µS/cm
Distilled water	0.5 µS/cm
De-ionized water	0.1 - 10.0 µS/cm
De-mineralized water	1 - 80 µS/cm
Mountain water	10 µS/cm
Drinking water	0.5 - 1.0 mS/cm
Waste water	0.9 - 9 mS/cm
Potable water (max)	1.5 mS/cm
Brackish water	1 - 80 mS/cm
Industrial process water	7 - 140 mS/cm
Ocean water	53 mS/cm

16.3 Temperature dependence of conductivity

Conductivity as a function of temperature: $C_t = C_{25}/(1+ a*(t - 25))$, where

C_t = conductivity at temperature t

a = temperature coefficient expressed in % / °C

t = process temperature in °C

As an example:

Let C_t = 100µS/cm, A = 2%/°C and T = 30°C

The transmitter will indicate the normalized value as below

$C_{25} = C_{30}/(1 + 0.02*(30 - 25)) = 90.90$µS/cm at 25°C

16.4 pH versus mV table

pH	mV					
	0°C	20°C	25°C	50°C	80°C	100°C
0	379.4	407.1	414.4	448.8	490.5	518.2
1	325.2	349.0	355.2	384.7	420.5	444.2
2	271.0	290.8	296.0	320.6	350.4	370.2
3	216.8	232.6	236.8	256.5	280.3	296.1
4	162.6	174.5	177.6	192.3	210.3	222.1
5	108.4	116.4	118.4	128.3	140.2	148.1
6	54.20	58.15	59.20	64.10	70.05	74.00
7	0	0	0	0	0	0
8	-54.20	-58.15	-59.20	-64.10	-70.05	-74.00
9	-108.4	-116.4	-118.4	-128.3	-140.2	-148.1
10	-162.6	-174.5	-177.6	-192.3	-210.3	-222.1
11	-216.8	-232.6	-236.8	-256.5	-280.3	-296.1
12	-271.0	-290.8	-296.0	-320.6	-350.4	-370.2
13	-325.2	-349.0	-355.2	-384.7	-420.5	-444.2
14	-379.4	-407.1	-414.4	-448.8	-490.5	-518.2

16.5 RTD table

Temperature °C	Pt100 Ω	Pt1000 Ω	Temperature °C	Pt100 Ω	Pt1000 Ω
-20	92.16	921.6	65	125.16	1251.6
-10	96.09	960.9	70	127.07	1270.7
0	100.00	1000.0	80	130.89	1308.9
5	101.95	1019.5	90	134.70	1347.0
10	103.90	1039.0	100	138.50	1385.0
15	105.85	1058.5	110	142.29	1422.9
20	107.79	1077.9	120	146.06	1460.6
25	109.73	1097.3	130	149.82	1498.2
30	111.67	1116.7	140	153.58	1535.8
35	113.61	1136.1	150	157.31	1573.1
40	115.54	1155.4	160	161.04	1610.4
45	117.47	1174.7	170	164.76	1647.6
50	119.40	1194.0	180	168.46	1684.6
55	121.32	1213.2	190	172.16	1721.6
60	123.24	1232.4	200	175.84	1758.4

16.6 Recommended spares

Aqua4Trans has been designed and manufactured to deliver reliable operation over long periods of time. However, in the unlikely event of under-performance we recommend that you stock the following spares to ensure high uptime of the product.

Sr. No.	Item	Order code
1	Conductivity / TDS module	
2	pH / ORP module	
3	Turbidity / TSS module	
4	4 ~ 20 mA module	
5	Relay module	
6	Power supply module	
6	CPU module	
7	Display module	
8	Battery	
9	Cable gland	
10	Mounting brackets	

16.7 Ordering information

Ordering Information- Configuration Selection : A4T-P-C1-C2-C3-C4-C5							
A4T	Transmitter Type						
	P	Panel mounting					
	W	Wall, common field mounting					
		C1	Card Input # 1				
		0	Nil				
		1	RS485 MODBUS				
		2	HART ; Special case "3" HART+ RS485 MOBBUS				
			C2	Card Input # 2			
			1	pH			
			2	Redox/ORP			
			3	Conductivity/Ratio			
			4	TDS			
			5	Free Chlorine(FRC) / Chlorine Dioxide(ClO_2)			
			6	Turbidity			
			7	TSS			
			8	Analogue Input Card(DO) 4-20 mA			
				C3	Card Input # 3		
				0	Nil		
				1	pH		
				2	Redox/ORP		
				3	Conductivity/Ratio		
				4	TDS		
				5	Free Chlorine(FRC) / Chlorine Dioxide(ClO_2)		
				6	Turbidity		
				7	TSS		
				8	Analogue Input Card (DO) 4-20 mA		
					C4	Card Input # 4	
					0	Nil	
					1	Relay- 6 nos	
						C5	Configuration*
						00	Default
						01	Ratio conductivity
						02	Chlorine Dioxide
A4T	P	0	1	2	0	XX	Complete Ordering Code

Forbes Marshall Pvt. Ltd.

B-85, Phase-II, Chakan Industrial Area
Sawardari, Chakan
Tal: Khed, District: Pune
Maharashtra, India – 410501
Tel: +91-21-35393400
Website: www.forbesmarshall.com
Email: support@forbesmarshall.com