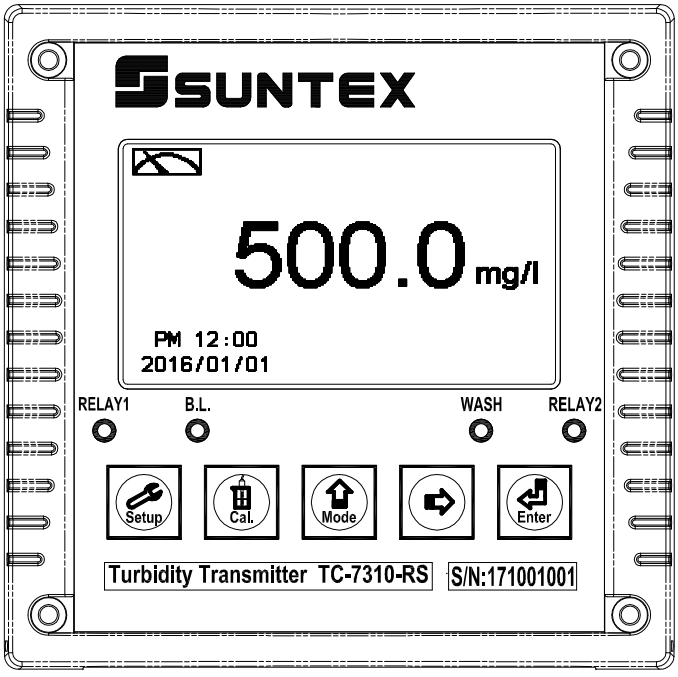
TC-7310-RS Intelligent Turbidity/S.S. Transmitter

Operation Manual



SUNTEX

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 3.5 "Electrical Connection Illustration")
- 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.

CONTENTS

Precautions for Installation

Brief Instructions 1

1. Specifications 4

2. Assembly and Installation

2.1 Transmitter Installation 5

2.2 Panel Mounting Illustration 5

2.3 Wall Mounting and Pipe Mounting Illustration 6

3. Overview of Turbidity/S.S. Transmitter TC-7310-RS

3.1 Rear Panel Illustration 7

3.2 Terminal Function Illustration 7

3.3 Terminal Function Description 8

3.4 Cable Wiring 8

3.5 Electrical Connection Illustration 9

4. Configuration

4.1 Front Panel Illustration 10

4.2 Keypad 10

4.3 LED Indicators 10

5. Operation

5.1 Measurement Mode 11

5.2 Setup Menu 11

5.3 Calibration Menu 11

5.4 Shortcuts 11

5.5 Default Values 11

5.5.1 Settings Default Values 11

5.5.2 Calibration Default Values 12

6. Measurement Display Mode

6.1 Text Mode 13

6.2 Real-Time Chart Mode 14

6.3 Trace Mode 15

6.4 Warning Symbols and Text 16

7. Settings

Settings Block Diagram 17

7.1 Setup Menu 19

7.2 Settings Security Code (Code) 20

7.3 Language 21

7.4 Measurement Mode/Unit (Mode) 22

7.5 Product Adjustment 24

7.6 Relay 1 25
7.7 Relay 2 26
7.8 Wiper 27
7.9 Electrode Zero 28
7.10 Clean 39
7.11 Analog Output 30
7.12 Date/Time (Clock) 31
7.13 RS-485 Communication 32
7.14 Sample Measurement Average (Digital Filter) 33
7.15 Backlight 34
7.16 Contrast 35
7.17 Logbook 36
7.18 Automatic Return (Return) 37
8. Calibration
Calibration Block Diagram 38
8.1 Calibration Setup Menu 39
8.2 Calibration Security Code (Code) 41
8.3 Calibration 42
8.3.1 Known Solution Calibration 42
8.4 Correction Factor 45
8.5 Automatic Return (Return) 46
9. MODBUS Protocol and Instructions
9.1 Communication Connection 47
9.2 MODBUS Name and Address Table 49
9.3 MODBUS Description Example 53
10. Error Messages (Error Code) 54
11. Maintenance 54

Brief Instructions

Description of Setup Settings (See Chapter 7 for Details)

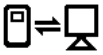
Press Setup and Mode simultaneously to see the overview of the setup settings. Then press Enter to modify setup settings. Press keypad according to the index bar on the bottom of the screen.

Index of Keypad

Keypad	Index Bar	Description
Setup	SET:Back	Return to previous level or action
Mode	▲:◢	Left or left page
	▲:+	Increase digit
⇨	▶:◢	Right or right page
	▶:−	Decrease digit
Enter	ENT:Enter	Confirm and proceed to next step

Setup Items

Function	Icon	Description
Mode		Measurement mode 1. Select from TC-100, TC-500, TC-3000, or TCS-1000 electrodes. 2. Select display mode from text, real-time or trace mode. 3. Measuring unit selection ● TC-100, TC-500, TC-3000: NTU, FNU, or FTU. ● TCS-1000: 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 Turbidity/SS setting range
Clock		Time and date settings (An internal battery keeps the clock running when disconnected from power. Replace with 3V CR2025/2032 lithium battery.)
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

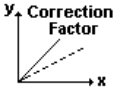
Description of Calibration Settings (See Chapter 8 for Details)

Press [Cal.] and [Mode] simultaneously to see the last calibration information. Press [Enter] 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
Cal.	CAL:Back	Return to previous level or action
Mode	▲: ◢	Left or left page
	▲: +	Increase digit
⇨	▶: ◢	Right or right page
	▶: −	Decrease digit
Enter	ENT: Enter	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 correction factor (applicable for Turbidity and SS measurement value interconversion)
Code		Calibration mode security passcode
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**
Measuring Mode		Turbidity/Suspended Solids
Measuring Unit		Turbidity: NTU, FTU, FNU
		Suspended Solids: mg/l, ppm
Measuring Range		0~100 NTU (TC-100 sensor) 0~500 NTU (TC-500 sensor) 0~3000 NTU (TC-3000 sensor) 0~1000 ppm (TCS-1000 sensor)
Resolution		0.01 NTU (TC-100 sensor) 0.1 NTU (TC-500 sensor) 1 NTU (TC-3000 sensor) 0.1 ppm (TCS-1000 sensor)
Calibration Mode		Turbidity or S.S. standard 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 (Turbidity/S.S. 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 30min per wipe (TC-100 sensor), or 10 min per wipe (TC-500, TC-3000, TCS-1000 sensor)
		Manual, setting from 2~29 min per wipe(TC-100), or 2~9 min per wipe
Voltage Output		DC±12V
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.

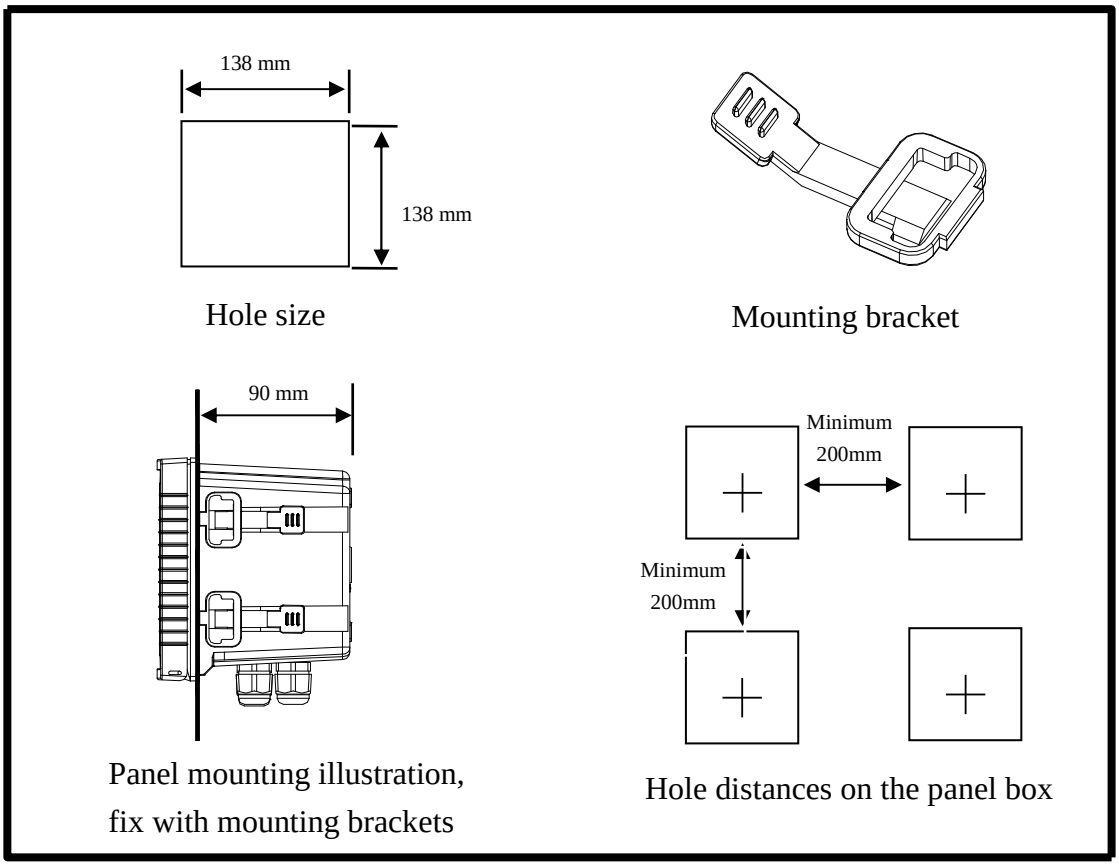
2. Assembly and Installation

2.1 Transmitter Installation

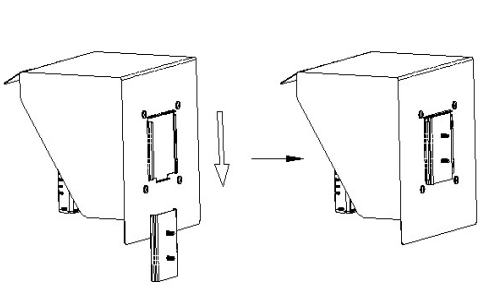
The transmitter can be installed by panel mounting, wall mounting, or 2” pipe mounting.

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.

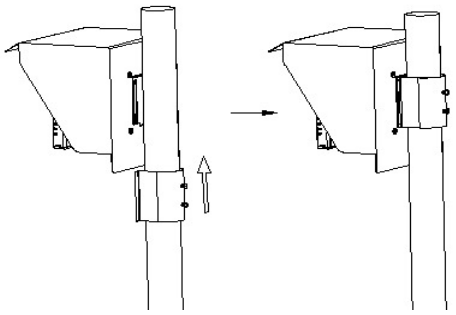
2.2 Panel Mounting Illustration



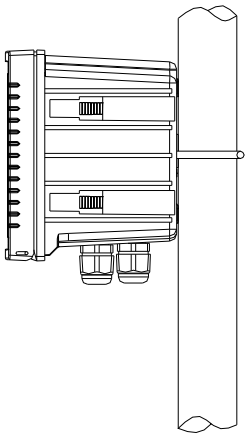
2.3 Wall Mounting and Pipe Mounting Illustration



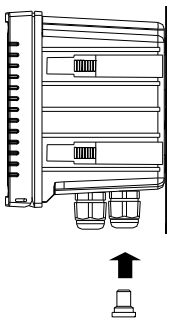
Sun Shield (wall mounting, optional)
(Order No.: 8-35 + 8-35-2)



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



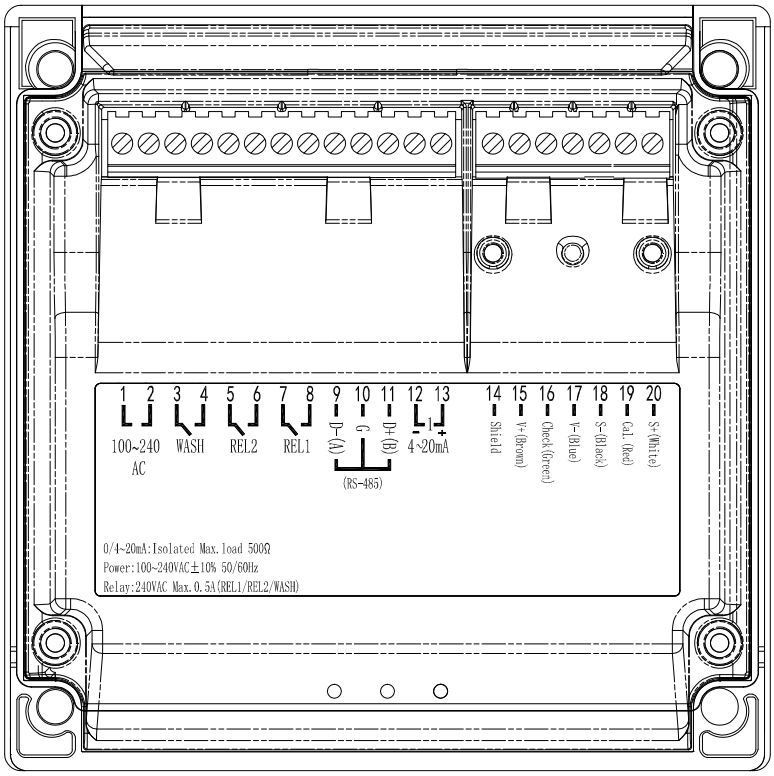
Pipe mounting illustration, fix with a U-shaped pipe clamp (optional).
(Order Number: 8-34)



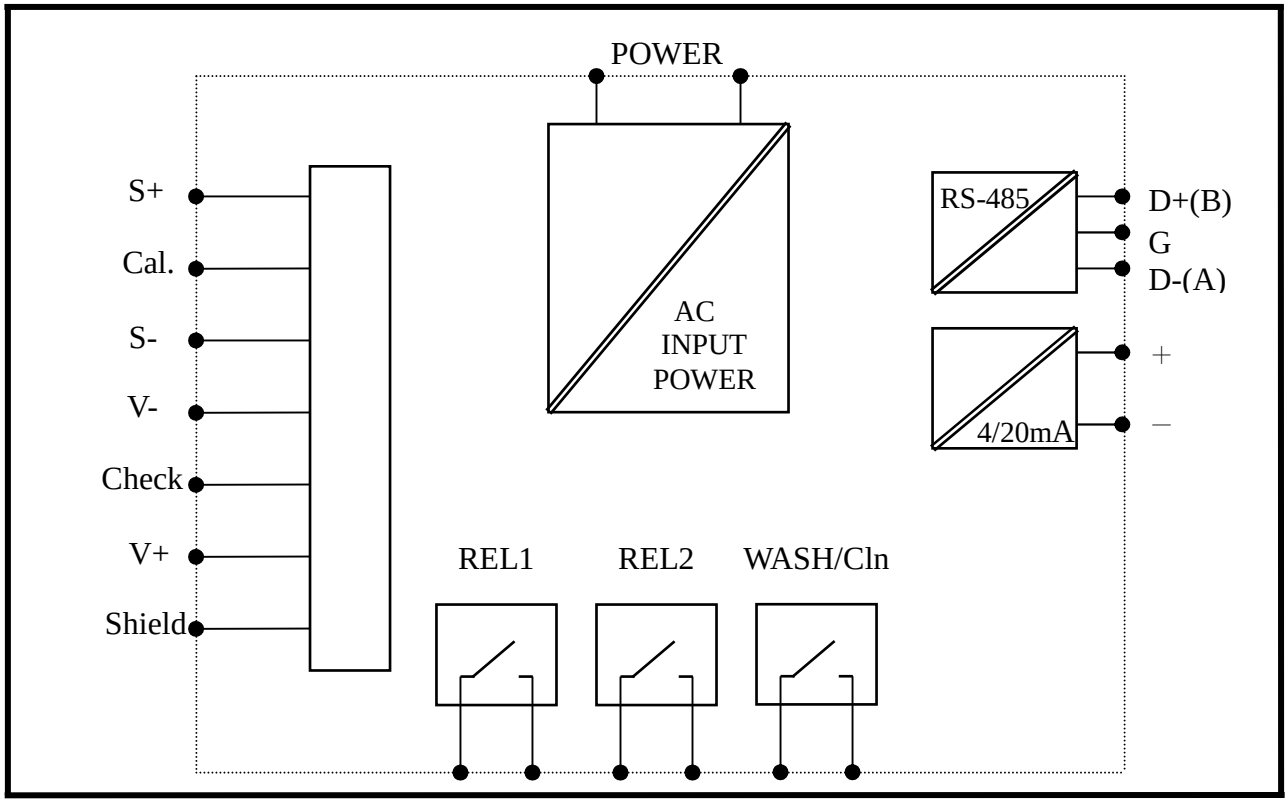
Insert rubber plug into unused cable glands. Tighten up the cable gland to prevent water vapor infiltration.

3. Overview of Turbidity/S.S. Transmitter TC-7310-RS

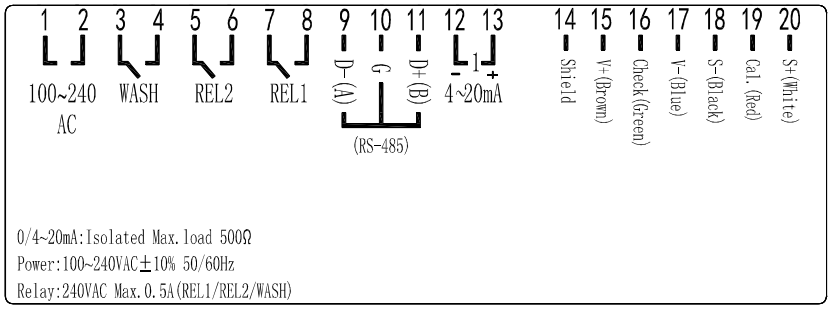
3.1 Rear Panel Illustration:



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:** Turbidity/SS current output terminal -, for an external recorder or PLC control

13 —— **4~20mA +Terminal:** Turbidity/SS 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)

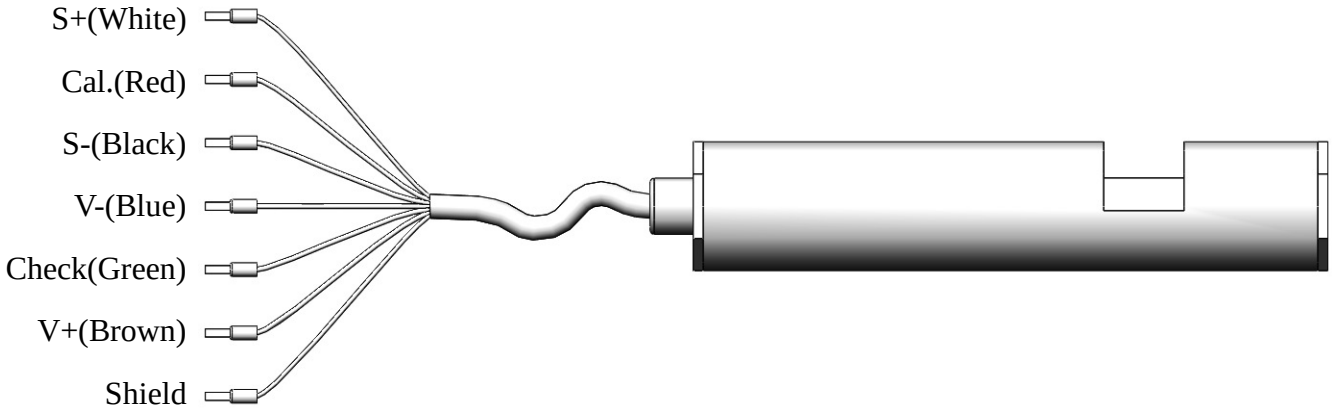
17 —— **V- :** BLUE sensor wire (power - terminal)

18 —— **S- :** BLACK sensor wire (signal - terminal)

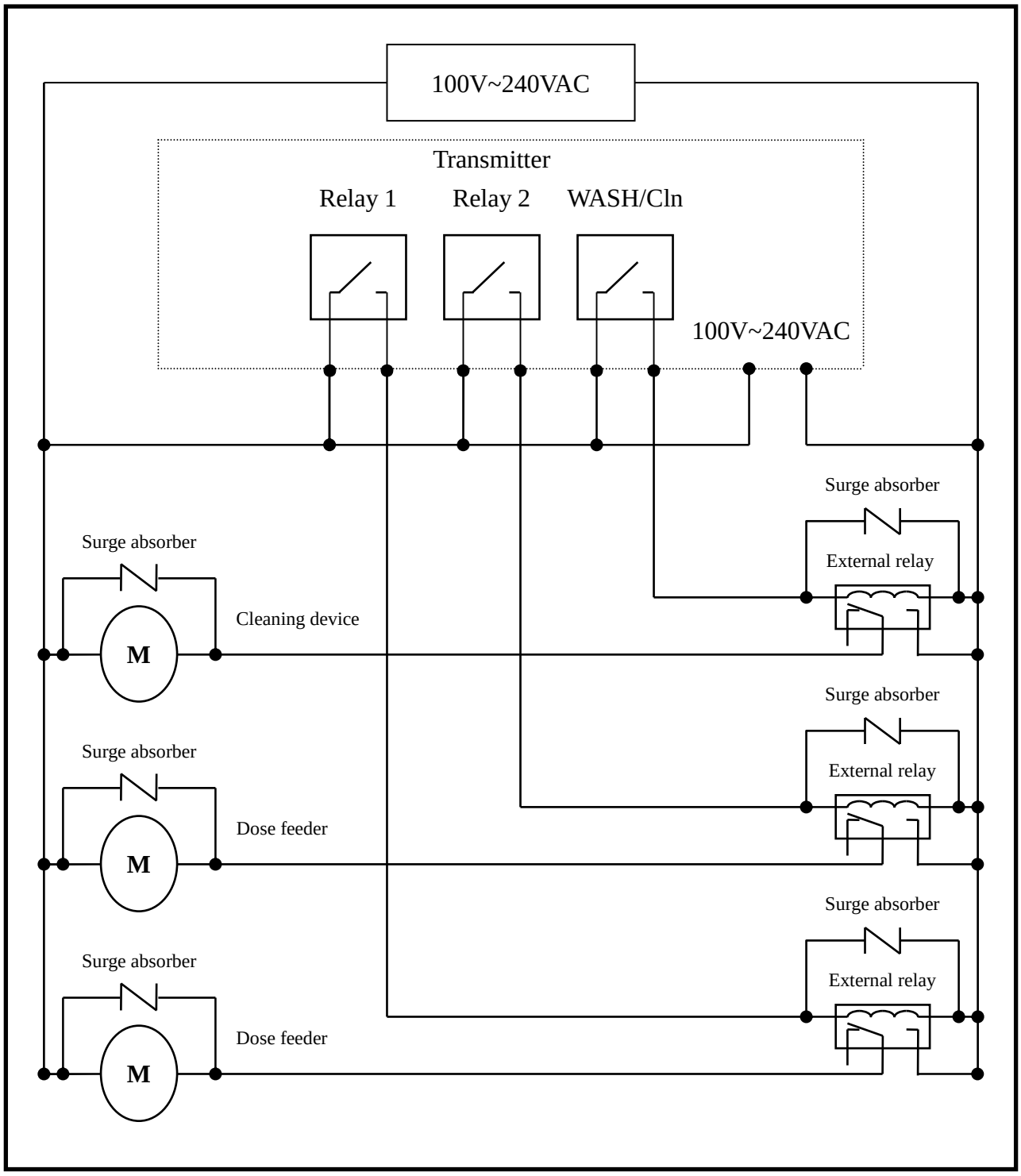
19 —— **Cal. :** RED sensor wire (calibration signal input terminal)

20 —— **S+ :** WHITE sensor wire (signal + terminal)

3.4 Cable Wiring



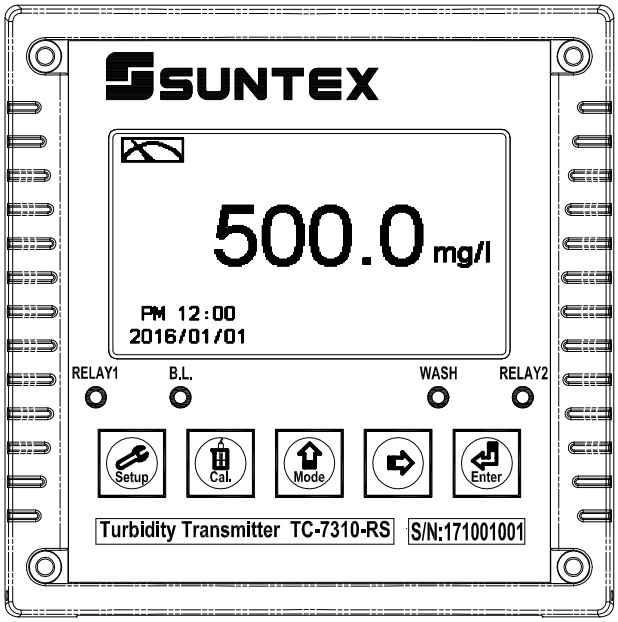
3.5 Electrical Connection Illustration



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 [Setup] and [Mode] simultaneously to enter set-up menu, and press [Setup] to return to measurement mode.

5.3 Calibration Menu:

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

5.4 Shortcuts:

1. Under measurement mode, press and hold [Setup] for 2 seconds to enter Logbook function. Press [Setup] to return to measurement mode.

2. Under measurement mode, press and hold [Enter] 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: TCS-1000
Measuring unit: mg/l
Product adjustment: 0.0 mg/l
Relay 1: High point alarm: AUTO, SP1=800.0 mg/l, Hys = 10.0 mg/l
Relay 2: Low point alarm: AUTO, SP2= 200.0 mg/l, Hys = 10.0 mg/l
Wash time: OFF
Wiper: Manual, 9 minute/per wipe
Analog current output: 4~20 mA, 0.0~1000.0 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:

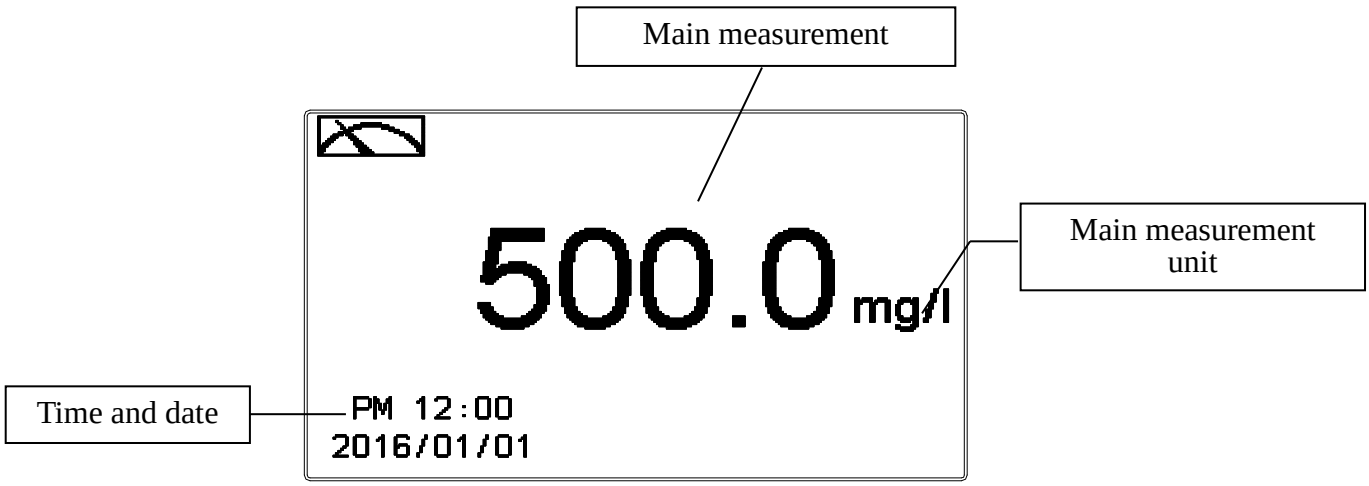
Calibration unit: mg/l
Calibration point: No Cal.
Correction factor: 1.0000
Auto return: Auto, 3 minutes
Code settings: OFF

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

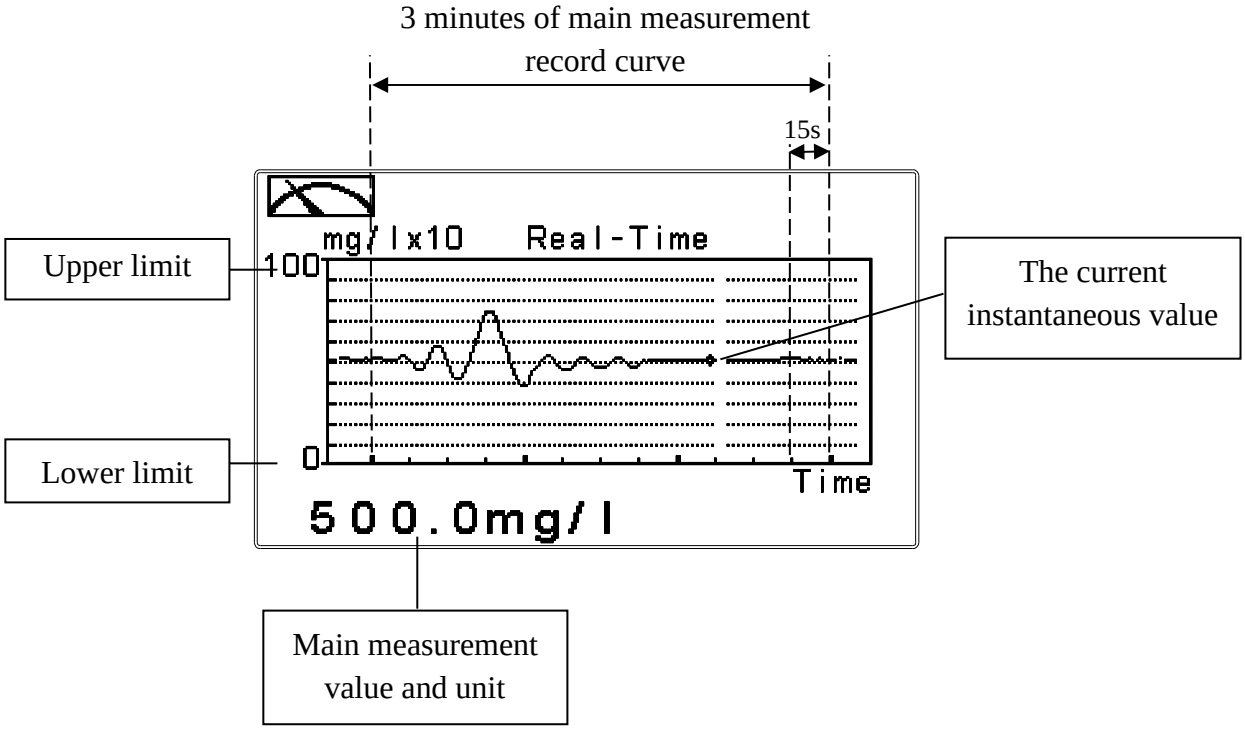
6.1 Text Mode

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 Turbidity/SS 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).

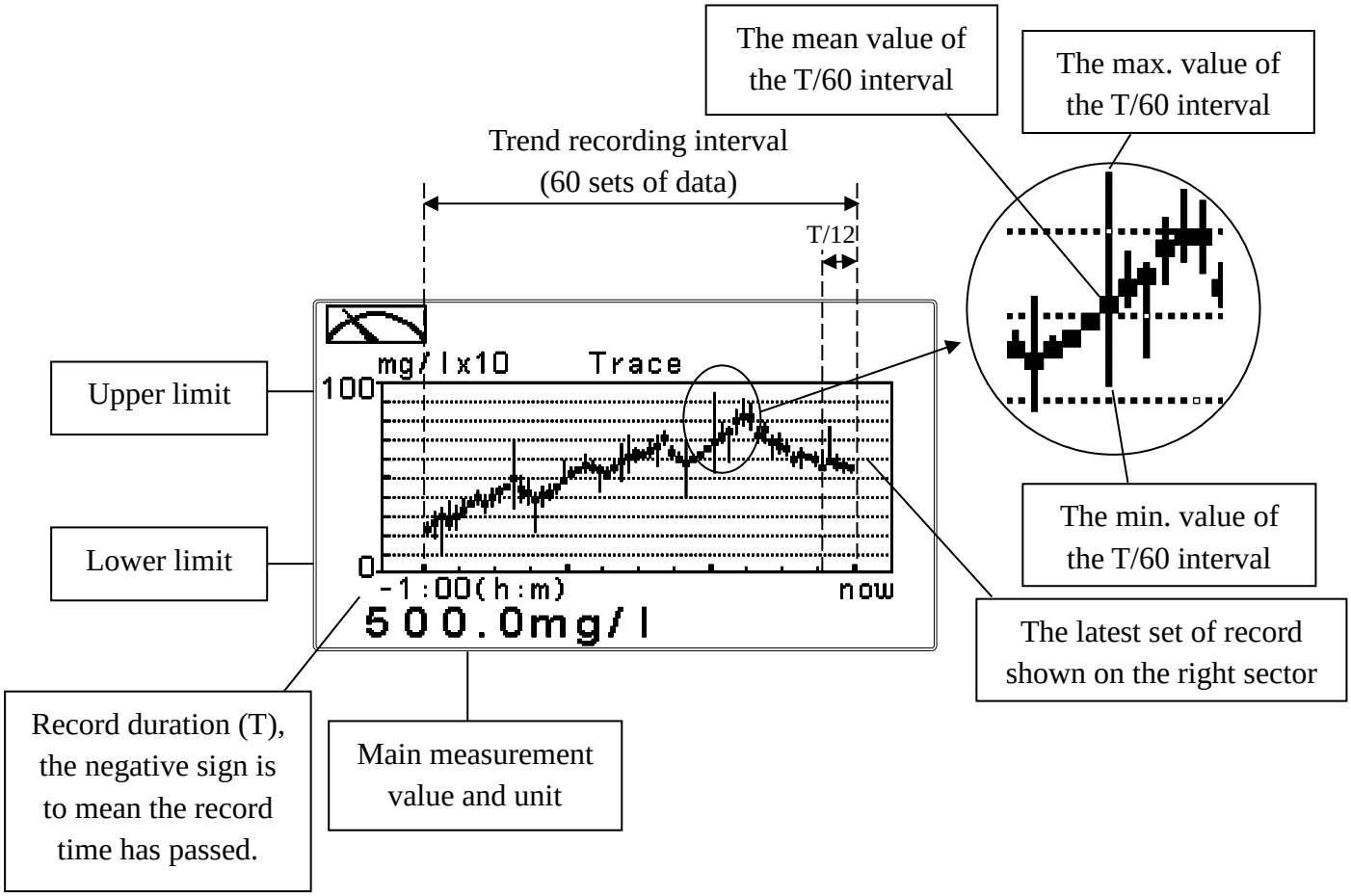


6.3 Trace Mode

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 Turbidity/SS graph range under Mode in Settings (see section 7.4). The smaller the range, the higher 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.

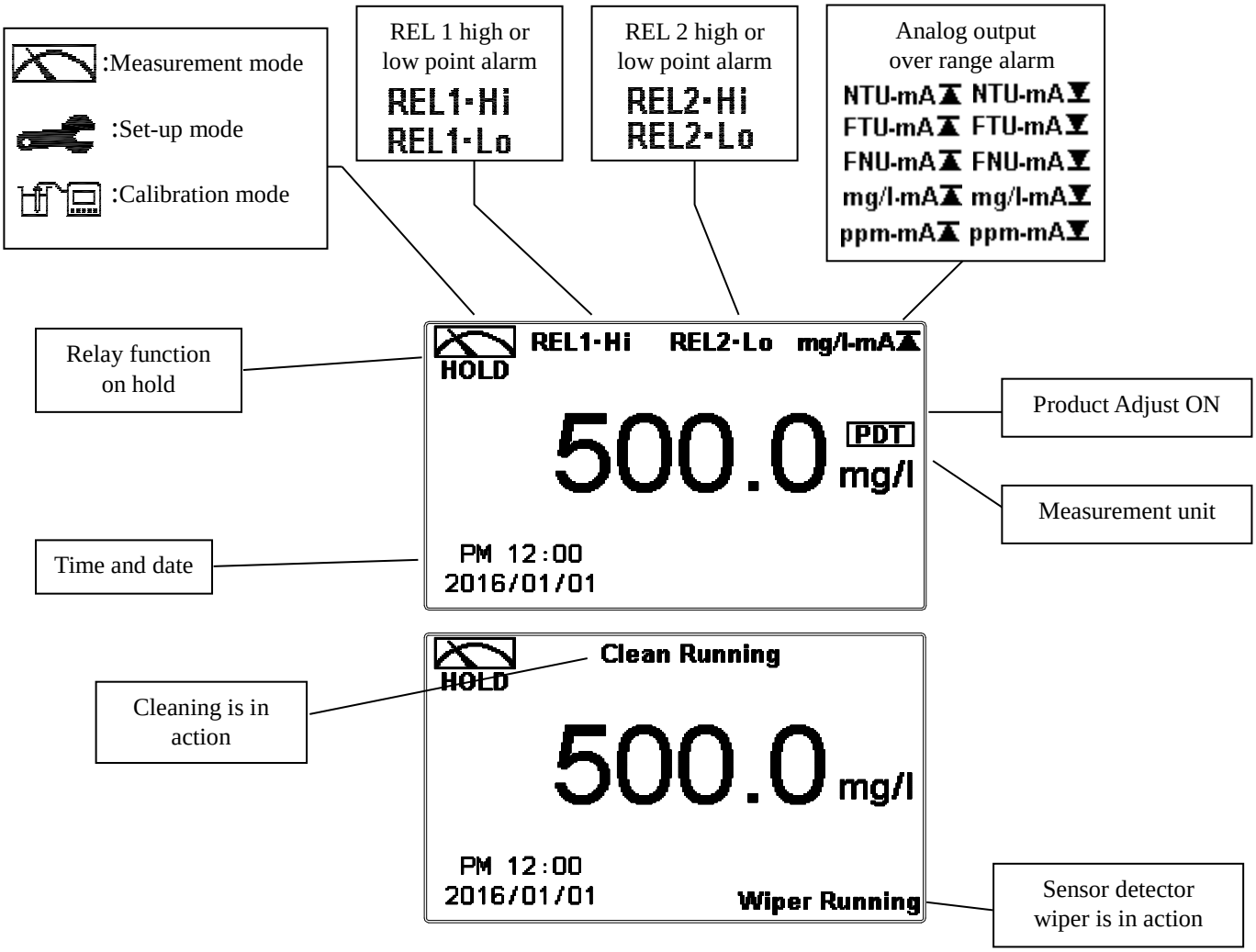
Attention: If the time interval is reset, the trend in the data will not be retained, and will start a new trace record.

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 limit, the display will flash “mg/l-mA▲ /mg/l-mA ▼, or ppm-mA ▲ / ppm-mA▼

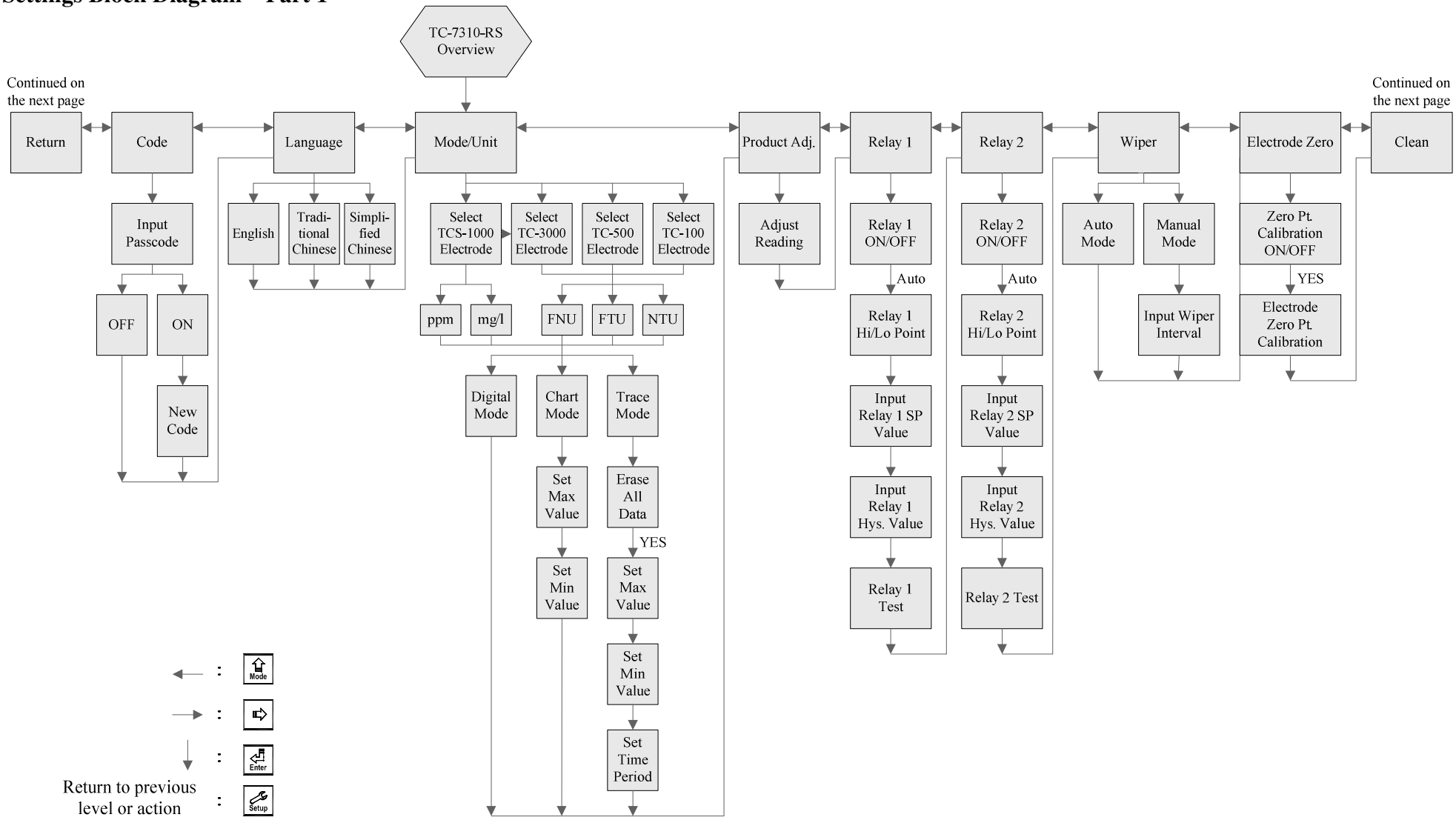


Note: The “HOLD” warning text appears when clean function is activated, or when in setup menu, or in calibration menu. Under HOLD status, the corresponding display and output are as follows:

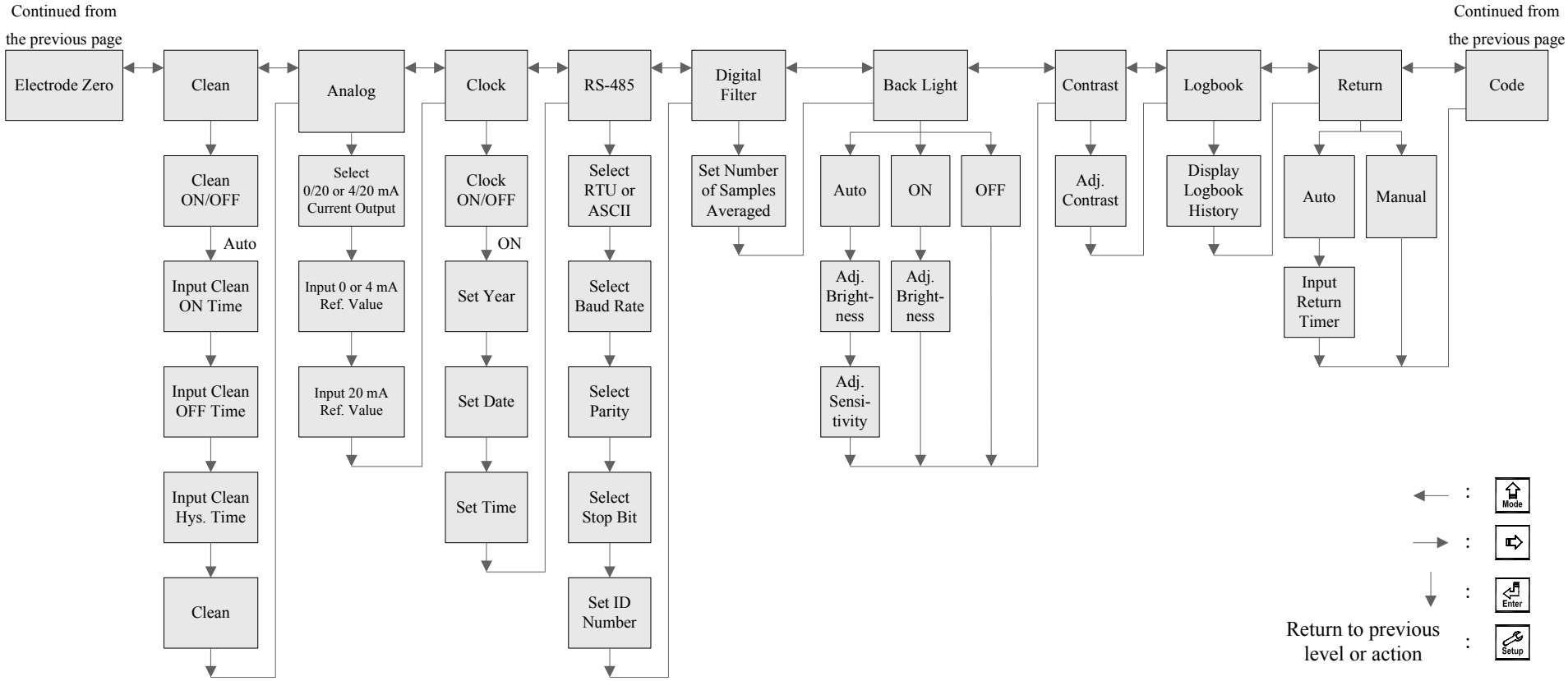
1. Both Relay 1 and Relay 2 will cease from action. When entering settings menu or calibration menu under cleaning status, the instrument will automatically halt the cleaning action.
2. The current output corresponding to measurement value remains at the last output value before HOLD status.
3. The last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

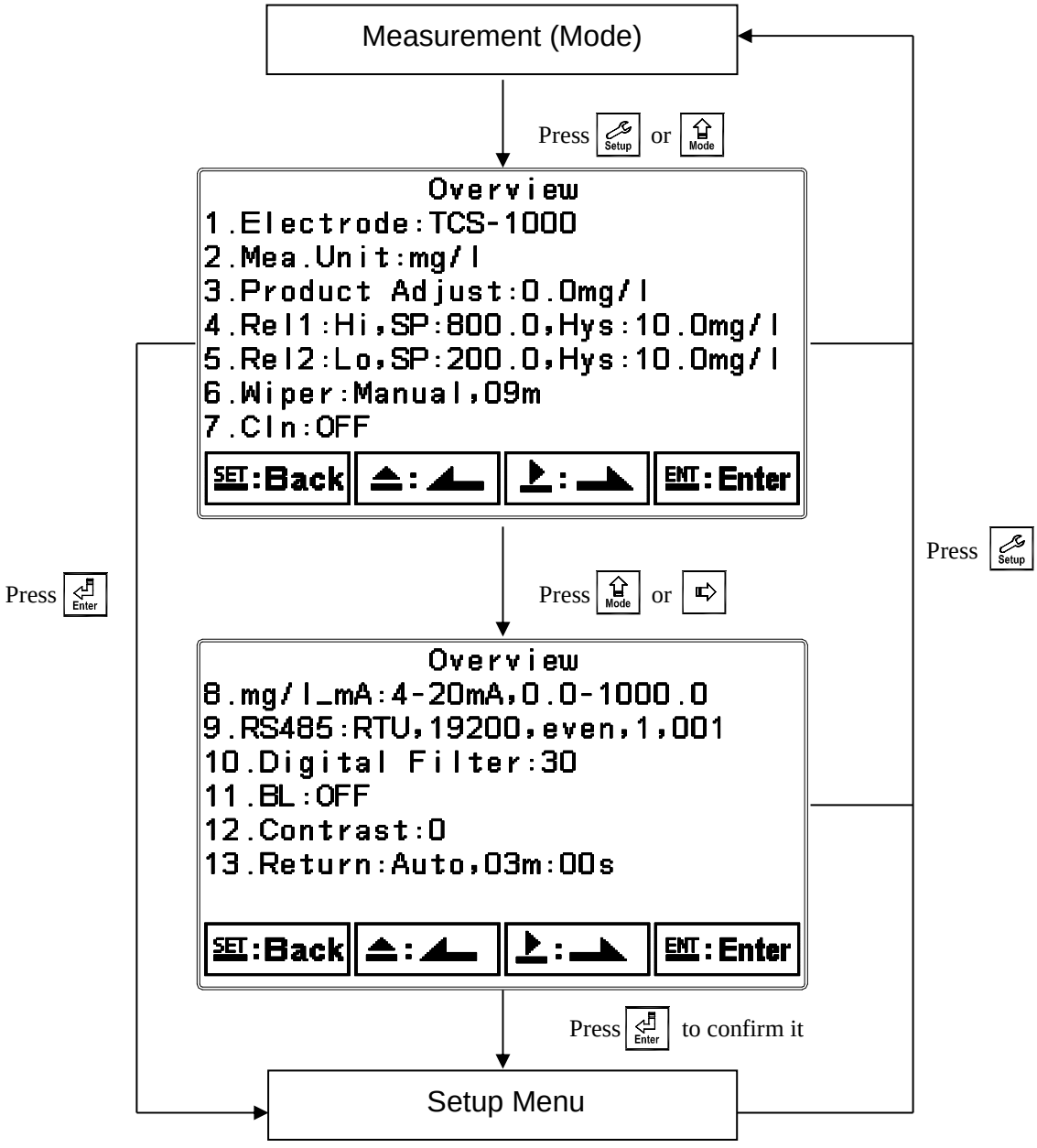


Settings Block Diagram – Part 2



7.1 Setup Menu

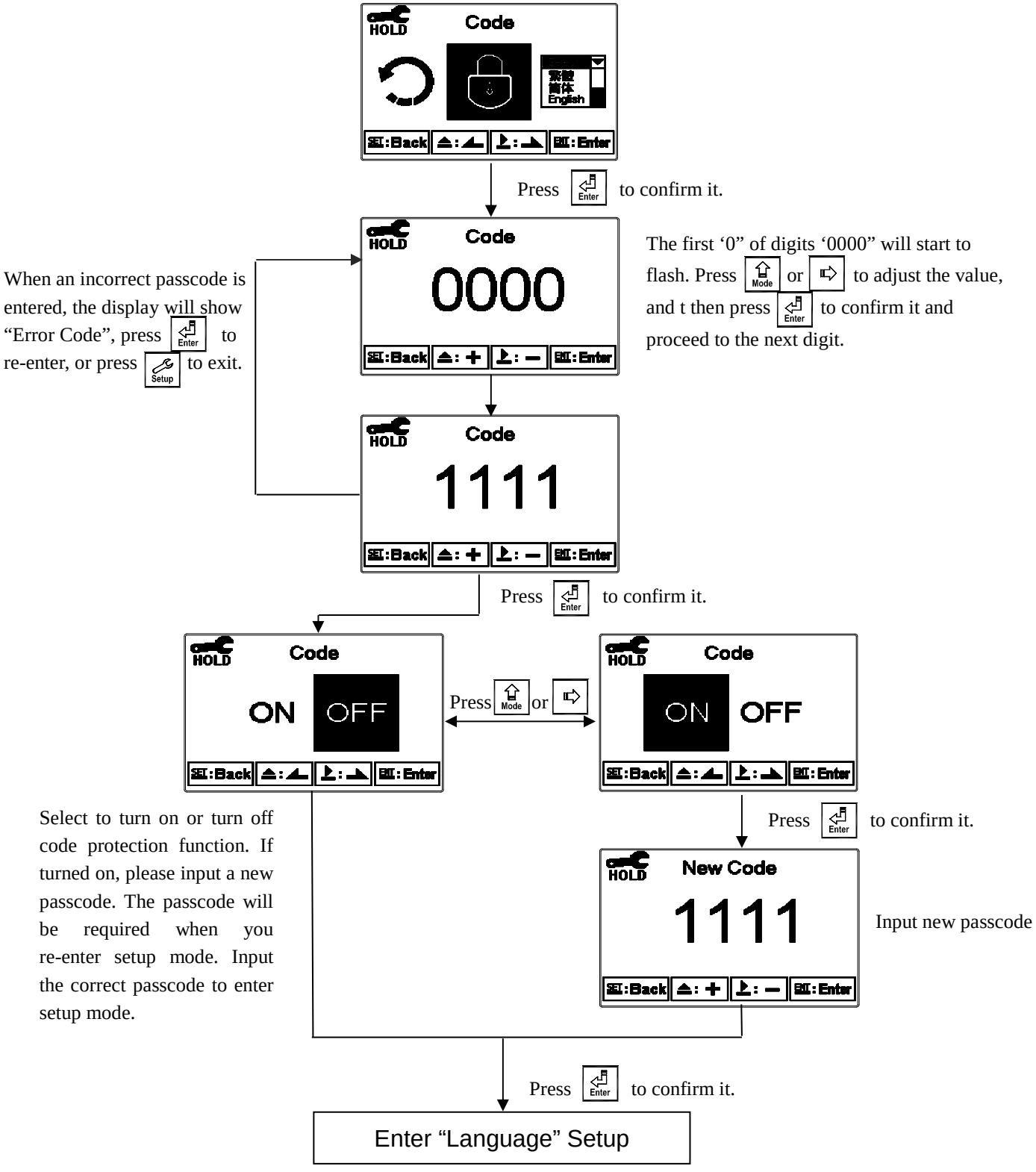
Under measurement mode, press the two keys Setup and Mode simultaneously to enter the current settings overview. Press Enter to enter setup mode to modify the settings if necessary.



7.2 Settings Security Code (Code)

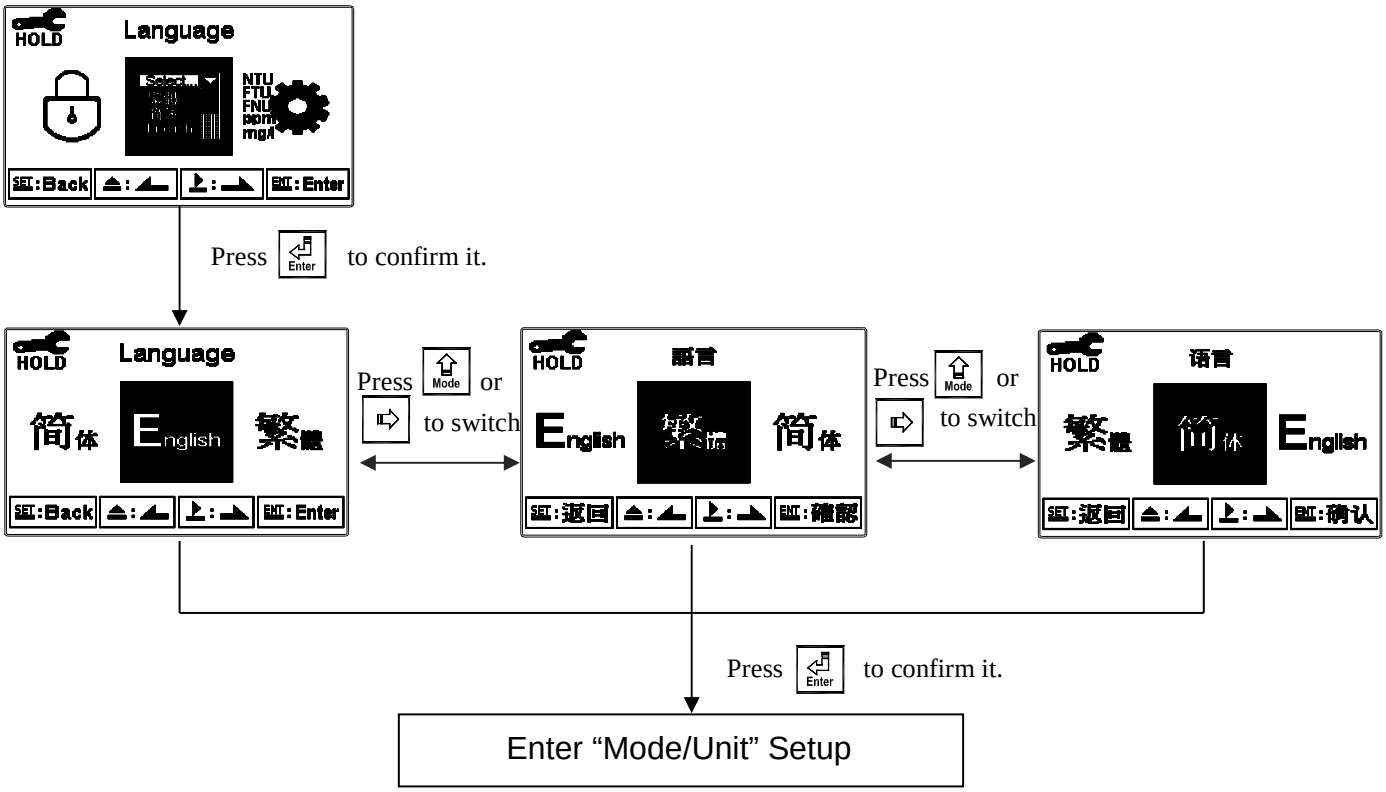
After entering setup mode, select “Code” and press [Enter] to enter code setting procedure. **The preset settings code is 1111.**

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 Enter to enter system language selection. Select from English, Traditional Chinese or Simplified Chinese.

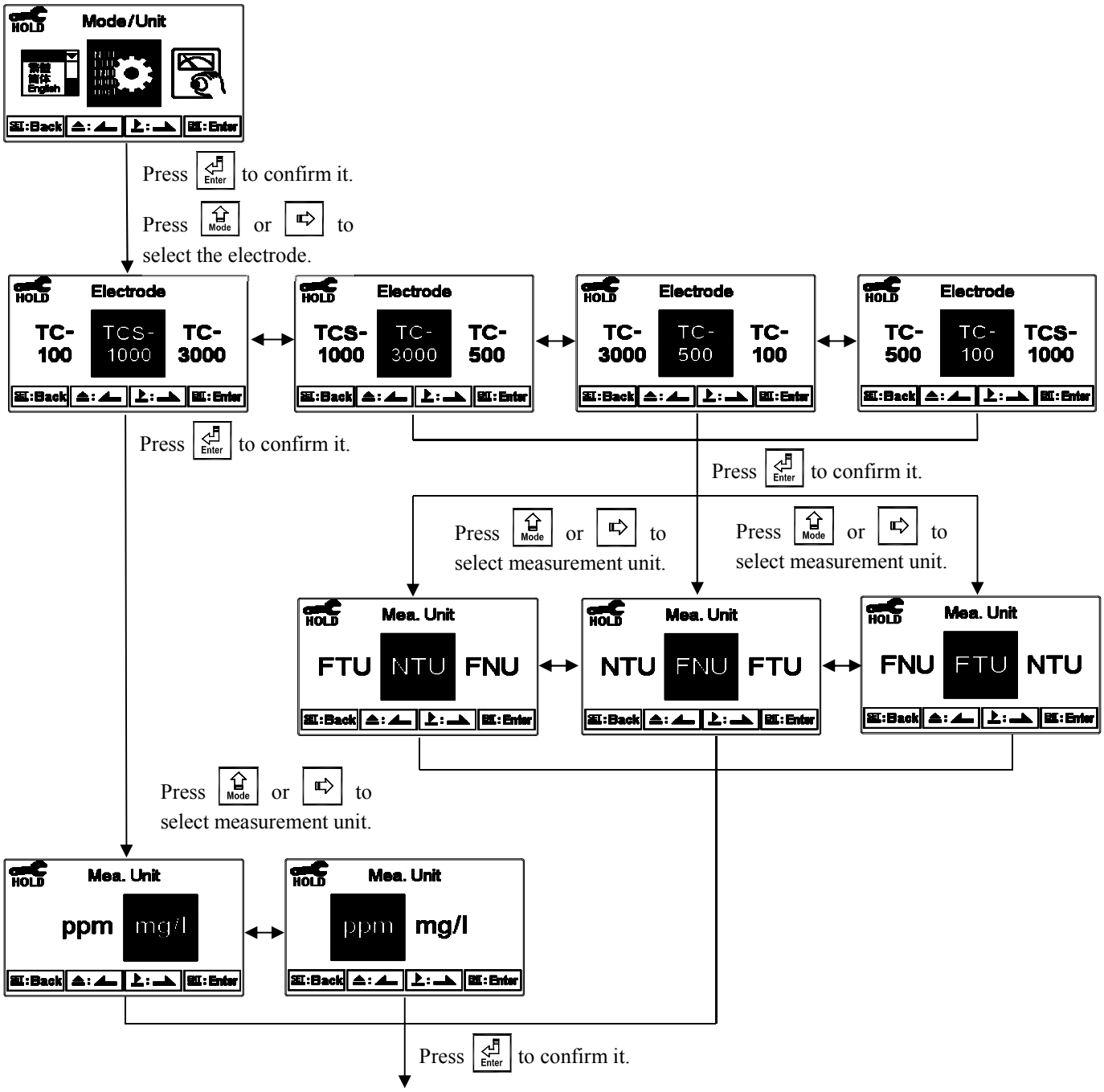


7.4 Measurement Mode/Unit (Mode/Unit)

After entering setup mode, select "Mode/Unit" and press Enter to configure measurement settings: reference table, unit, and display mode.

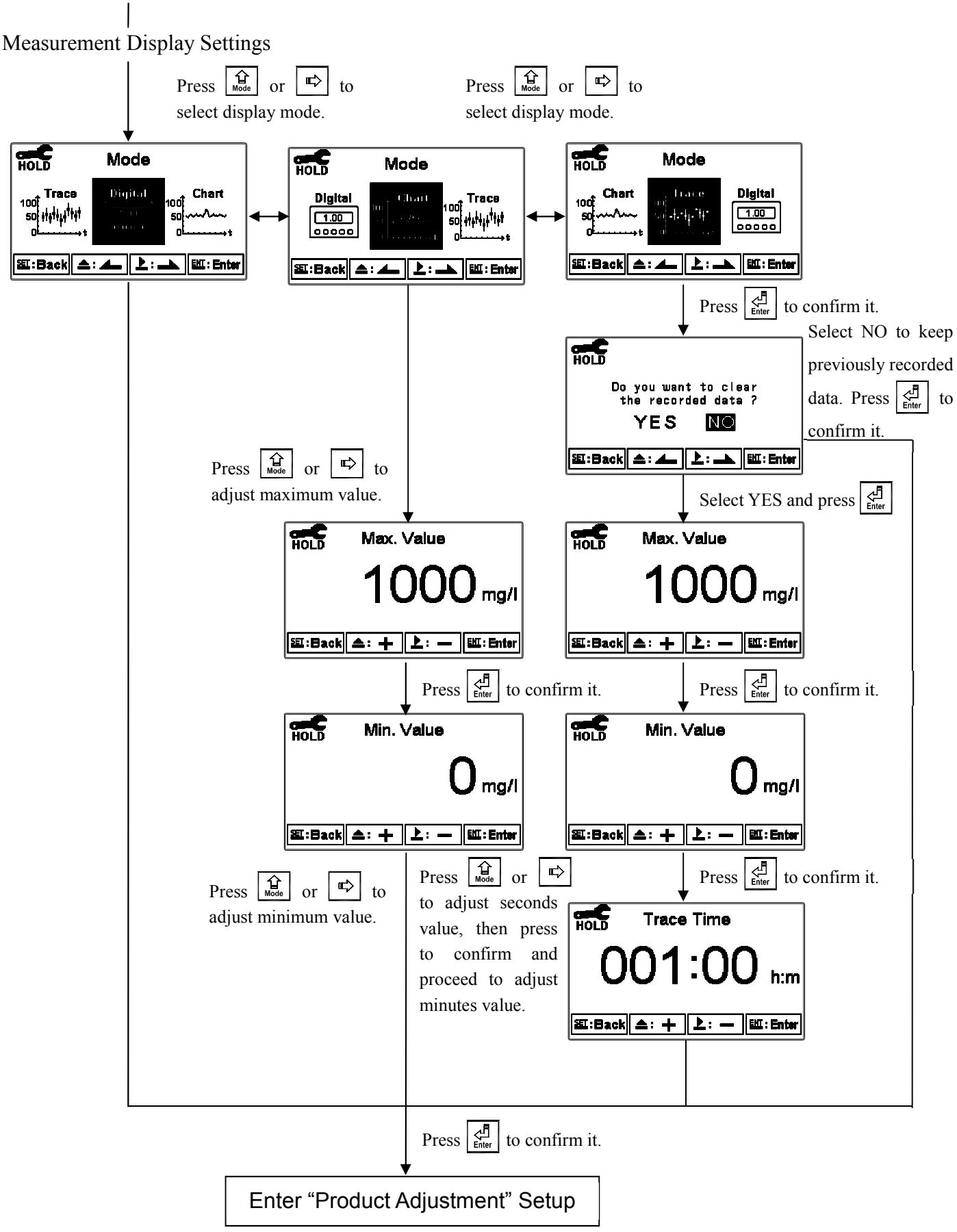
For TC-100, TC-500, TC-3000 electrodes, selectable modes: NTU, FTU, FNU.

For TCS-1000, selectable modes: mg/l, ppm.



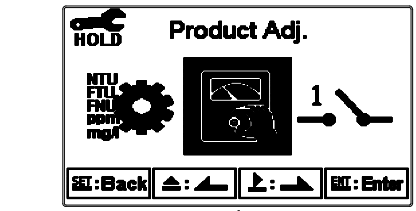
(continued on next page)

Measurement Display Settings

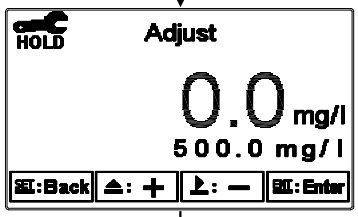


7.5 Product Adjustment

After entering setup mode, select “Code” and press [Enter] 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 pH unit if the product is adjusted (see section 6.4).



Press [Enter] to confirm it.



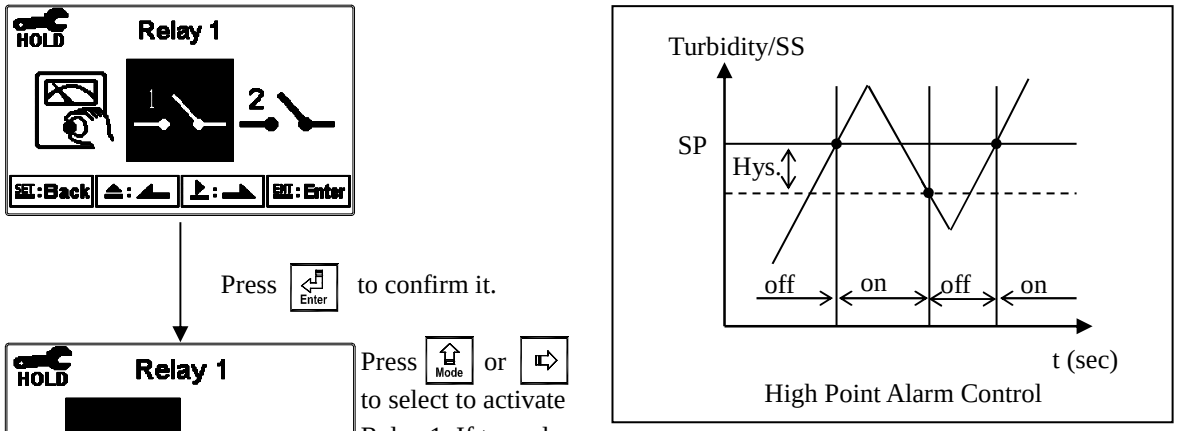
Users may compare the measurement reading with the reference value. Press [Mode] or [→] to tune the adjustment value in the main display in order to modify the reading of measurement which will show in the bottom part of display.

Press [Enter] to confirm it.

Enter “Relay 1” Setup

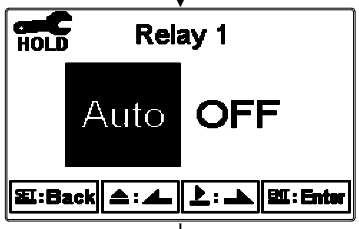
7.6 Relay 1

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 of the parameters (for high point alarms).



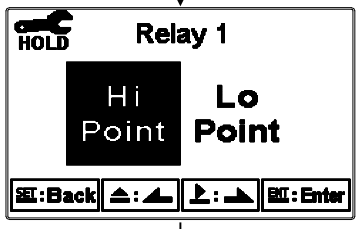
High Point Alarm Control

Press Enter to confirm it.



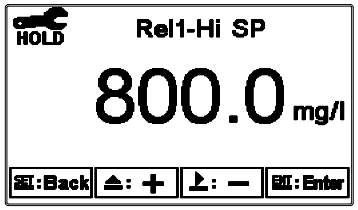
Press Mode or to select to activate Relay 1. If turned off, the menu will proceed to setup of Relay 2.

Press Enter to confirm it.



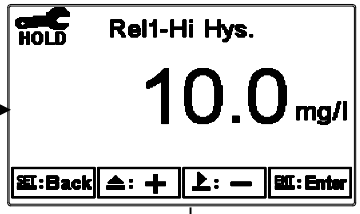
Press Mode or to select Relay 1 as Hi point or Lo point alarm.

Press Enter to confirm it.



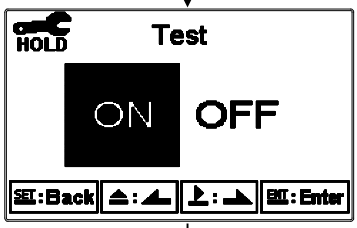
Press Mode or to adjust Setting Point (SP) value.

Press Enter to confirm it.



Press Mode or to adjust Hysteresis (Hys.) value

Press Enter to confirm it.



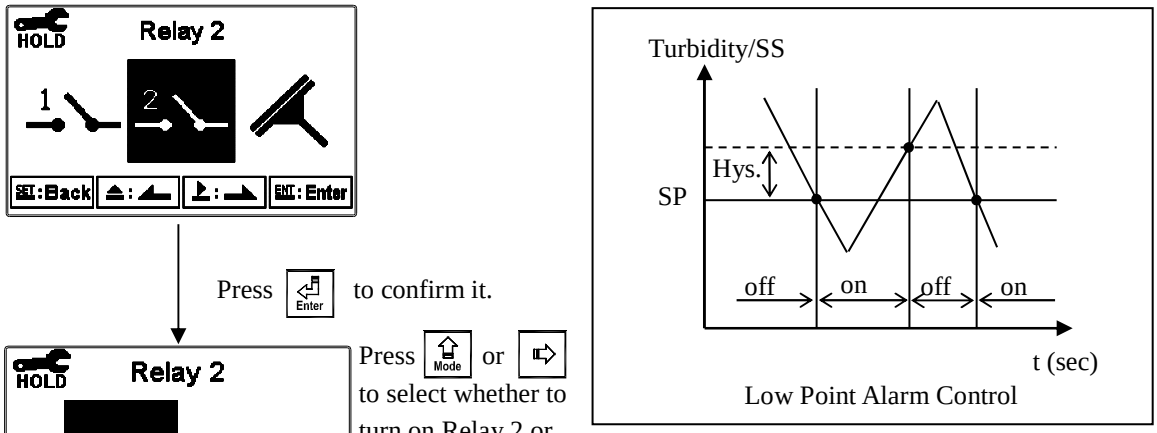
Press Mode or to select to activate testing of Relay 1. If turned on, Relay 1 will begin testing, and RELAY 1 indication lamp will light up.

Press Enter to confirm it.

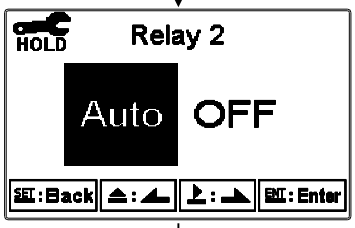
Enter “Relay 2” Setup

7.7 Relay 2

Enter setup of Relay 2. Select the item to turn the relay 2 function ON / OFF. If you select to turn on relay 2, set relay 2 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 of the parameters (for low point alarms).

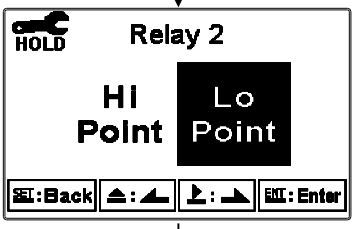


Press Enter to confirm it.



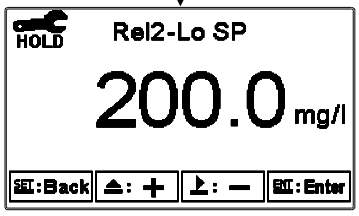
Press Mode or to select whether to turn on Relay 2 or not. If OFF, the guide menu will go to setup of Wiper.

Press Enter to confirm it.



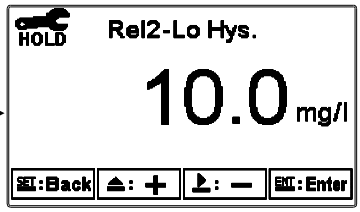
Press Mode or to select Hi point or Lo point alarm of Relay 2.

Press Enter to confirm it.



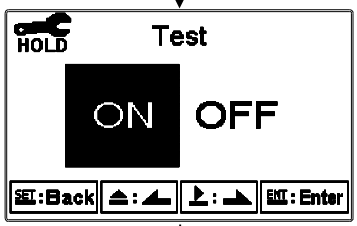
Press Mode or to adjust Setting Point (SP) value.

Press Enter to confirm it.



Press Mode or to adjust Hysteresis (Hys.) value

Press Enter to confirm it.



Press Mode or to select to activate testing of Relay 2. If turned on, relay 1 will begin testing, and RELAY 2 indication lamp will light up.

Press Enter to confirm it.

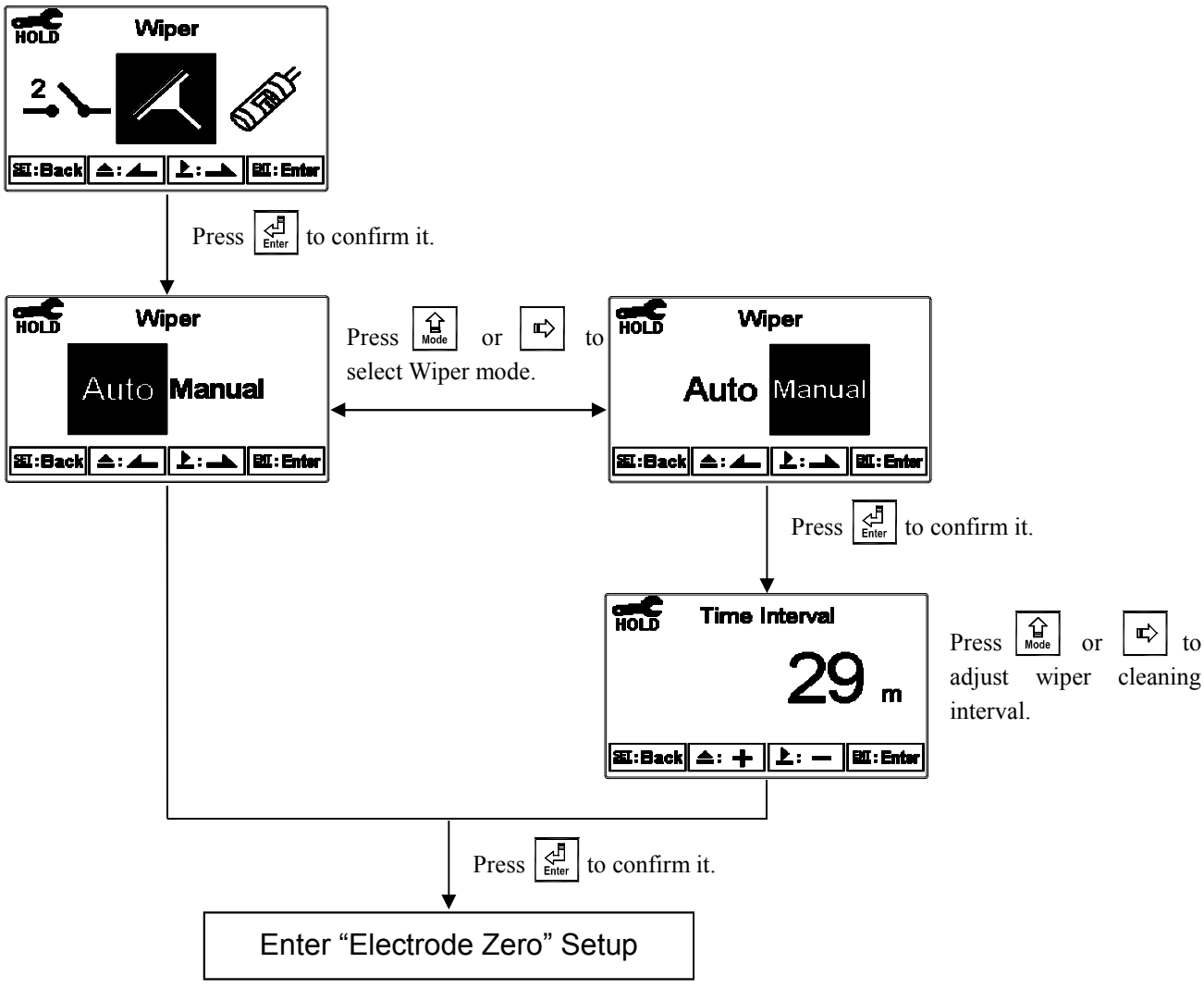
Enter “Wiper” Setup

7.8 Wiper

After entering setup mode, select "Wiper" and press Enter to configure wiper settings: activation mode and time interval. Select Auto to set automatic wiper cleaning according to the sensor connected. Select manual to configure automatic cleaning interval.

TC-100: Auto – Electrode default is 30 minute interval.
Manual – Configure from 2 to 29 minutes.

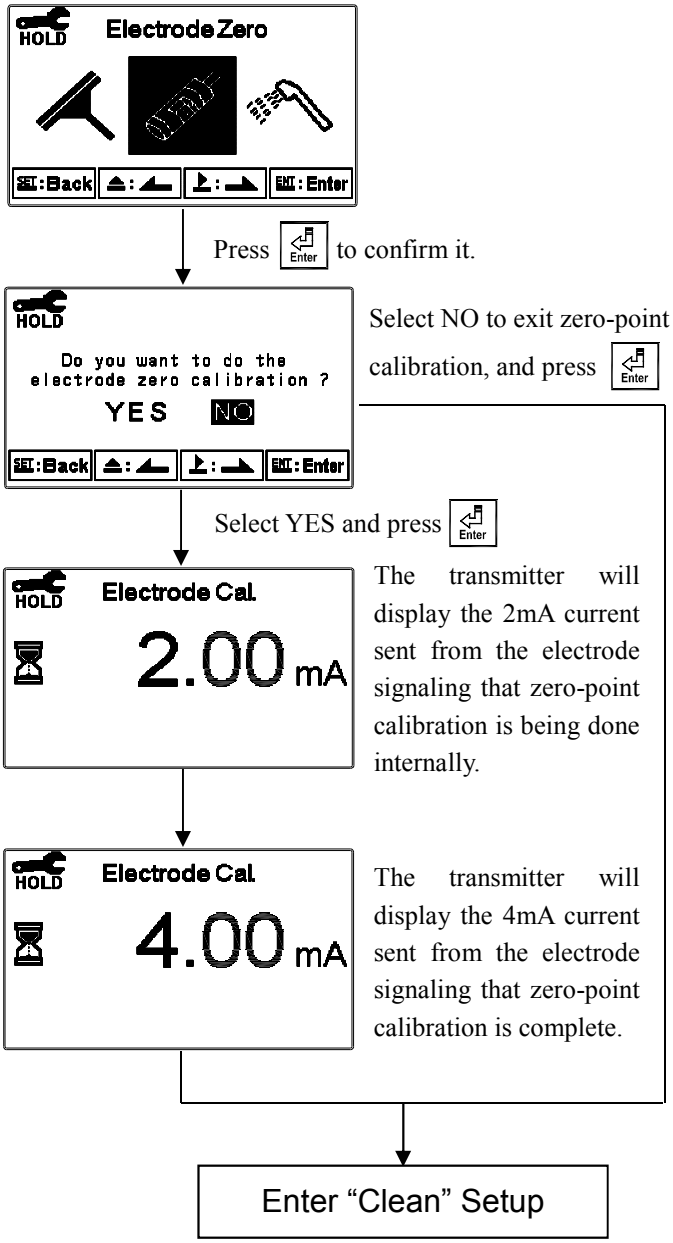
TC-500, TC-3000, TCS-1000: Auto – Electrode default is 10 minute interval
Manual – Configure from 2 to 9 minutes.



7.9 Electrode Zero

After entering setup mode, select “Electrode Zero” and press Enter to perform zero-point calibration. The user can determine if zero-point calibration is necessary from the 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.

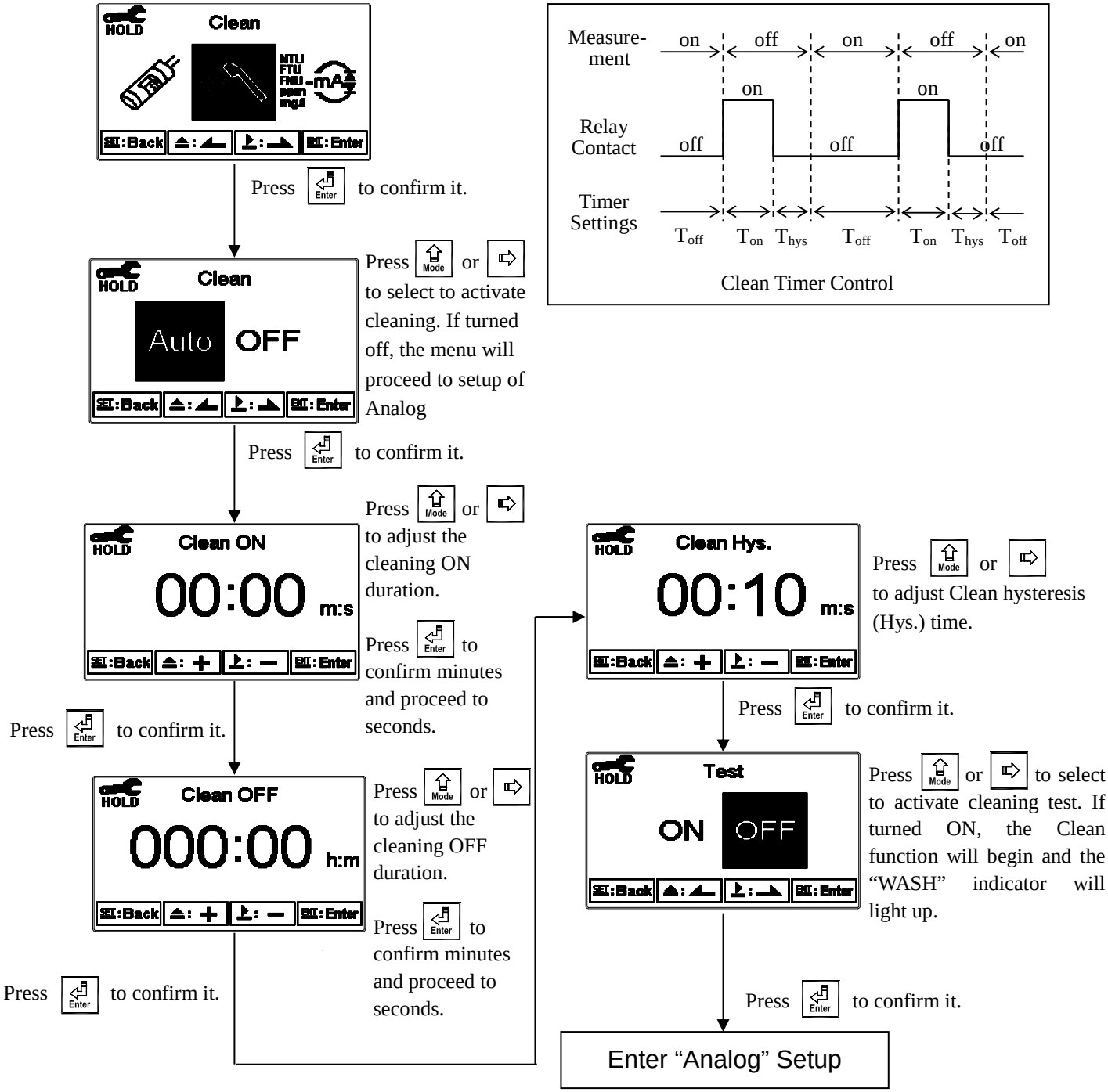
Note: When performing zero-point calibration, factory default electrode output signals will be altered.



7.10 Clean

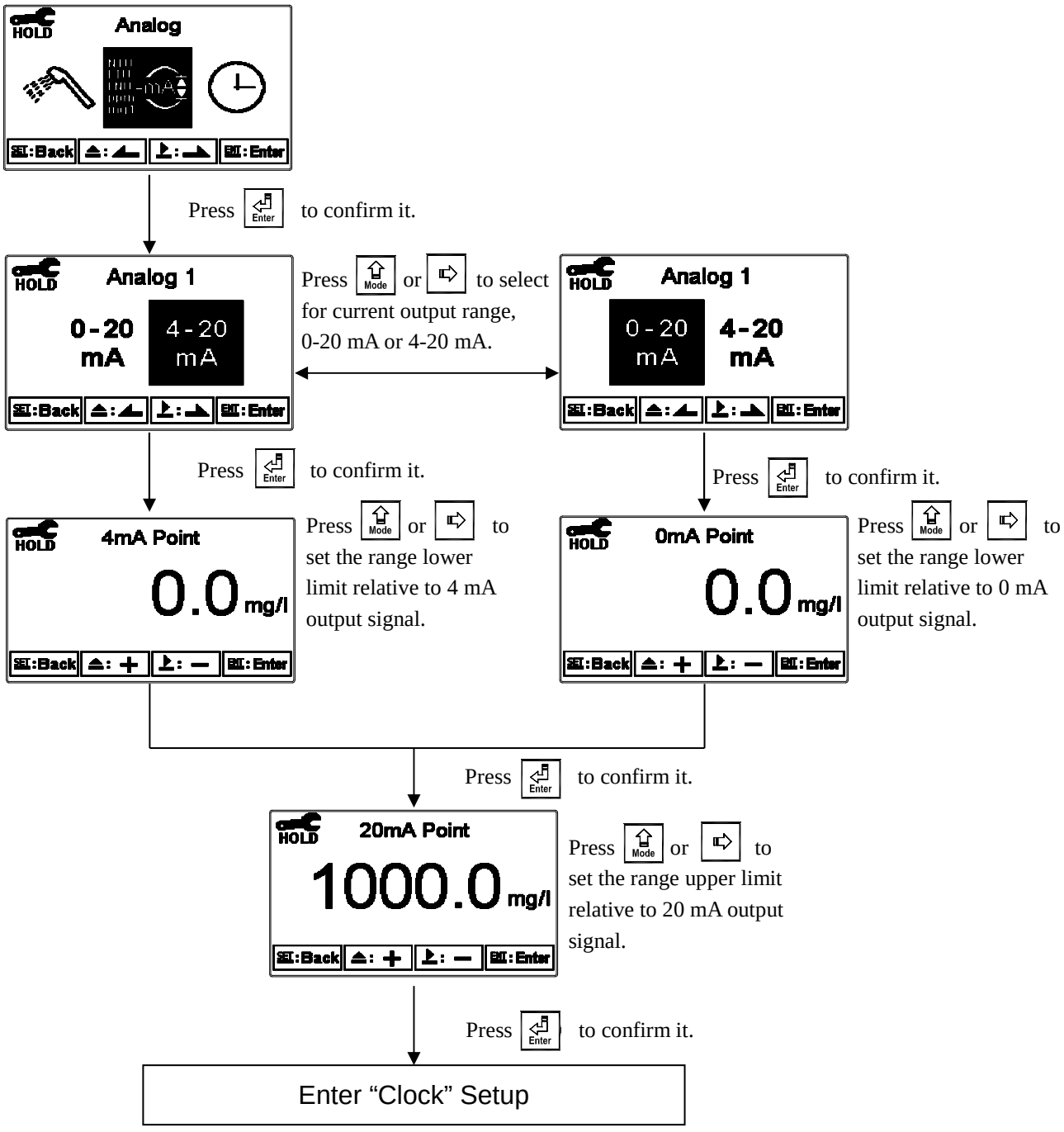
After entering setup mode, select “Clean” and press Enter to activate and configure cleaning settings. Select “Auto” to turn on the function as automatic. Set the timer for the clean function to automatically turn cleaning on or off, and then set the Hysteresis value (Hys.). The relationship of these settings can be seen in the graph provided below.

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

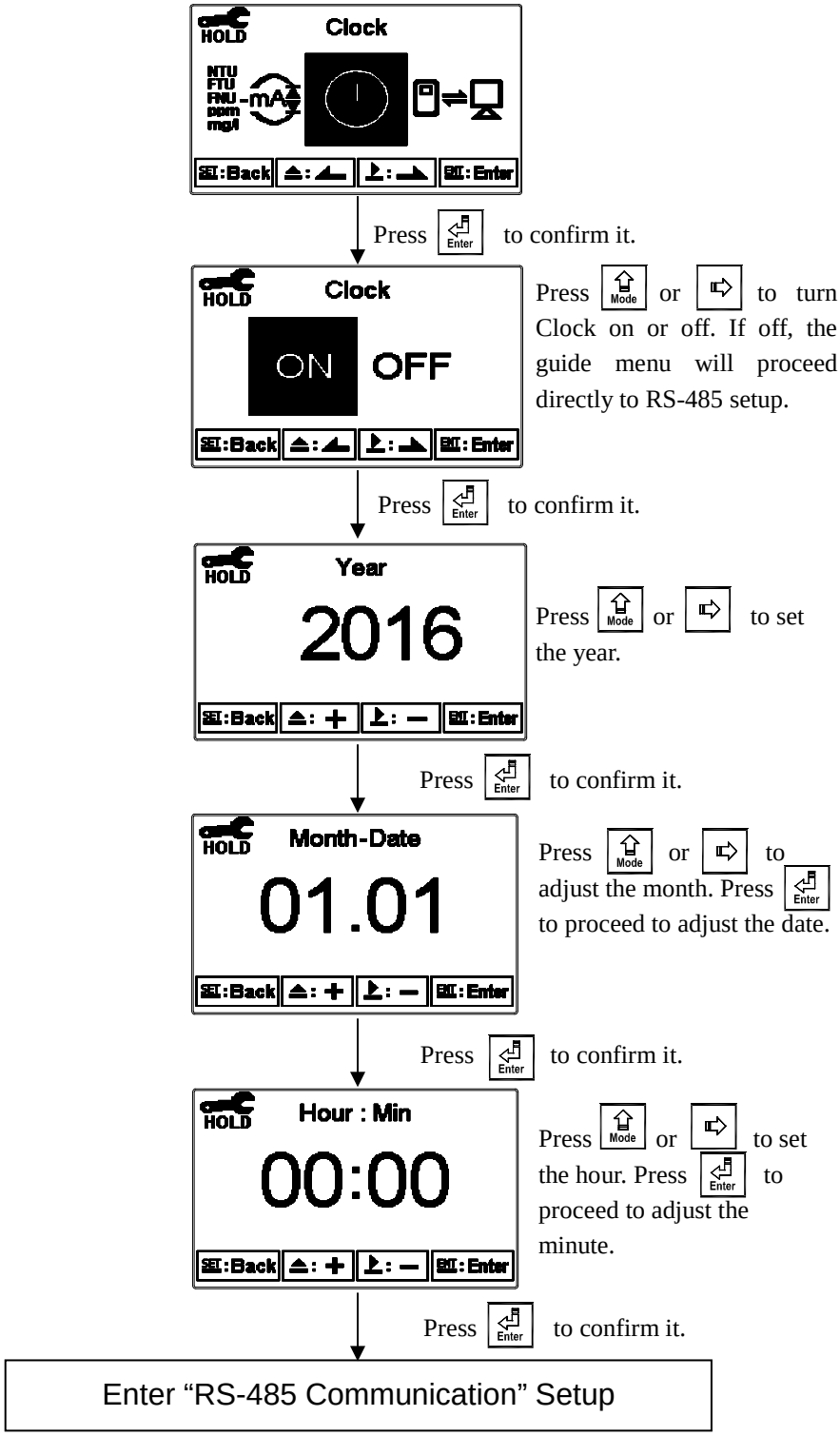
After entering setup mode, select “Analog” and press [Enter] to configure analog output settings. Select 0~20 mA or 4~20 mA current output. Set the upper and lower limit relative to the desired measuring range. The smaller the range, the greater the current output resolution. When the measured value 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 values can be used as an indication for determination failure. Under HOLD (measurement) status, the current output maintains the last output value before HOLD status. 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)

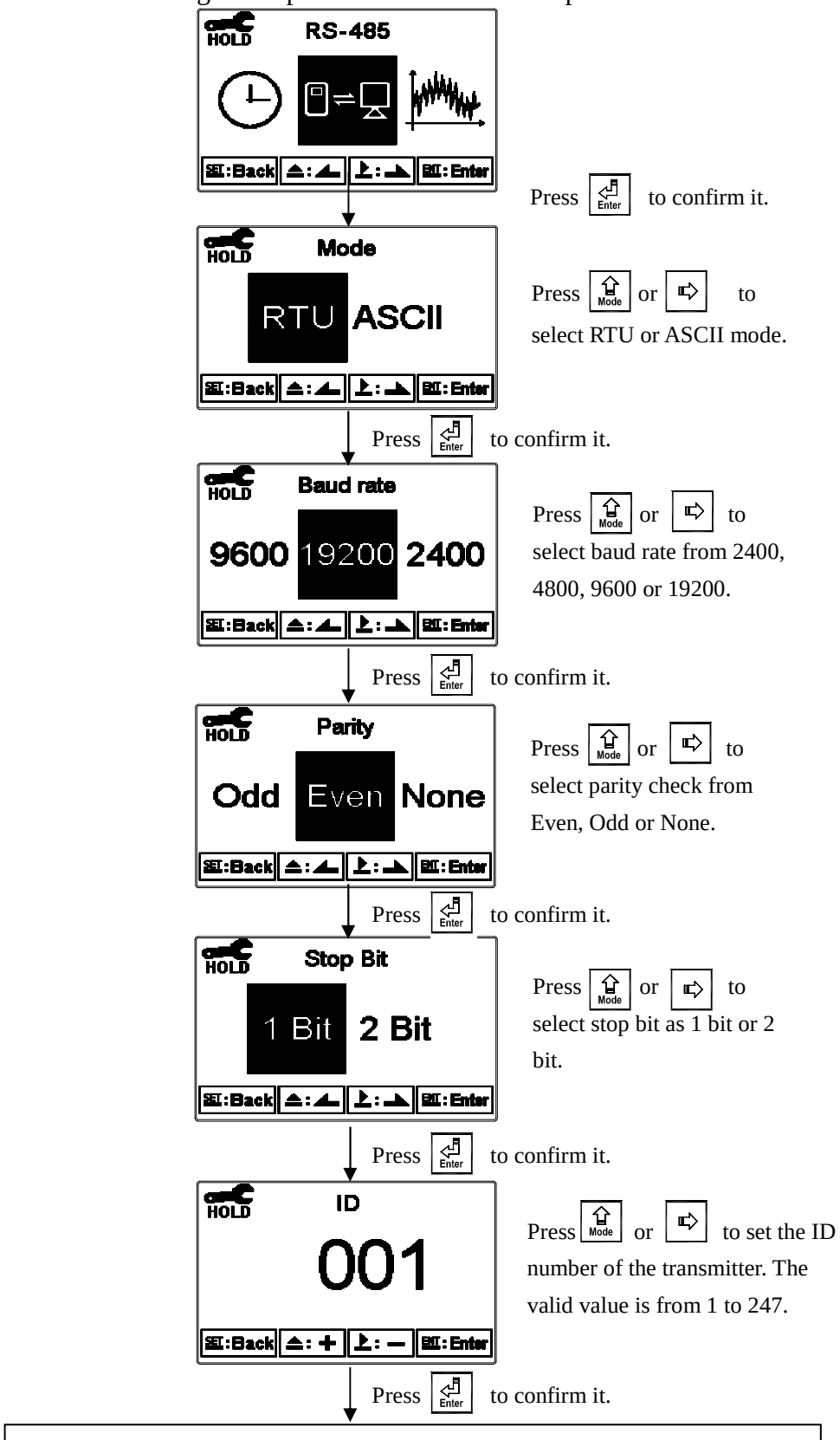
After entering setup mode, select “Clock” and press Enter to set or edit the date and time. If the clock is set to off, a clock will not be displayed under measurement mode. The calibration time of calibration records will also show “OFF” under calibration overview display.

Note: The transmitter is able to clock in action even if the power supply is cut off due to an internal battery. If this fails, please replace the 3V CR2025 Li battery inside the transmitter.



7.13 RS-485 Communication

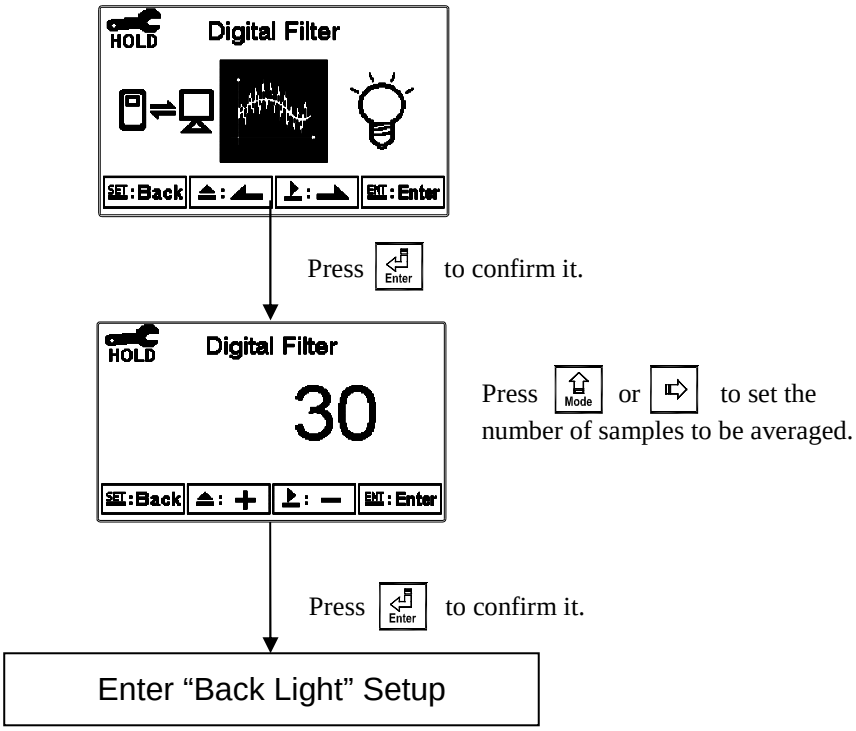
After entering setup mode, select “RS-485” and press [Enter] to configure RS-485 communication. According to the Modbus protocol, set the transmitting mode, parity, baud rate, stop bit, and ID number. For Modbus protocol details, please refer to chapter 9. When under hold status, the measurement signal output maintains the last output value before hold.



Enter “Sample Measurement Average (Digital Filter)” Setup

7.14 Sample Measurement Average (Digital Filter)

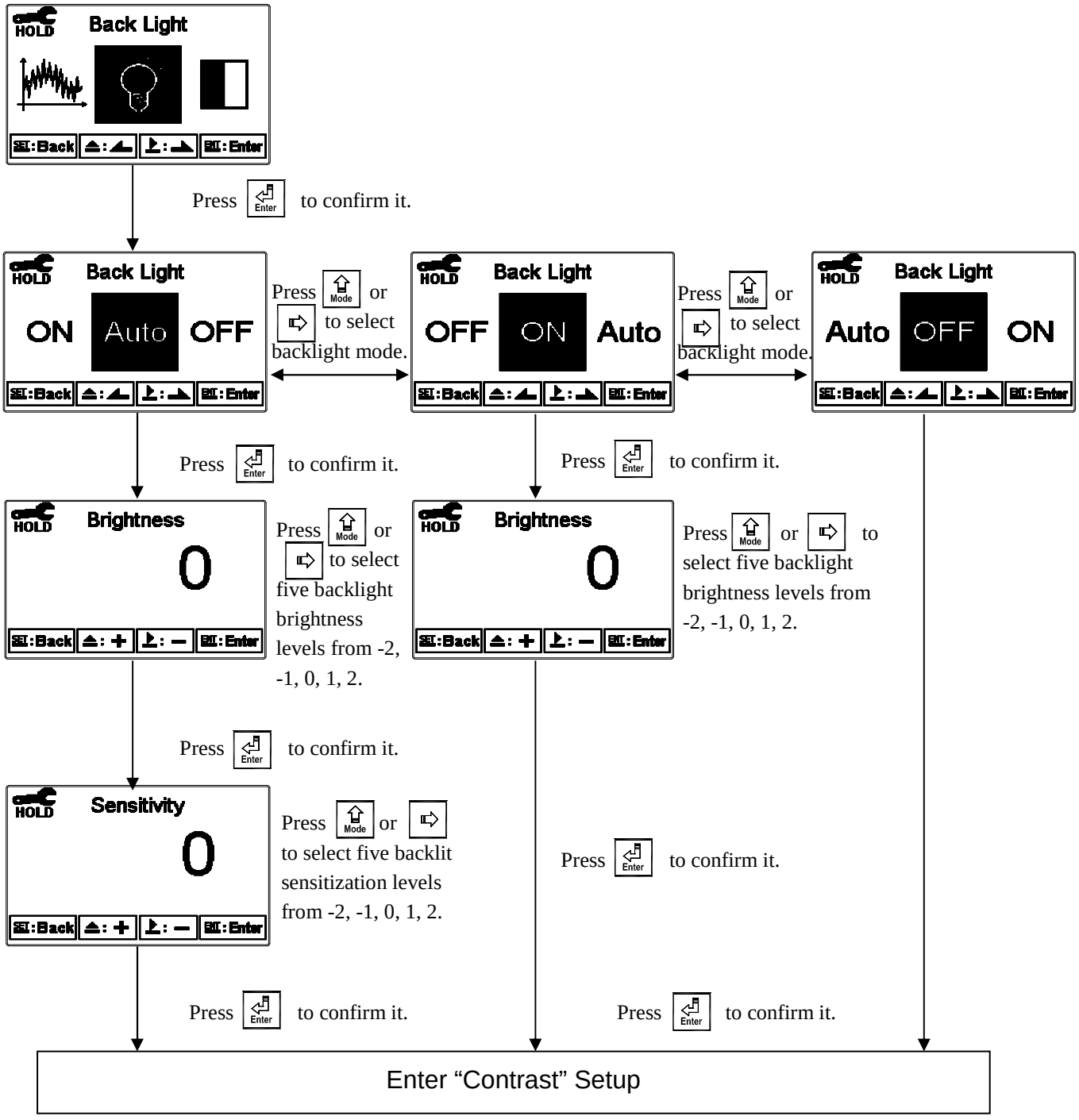
After entering setup mode, select “Digital Filter” and press Enter to configure transmitter digital filter. You may select the number of sample measurements to be averaged for each reading to increase the stability of the displayed measurement. The greater the number, the more stable the measurement value; the smaller the number, the more acute the measurement value.



7.15 Backlight

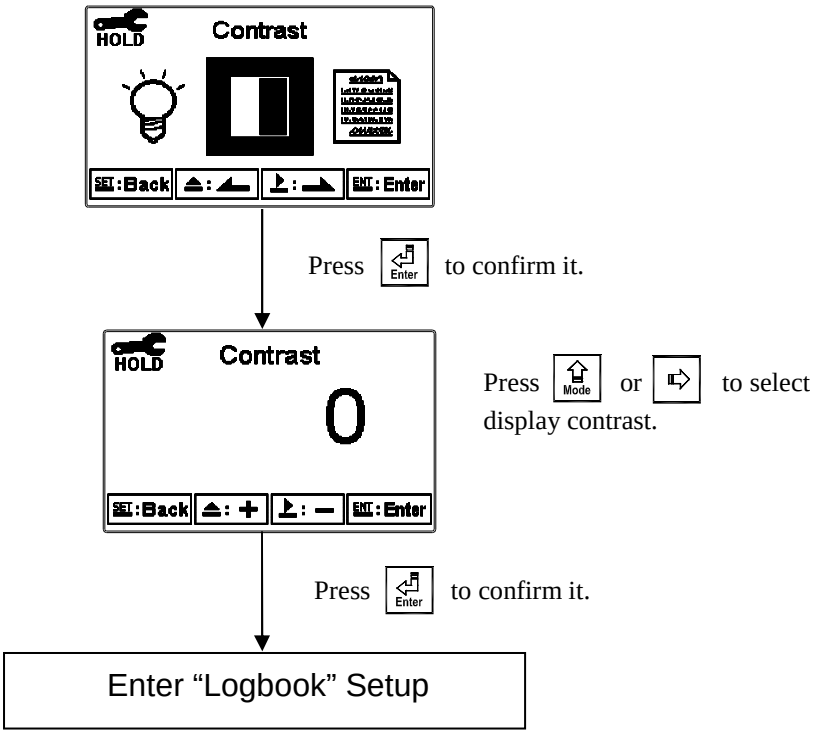
After entering setup mode, select “Backlight” and press Enter to adjust display brightness (-2~2, dark ~ bright) and sensitivity of the brightness sensor (-2~2, insensitive ~ sensitive). Whether under OFF or AUTO mode, the touch-on function will activate the backlight when any button is pressed. If no 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.



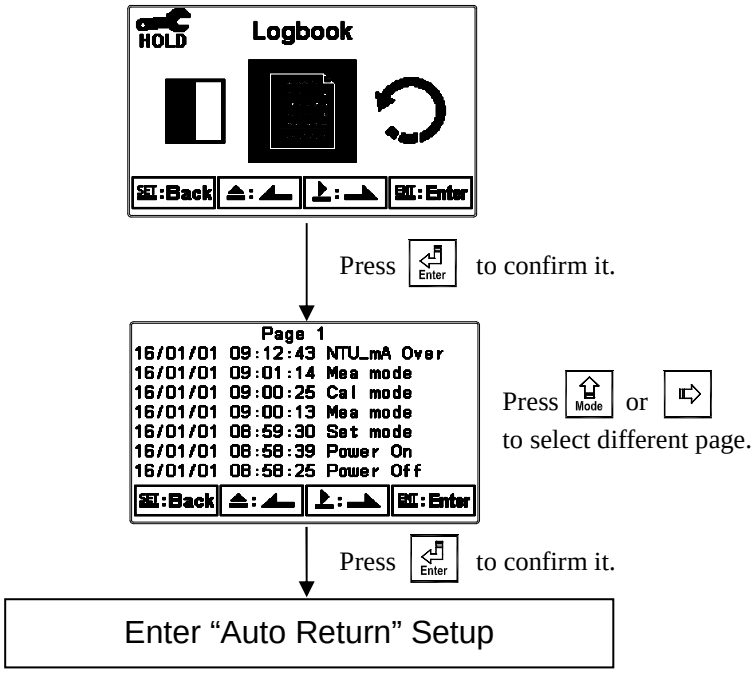
7.16 Contrast

After entering setup mode, select “Contrast” and press Enter to adjust the display contrast (-2, -1, 0, 1, 2, light to dark).



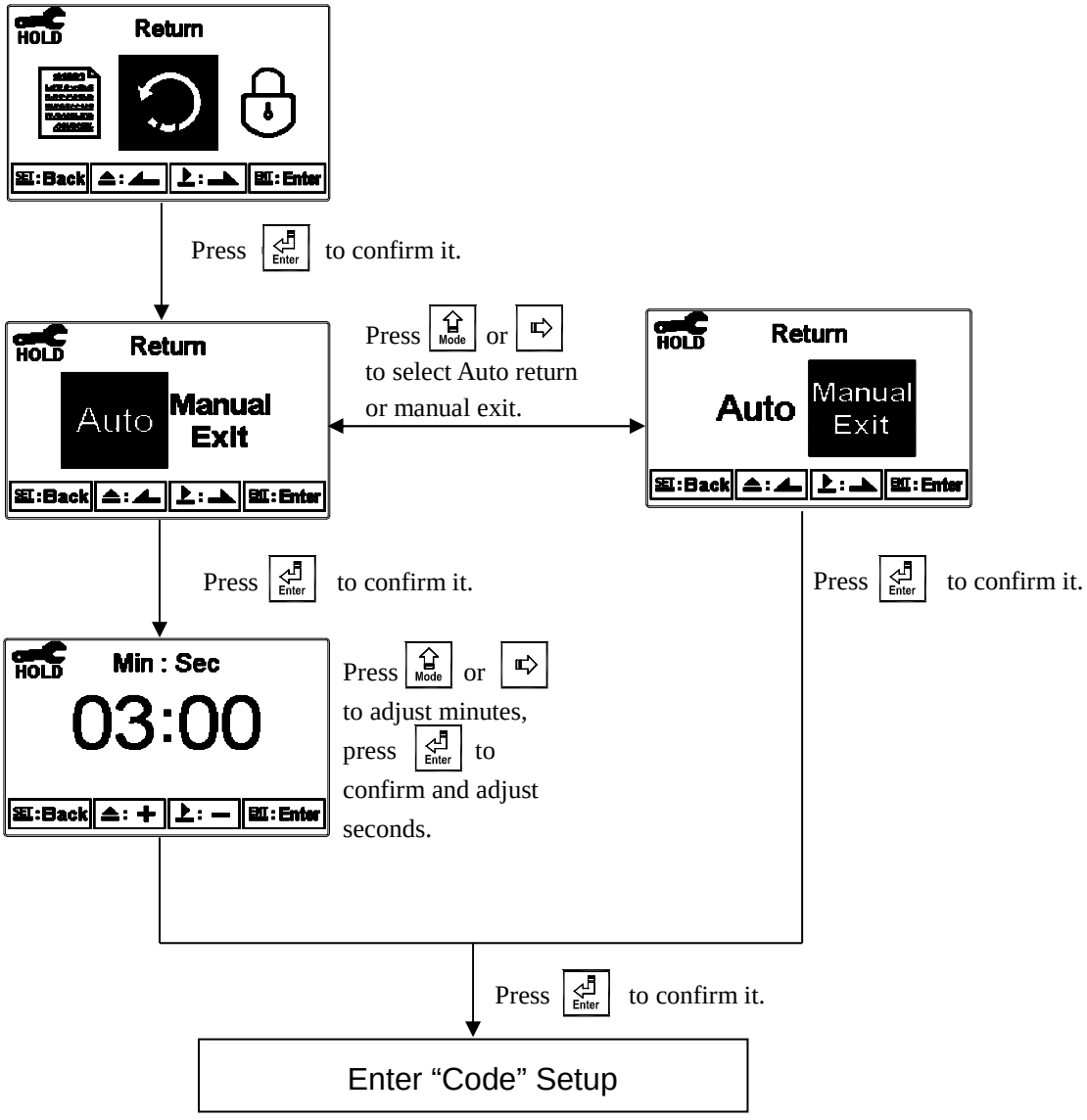
7.17 Logbook

After entering setup mode, select “Logbook” and press [Enter] to view event logbook. It is able to record and display up to 50 important events and error diagnosis records. The user can read important events via Logbook or Modbus. For detailed Modbus definitions of events please see to section 9.2, Modbus Address and Command Table.



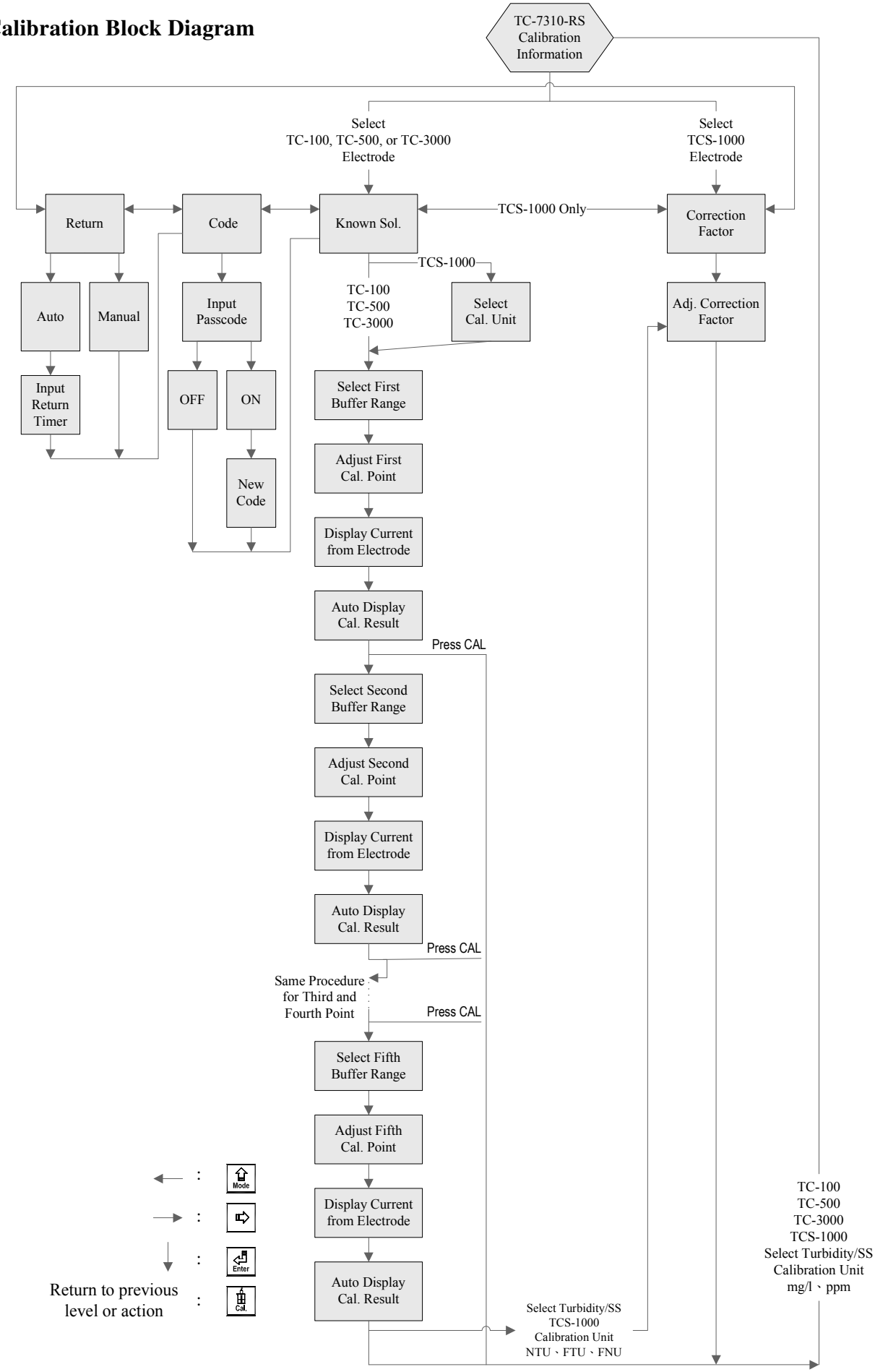
7.18 Automatic Return (Return)

After entering setup mode, select “Return” and press Enter to set the instrument to automatically exit the setup menu after a period of time without pressing any keys. “Manual Exit” requires the user to exit setup menu manually, while “Auto” will set the display to automatically exit the setup menu and return to measurement mode after a period of time without pressing any keys.



8. Calibration

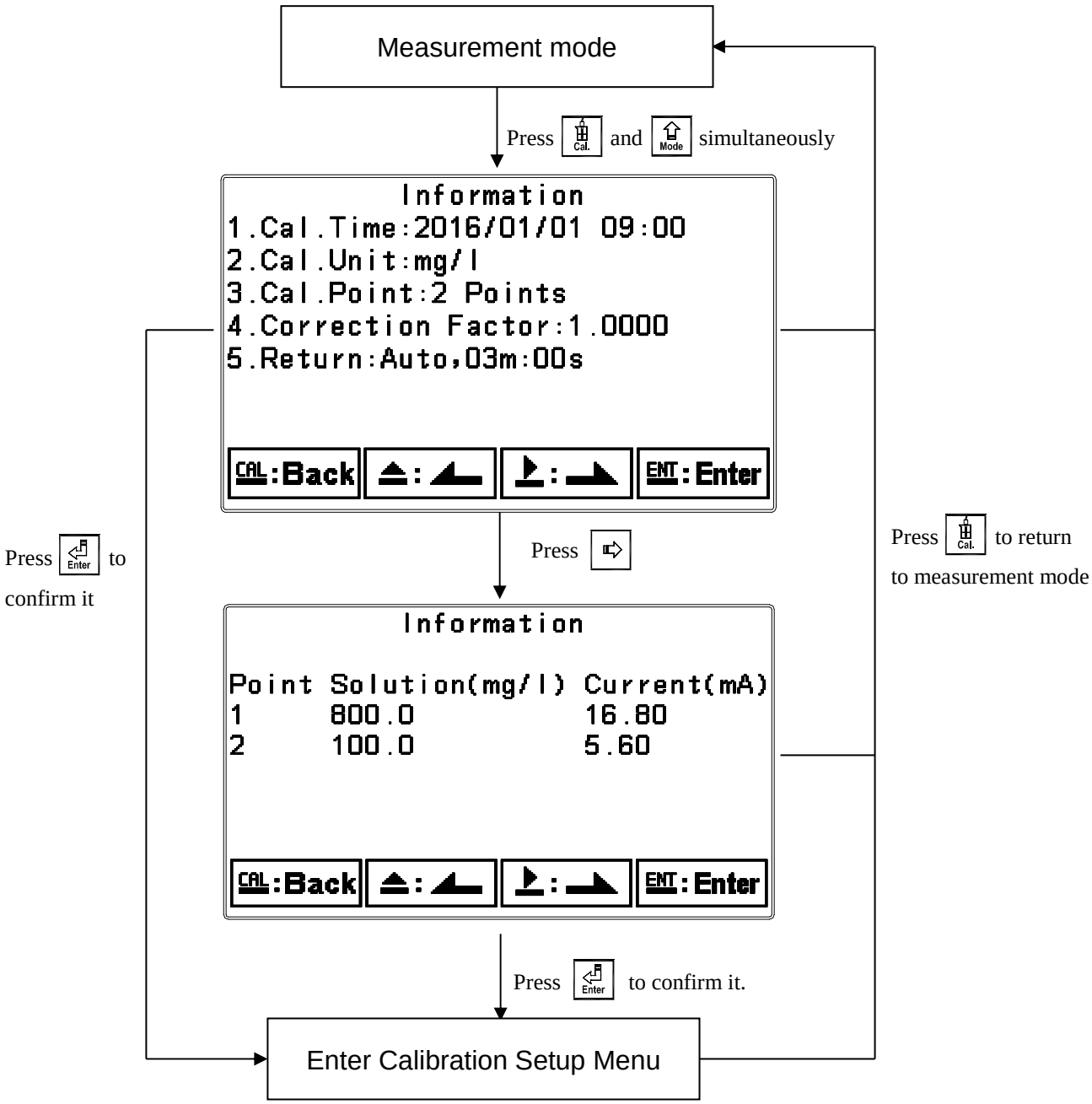
Calibration Block Diagram



8.1 Calibration Setup Menu

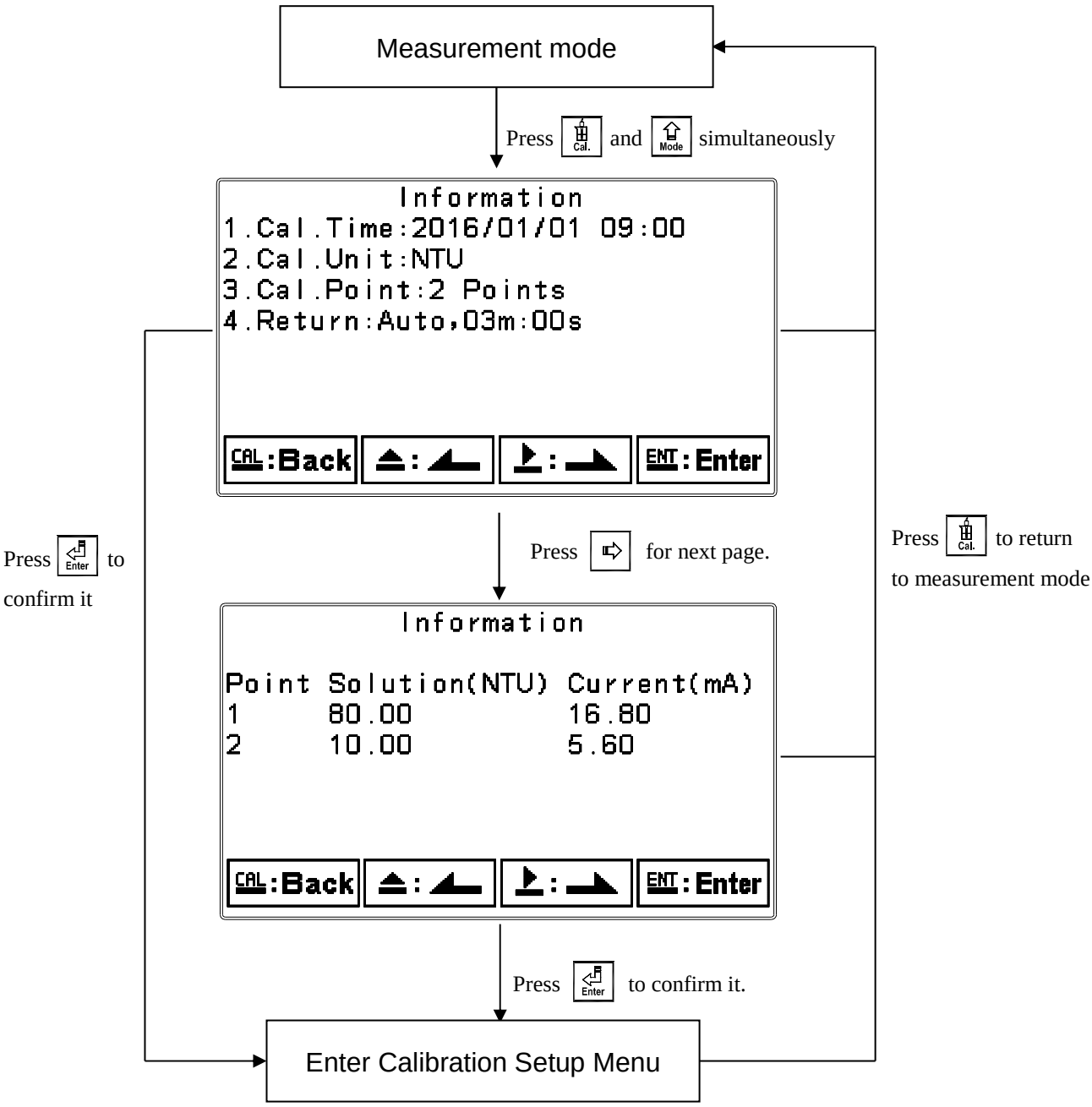
Under measurement mode, press [Cal.] and [Mode] simultaneously to display Calibration Information. If you do not need to re-calibrate the measurement system, press [Cal.] to return to measurement mode. If you need to re-calibrate the system, press [Enter] to enter calibration setup menu. (If the calibration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

TCS-1000 Calibration Information



TC-100 Calibration Information

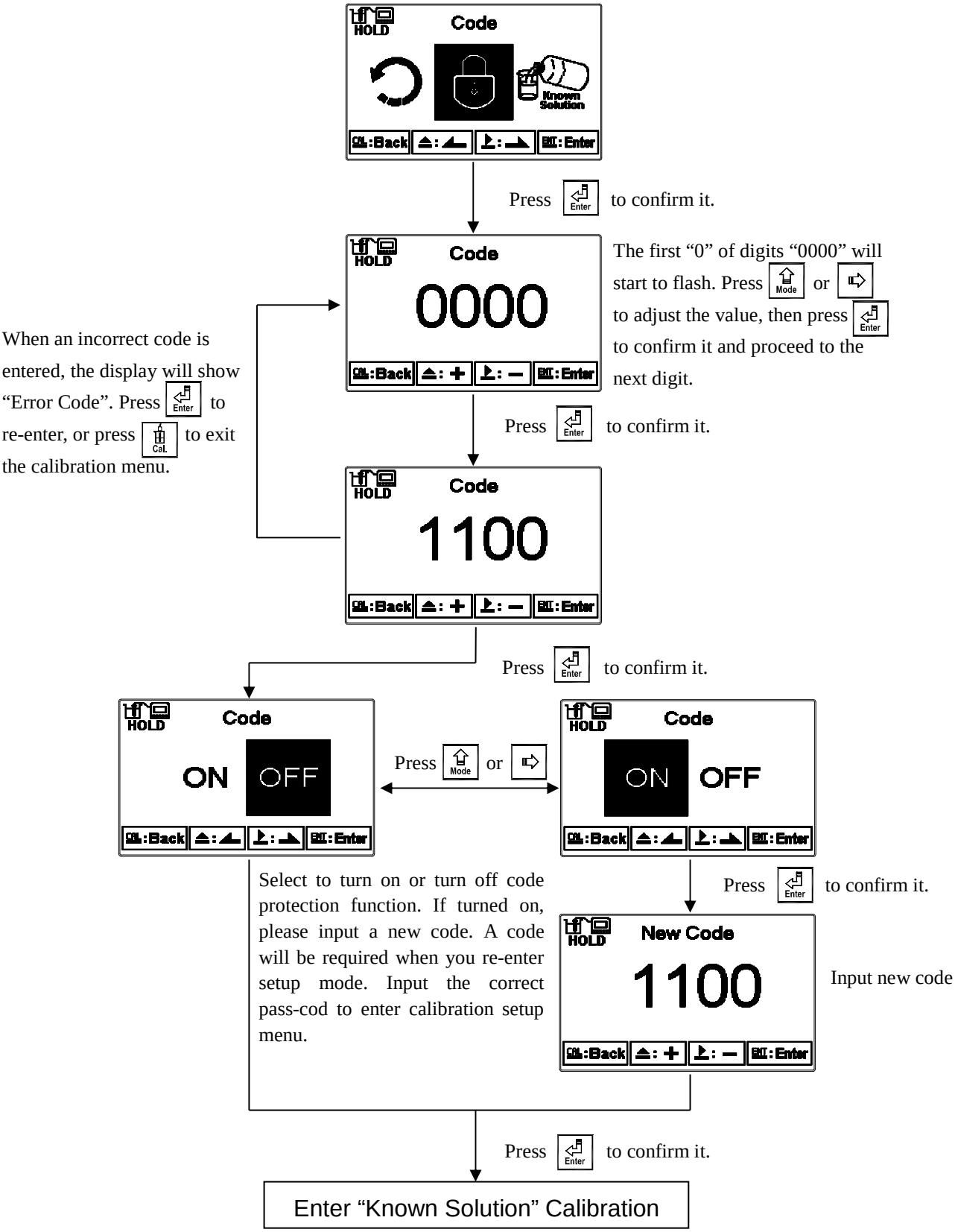
Note: TC-100, TC-500, TC-3000 electrodes do not have correction factor function.



8.2 Calibration Security Code (Code)

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

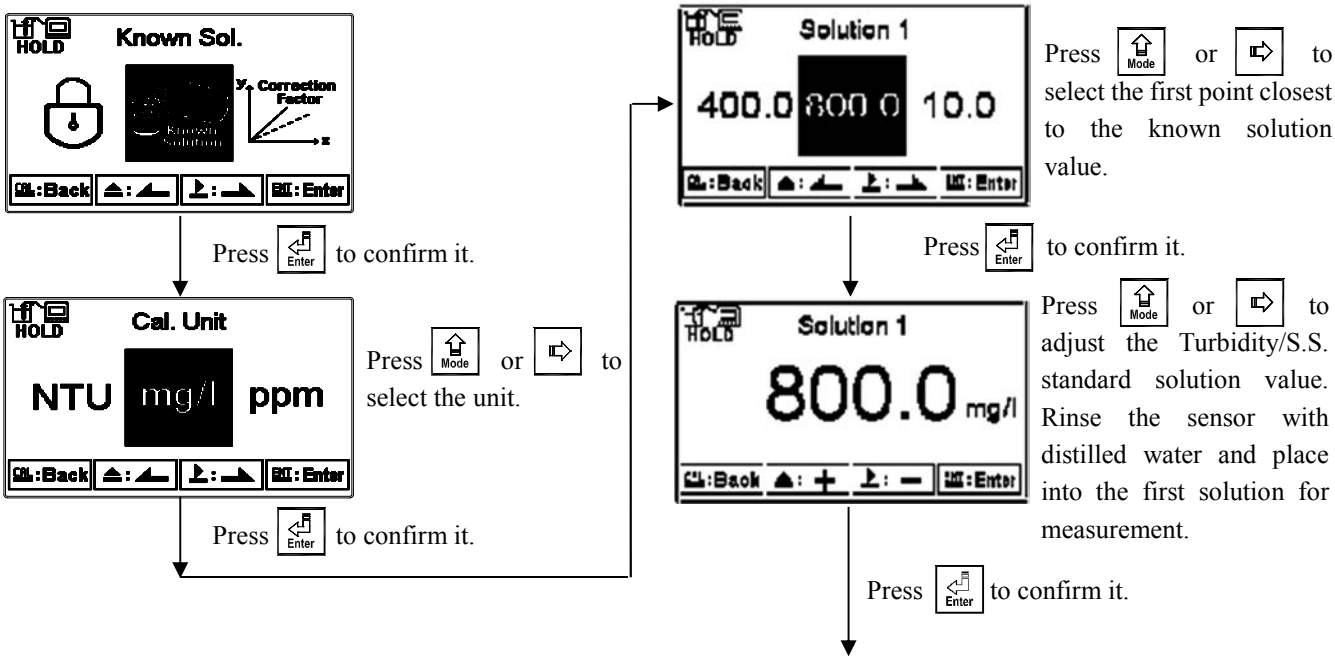
- This instrument provides multi-point standard buffer solution (Known Sol.) calibration allowing users to decide the number of points to calibrate to (max. 5 points).
- When calibrating, users can select the following electrodes in setup mode for calibration: Turbidity TC-100, TC-500, TC-3000, or Suspended Solids TCS-1000.
- During calibration, the displayed information will be slightly different based on the sensor selected in setup mode.
- During calibration, exceeding 80% of the sensor manufacturer's suggested range is **not recommended**.
- For single point calibration, the reference value cannot be 0.
- TCS-1000 electrode uses suspended solids (SS) standard solution, but is not easily acquired. The transmitter is able to use turbidity standard solution to calibrate and adjust the suspended solids measurement via a correction factor.

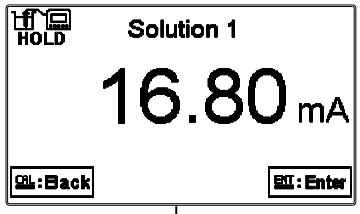
8.3.1 Known Solution Calibration

8.3.1.1 Suspended Solids (SS) TCS-1000 Electrode Calibration

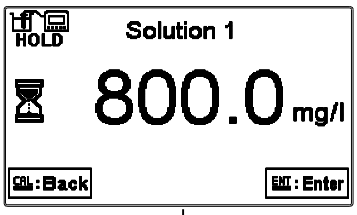
- During calibration, select SS unit: mg/l or ppm
  or select Turbidity unit: NTU, FTU, or FNU
- SS and Turbidity calibration each provides 5 preset standard solution values for selection:
  SS: 800.0, 400.0, 200.0, 100.0, 10.0
  Turbidity: 1000, 800, 100, 20.0, 1.00
- If a turbidity unit is selected for calibration, the system will procced directly to correction factor adjustment following standard solution calibration.

The procedure for TCS-1000 using suspended solids standard solution for two-point calibration is as follows:

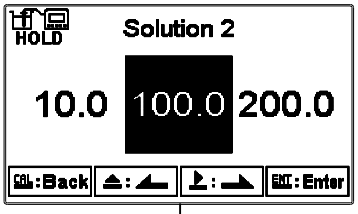




The sensor will display the current received. Wait until the value is stable.

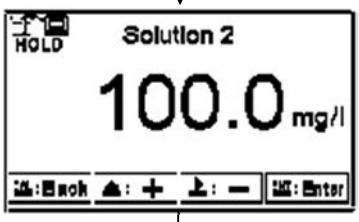


Press Enter to directly display the result or wait for the transmitter to automatically confirm it.



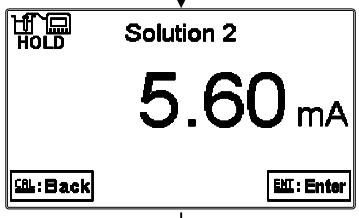
Press Mode or ⇨ to select the second point closest to the known solution value.
Press Cal. to complete single point calibration.

Press Enter to confirm it.



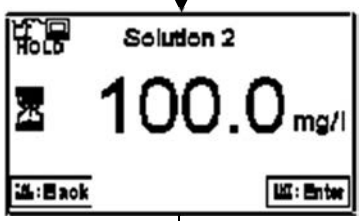
Press Mode or ⇨ to adjust the MLSS standard solution value. Rinse the sensor with distilled water and place into the second solution for measurement.

Press Enter to confirm it.

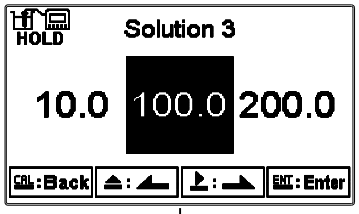


The transmitter will display the current received. Wait until the value is stable.

Press Enter to confirm it.

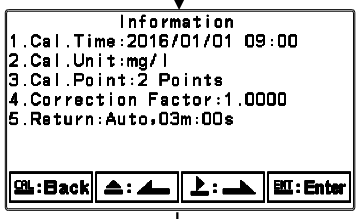


Press Enter to directly display the result or wait for the transmitter to automatically confirm it.



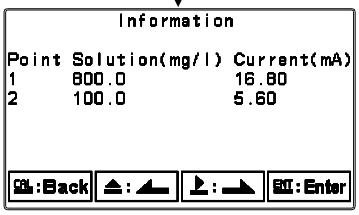
Press Cal. to complete two-point calibration and directly display the result.
Press Enter to continue and proceed to multi-point calibration

Press Enter to confirm it.



Calibration results overview

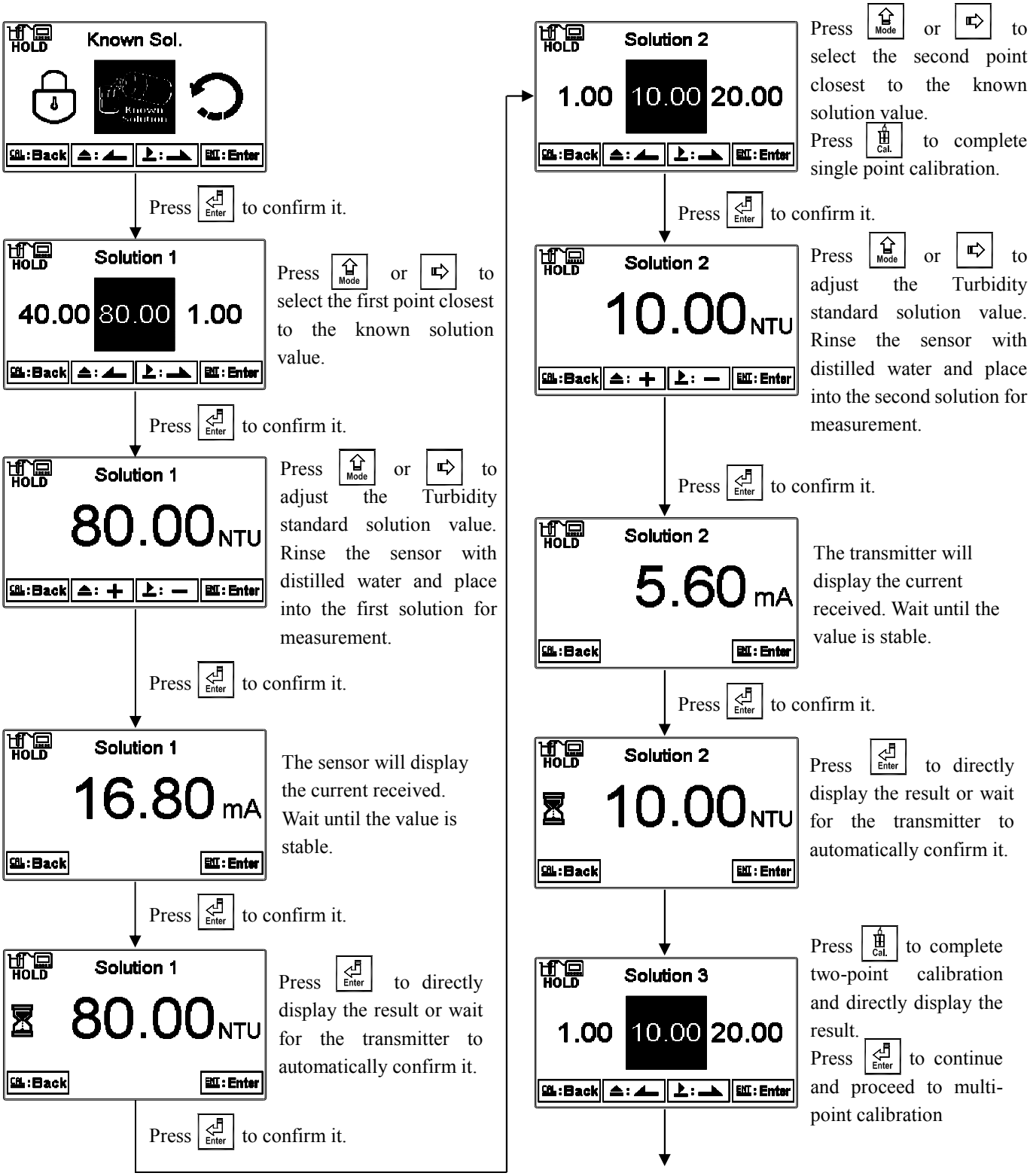
Press Mode or ⇨ to move between pages.

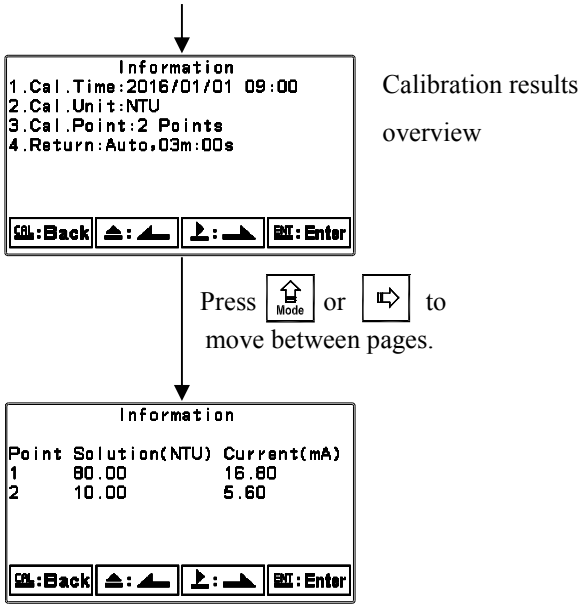


8.3.1.2 Turbidity TC-100, TC-500, TC-3000 Electrode Calibration

- Turbidity calibration each provides 5 preset standard solution values for selection:

  TC-100: 80.0, 40.0, 20.0, 10.0, 1.0
  TC-500: 400.0, 200.0, 100.0, 50.0, 5.0
  TC-3000: 2400, 1200, 600, 300, 30

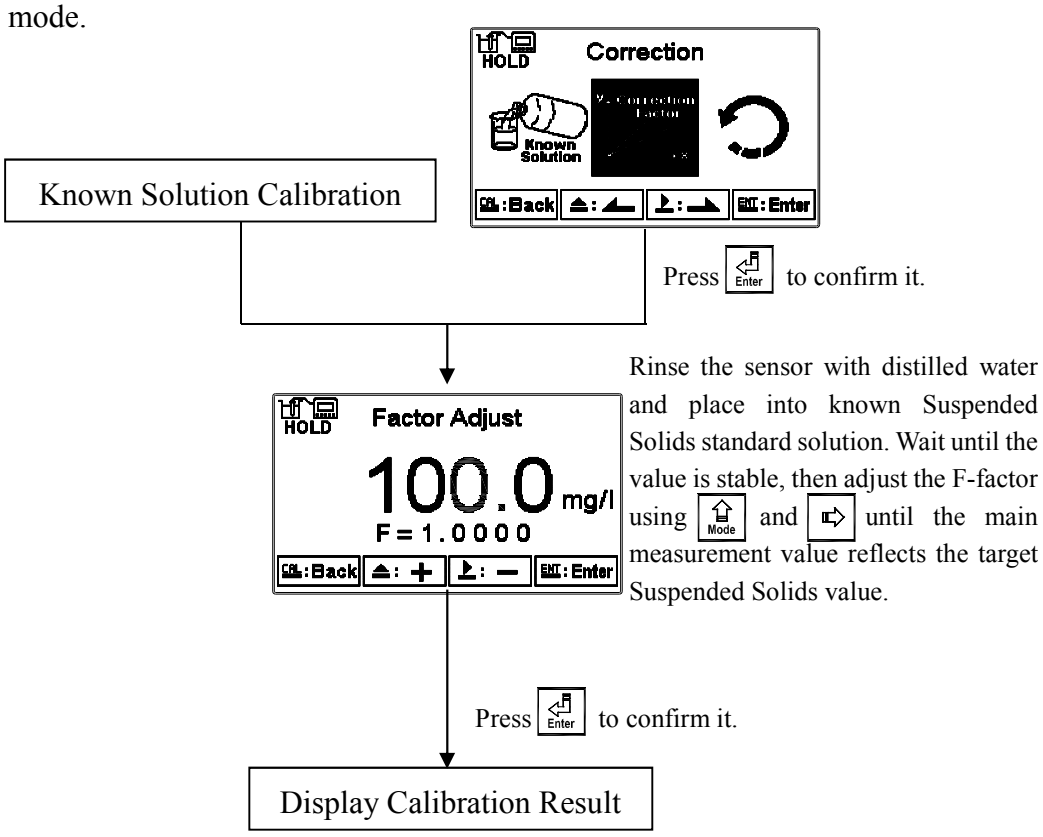




8.4 Correction Factor

When calibrating TCS-1000 suspended solids electrode using turbidity standard solution, a correction factor needs to be applied to adjust the measured values for suspended solids measurement values.

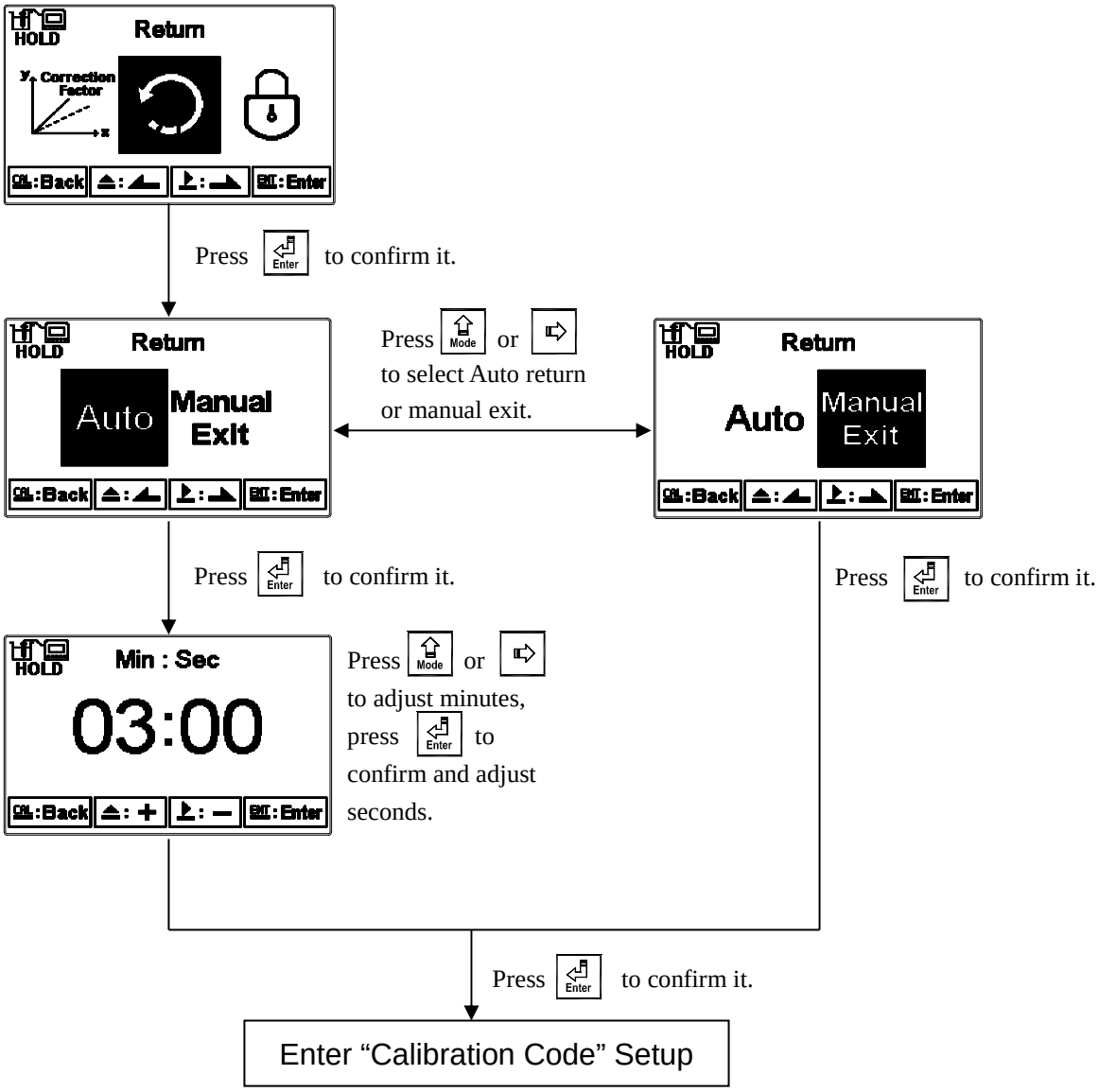
Once "Known Solution Calibration" is complete (refer to section 8.3.1.1 for TCS-1000 suspended solids electrode calibration procedure), correction factor adjustment screen will follow. Users may also directly enter the correction factor adjustment screen from setup mode.



8.5 Automatic Return (Return)

After entering setup mode, select “Return” and press [Enter] to set the instrument to automatically exit the setup menu after a period of time without pressing any keys. “Manual Exit” requires the user to exit setup menu manually, while “Auto” will set the display to automatically exit the setup menu and return to measurement mode after a period of time without pressing any keys.

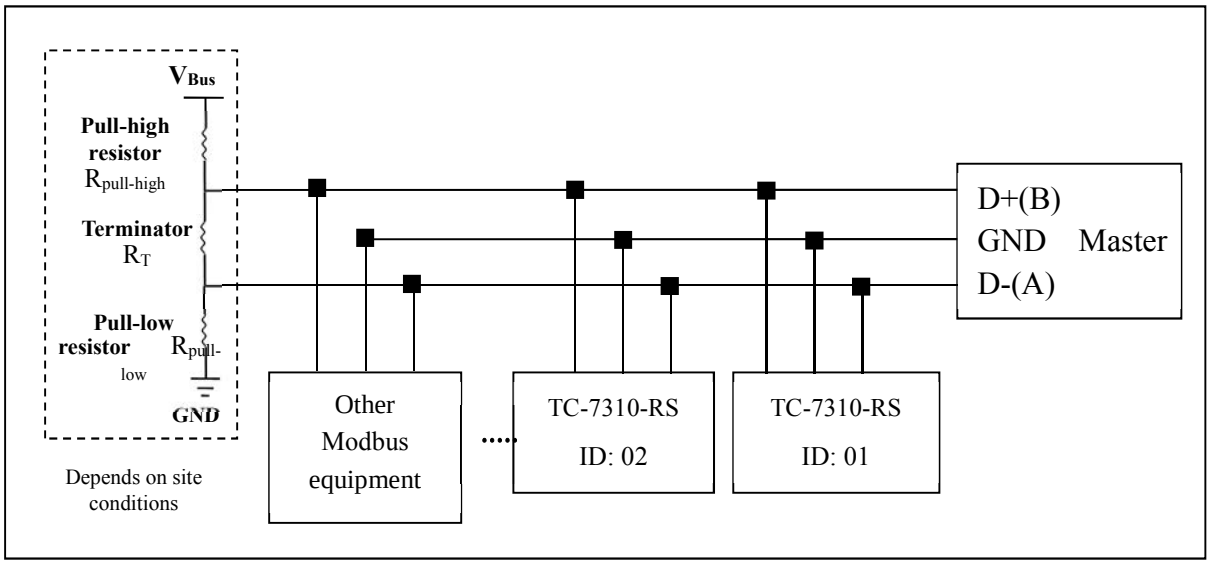
Note: The return function for setup menu and calibration setup menu are independent settings.



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 (VBus). 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 VBus,

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 KΩ, and for terminating resistors, 120 KΩ.

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 Turbidity/SS measurement logic address 0035H (16-bit) or 53 (10-bit), if the output signal is subtracted by 1 by the 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 1: ASCII	0	
0006H	R	Serial Transmission Speed (Baud Rate)	2	USHORT	0: 2400 1: 4800 2: 9600 3: 19200	3	
0007H	R	Parity	2	USHORT	0: None 1: Even 2: Odd	1	
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 1: AUTO	0	
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: AUTO	1	
0016H			2	USHORT	0: Hi 1: Lo	0	
0017H			4	FLOAT	SP1	800.0 mg/l	Data affected by sign byte
0019H			4	FLOAT	Hys1	10.0 mg/l	
001BH	R/W	Relay 2 *	2	USHORT	0: OFF 1: AUTO	1	
001CH			2	USHORT	0: Hi 1: Lo	1	
001DH			4	FLOAT	SP2	200.0 mg/l	Data affected by sign byte
001FH			4	FLOAT	Hys2	10.0 mg/l	
0021H	R/W	Backlight Brightness*	2	USHORT	0: AUTO 1: ON 2: OFF	2	
0022H			2	SHORT SHORT SHORT SHORT SHORT	2: Highest Brightness 1: High Brightness 0: Standard -1: Low Brightness -2: Lowest Brightness	0	
0023H	R/W	Backlight Sensitivity*	2	SHORT SHORT SHORT SHORT SHORT	2: Highest Sensitivity 1: High Sensitivity 0: Standard -1: Low Sensitivity -2: Lowest Sensitivity	0	
0024H	R/W	Sample Average of Measurements	2	USHORT	1-60	30	
0025H	R/W	Product Adjustment	4	FLOAT	TC-100: -20~20NTU TC-500: -100~100NTU TC-3000: -600~600NTU TCS-1000: - 200~200mg/l	0	
0027H	R/W	Wiper*	2	USHORT	0：MANUAL 1：AUTO	0	

0028H	R/W	Event Number*	2	USHORT	1~50	1	
0029H	R	Event Time	12	USHORT	Second	2016-01-01 00:00:00	
002AH	R			USHORT	Minute		
002BH	R			USHORT	Hour		
002CH	R			USHORT	Day		
002DH	R			USHORT	Month		
002EH	R			USHORT	Year		
002FH	R	Event ID	2	USHORT	0~15	0	
0030H	R/W	Wiper Act. Time Interval	2	USHORT	Minute	09	

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 is divided into two 16-bit register data transmissions. The second 16-bit register (CC CD) 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 Turbidity/SS measured value is 25.10NTU, the 16-bit of FLOAT data (hexadecimal) will be 41 C8 CC CD. The transmission order will be CC CD 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
NTU_mA Over	Current over range	05
FTU_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
FNU_mA Over	Current over range	12
Modbus Write	Modbus input action	13
ppm_mA Over	Current over range	14
mg/l_mA Over	Current over range	15

Function Code: 03H Modbus Response (Measurement Parameter)

Logic Address	R/W	Item	Number of Bytes	Information Type	Description of Data Transmission	Default Value	Note
0031H	R	Measurement Status	2	USHORT	0: Hold Status 1: Measurement Status	1	
0032H	R	Sign Byte	6	CHAR	NTU FTU FNU ppm mg/l	mg/l	ASCII Code
0035H	R	Turbidity/SS Measurement	4	FLOAT	Turbidity/SS 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	Turbidity/SS out of 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				

9.2 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 Turbidity/SS measurement logic address 0035H (16-bit) or 53 (10-bit), if the output signal is subtracted by 1 by the 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 1: ASCII	0	
0006H	R	Serial Transmission Speed (Baud Rate)	2	USHORT	0: 2400 1: 4800 2: 9600 3: 19200	3	
0007H	R	Parity	2	USHORT	0: None 1: Even 2: Odd	1	
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 1: AUTO	0	
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: AUTO	1	
0016H			2	USHORT	0: Hi 1: Lo	0	
0017H			4	FLOAT	SP1	800.0 mg/l	Data affected by sign byte
0019H			4	FLOAT	Hys1	10.0 mg/l	
001BH	R/W	Relay 2 *	2	USHORT	0: OFF 1: AUTO	1	
001CH			2	USHORT	0: Hi 1: Lo	1	
001DH			4	FLOAT	SP2	200.0 mg/l	Data affected by sign byte
001FH			4	FLOAT	Hys2	10.0 mg/l	
0021H	R/W	Backlight Brightness*	2	USHORT	0: AUTO 1: ON 2: OFF	2	
0022H			2	SHORT SHORT SHORT SHORT SHORT	2: Highest Brightness 1: High Brightness 0: Standard -1: Low Brightness -2: Lowest Brightness	0	
0023H	R/W	Backlight Sensitivity*	2	SHORT SHORT SHORT SHORT SHORT	2: Highest Sensitivity 1: High Sensitivity 0: Standard -1: Low Sensitivity -2: Lowest Sensitivity	0	
0024H	R/W	Sample Average of Measurements	2	USHORT	1-60	30	
0025H	R/W	Product Adjustment	4	FLOAT	TC-100: -20~20NTU TC-500: -100~100NTU TC-3000: -600~600NTU TCS-1000: - 200~200mg/l	0	
0027H	R/W	Wiper*	2	USHORT	0：MANUAL 1：AUTO	0	

0028H	R/W	Event Number*	2	USHORT	1~50	1	
0029H	R	Event Time	12	USHORT	Second	2016-01-01 00:00:00	
002AH	R			USHORT	Minute		
002BH	R			USHORT	Hour		
002CH	R			USHORT	Day		
002DH	R			USHORT	Month		
002EH	R			USHORT	Year		
002FH	R	Event ID	2	USHORT	0~15	0	
0030H	R/W	Wiper Act. Time Interval	2	USHORT	Minute	09	

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 is divided into two 16-bit register data transmissions. The second 16-bit register (CC CD) 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 Turbidity/SS measured value is 25.10NTU, the 16-bit of FLOAT data (hexadecimal) will be 41 C8 CC CD. The transmission order will be CC CD 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
NTU_mA Over	Current over range	05
FTU_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
FNU_mA Over	Current over range	12
Modbus Write	Modbus input action	13
ppm_mA Over	Current over range	14
mg/l_mA Over	Current over range	15

Function Code: 03H Modbus Response (Measurement Parameter)

Logic Address	R/W	Item	Number of Bytes	Information Type	Description of Data Transmission	Default Value	Note
0031H	R	Measurement Status	2	USHORT	0: Hold Status 1: Measurement Status	1	
0032H	R	Sign Byte	6	CHAR	NTU FTU FNU ppm mg/l	mg/l	ASCII Code
0035H	R	Turbidity/SS Measurement	4	FLOAT	Turbidity/SS 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	Turbidity/SS out of 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 Turbidity/SS reading 0035H as an example. If the Turbidity/SS measured value is 25.10 NTU, 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	CC
No. of Registers Hi	00	Register value Lo	CD
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	CC
No. of Registers Hi	00	Register value Lo	CD
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 (CC CD) 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 Turbidity/SS reading is now 25.10 NTU, the 16-bit of FLOAT data (hexadecimal) is 41 C8 CC CD. However, the transmission order will be CC CD 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.

SUNTEX

SUNTEX INSTRUMENTS CO., LTD.

13F, No. 31, Lane 169, Kangning St.,
Xizhi Dist., New Taipei City, Taiwan (R.O.C.)
Tel: 886-2-2695-9688
Fax: 886-2-2695-9693
e-mail: suntex@ms1.hinet.net

www.suntex.com.tw/en

5040E TC-7310-RS/Technical data subject to alternations/ Quality Systems ISO 9001/201712