

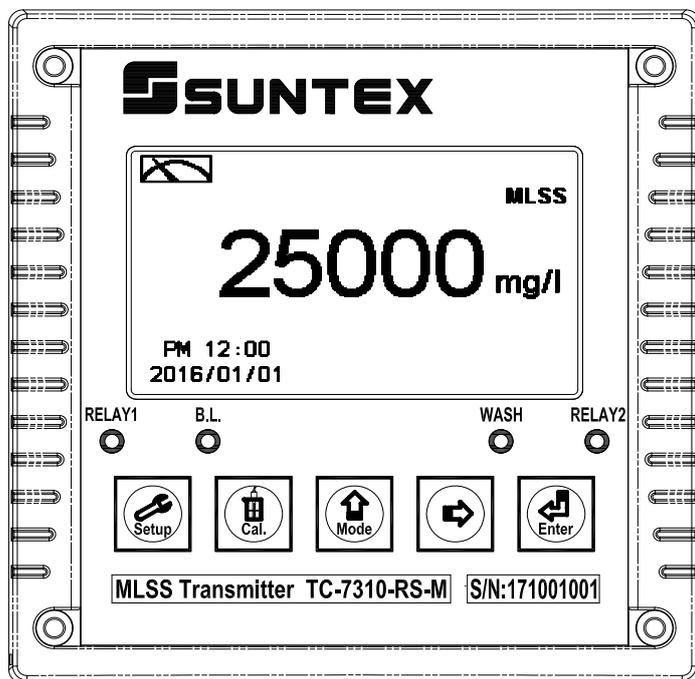
TC-7310-RS-M

Intelligent

MLSS

Transmitter

Operation
Manual



Thank you for purchasing Suntex products. In order to continuously improve and enhance the transmitter's function and capabilities, Suntex reserves the right to modify the content and icon display of the product without notice. When using this transmitter, please follow all instructions on installation and operation as described within this manual. Suntex Instruments Co., Ltd. is not liable for any direct or indirect loss or damages caused by improper usage of this product. If there are any omissions or mistakes, questions or concerns, regarding the product of this operation manual, please contact our staff. Thank you.

Precautions for Installation

Please read this operation manual thoroughly before installation to prevent incorrect wiring which may lead to instrument damage and/or safety issues.

- In order to avoid electrical hazards, all wiring must be correctly connected and inspected before connecting to power supply.
- Meter installation site should be properly ventilated and kept from direct sunlight and high temperature.
- The signal cable requires a special coaxial cable material. Cables provided by Suntex are strongly recommended. Please do not use normal electric wires.
- Prevent power surge interference to the transmitter. Especially when using a three-phase power system, make sure the device is properly grounded. If power surge interference occurs, separate the power supply of the transmitter from that of the controlled device (i.e. dosing machines, mixers, etc.), or install surge absorber to reduce power surges from all electromagnetic switches and power control device coils.
- To protect the instrument, the internal relays must be connected to **external power relays with sufficient ampere capacity** before connecting to external alarms or devices. (Please refer to chapter 3.7 “Illustration of electrical connections”)
- Suntex logo is shown on the top right corner of the display during all operations. For function illustration purposes, the logo is not shown in the figures presented in this operation manual.

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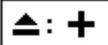
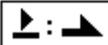
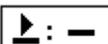
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Brief Instructions

Description of Setup Settings (See Chapter 7 for Details)

Press  and  simultaneously to see the overview of the setup settings. Then press  to modify setup settings. Press keypad according to the index bar on the bottom of the screen.

Index of Keypad

Keypad	Index Bar	Description
		Return to previous level or action
		Left or left page
		Increase digit
		Right or right page
		Decrease digit
		Confirm and proceed to next step

Setup Items

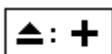
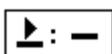
Function	Icon	Description
Mode		Measurement mode 1. Select from MLSS, Digested Sludge, Activated Sludge or or Defined table mode 2. Select display mode from text, real-time or trace mode. 3. Measuring unit selection <ul style="list-style-type: none"> ● MLSS: ppm or mg/l ● Digested Sludge: mg/l ● Activated Sludge: mg/l ● Defined: ppm or mg/l
Product Adj.		Product Adjustment. Modify the measuring value attained from the field based on the measuring value attained by sampling, so it is not necessary to take out the sensor for calibration.
Relay 1		First relay settings, select action off or Hi/Lo alarm

Relay 2		Second relay settings, select action off or Hi/Lo alarm
Wiper		Automatic wiper wash time settings, adjust detector window cleaning duration and interval
Electrode Zero		Sensor itself zero point correction, for sensor internal calibration
Clean		Automatic wash time settings; adjust external sensor cleaning device ON and OFF duration
Analog		Current output corresponding to MLSS setting range
Clock		Time and date settings
RS-485		RS485 serial interface (Modbus protocol)
Digital Filter		Take 1~60 serial measurements, average continuously, and display as the reading following stabilization
Black-light		Backlight settings, set Auto/ON/OFF backlight, brightness, and sensitivity
Contrast		Screen contrast settings
Logbook		Event recorder logbook (50 data)
Return		Measurement mode return settings
Code		Setup mode security code. The setup code is precedential to calibration code. A different security code for calibration mode can be set.
Language		Available in English, Traditional Chinese, and Simplified Chinese

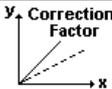
Description of Calibration Settings (See Chapter 8 for Details)

Press  and  simultaneously to see the last calibration information. Press  to make a new calibration or to modify calibration settings. Press keypad according to the index bar on the bottom of the screen.

Index of Keypad:

Keypad	Index Bar	Description
		Return to previous level or action
		Left or left page
		Increase digit
		Right or right page
		Decrease digit
		Confirm and proceed to next step

Calibration Items (Up to Five-Point Calibration)

Function	Icon	Description
Known Sol.		Calibration by known value solution
Correction		Calibration by factor correction
Code		Calibration mode security code
Return		Measurement mode return settings

Note

Due to the need for continuous improvement of the transmitter, we reserve the right to modify the icons and content. The icons and contents of the instrument are subject to change without notice.

1. Specifications

Model	TC-7310-RS-M	
Measuring Mode	MLSS	
Measuring Unit	mg/l, ppm	
Measuring Range	0~50,000 mg/l (ppm) (TS-MxS-A sensor)	
Resolution	1 mg/l (ppm)	
Calibration Matrix Type	Selection by MLSS, Defined, Digested Sludge and Activated Sludge. Except MLSS, other 3 matrix types provide display value alarm function when the measuring value exceeds the defined boundary value	
Calibration Mode	MLSS solution up to 5 points calibration and calibration by factor correction	
Electrode Zero	Sensor internal zero point correction activation function	
Ambient Temp.	0~50 °C (TS-MxS-A Sensor working temp.: 0~40°C)	
Storage Temp.	-20~70 °C	
Display	Large LCM with sensor for backlight and contrast	
	Text mode: Numerical display	
	Chart mode: 3 min real-time dynamic graph	
	Trace mode: Programmable 3 min to 4 week trend graph	
Analog Output	Isolated DC 0/4~20 mA corresponding to main measurement, Max. load 500Ω	
Serial Interface	Isolated RS-485 (MODBUS RTU or ASCII)	
Logbook	50 events	
Settings	Contact	RELAY contact, 240 VAC 0.5 A Max. (recommended)
	Activate	Hi/Lo, Hi/Hi, Lo/Lo selectable, two limited programmable, ON/OFF
Wash	RELAY contact: ON 0~99 min 59 sec / OFF 0~999 hr 59 min	
Sensor Wiper	Auto, sensor internal function for fixed 10 min/per wipe	
	Manual, setting from 2~9 min/per wipe	
Voltage Output	DC±24V	
Power Supply	100 V~240 VAC ±10 %, 8W max., 50/60 Hz	
Installation	Wall or Pipe or Panel Mounting	
Dimensions	144 mm x 144 mm x 115 mm (H×W×D), 1/2 DIN	
Cut-off Dimensions	138 mm × 138 mm (H×W)	
Weight	0.8 kg	
Protection	IP65 (NEMA 4X)	

Note: The specifications are subject to change without notice.

2. Assembly and Installation

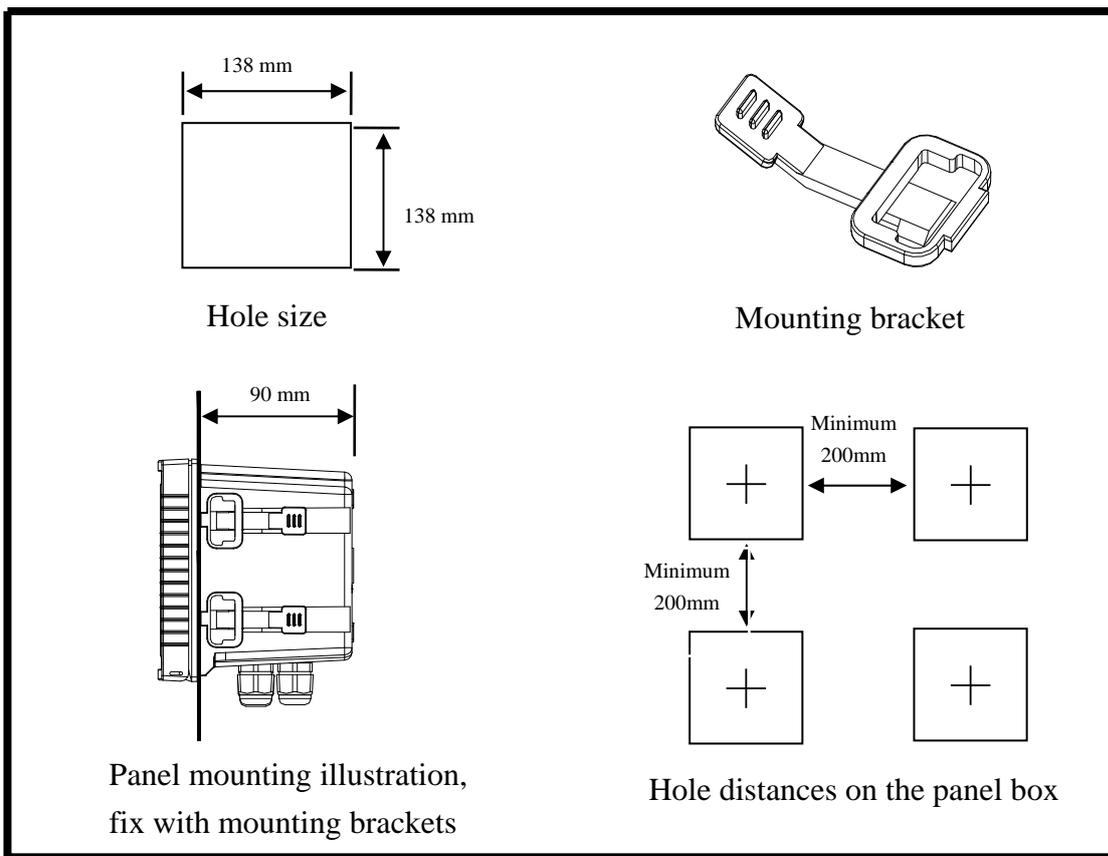
2.1 Transmitter Installation

The transmitter can be installed by panel mounting, wall mounting, or 2" pipe mounting.

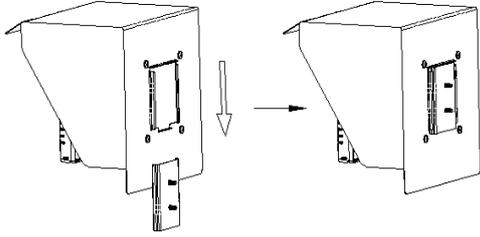
Panel Mounting:

Prepare a square hole of 138 mm x 138 mm on the panel box, and then insert the controller directly into the hole. Insert the accessorial mounting bracket from the rear, and fix into the pickup groove.

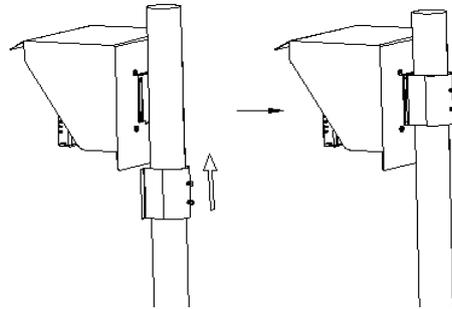
2.2 Panel Mounting Illustration



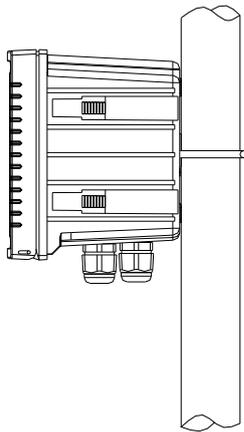
2.3 Wall Mounting and Pipe Mounting Illustration



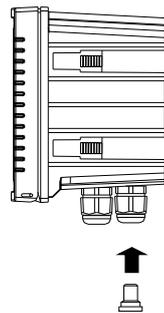
Sun Shield (wall mounting, optional)
(Order No.: 8-35 + 8-35-2)



Sun Shield (pipe mounting, optional)
(Order No.: 8-35 + 8-35-1)



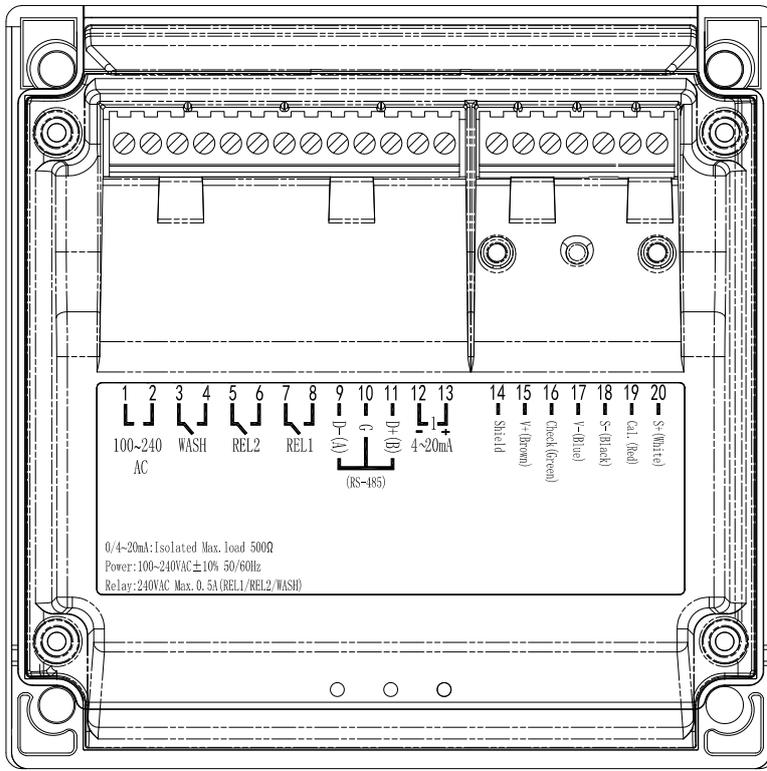
Pipe mounting illustration,
fix with a U-shaped pipe
clamp (optional).
(Order Number: 8-34)



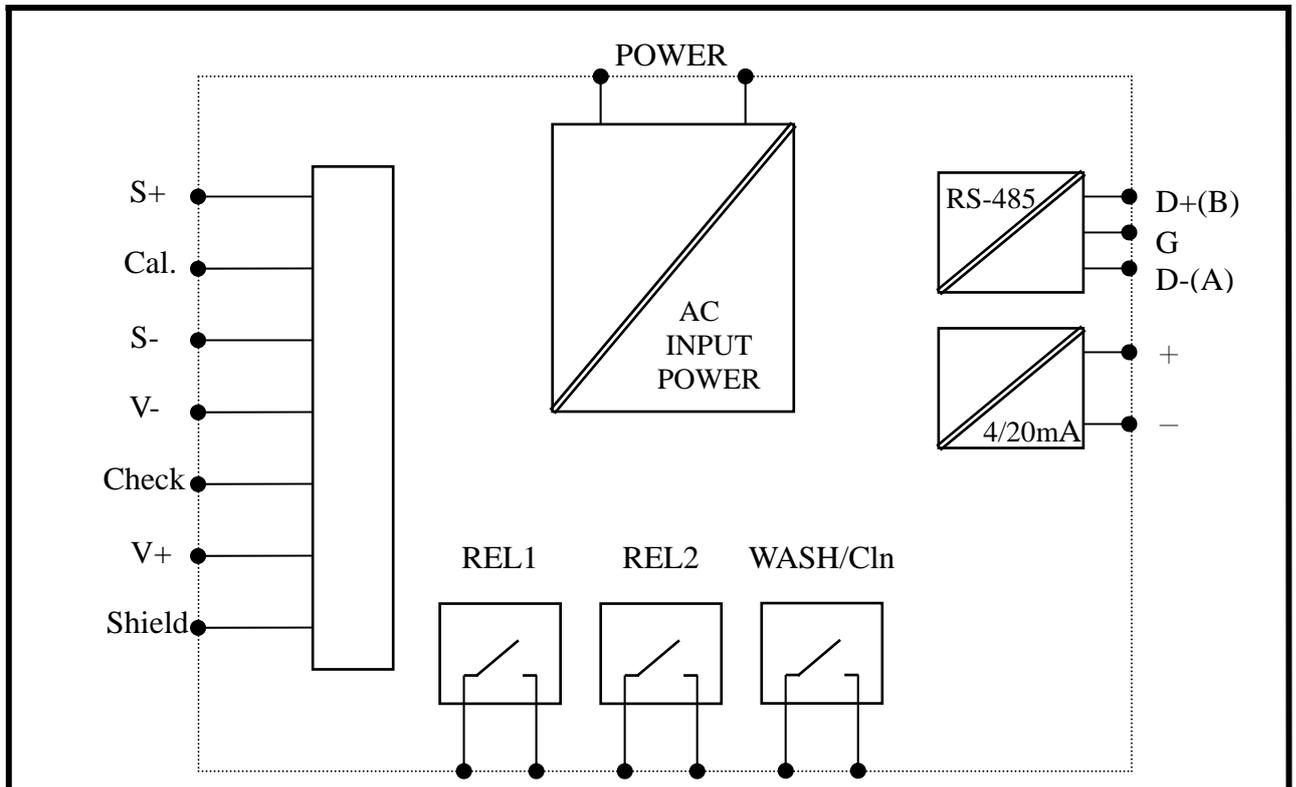
Insert rubber plug into
unused cable glands.
Tighten up the cable gland
to prevent water vapor
infiltration.

3. Overview of MLSS Transmitter TC-7310-RS-M

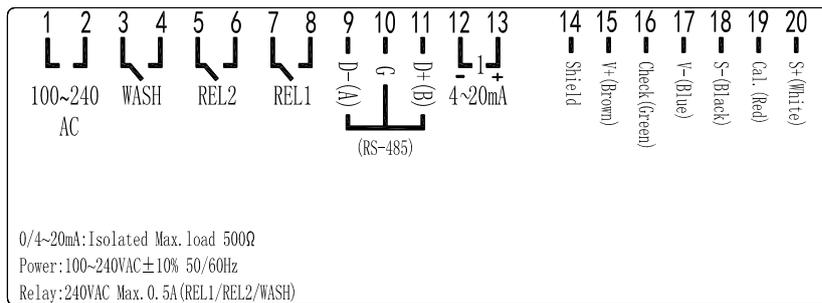
3.1 Rear Panel Illustration:



3.2 Terminal Function Illustration:

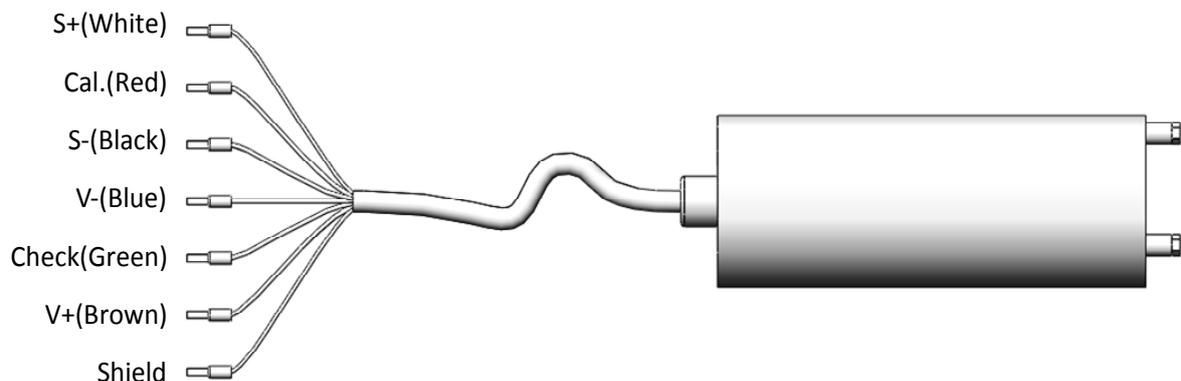


3.3 Terminal Function Description

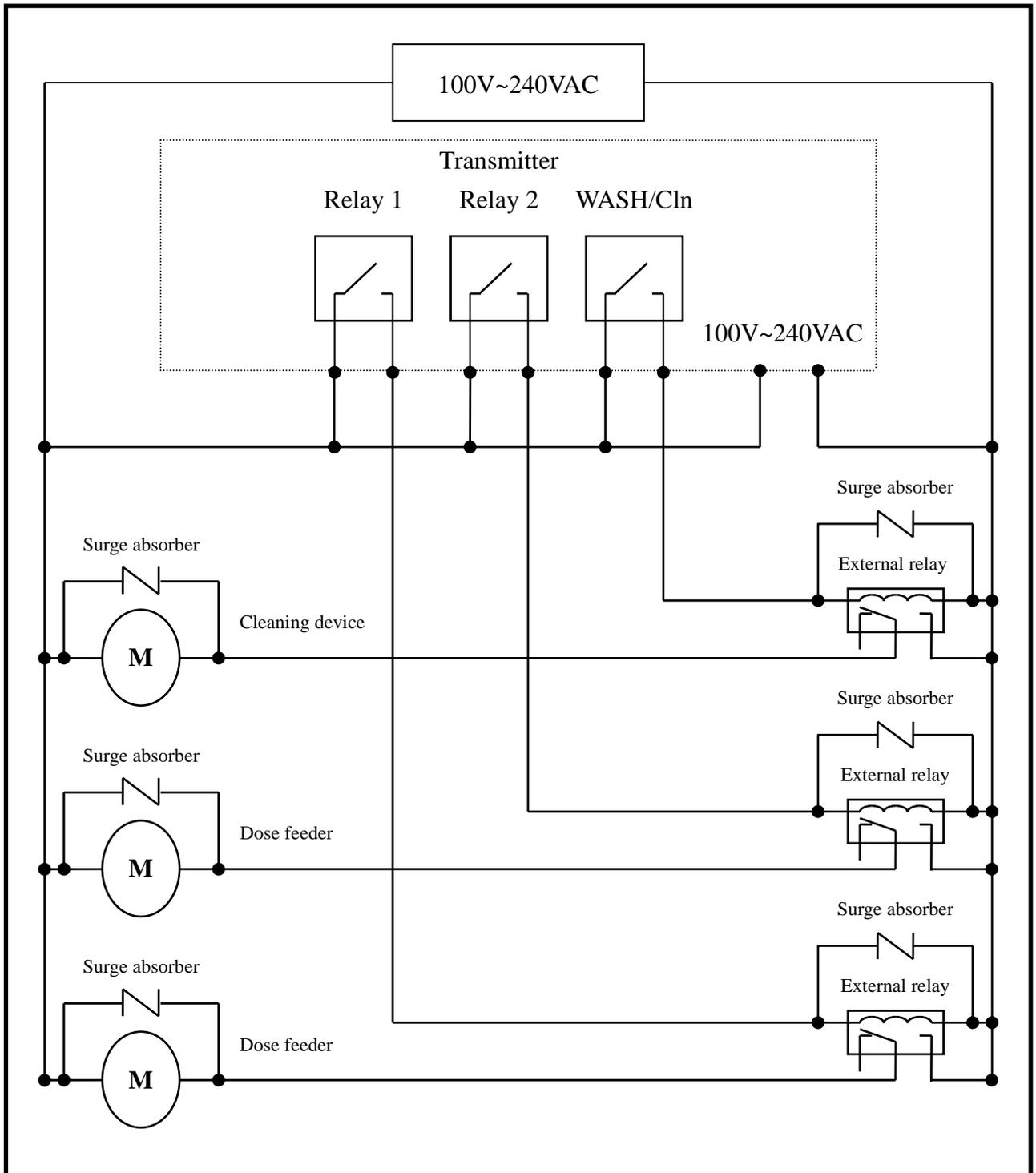


- 1 2 **100~240 AC:** Power supply terminal
- 3 4 **WASH:** Wash relay contact for an external relay
- 5 6 **REL2:** Second alarm control, the contact for an external relay
- 7 8 **REL1:** First alarm control, the contact for an external relay
- 9 **D-(A):** RS-485 output D+(A)
- 10 **G:** RS-485 output GND
- 11 **D+(B):** RS-485 output D+(B)
- 12 **4~20mA -terminal:** MLSS current output terminal -, for an external recorder or PLC control
- 13 **4~20mA +terminal:** MLSS current output terminal +, for an external recorder or PLC control
- 14 **Shield:** Sensor signal shield wire
- 15 **V+ :** BROWN sensor wire (power + terminal)
- 16 **Check:** GREEN sensor wire (self-test signal output terminal)
- 17 **V- :** BLUE sensor wire (power - terminal)
- 18 **S- :** BLACK sensor wire (signal - terminal)
- 19 **Cal. :** RED sensor wire (calibration signal input terminal)
- 20 **S+ :** WHITE sensor wire (signal + terminal)

3.4 Cable Wiring



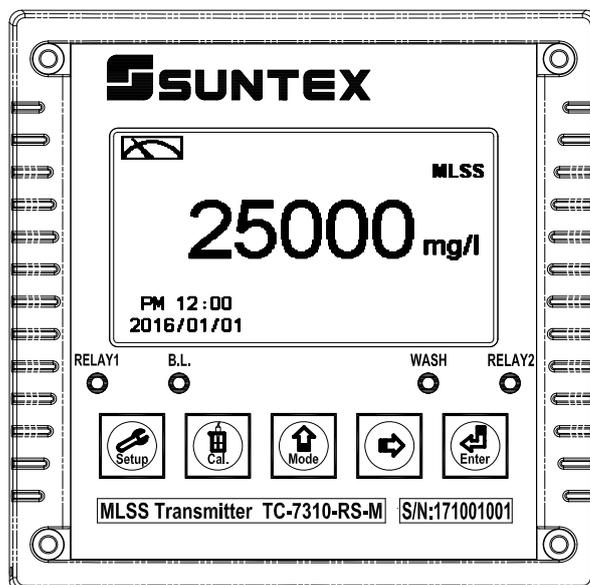
3.5 Electrical Connection Illustration



Note: The transmitter's built-in miniature relays are required to be repaired and replaced by professional technicians. **External relays** (Power Relay) must be connected to activate external devices to protect the instrument.

4. Configuration

4.1 Front Panel Illustration:



4.2 Keypad:

In order to prevent unauthorized operations, the transmitter utilizes multi-key and passcode functions to enter parameter and calibration setting modes. Descriptions of the key functions are as follows:



: In parameter set-up mode, press this key to exit and return to measurement mode.



: In calibration mode, press this key to exit and return to measurement mode.



1. In the parameter set-up mode and calibration mode, press this key to move left or return to the previous page.
2. When adjusting values, press this key to increase the value.



1. In the parameter set-up mode and calibration mode, press this key to move right or advance to the next page.
2. When adjusting values, press this key to decrease the value.



: Key for confirmation; press this key to confirm data values or select parameter item settings.

4.3 LED Indicators:

WASH : Washing device operation indicator

RELAY1 : Controlling of dose feeding operation indicator (Relay 1)

RELAY2 : Controlling of dose feeding operation indicator (Relay 2)

B.L. : Light sensor, under automatic display backlight mode, the indicator will light up when the surrounding brightness changes

5. Operation

5.1 Measurement Mode:

After all electrical connections are secured and tested, connect the instrument to the power supply and turn it on. The transmitter will automatically enter measurement mode with the factory default settings or the previous user settings.

5.2 Setup Menu:

Please refer to the set-up instructions in Chapter 7. Press  and  simultaneously to enter set-up menu, and press  to return to measurement mode.

5.3 Calibration Menu:

Please refer to the calibration instructions in Chapter 8. Press  and  simultaneously to enter calibration menu, and press  to return to measurement mode.

5.4 Shortcuts:

1. Under measurement mode, press  and hold for 2 seconds to enter Logbook function. Press  to return to measurement mode.
2. Under measurement mode, press  and hold for 2 seconds to switch from display mode to text mode, trace mode, or real-time chart display mode.

5.5 Default Values:

5.5.1 Settings Default Values:

Sensor model: TS-MxS-A

Matrix table: MLSS

Measuring unit: mg/l

Product adjustment: 0 mg/l

Relay 1: High point alarm: AUTO, SP1=40,000 mg/l, Hys = 10 mg/l

Relay 2: Low point alarm: AUTO, SP2= 10,000 mg/l, Hys = 10 mg/l

Wash time: OFF

Wiper: Manual, 9 minute/per wipe

Analog current output: 4~20 mA, 0~50,000 mg/l

Date & Time: 2016/1/1 00:00:00

RS-485: RTU, 19200, Even, 1, ID: 001

Digital filter: 30

Backlight settings: OFF

Contrast: 0

Logbook: None

Auto return: Auto, 3 minutes

Code settings: OFF

5.5.2 Calibration Default Values:

Calibration unit: mg/l

Calibration point: No Cal.

Correction factor: 1.0000

Auto return: Auto, 3 minutes

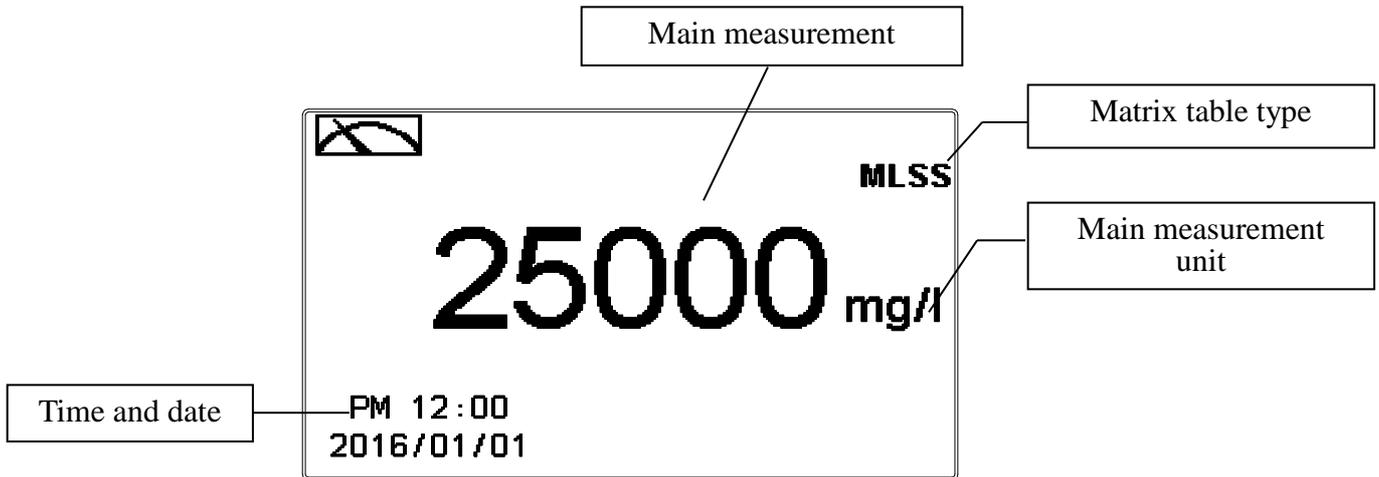
Code settings: OFF

Note: The factory default calibration setting is “No Cal”, and the calibration value is “None”. This means that the user has not yet calibrated the sensor with the transmitter. After every calibration, the calibration information display will be updated.

6. Measurement Display Mode

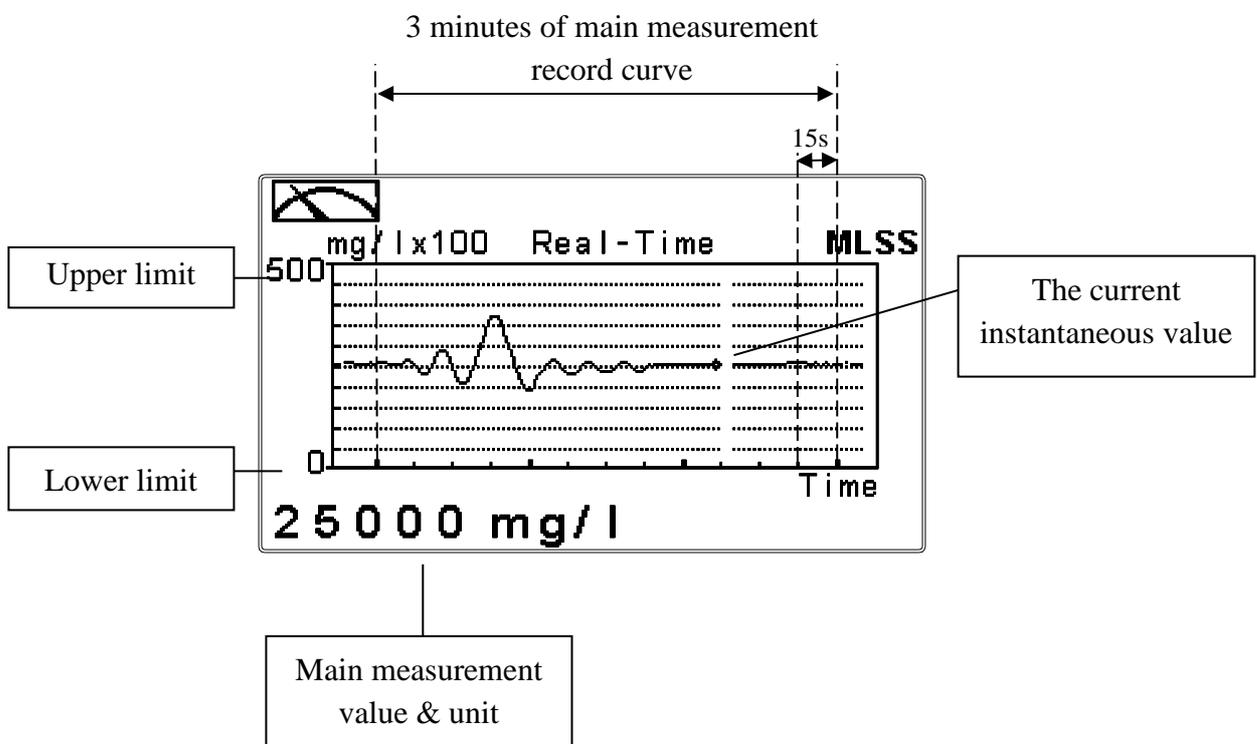
6.1 Text Mode

Text mode is the main measurement screen and shows the measurement value and unit, temperature compensation mode, temperature measurement and unit, time and date, as seen in the following illustration.



6.2 Real-Time Chart mode

Real-time chart mode shows a dynamic change of the measuring values during the last 3 minutes. Under setting mode, users are allowed to set corresponding MLSS measuring range (see section 7.4) to adjust the resolution of the curve. The smaller the range is being set, the higher resolution the display is. When the unit enters the setup or calibration mode, the real-time graphic will be re-updated after returning to measurement mode. When the measured value exceeds a set range of the upper and lower limit, the graphics will be presented in the upper and lower limits dotted line. Real-time chart mode display is shown as below. There are also real-time measurement value, & unit, and temperature value & unit which are displayed in the bottom of the screen. The timeline in real-time graphic is divided into 12 depicts, each of which describes a quarter minute (15 seconds).

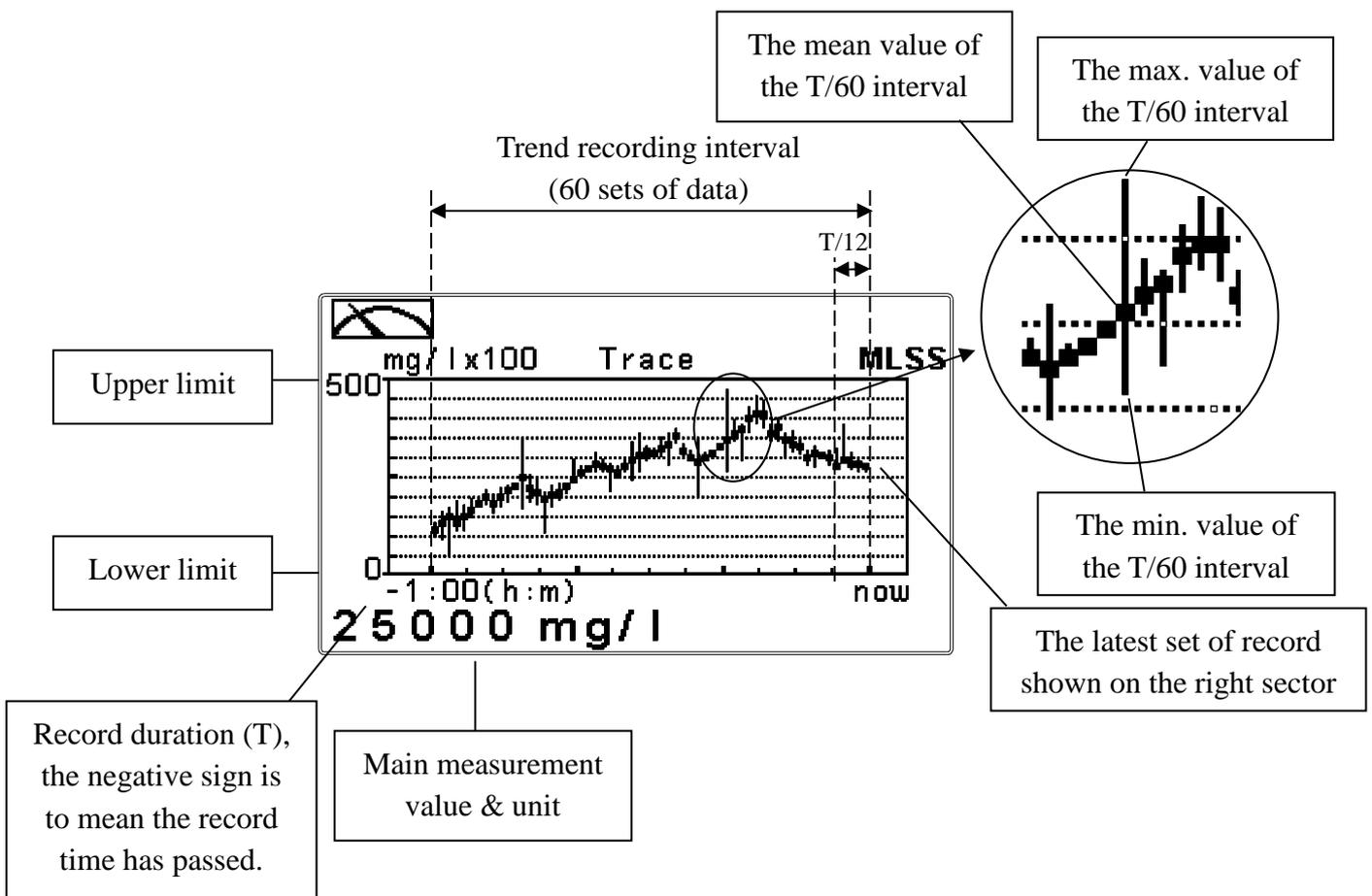


6.3 Trace mode

Trace mode features value tracing on a graph with duration configurable from three minutes up to four weeks. The graph is composed of 60 record sets over time interval T. Each set of data (T/60) is displayed by calculating the mean, maximum, and minimum value of the previous 60 values. When a new data set is calculated, the set will be displayed on the right and thus shifting the previous sets to the left by one unit. If time (T) is set for 60 hours, then each displayed set will represent a calculation of the mean, maximum, and minimum values of the data recorded during the hour (T/60). The horizontal x-axis of the graph is divided into 12 marks, with each mark representing T/12, and five data sets between each mark. The user can set the MLSS graph range under Mode in Settings (see section 7.4). The smaller the range, the greater the display resolution. Trace mode shows the real-time measurement value and unit, and temperature value and unit at the bottom of the screen, as seen in the following illustration.

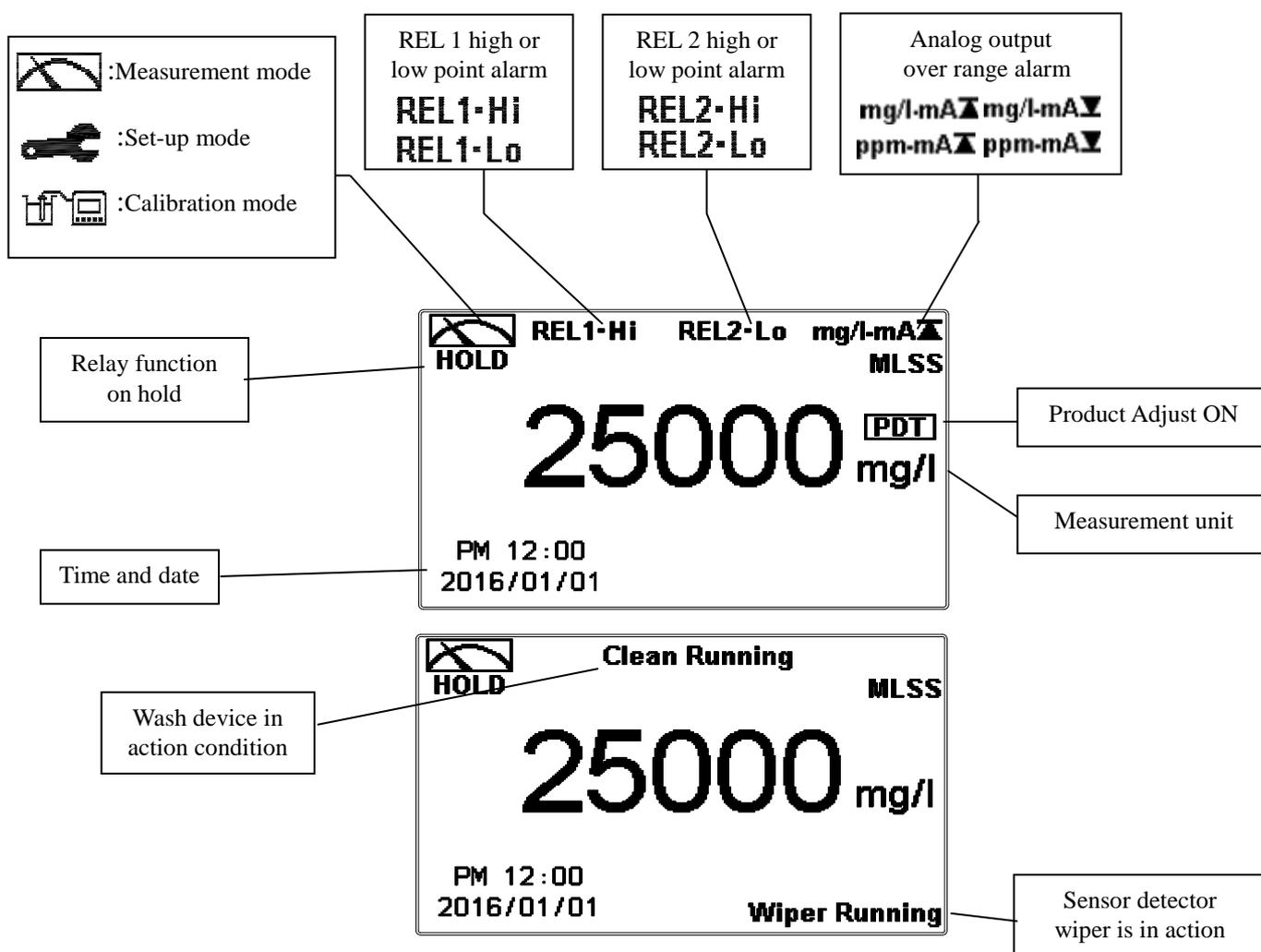
Attention: If the time interval is reset, the trend in the data will not be retained, and will start a new trace record.

Note: The time is displayed as (XX: XX) (hr: min); e.g. four weeks (672:00).



6.4 Warning Symbols and Text

1. When detector wiper is activated, the display will show “HOLD” and flash “Wiper Running”. At the same time, the transmitter will automatically turn off Relay 1 and Relay 2 function. After wiper cleaning is completed, both Relay 1 and Relay 2 will automatically returns normal status.
2. When the clean function is activated, the display will show “HOLD” and flash “Clean Running”. At the same time, the WASH indicator LED will light up, and the transmitter will automatically turn off Relay 1 and Relay 2 function. After cleaning is completed, both Relay 1 and Relay 2 will automatically returns normal status.
3. When Relay 1/Relay 2 Hi settings are activated, the display will flash “REL1-HI/ REL2-HI”, and RELAY1/RELAY2 indicator LED will light up. hen Relay 1/Relay 2 Lo settings are activated, the display will flash “REL 1-Lo/ REL 2-Lo”, and the RELAY1/RELAY2 indicator LED will light up.
4. When the Analog current output exceeds the upper/lower limitation, the display will flash “mg/l-mA▲ /mg/l-mA ▼ , or ppm-mA▲ / ppm-mA ▼ .

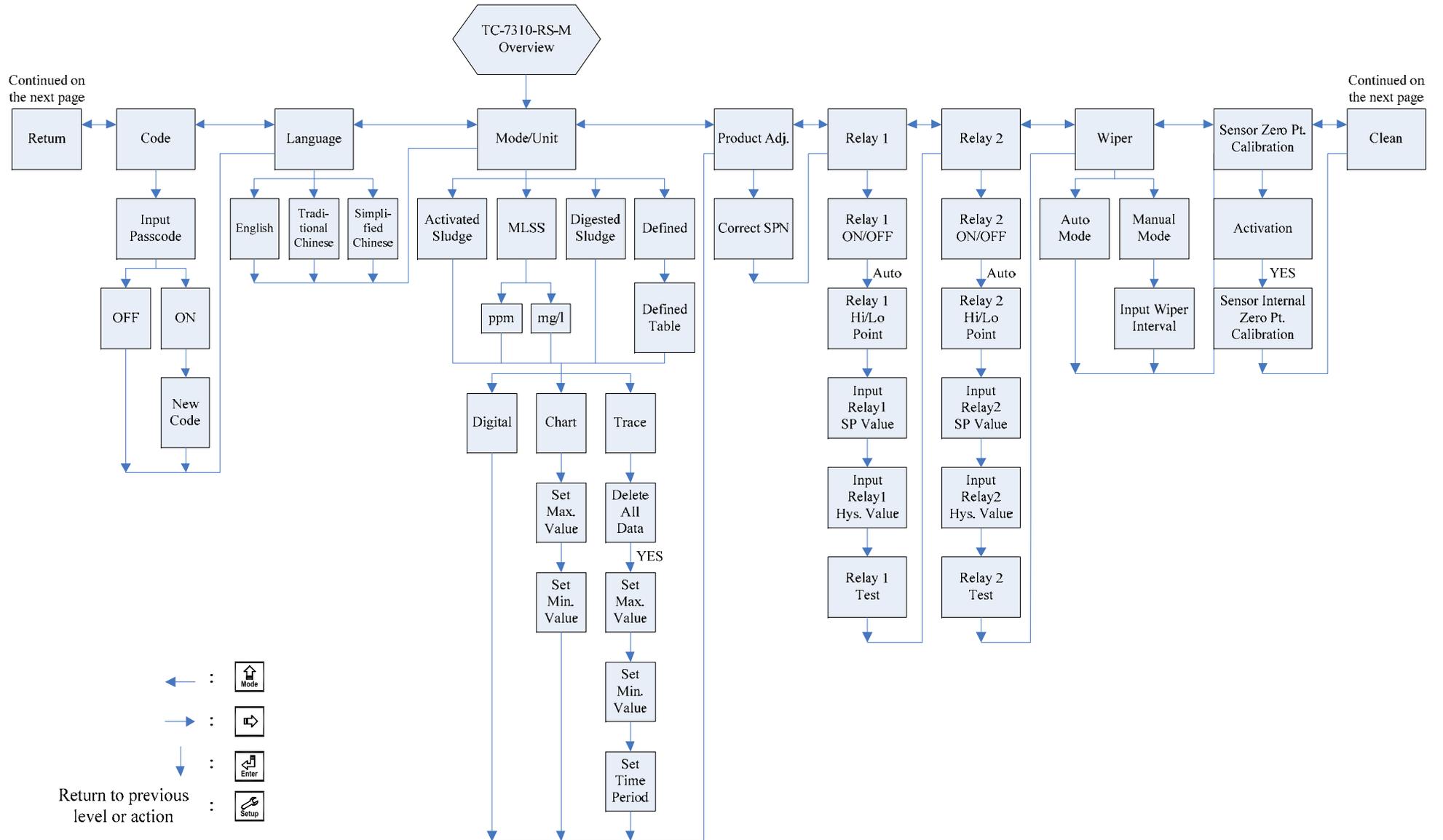


Note: The “HOLD” warning text appears when clean function is activated, or when in setup menu, or in calibration menu. Under HOLD status, the corresponding display and output are as follows:

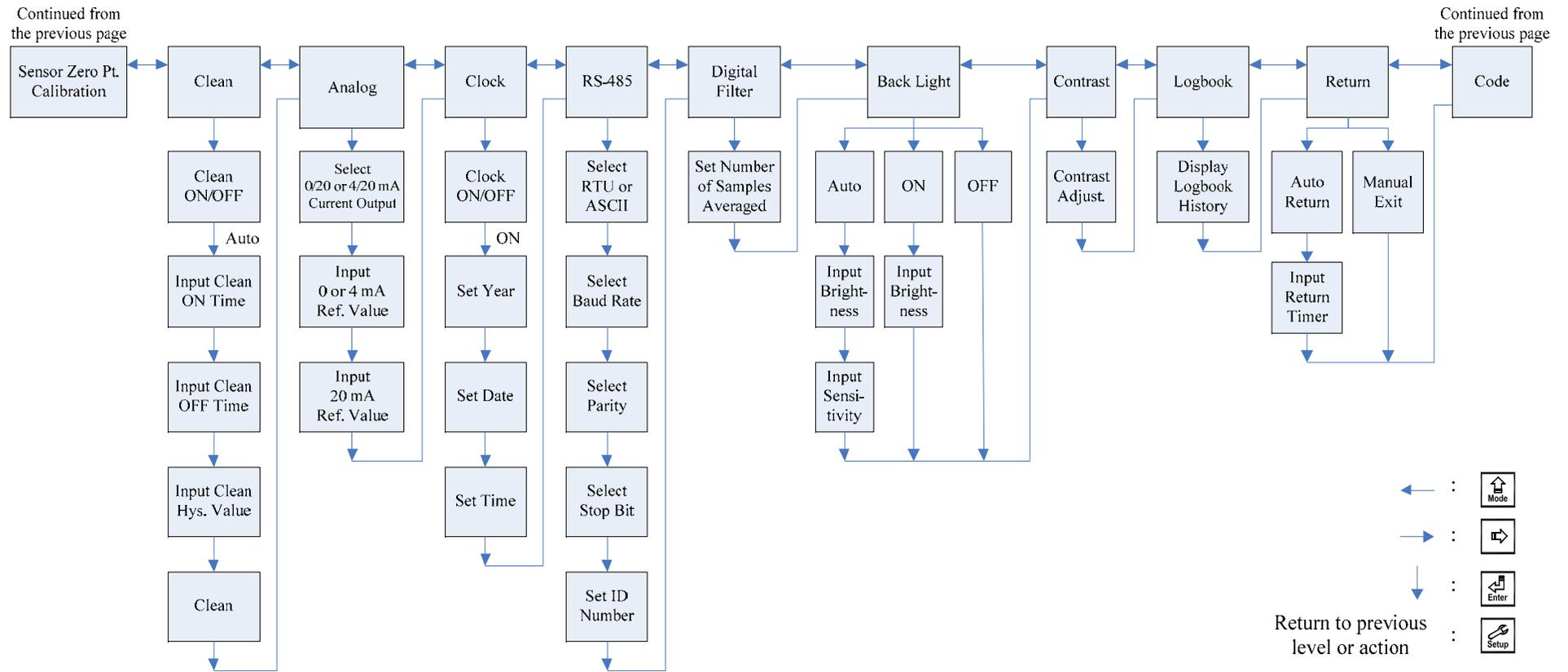
1. Both Relay 1 and Relay 2 will cease from action. When entering settings menu or calibration menu under cleaning status, the instrument will automatically halt the cleaning action.
2. The current output corresponding to measurement value remains at the last output value before HOLD status.
3. The last signal output value from the RS-485 interface is kept at the last output value before HOLD status.

7. Settings

Settings Block Diagram – Part 1

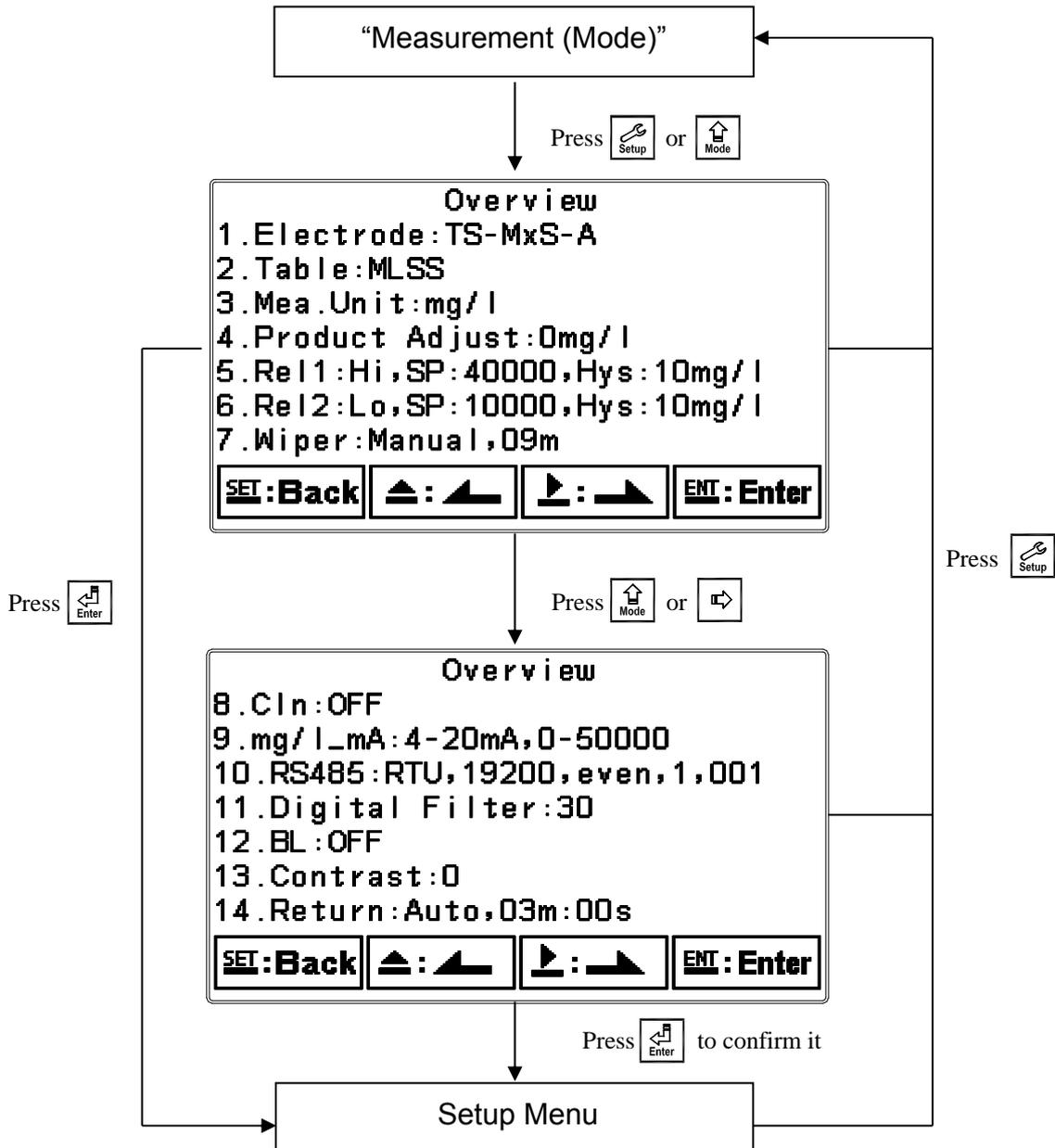


Settings Block Diagram – Part 2



7.1 Setup Menu

Under measurement mode, press the two keys  and  simultaneously to enter the current settings overview. Press  to enter setup mode to modify the settings if necessary.

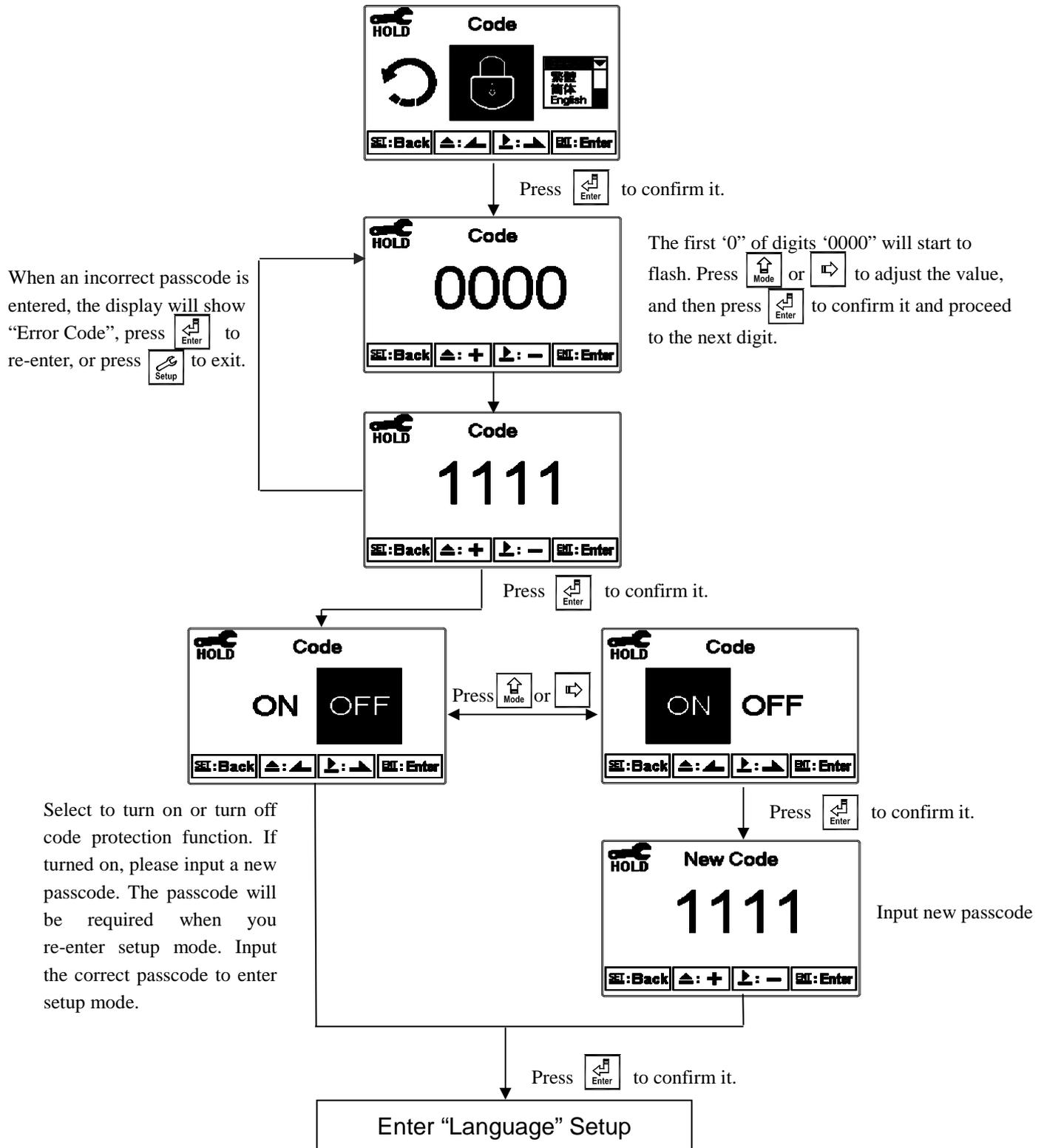


7.2 Settings Security Code (Code)

After entering setup mode, select “Code” and press  to enter code setting procedure.

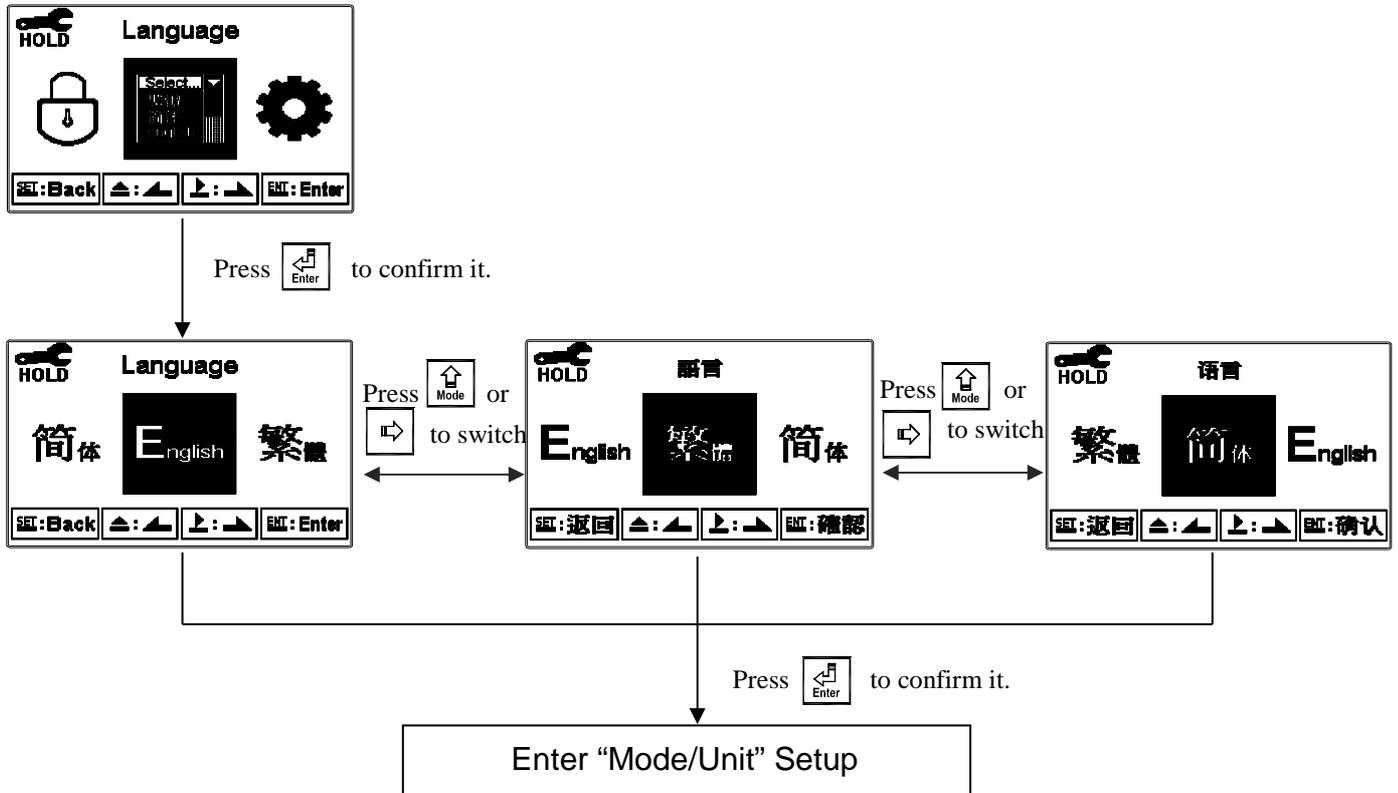
The preset settings code is 1111.

Note: The code for settings mode is at a higher security level than the code for calibration. Thus, the code for setting mode can be used to unlock calibration mode.



7.3 Language

After entering setup mode, select “Language” and press  to enter system language selection. Select from English, Traditional Chinese or Simplified Chinese.

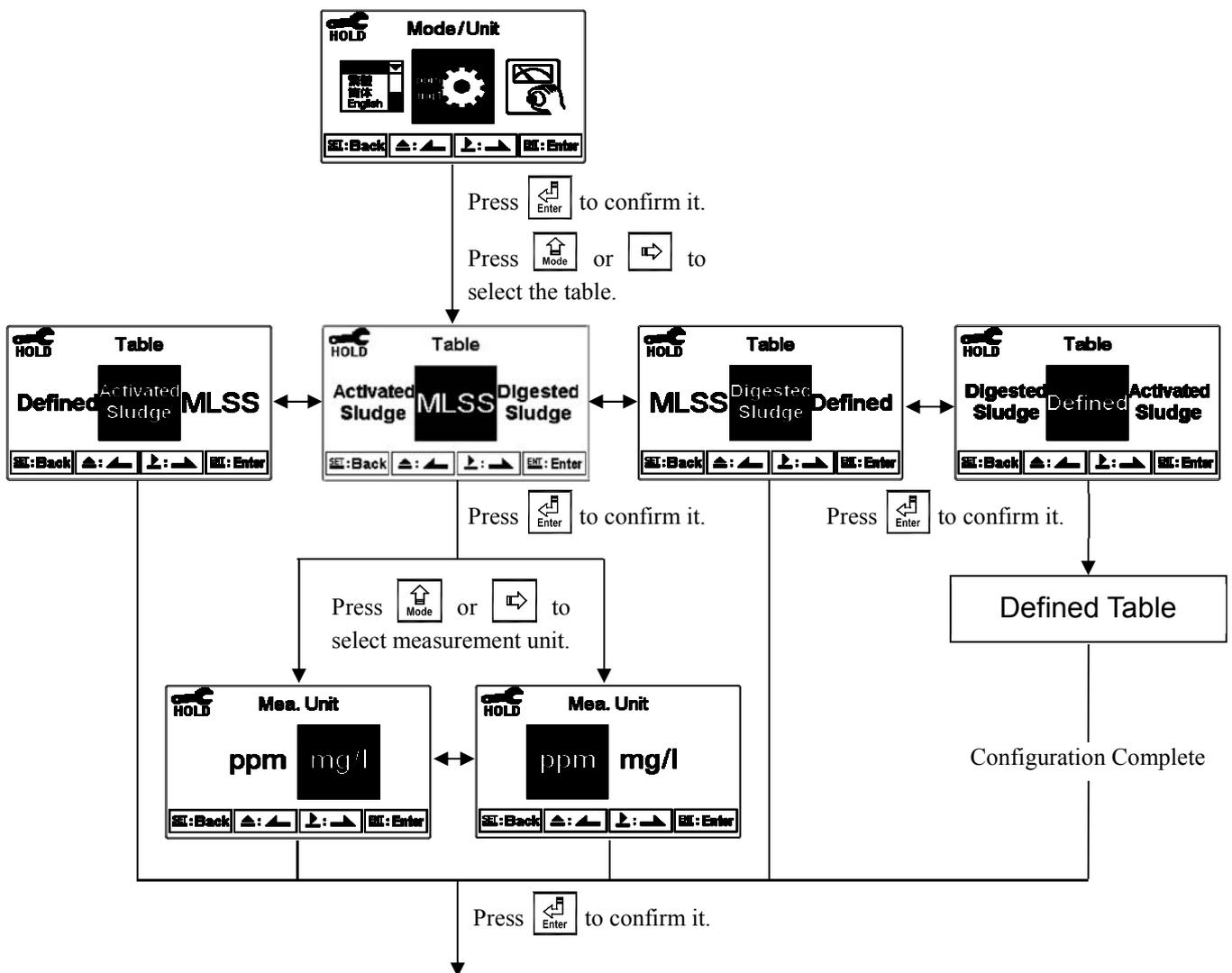


7.4 Measurement Mode/Unit (Mode/Unit)

After entering setup mode, select “Mode/Unit” and press  to configure measurement settings: reference table, unit, and display mode. Selectable mode include: MLSS, Digested Sludge, Activated Sludge, and Defined.

- MLSS: (mg/l or ppm)
- Activated Sludge Matrix: Built-in activated TSS and SiO₂ matrix curve (mg/l).
- Digested Sludge Matrix: Built-in digested TSS and SiO₂ matrix curve (mg/l).
- Defined Table: Manually defined table and curve (mg/l or ppm).

Note: Activated Sludge and Digested Sludges Matrix are only applicable to municipal water measurements (see Appendix, Table 1 & 2).



Measurement Display Settings
(continued on next page)

Measurement Display Settings

Press or to select display mode.

Press or to select display mode.

Mode

Trace Digital Chart

100f 50f 0

100f 50f 0

100f 50f 0

SEL:Back ▲: ◀ ▶: ▶ EMI:Enter

Mode

Digital Chart Trace

1.00 00000

100f 50f 0

100f 50f 0

100f 50f 0

SEL:Back ▲: ◀ ▶: ▶ EMI:Enter

Mode

Chart Trace Digital

100f 50f 0

100f 50f 0

100f 50f 0

1.00 00000

SEL:Back ▲: ◀ ▶: ▶ EMI:Enter

Press or to adjust maximum value.

Max. Value

50000 mg/l

SEL:Back ▲: + ▶: - EMI:Enter

Max. Value

50000 mg/l

SEL:Back ▲: + ▶: - EMI:Enter

Min. Value

0 mg/l

SEL:Back ▲: + ▶: - EMI:Enter

Min. Value

0 mg/l

SEL:Back ▲: + ▶: - EMI:Enter

Press or to adjust minimum value.

Press or to adjust seconds value, then press to confirm and proceed to adjust minutes value.

Trace Time

001:00 h:m

SEL:Back ▲: + ▶: - EMI:Enter

Press to confirm it.

Select NO to keep previously recorded data. Press to confirm it.

HOLD

Do you want to clear the recorded data?

YES NO

SEL:Back ▲: ◀ ▶: ▶ EMI:Enter

Select YES and press

Press to confirm it.

Press to confirm it.

Press to confirm it.

Press to confirm it.

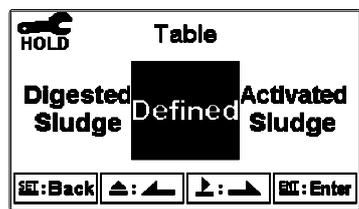
Enter "Product Adjustment" Setup

User Defined Table (Defined)

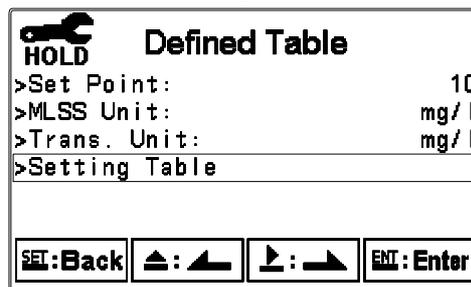
This transmitter features a user definable reference table to create an application suitable calibration curve.

User defined table requires at least two reference points and allows at most 10 reference points. The more reference points provided, the higher the conversion accuracy. MLSS measurement unit and transferred (Trans.) unit can be set as mg/l or ppm. The preset values for user defined table is identical to the table for activated sludge (see Appendix, Table 1), with ten built-in reference points. The user may edit each reference point as needed; however, points within the table must be arranged in ascending or descending order.

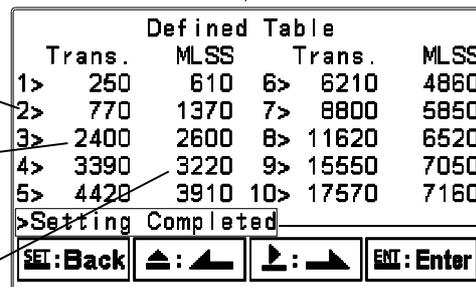
“Defined” table must be selected under “Mode/Unit” in setup mode.



Press or to select Defined, press to confirm it.



Press or to select Set Point, MLSS Unit, or Trans. Unit. Press to modify the selection. Select Setting Table and press to proceed to Defined Table modification.



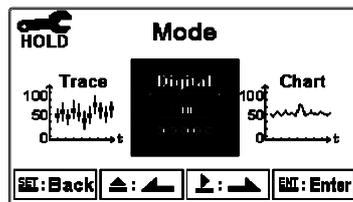
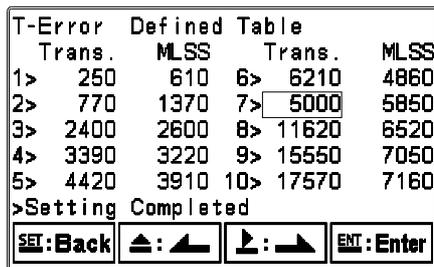
Reference Point

Corresponding Transferred Value

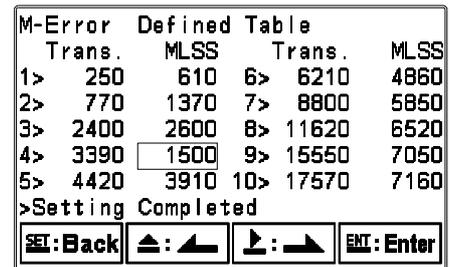
Originally Measured MLSS Value

Configuration Complete

Defined Table settings complete, press to confirm it.



Measurement Display Mode

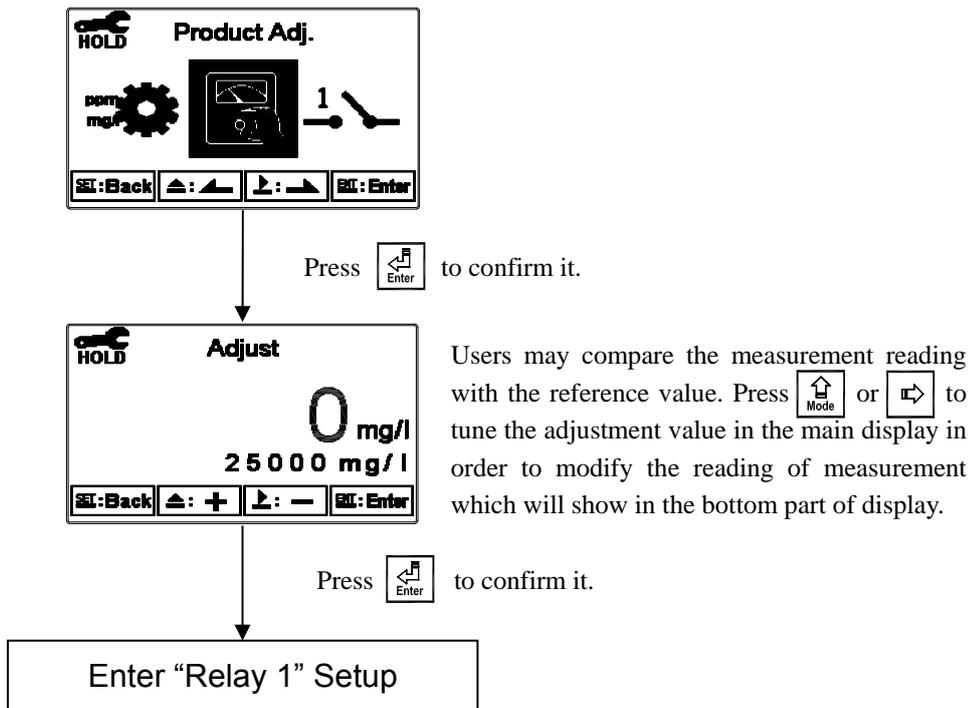


1. A T-Error (top left) message indicates Trans. values are not arranged in order as required.

2. An M-Error (top left) message indicates MLSS values are not arranged in order as required.

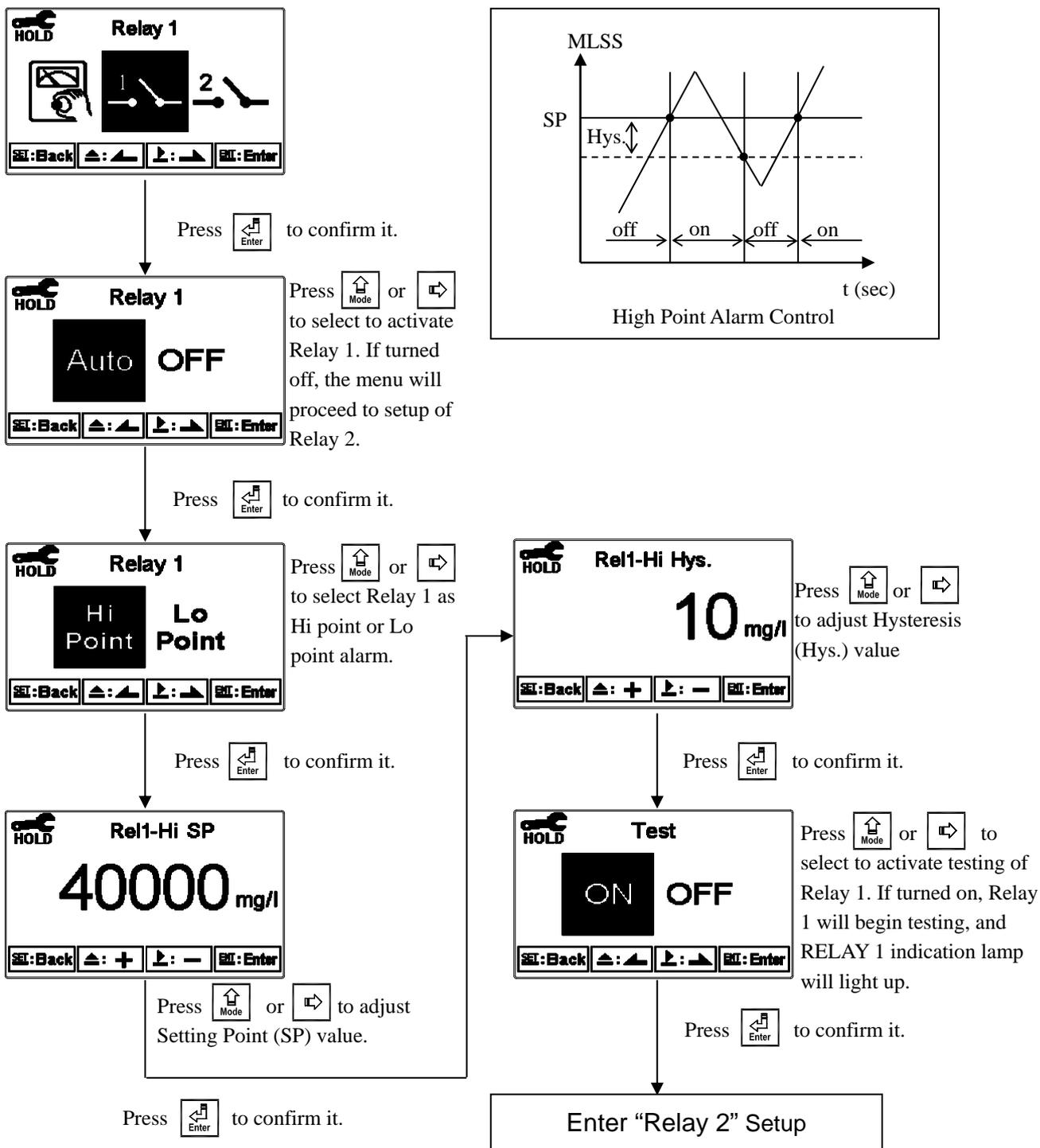
7.5 Product Adjustment

After entering setup mode, select “Code” and press  to make fine adjustments to the measurement reading. Users are able to make sample reading adjustments based on actual sample measurement values without retrieving the sensor for calibration. A PDT icon will display on the main screen above the measurement unit if the product is adjusted (see section 6.4).



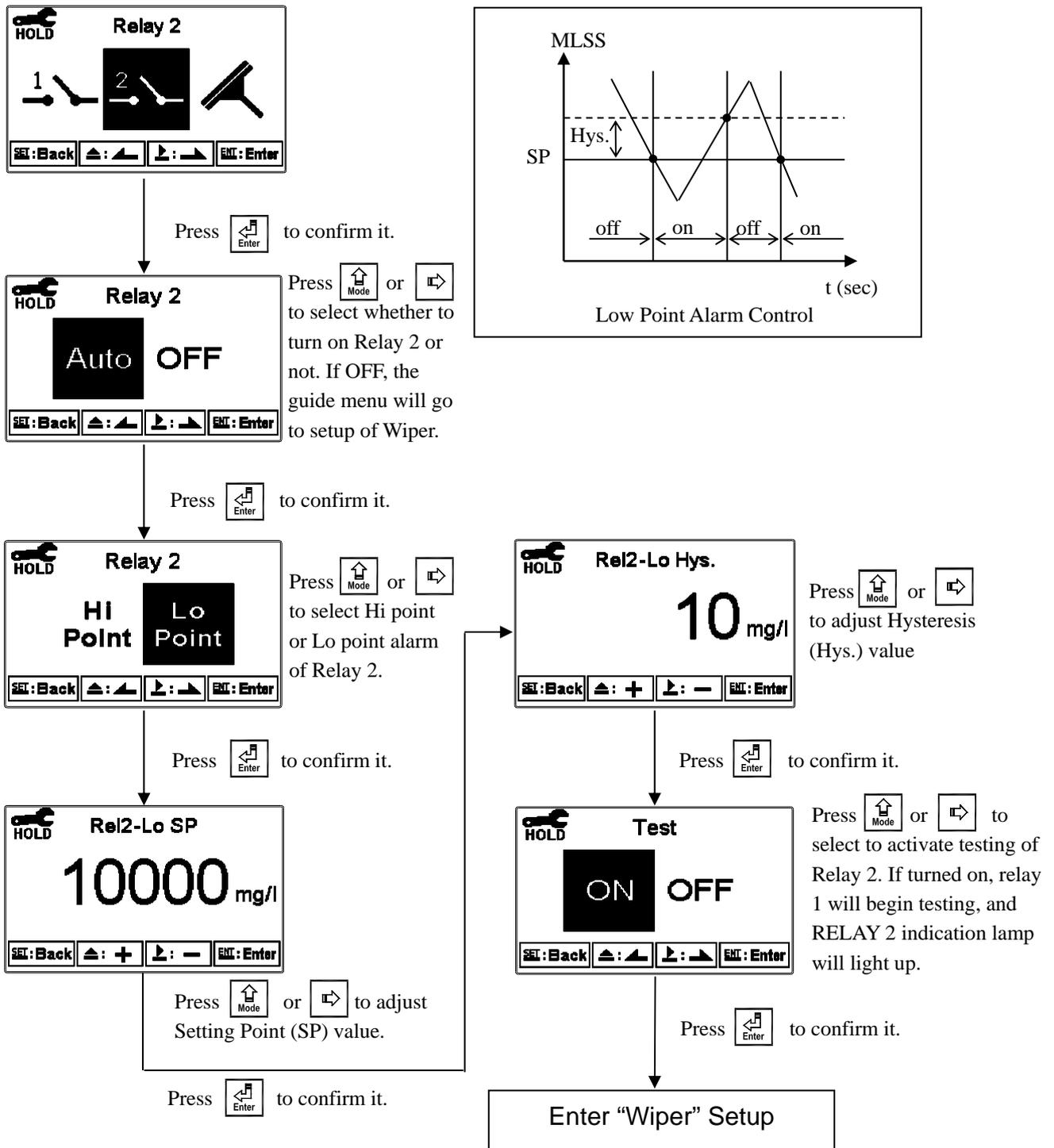
7.6 Relay 1

Enter setup of Relay 1. Select the item to turn the relay 1 function ON / OFF. If you select to turn on relay 1, set relay 1 as “High set-point” alarm or “Low set-point” alarm. Set the value of set-point (SP) and Hysteresis (Hys.). Refer to the graph below for the relationship between parameters (for high point alarms).



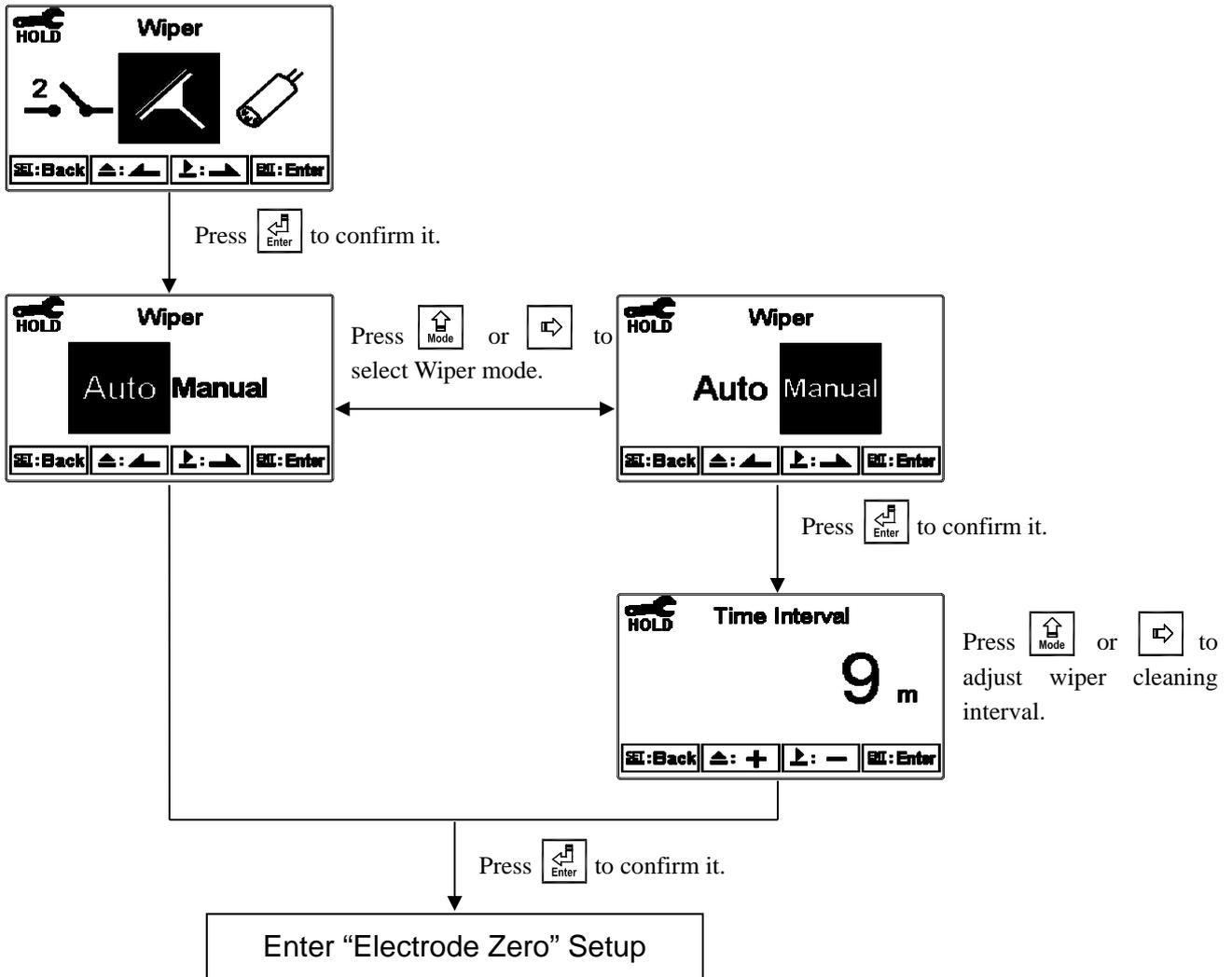
7.7 Relay 2

Enter setup of Relay 2. Select whether to turn on or turn off the relay 2 function. If you select to turn on the relay 2, then select for using relay 2 as “High set-point” alarm or “Low set-point” alarm. Set the value of Setting Point (SP) and Hysteresis (Hys.). The relationship among each parameter can refer to an explanatory diagram of the box (Low Point Alarm Control).



7.8 Wiper

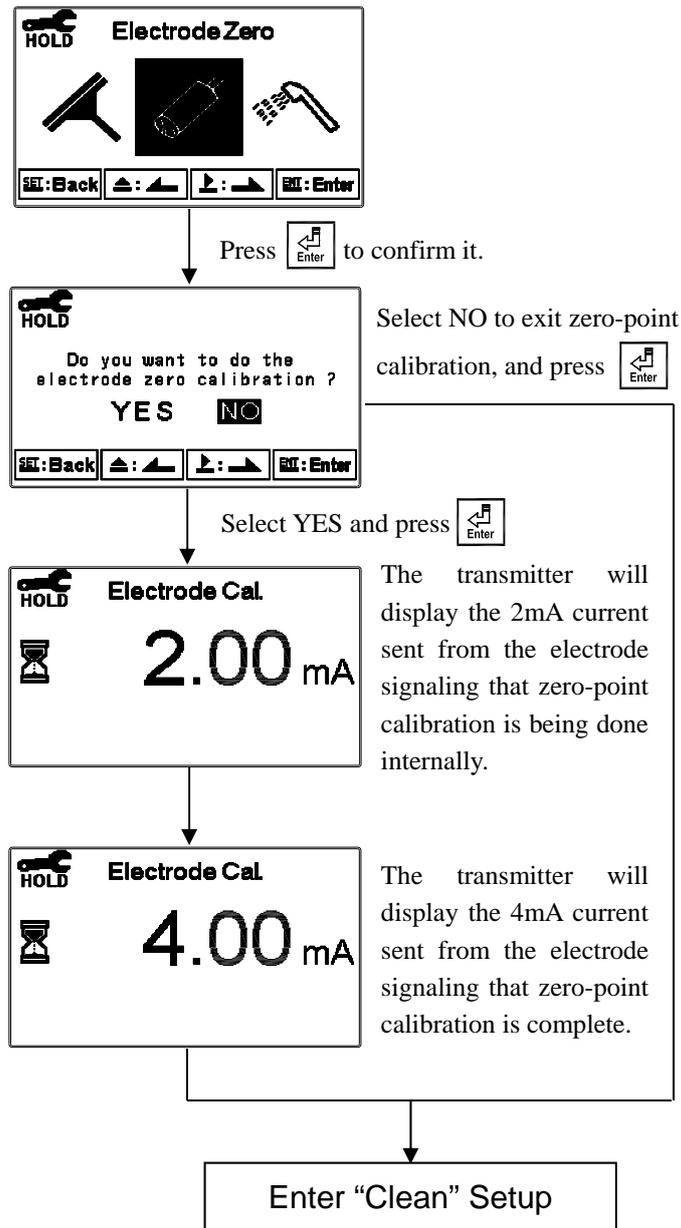
After entering setup mode, select “Wiper” and press  to configure wiper settings: activation mode and time interval. Select Auto to set automatic wiper cleaning every 10 minutes. Select Manual to configure automatic cleaning interval between 2 to 9 minutes. Adjust cleaning frequency as needed to suit application requirement.



7.9 Electrode Zero

After entering setup mode, select “Electrode Zero” and press  to perform zero-point calibration. The user can determine if zero-point calibration is necessary from deviation of the electrode’s measurement values. If calibration procedure is necessary, the electrode must be placed into distilled or deionized water for zero-point calibration.

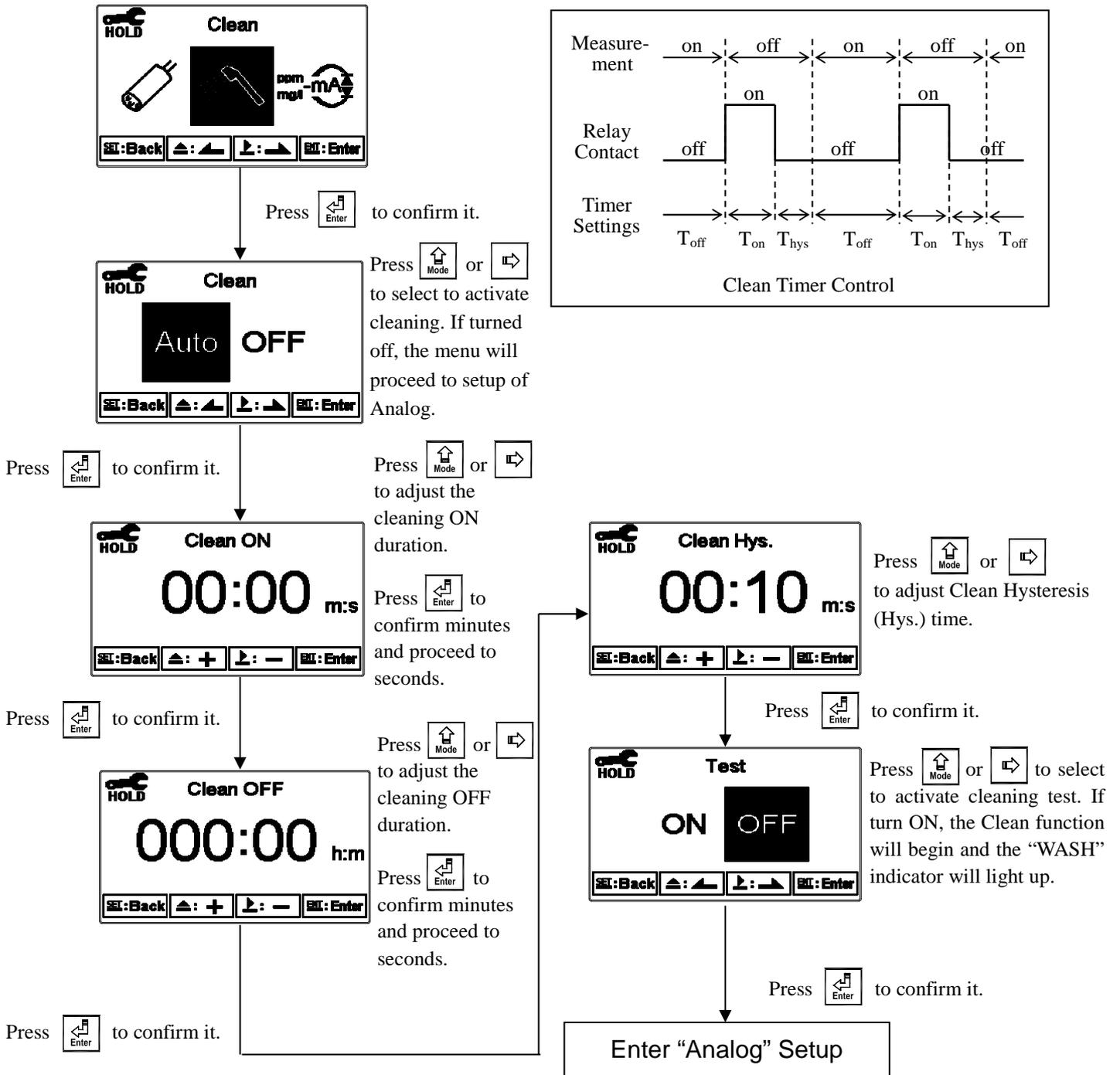
Note: When performing zero-point calibration, factory default electrode output signals will be altered.



7.10 Clean

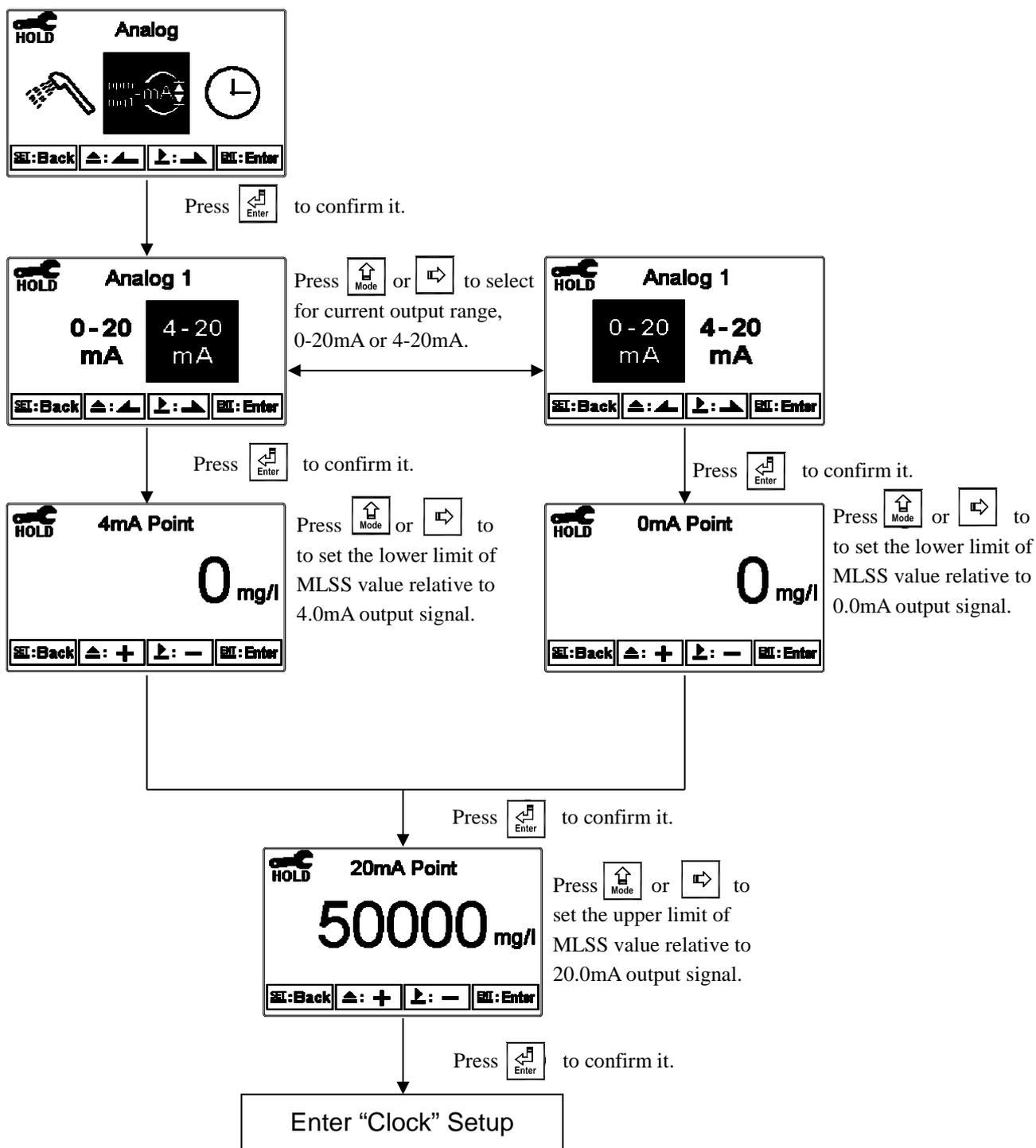
Enter setup of “Clean” function. Select the icon to turn on or turn off the clean function. Select “Auto” to turn on the function as automatic. Set the timer for the clean function to automatically turn cleaning on or off, and then set the Hysteresis value (Hys.).

Note: When the clean function is turned on, if any value is set to 0, the instrument will automatically turn off this function. When the clean function is activated under measurement mode, a “Clean Running” message will show on the top of the display. The measurement value will remain at the last measured value before cleaning. When entering settings menu or calibration menu while the clean function is activated, the instrument will automatically stop the cleaning action.



7.11 Analog Output

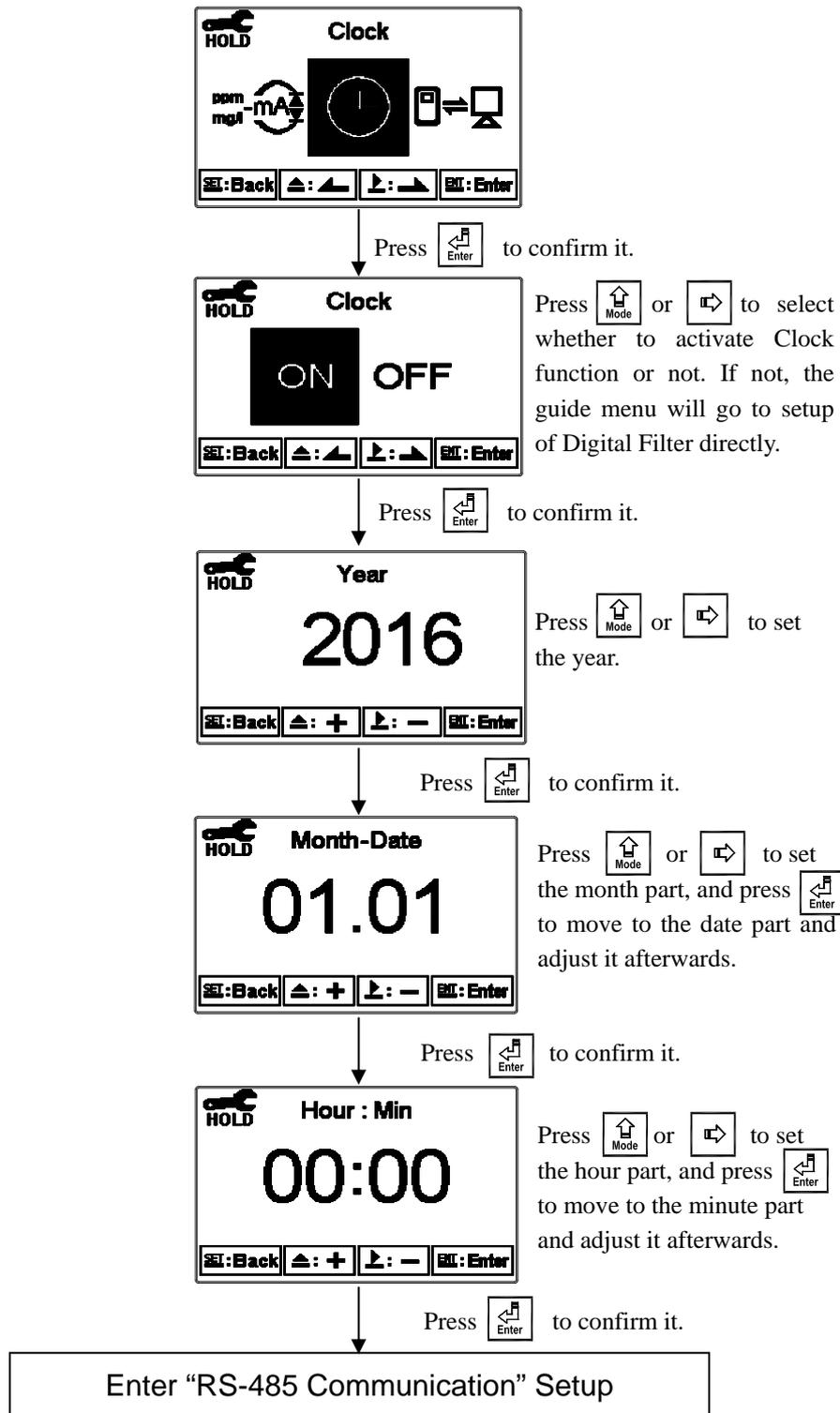
Enter setup of Analog. Select 0~20 mA or 4~20 mA current output. Set the related value to the range of MLSS measurement. The smaller the range of the MLSS measurement is set, the higher the resolution of current output. When the measured value exceeds the higher range limit, the current will remain approximately 22 mA output. When the measured value exceeds the lower range limit, under 0~20 mA mode the current output will remain 0mA, under 4~20 mA mode the current output will remain approximately 2 mA. The exceptional output value can be used as a basis for failure determination. Under HOLD (measurement) status, the current output maintains the last output value before HOLD status. However, for the convenience of ensuring the current settings of an external recorder or of a PLC controller, the current output will be 0/4 mA or 20 mA under the analog output setup menu.



7.12 Date/Time (Clock)

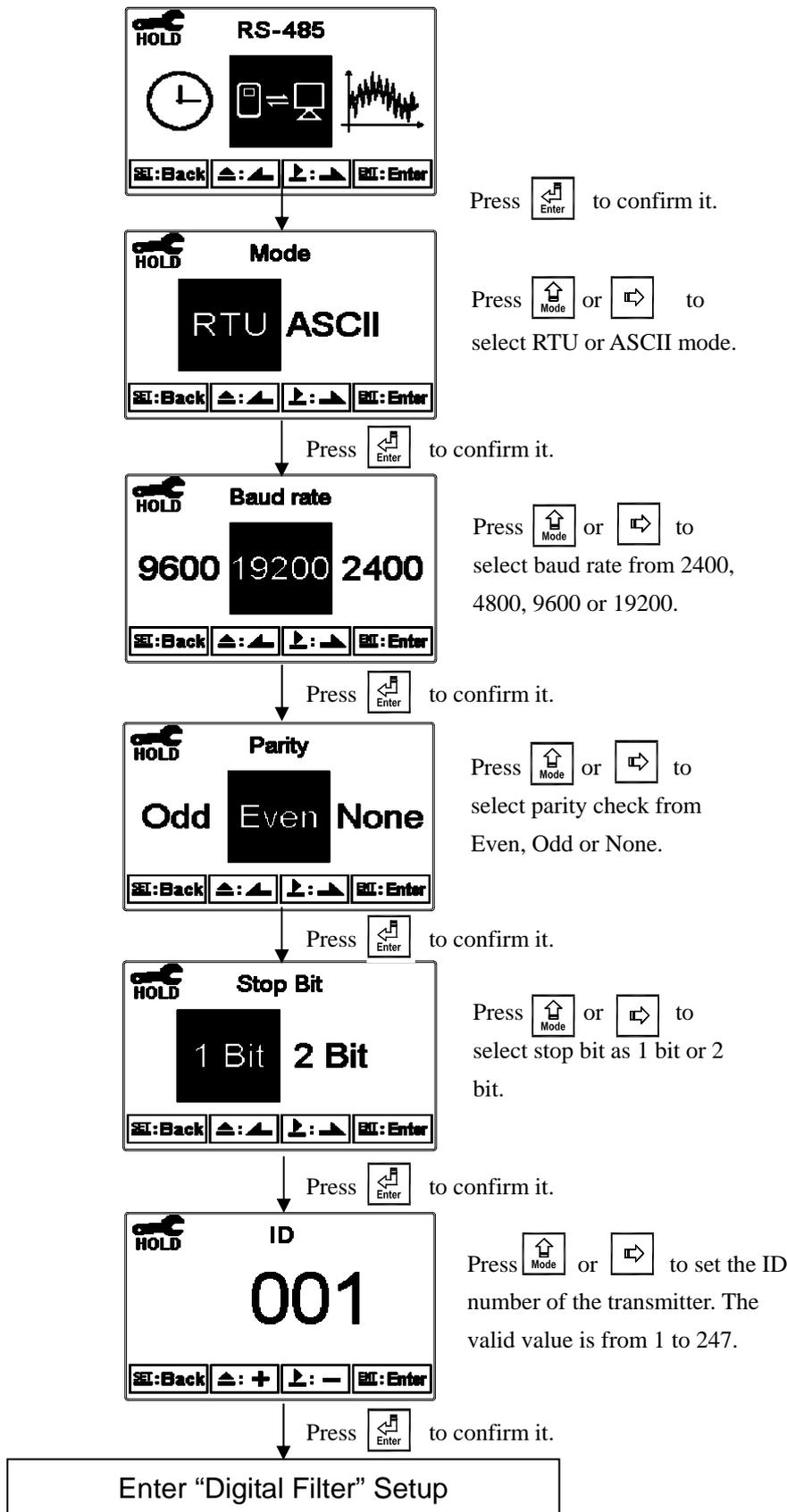
Enter setup of Date/Time (Clock). Set the “Year”, “Month”, “Date”, “Hour”, and “Minute”. If you select to turn off the clock function, a clock will not be displayed under measurement mode. The calibration time of calibration records will also show “OFF” under calibration overview display.

Note: The transmitter can remain the clock in action even if the power supply is cut off. If it cannot, which mean the battery fails, please replace the 3V CR2025 Li battery inside the transmitter.



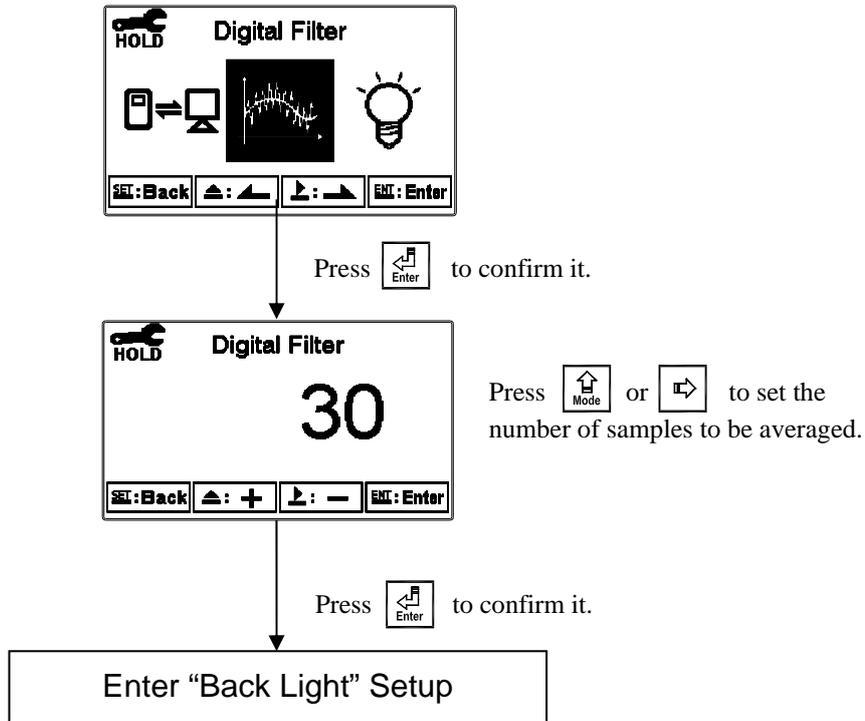
7.13 RS-485 Communication

Enter setup of RS-485 communications. According to the Modbus protocol, set the transmitting mode, parity, baud rate, stop bit, and ID number. About the details of Modbus protocol, please refer to chapter 9. If under hold status, the measurement signal output maintains the last output value before hold status.



7.14 Sample Measurement Average (Digital Filter)

Enter setup of “Digital Filter”. You may select the number of sample measurements to be averaged for each reading to increase the stability of the displayed measurement. The greater the number, the more stable the measurement value; the smaller the number, the more acute the measurement value.



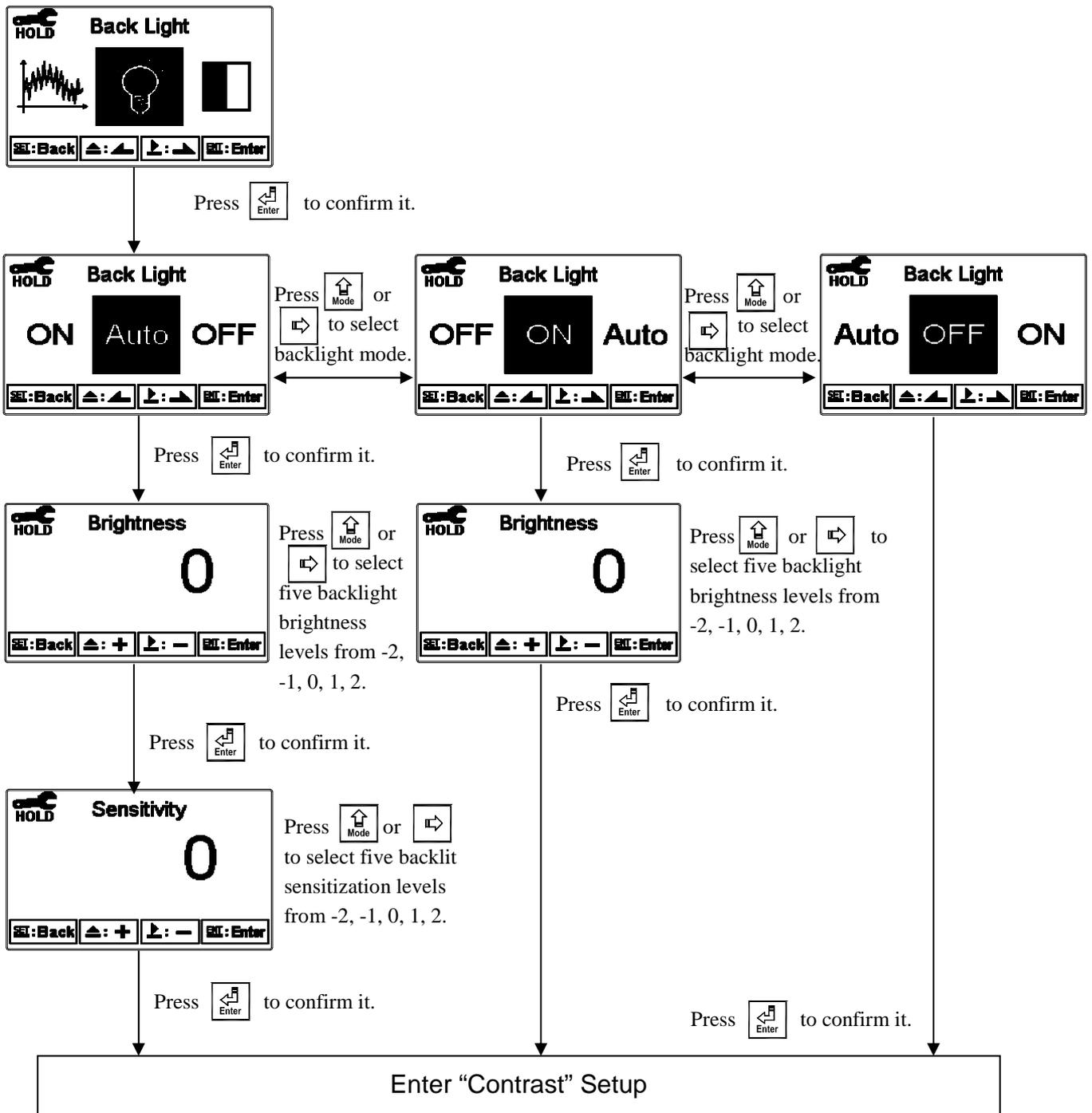
7.15 Backlight

Enter setup of backlight display. According to your needs, you can set the brightness of the display (-2~2, dark ~ bright) and sensitivity of the brightness sensor (-2~2, insensitive ~ sensitive). Whether under OFF or AUTO mode, the touch-on function will activate the backlight when any button is pressed. If no buttons are pressed for 5 seconds, the display will return to the original backlight setting status.

ON setting: The backlight is always on.

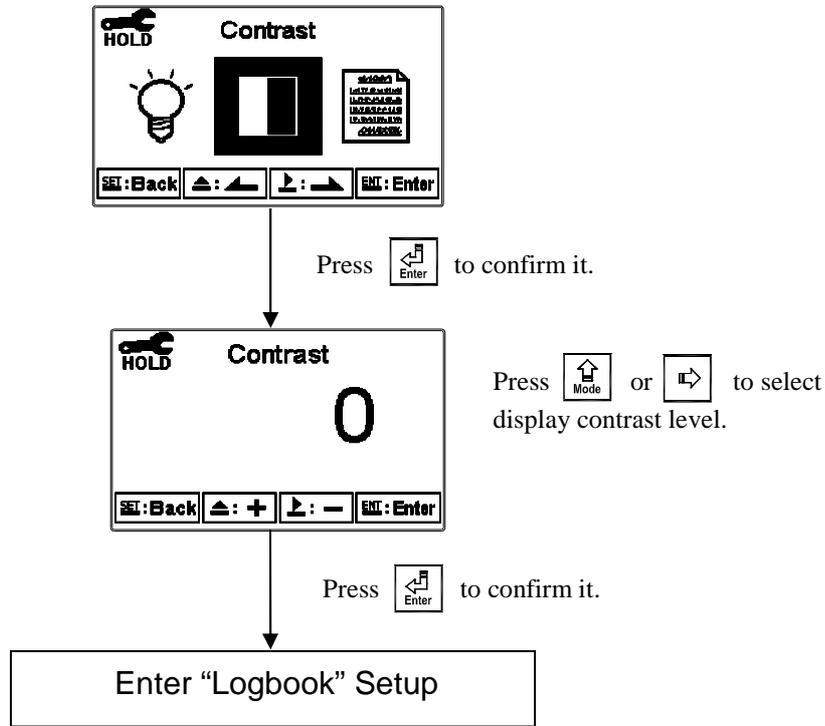
OFF setting: The backlight is off. When a button is pressed, it will enter touch-on status.

Auto setting: Transmitter will activate or deactivate the backlight according to the ambient lighting. When a button is pressed, it will enter touch-on status.



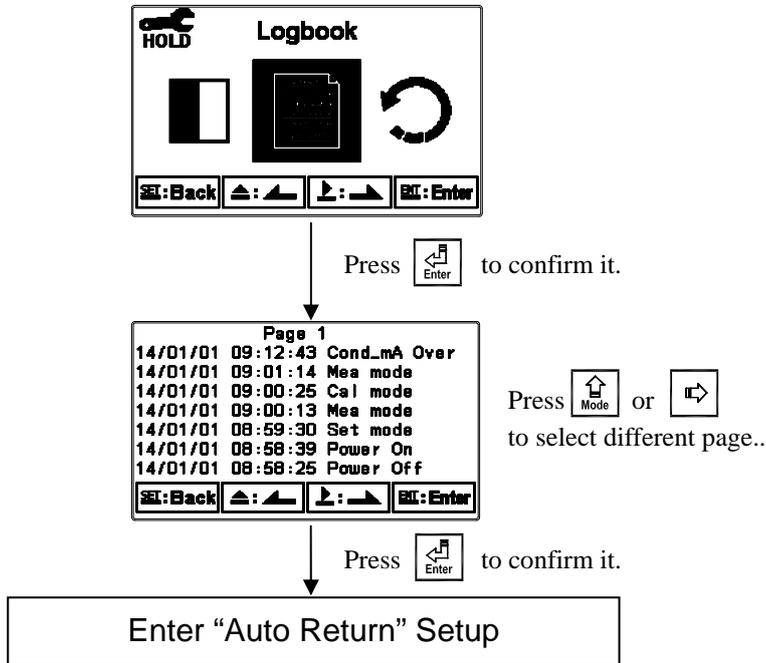
7.16 Contrast

Enter setup of display contrast. You can set the contrast of display according to your needs (-2, -1, 0, 1, 2, light to dark).



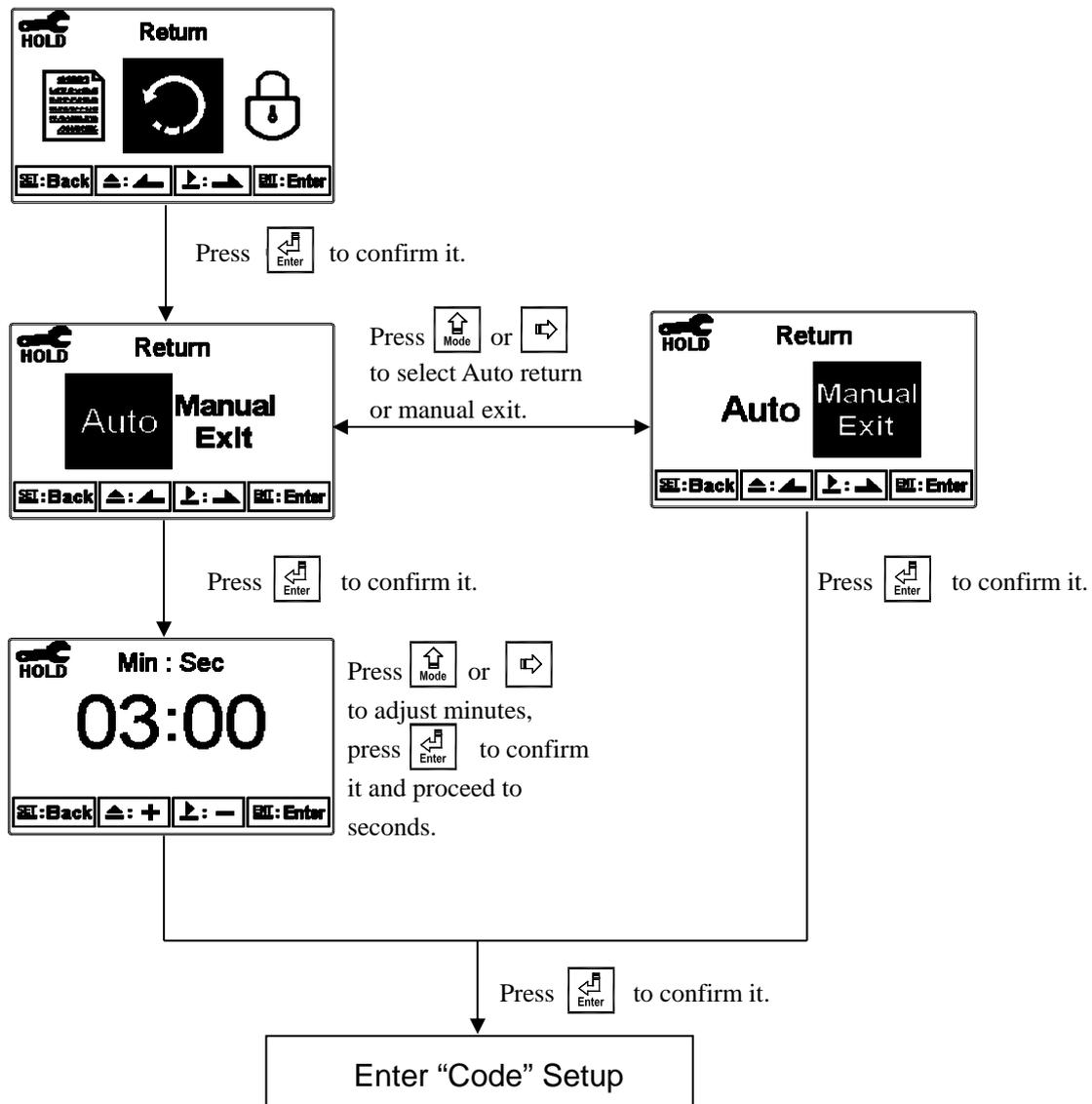
7.17 Logbook

Enter setup of Logbook. It is available for user to look up 50 sets of important events and error diagnosis records. The user can read important events by either by Logbook or Modbus. For detailed definitions of events please see to section 9.2, Modbus Address and Command Table.



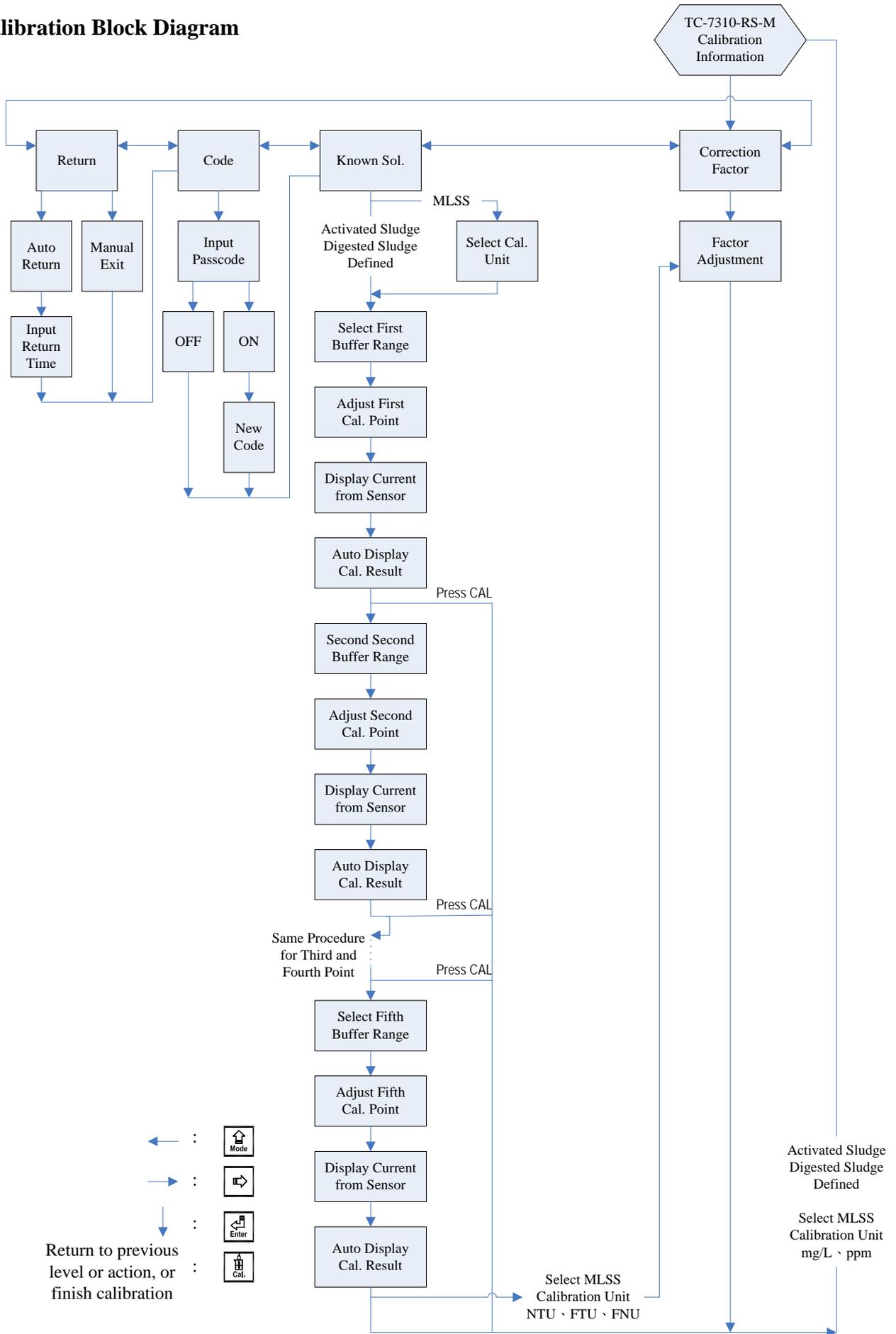
7.18 Automatic Return (Return)

Enter setup of auto return mode “Return” to set the instrument to automatically exit the setup menu after a period of time without pressing any keys. The “Manual Exit” means that it needs to exit setup menu manually, while “Auto” means that the display automatically exits the setup menu and returns to measurement mode after a period of time without pressing any keys.



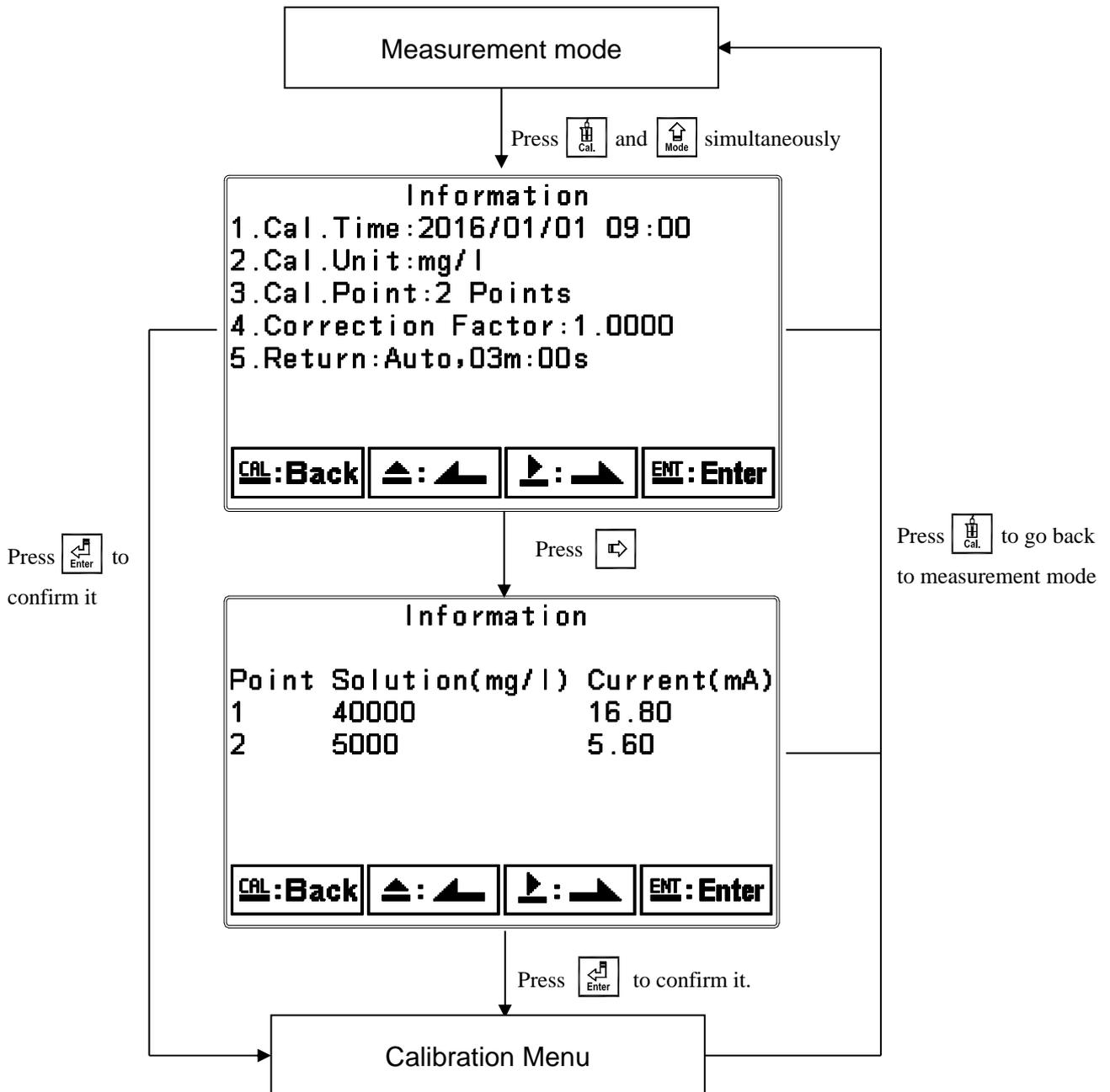
8. Calibration

Calibration Block Diagram



8.1 Calibration Setup Menu

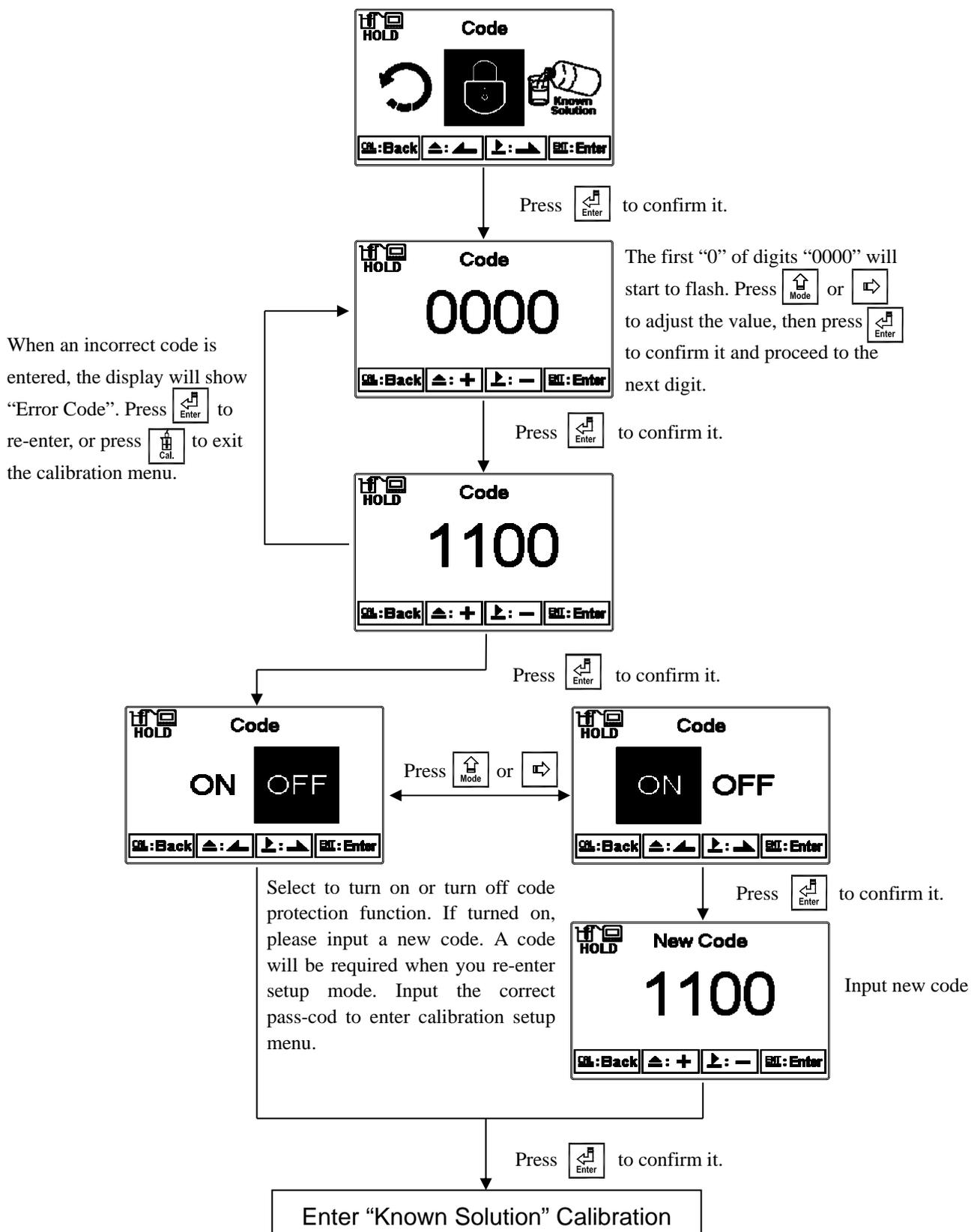
Under measurement mode, press  and  simultaneously to display Calibration Information. If you do not need to re-calibrate the measurement system, press  to return to measurement mode. If you need to re-calibrate the system, press  to enter calibration setup menu. (If the calibration time shows “OFF”, it represents that the clock function has been turned off.)



8.2 Calibration Security Code (Code)

Select the “Code” (passcode) after entering calibration setup mode. Select to activate passcode function.

The preset calibration settings code is 1100.



8.3 Calibration

As each sensor has its unique characteristics, the transmitter is not calibrated to a sensor by default (Cal. Point: No Cal). Calibration procedure must be performed by trained personnel each time a new sensor is connected.

- This instrument provides multi-point standard buffer solution calibration allowing users to decide the number of points to calibrate against.
- When calibrating, users can select the following tables for reference: Activated Sludge, Digested Sludge, or Defined under Mode/Unit in setup mode (see section 7.4, Measurement Mode/Unit).
- During calibration, the reference value is recommended to not exceed 80% of the factory set sensor measuring range (e.g. 40,000ppm for TS-MxS-A sensor)
- For single point calibration, the reference value cannot be 0.
- MLSS standard solution is not easily obtainable. The transmitter uses turbidity standard solution to for MLSS calibration and corrects the measured value according to a correction factor.

8.3.1 Known Solution Calibration

8.3.1.1 MLSS Calibration

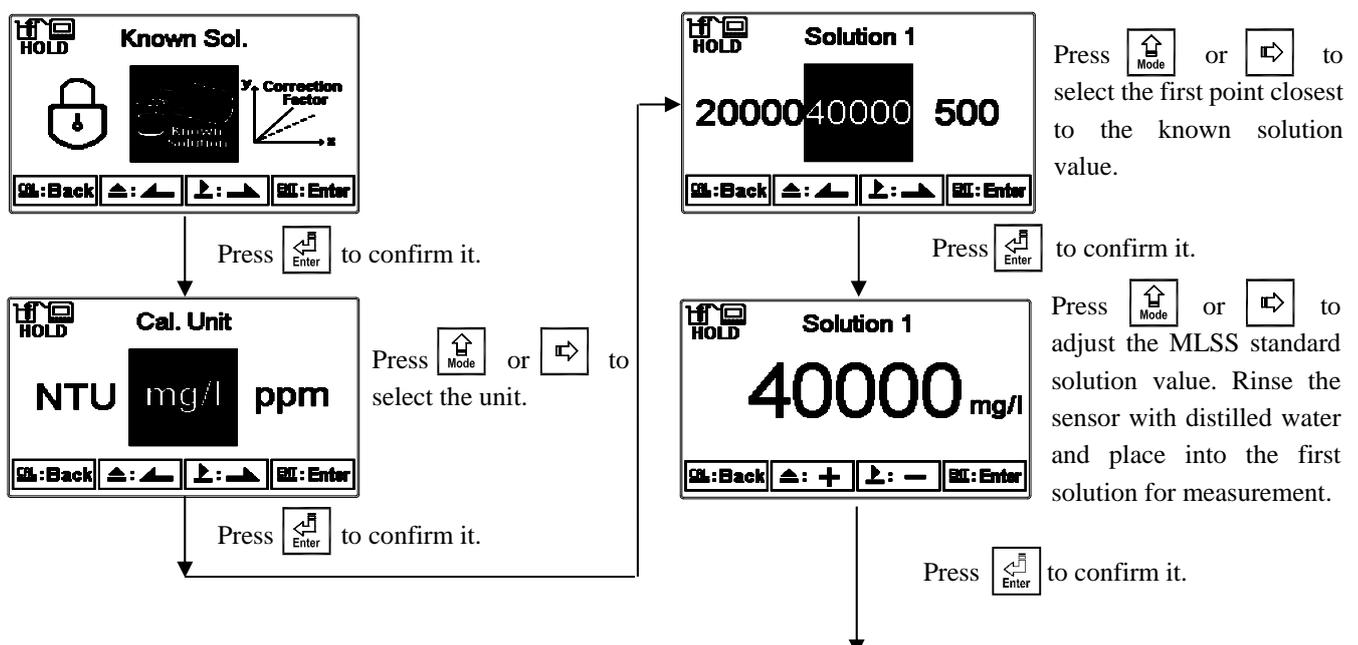
- During calibration, select MLSS unit from: mg/l or ppm
or select Turbidity units from: NTU, FTU, or FNU
- MLSS and Turbidity calibration provides each 5 preset standard solution values for selection:

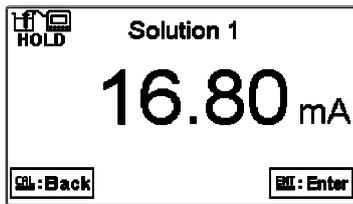
MLSS: 40000, 20000, 10000, 5000, 500.0

Turbidity: 1000, 800, 100, 20.0, 1.00

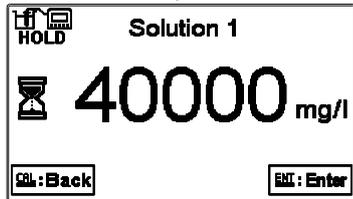
- If a turbidity unit is selected for calibration, the system will proceed directly to correction factor adjustment following standard solution calibration.

MLSS two-point calibration procedure is as follows:

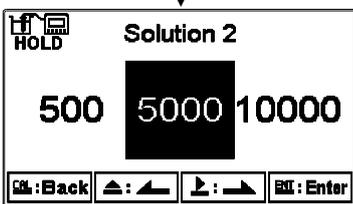




The sensor will display the current received. Wait until the value is stable.

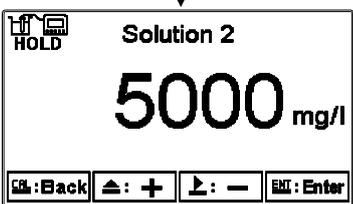


Press to directly display the result or wait for the transmitter to automatically confirm it.



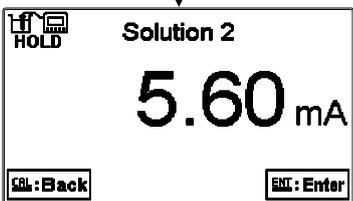
Press or to select the second point closest to the known solution value. Press to complete single point calibration.

Press to confirm it.



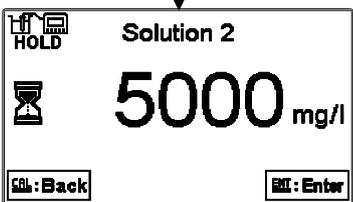
Press or to adjust the MLSS standard solution value. Rinse the sensor with distilled water and place into the second solution for measurement.

Press to confirm it.

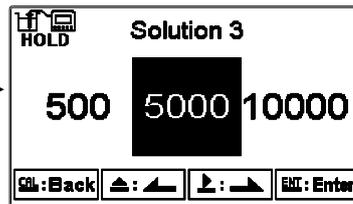


The transmitter will display the current received. Wait until the value is stable.

Press to confirm it.

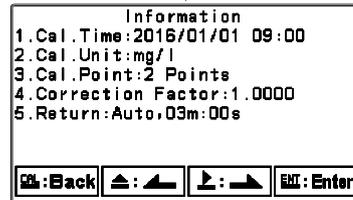


Press to directly display the result or wait for the transmitter to automatically confirm it.



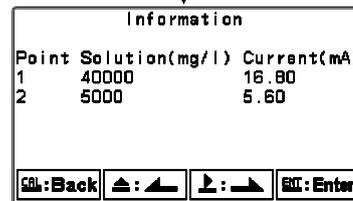
Press to complete two-point calibration and directly display the result. Press to continue and proceed to multi-point calibration

Press to confirm it.



Calibration results overview

Press or to move between pages.



8.3.1.2 Activated Sludge and Digested Sludge Calibration Matrix

- Calibration procedure is identical to MLSS calibration procedure (see section 8.3.1.1, MLSS Calibration). Unit selection is not applicable.
- Calibration unit is set at mg/l.
- 5 preset standard solution values are available for selection: 40000, 20000, 10000, 5000, 500.0.

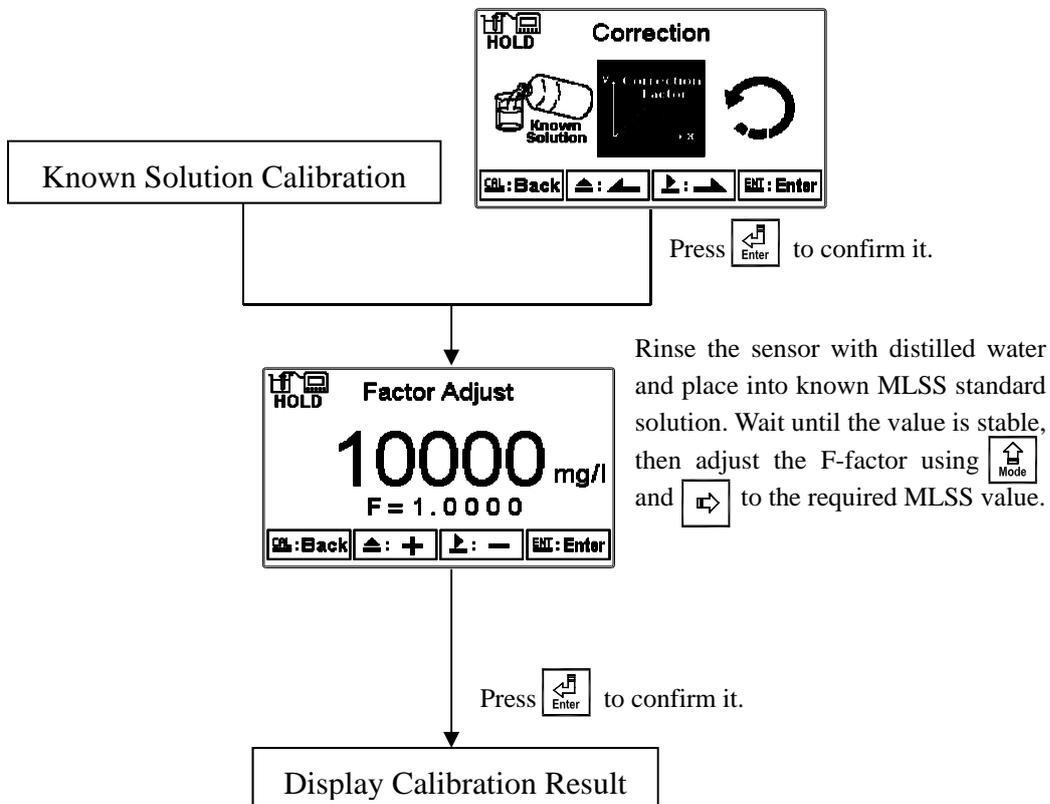
8.3.1.3 Defined Calibration Table

- Calibration procedure is identical to MLSS calibration procedure (see section 8.3.1.1, MLSS Table Calibration). Unit selection is not applicable.
- Select Defined Table under “Mode/Unit” in setup mode (see section 7.4, Measurement Mode/Unit), then select calibration unit, mg/L or ppm.

8.4 Correction Factor

A correction factor needs to be applied when calibrating for MLSS using turbidity standard solutions to correct measured MLSS values.

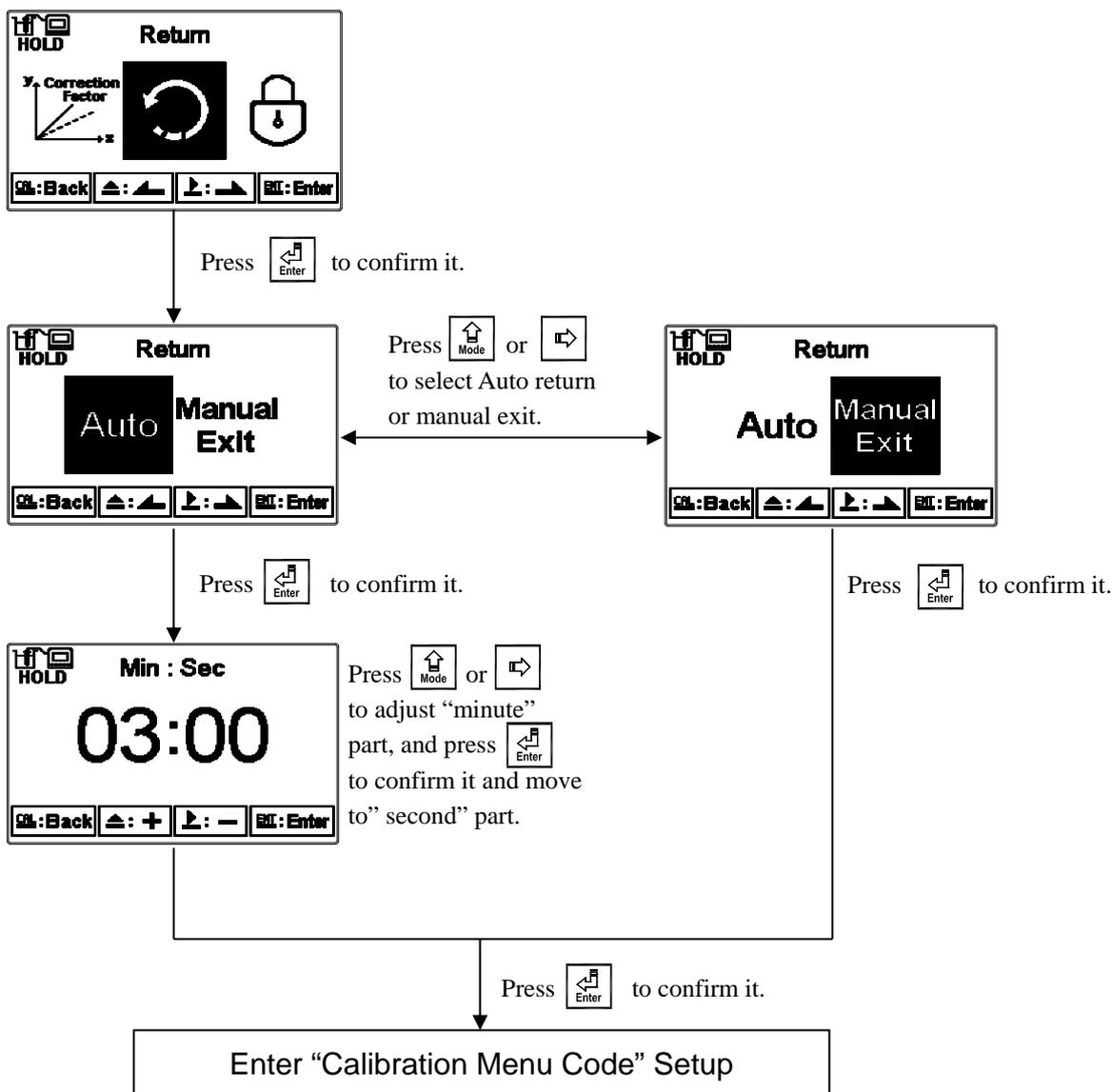
Under MLSS Table calibration mode, select the appropriate turbidity unit (NTU, FTU, or FNU) and calibrate to known standard solutions, then proceed to correction factor adjustment. Users can also directly enter correction factor adjustment screen.



8.5 Automatic Return (Return)

Enter setup of auto return mode (Return) to set the function that the instrument automatically exit the setup menu after a period of time without pressing any key. The “Manual Exit” requires the user to exit calibration menu manually; “Auto” sets the display to automatically exit calibration mode and return to measurement mode after a set time of user inactivity.

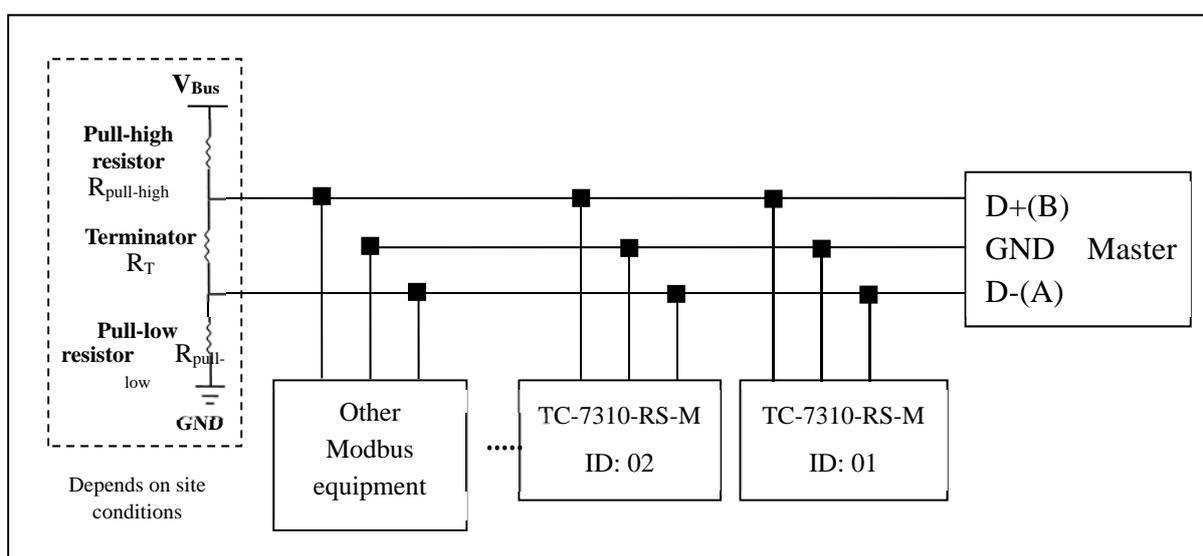
Note: The return function of setup menu and calibration setup menu are independent settings.



9. MODBUS Protocol and Instructions

9.1 Communication Connection

The transmitter's RS-485 communication port features electronic isolation protection, lightning protection, and provides an isolated ground terminal. It is able to connect using standard twisted pair (segregated, double-stranded) cables. The positive connection point D+(B) of all devices are connected together with one strand of the double-stranded twisted-pair cable, and all the negative contacts D-(A) with the other strand; the isolated wire shield must be connected to the ground terminal (GND). In the laboratory, a standalone master-slave communication is relatively simple. Therefore, standard cables can be used. However, for industrial settings, strict engineering construction requirements must be taken into account for proper installation. The wiring diagram is as follows:



Note:

1. The transmitter's RS-485 interface is equipped with a protective ground terminal. When communicating with the RS-485, the ground terminal must be used to eliminate safety risks.
2. Use 120 ohm impedance matching resistors at the signal cable terminals (D+(B) and D-(A)) of the terminal devices to effectively reduce or eliminate signal reflection.

Note: Three common causes of connection failures:

- a. Open circuits: the signal cable has an open circuit.
- b. Short circuits: there is insufficient insulation between signal cables causing a short circuit.
- c. Idle-bus: there is no data transmission in the Controlbus.

The three conditions above can cause an unknown state of the Controlbus voltage, leading to the receiver receiving unexpected signals. Therefore, in complicated setups like multi-transmitter connections, the Controlbus requires a terminating resistor to avoid baud rate reflection, in addition to biasing circuits composed of pull-high and pull-low resistors, and voltage source (V_{Bus}). As seen in the diagram above, make sure the signal cable terminals D+(B) and D-(A) has free voltage in between to keep the signals complete. Some systems may not be suitable for a fixed resistor and V_{Bus} ,

therefore users will need to be more aware of the settings. Some equipment parts (RS-485 converters or modules) provide terminating, pull-high, pull-low resistors, and VBus settings. Please refer to the corresponding operation manuals before installation and connection. For VBus, the standard is 5 V, for pull-high and pull-low resistors, 1 K Ω , and for terminating resistors, 120 K Ω .

3. Without repeaters, the RS-485 network cannot exceed a maximum of 32 nodes. The maximum transmission communication distance for RS-485 is up to 1200 meters. For long distance transmission, it is recommended to use cables that are specifically design for RS-485.
4. When communicating, all equipment within the network should be consistently kept in the same transfer mode, baud rate, and parity. All devices must be under different addresses to prevent conflicts within the network communications.
5. The transmitter's Modbus command can only access 50 registers. Abnormal information will be returned if the maximum length is exceeded.
6. The idle time in which a slave instrument responds to a master machine is different according to each model. Generally, the time needed should be longer than 0.5 seconds (some models may require a longer waiting-responding time, please note if the operation manual specifies).

9.2 MODBUS Name and Address Table

Modbus response table is as follows. As users communicate with transmitters through PLC or Man-machine Interface, check to see if the transmission of address subtracts 1 by default. If so, add 1 onto each address to match the table; e.g. for MLSS measurement logic address 0035H (16-bit) or 53 (10-bit), if there is a minus 1 output signal proceeded by PLC or Man-machine Interface, users must input 0036H (16-bit) or 54 (10-bit) to match the appropriate logic address.

Function Code : 03H, 06, 10H Modbus response (setup parameter)

Logic Address	R/W	Item	Number of Bytes	Information Type	Description of Data Transmission	Default Value	Note
0000H		None					
0001H	R	Equipment's ID	2	USHORT	1-247	1	
0002H	R	Transmitter Model	6	USHORT	ASCII Code	TC7310	
0005H	R	Communication Protocol	2	USHORT	0: RTU	0	
					1: ASCII		
0006H	R	Serial Transmission Speed (Baud Rate)	2	USHORT	0: 2400	3	
					1: 4800		
					2: 9600		
					3: 19200		
0007H	R	Parity	2	USHORT	0: None	1	
					1: Even		
					2: Odd		
0008H	R/W	Real-Time Clock*	12	USHORT	Second	2016-01-01 00:00:00	
0009H				USHORT	Minute		
000AH				USHORT	Hour		
000BH				USHORT	Day		
000CH				USHORT	Month		
000DH				USHORT	Year		
000EH	R/W	Code Setting*	2	USHORT	Code setting	1111	
000FH	R/W	Reserved					
0010H	R/W	Clean relay*	2	USHORT	0: OFF	0	
				USHORT	1: AUTO		
0011H			2	USHORT	ON.S: 0-5999	0	Second
0012H			2	USHORT	OFF.H: 0-999	0	Hour
0013H			2	USHORT	OFF.M: 0-59	0	Minute
0014H	2	USHORT	Hys.S: 0-9999	0	Second		

0015H	R/W	Relay 1 *	2	USHORT	0: OFF	1	
					1: AUTO		
0016H			2	USHORT	0: AUTO	0	
					1: Lo		
0017H	4	FLOAT	SP1	40000 mg/l	Data affected by sign byte		
0019H	4	FLOAT	Hys1	10 mg/l			
001BH	R/W	Relay 2 *	2	USHORT	0: OFF	1	
					1: AUTO		
001CH			2	USHORT	0: Hi	1	
					1: Lo		
001DH	4	FLOAT	SP2	10000 mg/l	Data affected by sign byte		
001FH	4	FLOAT	Hys2	10 mg/l			
0021H	R/W	Backlight Brightness*	2	USHORT	0: AUTO	2	
					1: ON		
					2: OFF		
0022H			2	SHORT	2: Highest Brightness	0	
					1: High Brightness		
	SHORT	0: Standard	-1: Low Brightness				
	SHORT	-2: Lowest Brightness					
0023H	R/W	Backlight Sensitivity*	2	SHORT	2: Highest Sensitivity	0	
					1: High Sensitivity		
					0: Standard		
					-1: Low Sensitivity		
					-2: Lowest Sensitivity		
0024H	R/W	Sample average of measurements	2	USHORT	1-60	5	
0025H	R/W	Product Adjustment	4	FLOAT	-10000~10000 mg/l	0	
0027H	R/W	Wiper*	2	USHORT	0 : MANUAL	0	
					1 : AUTO		
0028H	R/W	Event Number*	2	USHORT	1~50	1	
0029H	R	Event Time	12	USHORT	Second		

002AH	R			USHORT	Minute	2016-01-01 00:00:00	
002BH	R			USHORT	Hour		
002CH	R			USHORT	Day		
002DH	R			USHORT	Month		
002EH	R			USHORT	Year		
002FH	R	Event ID	2	USHORT	0~12	0	
0030H	R/W	Wiper Act. Time Interval	2	USHORT	Minute	9	

Note 1: Actions without * only supports function code 03H. Actions with * supports function code 03H, 06H, 10H.

Note 2: FLOAT is a 32-bit IEEE 754 format. The above table, as an example, is divided into two 16-bit register data transmissions. The second 16-bit register (00 00) will be transferred first, followed by the first 16-bit register (41 C8). Every 16-bit format is high-bit in the front and low-bit in the back. For example, if the temperature now is 25.1°C, the 16-bit of FLOAT data (hexadecimal) will be 41 C8 00 00. The transmission order will be 00 00 41 C8. For detailed description, please refer to section 9.3, Modbus example description.

Note 3: USHORT represents unsigned short integer.

Note 4: Event Logbook ID

If the user requires Modbus to retrieve information from the logbook, 0028H must be input first before reading 0029H~002F corresponding event. Logbook ID #1 represents the newest recorded event, ID #2 represents the last recorded event, and so on.

Event	Definition	Modbus ID #
Mea mode	Measurement Mode	00
Set mode	Setup Mode	01
Cal mode	Calibration Mode	02
Power On	Power on	03
Power Off	Power off	04
ppm_mA Over	Current over range	05
mg/l_mA Over	Current over range	06
Error 2	Slope over range	07
Error 3	Calibration value not stable	08
Error 4	Cannot identify standard solution	09
Error 5	Incorrect passcode	10
Error 6	Electrode not connected or not working	11
Modbus Write	Modbus input action	12

Function Code: 03H Modbus response (measurement parameter)

Logic address	R/W	Item	Number of Byte	Information type	Description of data transmission	Default value	Note
0031H	R	Measurement status	2	USHORT	0: Hold status	1	
					1: Measurement status		
0032H	R	Sign byte	6	CHAR	ppm	mg/l	ASCII code
					mg/l		
0035H	R	MLSS measurement	4	FLOAT	MLSS measurement		
0037H-0050H	Factory reserved						

Function Code: 01H Modbus response (dispersion parameter)

Logic address	Item	BIT	Description	Default value	Note
0070H	LO Alarm	1	Contact on	0 (Contact off)	
0071H	Hi Alarm	1	Contact on	0 (Contact off)	
0072H	MA too high	1	Contact on	0 (Contact off)	
0073H	MA too low	1	Contact on	0 (Contact off)	
0074H	Factory reserved				
0075H	Exceed MLSS range	1	Contact on	0 (Contact off)	
0076H	RLY1 Action *	1	Contact on	0 (Contact off)	
0077H	RLY2 Action*	1	Contact on	0 (Contact off)	
0078H	Clean Action*	1	Contact on	0 (Contact off)	
0079H-008FH	Factory reserved				

9.3 Modbus Description Example (e.g.: function code 03H)

The following description uses MLSS reading 0035H as an example. If the MLSS is 25 mg/l, confirm that the host and sub-machine communication format settings are correct. The host sends request commands according to the left column of the table below, then receives a corresponding response from the sub-machine according to the right column. This example shows the function code 03H as transmission data format; for other function codes, the same logic applies.

ASCII Mode:

Request		Response	
Message Framing	Hex	Message Framing	Hex
ID, Address	01	ID, Address	01
Function code	03	Function code	03
Starting Address Hi	00	Byte Count	04
Starting Address Lo	35	Register value Hi	00
No. of Registers Hi	00	Register value Lo	00
No. of Registers Lo	02	Register value Hi	41
LRC	C5	Register value Lo	C8
		LRC	56

RTU Mode:

Request		Response	
Message Framing	Hex	Message Framing	Hex
ID, Address	01	ID, Address	01
Function code	03	Function code	03
Starting Address Hi	00	Byte Count	04
Starting Address Lo	35	Register value Hi	00
No. of Registers Hi	00	Register value Lo	00
No. of Registers Lo	02	Register value Hi	41
CRC Check Lo	0D	Register value Lo	C8
CRC Check Hi	45	CRC Check Lo	65
		CRC Check Hi	5A

Note: FLOAT is a 32-bit IEEE 754 format. The above table is divided into two 16-bit register data transfers. The back 16-bit register (00 00) is transferred first, followed by the front 16-bit register (41 C8). Every 16-bit format is high-bit in the front and low-bit in the post. For example, if the MLSS reading is now 25 mg/l, the 16-bit of FLOAT data (hexadecimal) is 41 C8 00 00. However, the transmission order will be 00 00 41 C8.

10. Error Messages (Error Code)

Messages	Reason	Dispositions
Error2	Slope exceeds the upper or lower limit	Please check if the standard solution has been re-used during the calibration or is expired.
Error3	The readout is unstable during calibration	1. Please check and clear electrode glass end of air bubbles, maintain or replace electrode and make another calibration.
Error4	Standard solution cannot be recognized	1. Please replace and use new standard solution. 2. Maintain or replace electrode and make another calibration.
Error5	Incorrect passcode ERROR CODE	Re-enter passcode.
Error6	No sensor connection or sensor failure	1. Please check if the sensor is connected to the instrument. 2. Maintain the electrode or replace a new electrode, and make another calibration.
Error9	Serious error that does not permit any further measurements	Please call service engineer.

11. Maintenance

Under normal operation and conditions, the transmitter does not need additional maintenance other than scheduled cleaning and calibration of the electrode to ensure accurate and stable measurements.

Appendix

Table 1: Activated Sludge (TSS-SiO₂ I)

SiO ₂ [mg/l]	610	1370	2600	3220	3910
Total suspended solids [mg/l] (Activated sludge value)	250	770	2400	3390	4420
SiO ₂ [mg/l]	4860	5850	6520	7050	7160
Total suspended solids [mg/l] (Activated sludge value)	6210	8800	11620	15550	17570

Table 2: Digested Sludge (TSS-SiO₂ II)

SiO ₂ [mg/l]	320	1130	1730	3190	4280
Total suspended solids [mg/l] (Digested sludge value)	410	1480	2370	5260	9970
SiO ₂ [mg/l]	5000	5600	6260	7160	7620
Total suspended solids [mg/l] (Digested sludge value)	14900	20700	32000	59400	100000

Note: Above two matrix tables are only applicable for municipal wastewater.



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