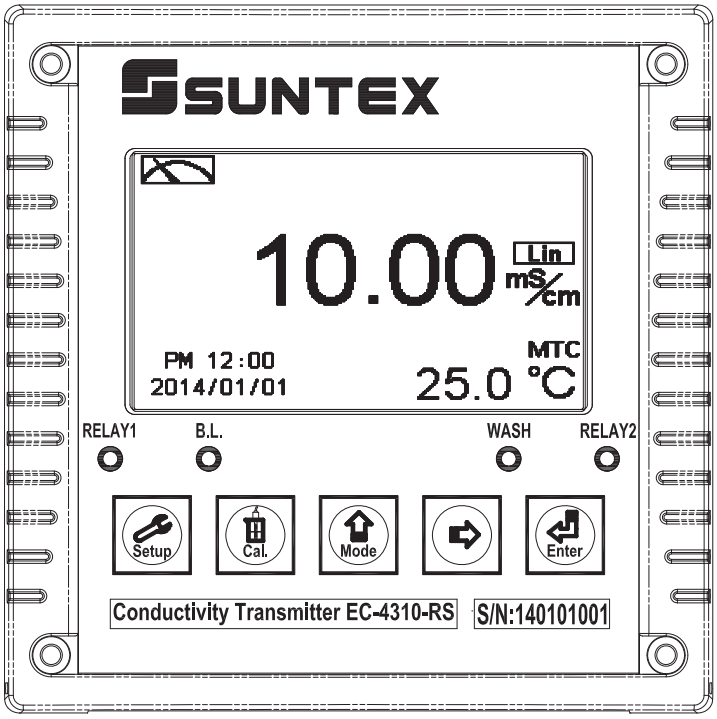
# EC-4310-RS Intelligent Conductivity Transmitter

**Operation Manual**




SUNTEX

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## Precautions for installation

Wrong wiring will lead to breakdown or electrical shock of the instrument, please read this operation manual clearly before installation.

- Make sure to remove AC power from the transmitter before wiring input, output connections, and remove it before opening the transmitter's housing.
- The installation site of the transmitter should be good in ventilation and avoid direct sunshine.
- The material of signal cable should be special coaxial cable. Strongly recommend using our coaxial cable. Do not use normal wires instead.
- Avoid electrical surge when using power. Especially when using three-phase power, use ground wire correctly. If the power surges interference occurs, separate the power supply of transmitter from the control device, such as: dosing machines, mixers, etc. to make individual power supply for the transmitter; or set surge absorber to reduce the power surges at all electromagnetic switches and power control device coils.
- The internal relay contact of the instruments is for alarm or control function. Due to safety, **please must connect to external relays which can stand enough ampere to make sure the safety operation of the instrument.**（Please refer to chapter 3.6 "Illustration of electrical connection"）
- There a manufacturer logo usually shows in the display of transmitter, and the illustration of each function in the manual is no longer expressed.

# Brief Instruction

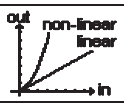
## Description of set-up settings (see chapter 7 for details)

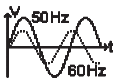
Press [Setup] and [Mode] simultaneously to see the overview of the set-up settings now. Then press [Enter] if you would like to modify set-up settings. Press keypad according to index of keypad on the screen.

**Index of keypad**

| keypad | Accordingly item | Description |
|---|---|---|
| Setup | SET:Back | Back to upper layer |
| Mode | ▲: ◢ | Choose leftward of change to left page |
| | ▲: + | Increase digit |
| ⇨ | ▶: ◢ | Choose rightward of change to right page |
| | ▶: − | Decrease digit |
| Enter | ENT: Enter | Confirm settings after modifications and then go through next step |

**Selection of set-up items**

| keypad | Accordingly item | Description |
|---|---|---|
| Mode |  | Measurement mode, to select Conductivity (Cond.), Resistivity (Res.), Total Dissolved Solids (TDS) or Salinity measurement |
| Product Adj. |  | Sample reading adjustment |
| Temperature |  | Temperature measurement and compensation, including MTC, PTC100Ω, PTC1KΩ, NTC (4 types total). MTC---Manual temperature compensation, PTC100Ω/PTC1KΩ/NTC--- auto temperature compensation |
| Compensation |  | Temperature compensation setting, selection from linear(Lin.), non-linear(Non-Lin.), off-compensation, 3 types |
| Relay 1 |  | First relay setting, to choose action off or Hi/Lo alarm |
| Relay 2 |  | Second relay setting, to choose action off or Hi/Lo alarm |

| | | |
|---|---|---|
| Clean |  | Automatic wash time setting, to choose electrode clean equipment's ON and OFF duration |
| Analog 1 |  | Current output according to Res, Cond., TDS or Sal. setting range |
| Clock |  | Clock setting **(When out of power and reboot it, the instrument's time setting will return to the factory pre-setting)** |
| RS-485 |  | RS485 serial interface (Modbus protocol) |
| Digital Filter |  | Take every serial 1~60 measurements, average them continuously, and make it as the readings |
| Black-light |  | Backlight setting, to set Auto/ON/OFF backlight, brightness, and sensitivity |
| Contrast |  | Contrast of screen setting |
| Logbook |  | Event recorder logbook (50 data) |
| Frequency |  | Power frequency setting |
| Return |  | Setting of returning to the measurement mode |
| Code |  | Security code of set-up mode. The set-up code is precedential to calibration code, thus it can pass a different security code of calibration. |
| Language |  | Available for English, Traditional Chinese, Simplified Chinese |

## Description of calibration settings (see chapter 8 for details)

Press [Cal.] and [Mode] simultaneously to see the last calibration information. Then press [Enter] if you would like to make a new calibration or modify setting of calibration. Press keypad according to index of keypad on the screen.

**Index of keypad**:

| keypad | Accordingly item | Description |
|---|---|---|
| Cal. | CAL:Back | Back to upper layer |
| Mode | ▲: ◢ | Choose leftward of change to left page |
| | ▲: + | Increase digit |
| ⇨ | ▶: ◢ | Choose rightward of change to right page |
| | ▶: − | Decrease digit |
| Enter | ENT: Enter | Confirm settings after modifications and then go through next step |

**Selection of calibration items**

| keypad | Accordingly item | Description |
|---|---|---|
| Cell Constant |  | To adjust the instrument cell constant setting until the value the same with the given cell constant of the sensor |
| Std. Solution |  | Use the appropriate standard solution to calibrate the system |
| Return |  | Time interval setting of returning to the measurement mode |
| Code |  | Security code of calibration mode. |

## Note

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

## 1. Specifications

| Model | | **EC-4310-RS** |
|---|---|---|
| Measuring modes | | Resistivity/Conductivity/TDS/Salinity/Temp. |
| Ranges | Resistivity | 0.00 MΩ·cm~20.00 MΩ·cm |
| | Conductivity | 0.000 μS/cm~2000 mS/cm (depends on selected sensor )in 7 ranges; Auto or Fixed |
| | Salinity | 0.0ppt~70.0ppt (according to IOT) |
| | TDS | 0ppm~19999ppm；0.00~199.99 ppt |
| | Temp. | PT-1000/PT-100: -30.0~200.0° C; NTC-30K: -30.0~130.0° C |
| Resolutions | Resistivity | 0.01 MΩ·cm |
| | Conductivity | 0.001 / 0.01 / 0.1 / 1 μS/cm, 0.01 / 0.1 / 1 mS/cm |
| | Temp. | 0.1˚C |
| Accuracy | Resistivity | ±1% (± 1 Digit) |
| | Conductivity | ±1% (± 1 Digit) |
| | Temp. | ± 0.2° C (± 1 Digit), (excluding two-wiring PT100) Equipped with temperature error correction function |
| Temperature Compensation | | Automatic with NTC 30K Ω / PT-1000 /PT-100 |
| | | Manual adjustment |
| Calibration mode | | (1) Manual cell-constant adjustment<br>(2) Conductivity standard solution calibration |
| Ambient Temp. | | 0~50 ˚C |
| Storage Temp. | | -20~70 ˚C |
| Cell constant | | 0.01, 0.05, 0.1, 0.5, 10.00 $cm^{-1}$ fixed,freely selectable 0.0080~19.99 $cm^{-1}$ |
| Temperature coefficient | | Linear temperature compensation at 0.00%~40.00%,<br>Non-linear compensation for pure water, and Off-compensation |
| Display | | Large LCM with auto-sense backlight and contrast function |
| | | Text mode: Numerical display |
| | | Chart mode: 3 mins real-time dynamic graph(Res. & Cond. only) |
| | | Trace mode: Set up from 3 mins to four weeks duration of the measured value trend graph(Res. & Cond. only) |
| Language | | Available for English, Traditional Chinese, Simplified Chinese |
| Analog output 1 | | Isolated DC 0/4~20mA corresponding to main measurement, max. load 500Ω |
| Logbook | | 50 event records |
| Serial interface | | RS-485(MODBUS RTU or ASCII) |
| Settings | Contact | 240VAC, 0.5A max. (recommend)) |
| | Activate | Hi/Lo. Hi/Hi. Lo/Lo selectable two limited programmable, ON/OFF |
| Wash | Contact | 240VAC, 0.5A max. (recommend) |
| | Time | ON: 0~99min.59sec. / OFF:0~999 hours59min |
| Power Supply | | 100~240VAC±10%, 7W Max., 50/60 Hz |
| Installation | | Wall or Pipe or Panel Mounting |
| Dimensions | | 144m × 144mm × 115mm (H×W×D) |
| Cut off Dimensions | | 138 mm × 138 mm (H×W) |
| Weight | | 0.8Kg |
| Protection | | IP 65 (NEMA 4X) |

**Note: The specifications and appearance of the instrument are subject to change without notice.**

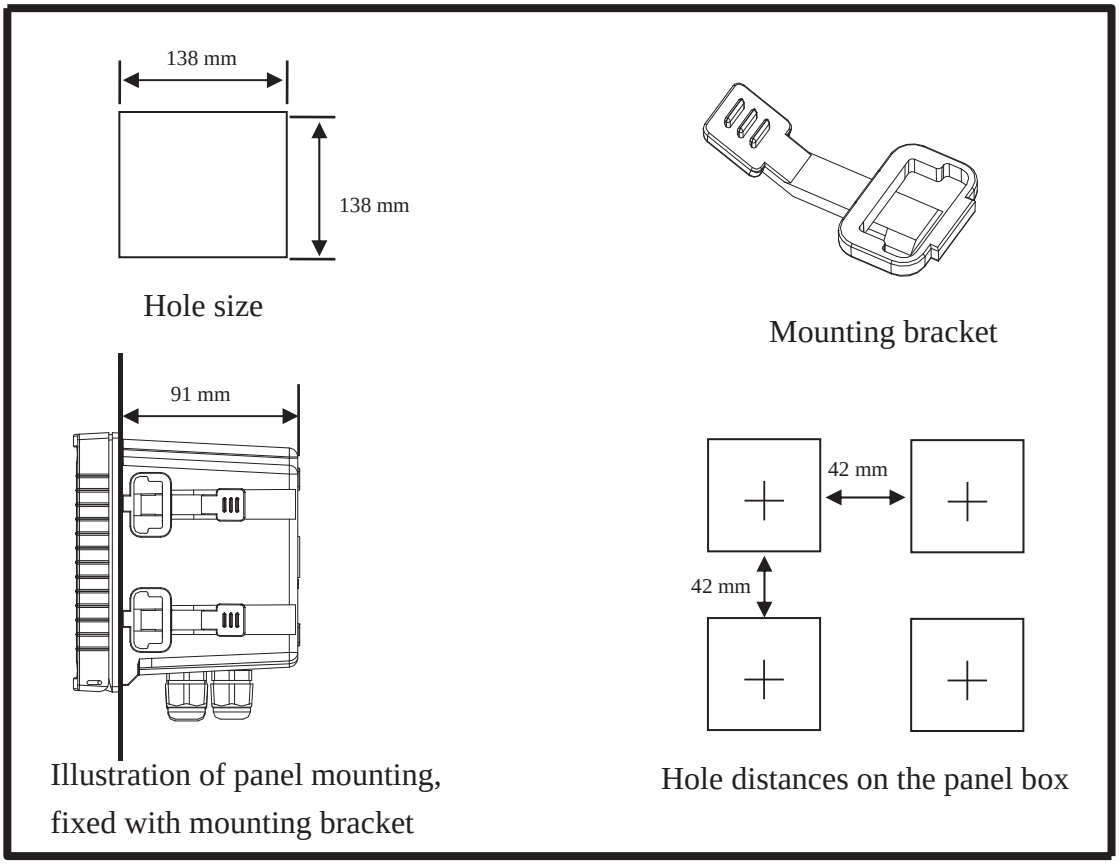
## 2. Assembly and installation

### 2.1 Transmitter installation:

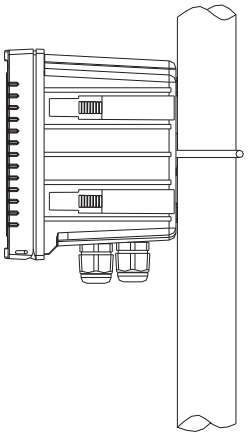
This Transmitter can be installed through panel mounting, wall mounting and 2” pipe mounting.

**Installation of panel mounting:**
First, prepare a square hole of 138 x 138mm on the panel box, and then insert the transmitter directly into the panel box. Insert the accessorial mounting bracket from the rear, and make it be fixed into pickup groove.

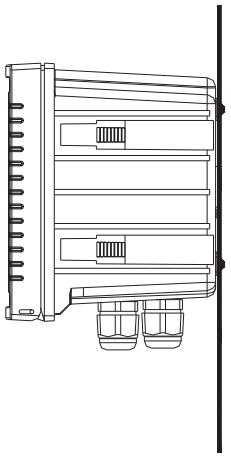
### 2.2 Illustration of panel mounting



## 2.3 Illustration of wall mounting and pipe mounting

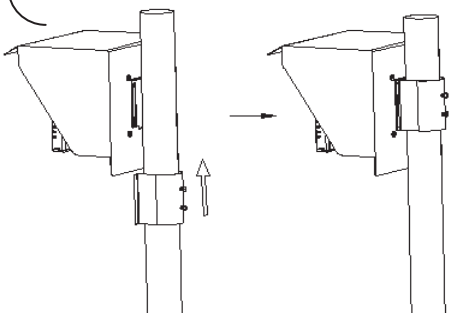


Installation of pipe mounting
Fixed with U-shaped pipe clamp.
(Optional, Order Number: 8-34)

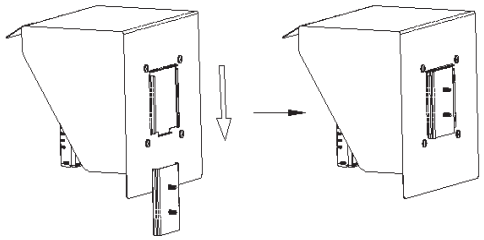


Installation of wall mounting
Fixed with 4 x M5 screws

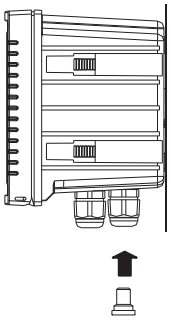
Penetrate the two prepared holes in the rear cover and fix the U-shaped pipe clip, and then install two waterproof squeezed caps (the transmitter's standard accessory kit) into the holes from inner rear cover to prevent from the water vapor.



Sun Shield (Pipe mounting, Optional)
( Order No.: 8-35 + 8-35-1)



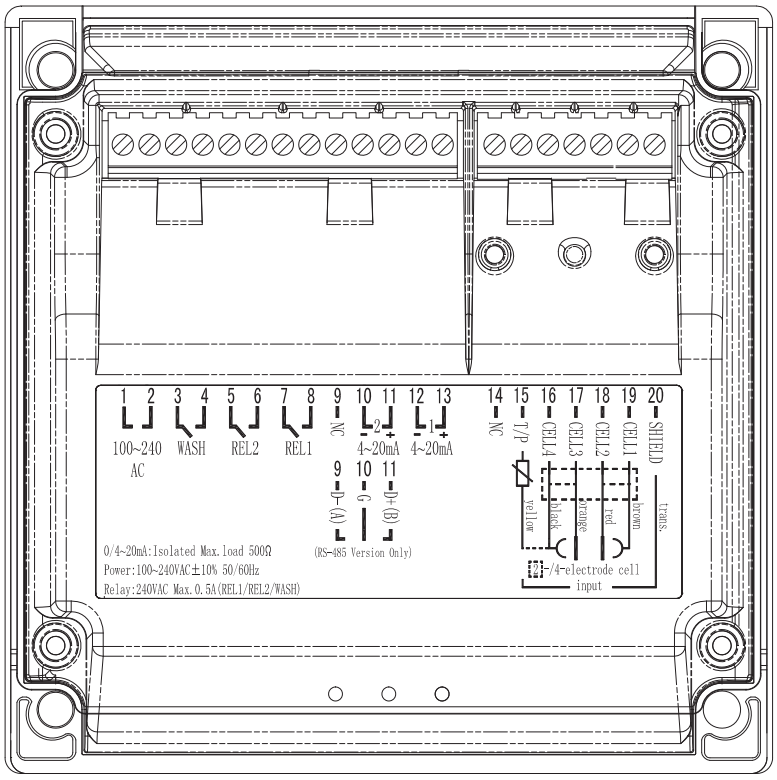
Sun Shield (Wall mounting, Optional)
(Order No.: 8-35 + 8-35-2)



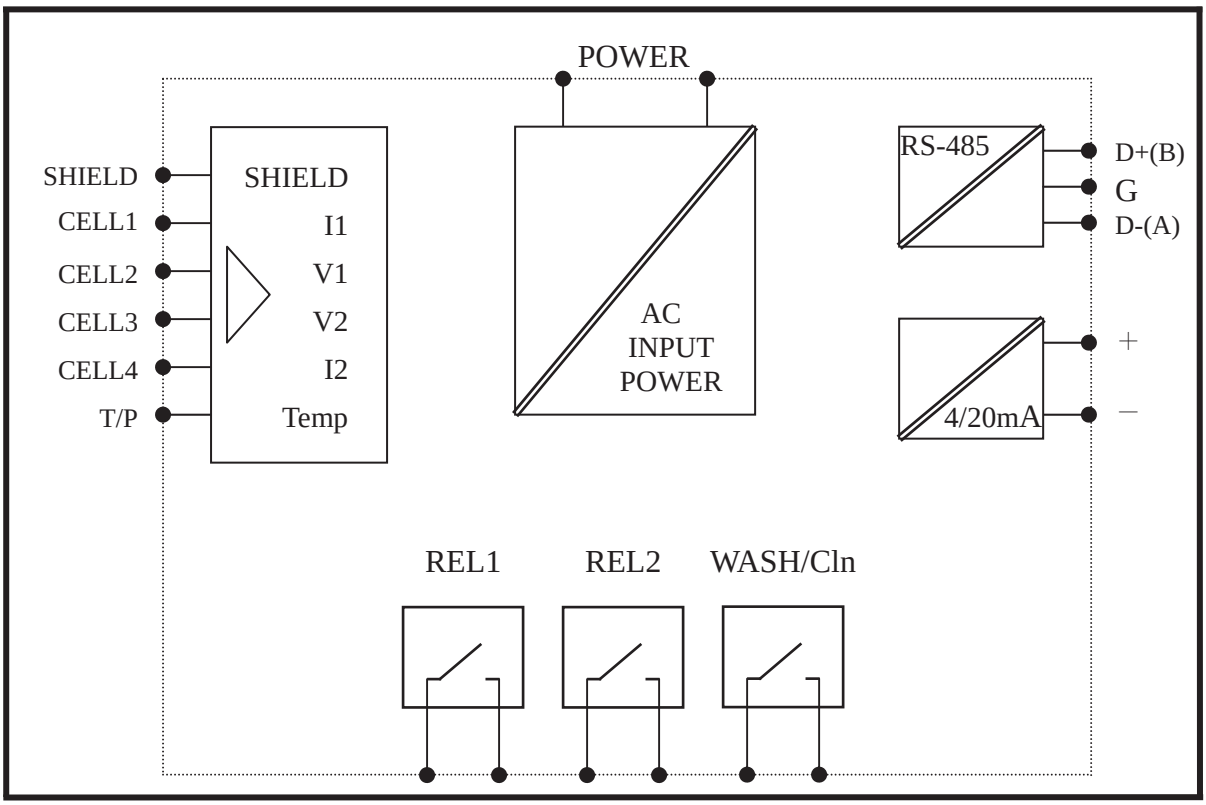
Insert the single hole rubber plug into the unused cable gland, and tighten up the cable gland to prevent from the penetration of water vapor.

# 3. Overview of Conductivity transmitter EC-4310-RS

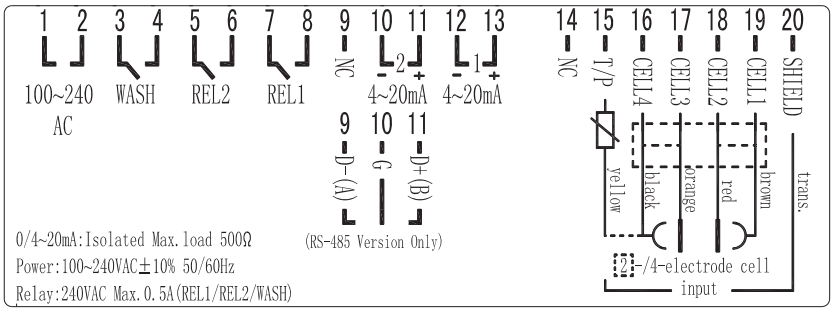
## 3.1 Illustration of rear panel




## 3.2 Illustration of terminal function



### 3.3 Description of terminal function




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 —— **NC / D-(A)**： None contact

10 —— **4~20mA -terminal / G**：RS-485 output GND

11 —— **4~20mA +terminal / D+(B)**：RS-485 output D+(B)

12 —— **4~20mA -terminal**：Master measure current output terminal -, for an external recorder or PLC control

13 —— **4~20mA +terminal**：Master measure current output terminal +, for an external recorder or PLC control

14 —— **NC**：None contact

15 —— **T/P**：Connect the cell wire of temperature probe

16 —— **CELL4**：The black cell wire or Current electrode 2。

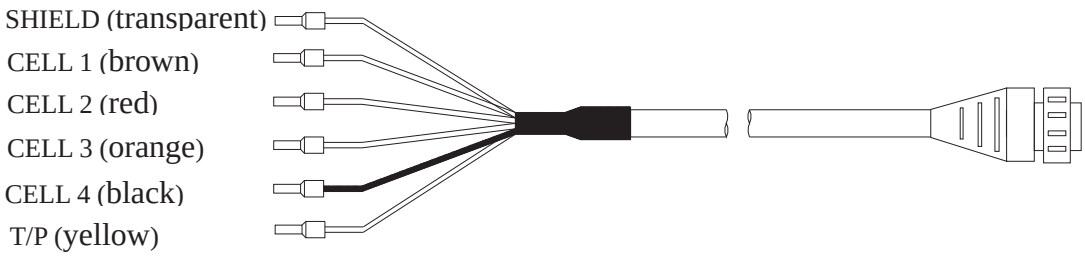
17 —— **CELL3**：The orange cell wire or Voltage electrode 2

18 —— **CELL2**：The red cell wire or Voltage electrode 1。

19 —— **CELL1**：The brown cell wire or Current electrode 1。

20 —— **SHIELD**：The transparent cell wire

### 3.4 Wiring of cable

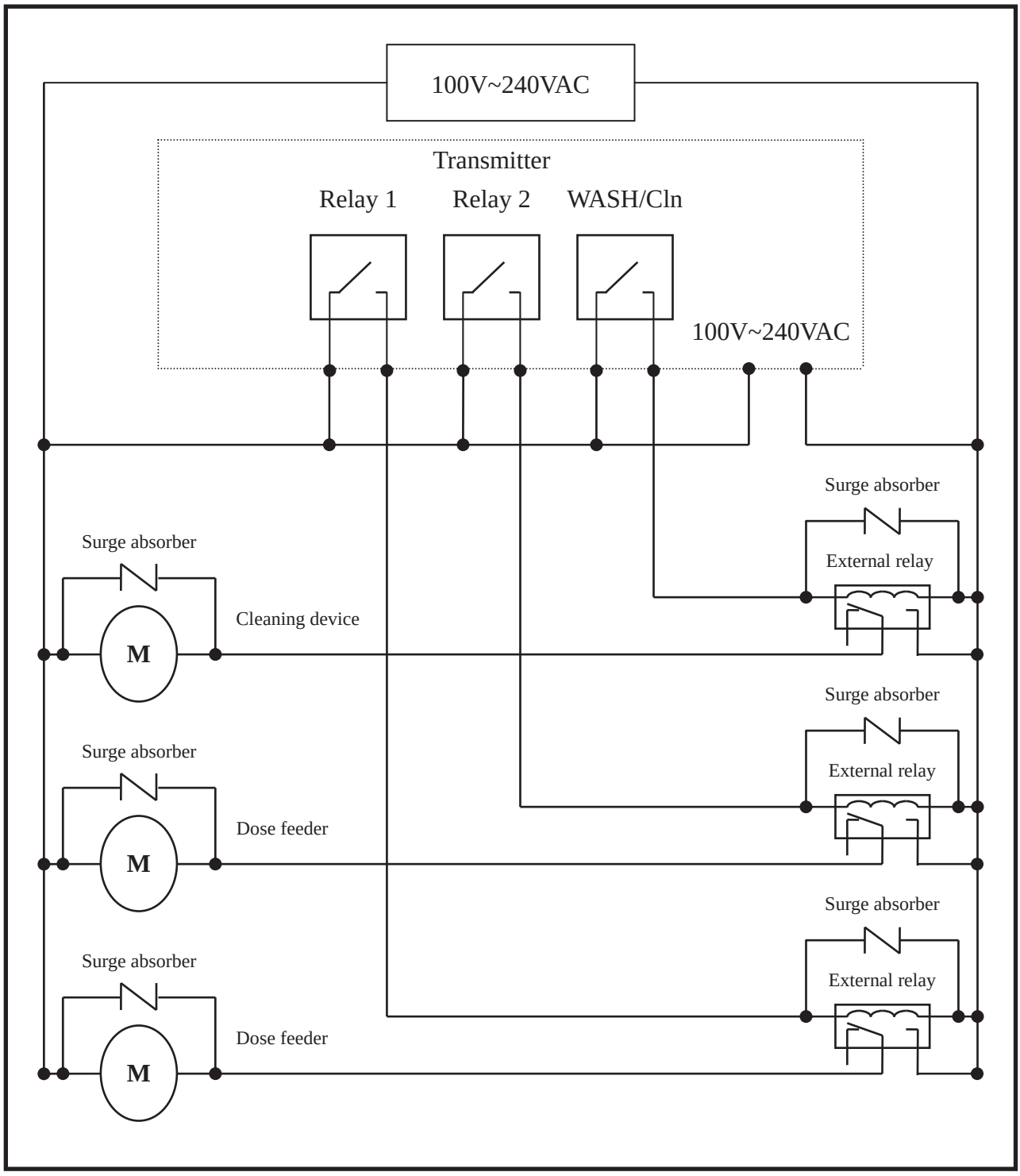



### 3.5 Circuit of cable

| | SUNTEX Conductivity Cell | | | Others |
|---|---|---|---|---|
| Terminal sign | 2-Electrode Cell 8-221/8-222/8-223 4-Electrode Cell 8-241/8-241-01/8-242/8-244 | Fixed Cable Resistivity Cell 8-11-3 | Fixed Cable Conductivity Cell 8-12-6 | Please read the instruction of the cells |
| SHIELD | Transparent line | Shield line | Shield line | SHIELD |
| CELL 1 | Brown line | Short with transparent line | Short with transparent line | Current electrode 1 |
| CELL 2 | Red line | | | Voltage electrode 1 |
| CELL 3 | Orange line | Short with white line | Short with green line | Voltage electrode 2 |
| CELL 4 | Black line | | | Current electrode 2 |
| T/P | Yellow line | Yellow line | Red line | T/P(the other side for CELL 4 |

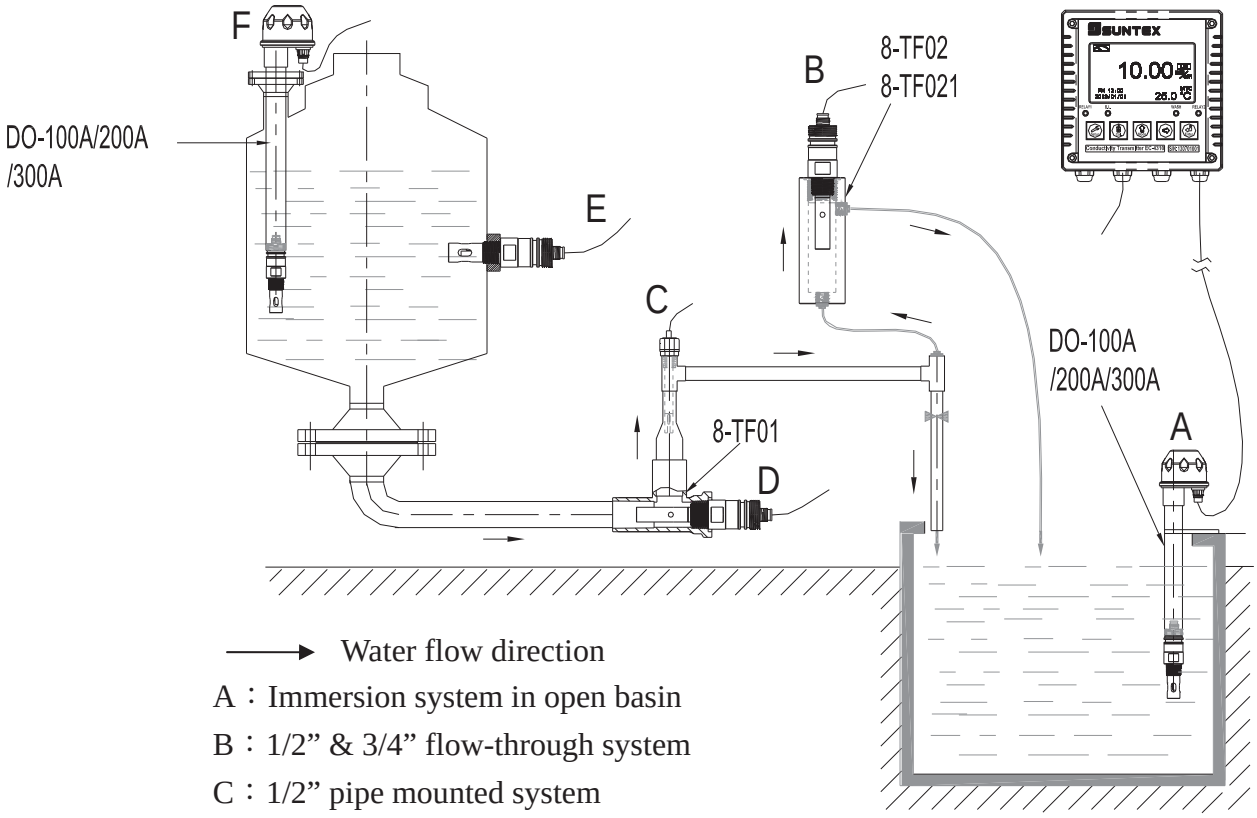
**Note: If use other brand's 2-Electrode cell, the circuit of cable is the same with that for 8-11-3 or 8-12-6 cell.**

### 3.6 Illustration of electrical connection




Note: The transmitter built-in miniature relay is necessary to be repaired and replaced by professional technicians. It is recommended to use an external relay (Power Relay) to activate the external equipments.

### 3.7 Online EC/RC pipe system（Optional）




Water flow direction

A：Immersion system in open basin

B：1/2” & 3/4” flow-through system

C：1/2” pipe mounted system

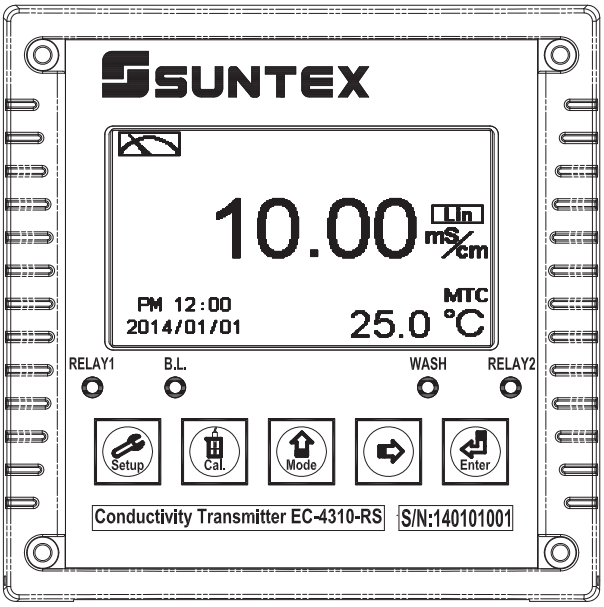
D：3/4” horizontal pipe mounted system

E：3/4” side-entry system in vessel

F：Top-entry system in closed vessel

# 4. Configuration

## 4.1 Illustration of front panel




## 4.2 Keypad

In order to prevent inappropriate operation by others, before the parameter setting and calibration, the operation applies multi-keys, and coding protection if necessary. Description of the key functions is in the following:


: In the parameter set-up mode, pressing this key allows you exit parameter set-up mode and back to Measurement mode.


: In the Calibration mode, pressing this key allows you exit Calibration mode and back to Measurement mode.


: 1. In the parameter set-up mode and Calibration mode, pressing this key to select leftward or change to another page.
2. When adjusting value, press this key to increase the value.

: 1. In the parameter set-up mode and Calibration mode, pressing this key to select rightward or change to another page.
2. When adjusting value, press this key to decrease the value.


: Key for confirmation; pressing this key is essential when modifying data value or selecting the parameter setting items in the window.

## 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, the lamp will light or go out as the change of environmental brightness in the automatic display backlit mode.

# 5. Operation

## 5.1 Measurement mode:

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

## 5.2 Set-up menu:

Please refer to the set-up instructions in Chapter 7. Press [Setup] and [Mode] simultaneously to enter into set-up menu, and press [Setup] to go press to back to measurement mode.

## 5.3 Calibration menu:

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

## 5.4 Shortcuts:

1. In the measurement mode, if selecting MTC for temperature compensation mode, you may press [Mode] and [⇨] to adjust MTC temperature value.
2. Under measurement mode, press [Setup] continuously for 2 seconds to see the Logbook function directly. Press [Setup] key to back to measurement mode.
3. Under measurement mode, press [Enter] continuously for 2 seconds to switch the display mode from text mode, trace mode, and real-time chart display mode.

## 5.5 Default value:

### 5.5.1 Setting default value:

Measurement mode: Conductivity, Auto-Range
Temperature compensation: NTC 25˚C
Temperature Coefficient: Lin, 2.00%
Relay 1: High point alarm: AUTO, SP1= 100.0mS, Hys.=10.0mS
Relay 2: Low point alarm: AUTO, SP2 =10.0 mS, Hys.= 1.00 mS
Wash time: OFF
Analog 1 current output (Cond/Res): 4~20 mA, 0.00~199.9mS
Date & Time: 2014/1/1 00:00:00
RS-485: RTU, 19200, Even, 1, ID:001
Digital filter: 0
Backlight setting: Off
Contrast: 0
Logbook: None
Auto back: Auto, 3 minutes
Code set-up: Off

### 5.5.2 Calibration default value:

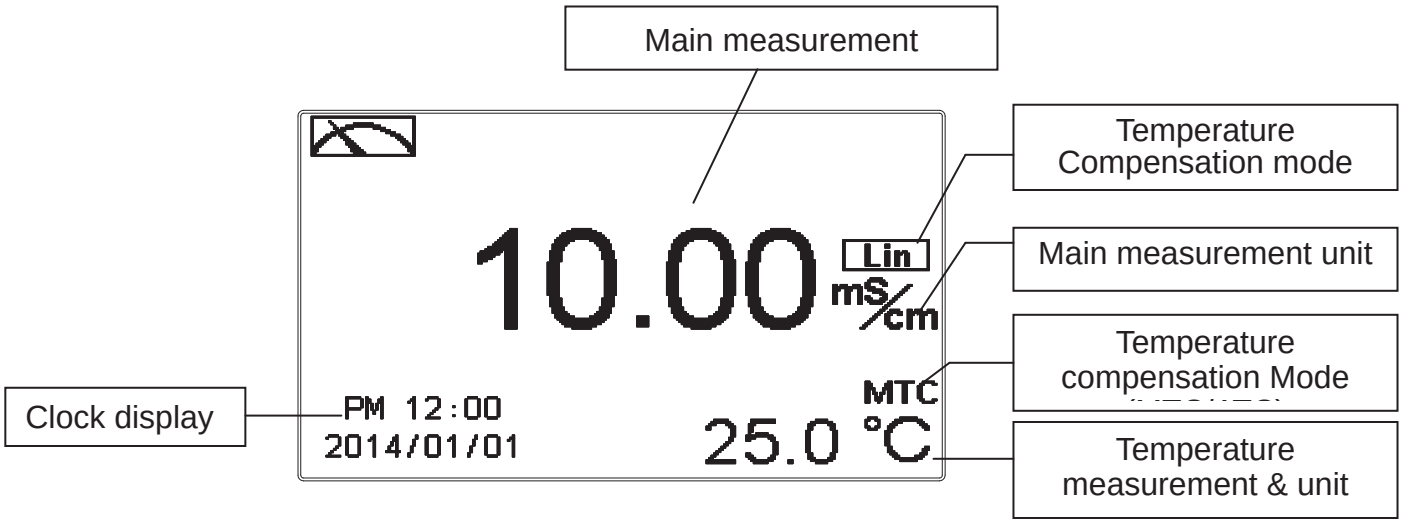
Cal Type: No Cal
Cal Temp: None
Cell Constant: 0.5000
Auto back: Auto, 3 minutes
Code set-up: Off

Note: The factory default of calibration presetting is “No Cal”, and the cell constant setting is “0.5000”. It means that the user has not calibrated the sensor with the transmitter yet. When selecting standard solution to finish calibration, the display shows cell constant of the cell and the value of the standard solution.

## 6. Measurement display mode

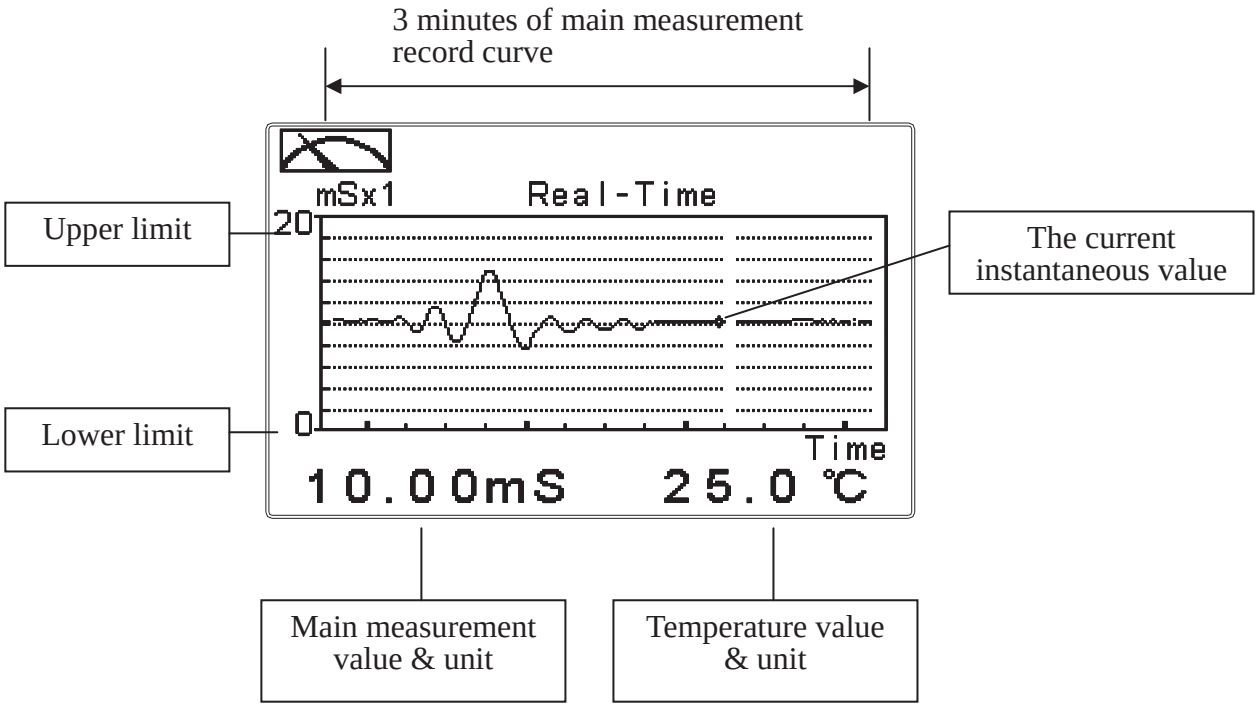
### 6.1 Text mode

The normal mode is for digit display, the content is as the following illustration. It mainly includes main measurement value and unit, temperature measurement value and unit, temperature compensation mode, and clock display.



### 6.2 Real-Time chart mode

Real-time chart mode is for dynamic display of real-time graphics. The duration is about three minutes of the recent changes in measured values of the curve. Users can set the mode to its corresponding Cond/Res measuring range (see section 7.4). The smaller the range is set, the higher resolution of the display is. When entering setup or calibration mode and returning to measurement mode, the real-time graphic will be re-updated. 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 depict, which is describe the range of representatives of each of 1 / 4 minutes (15 seconds).

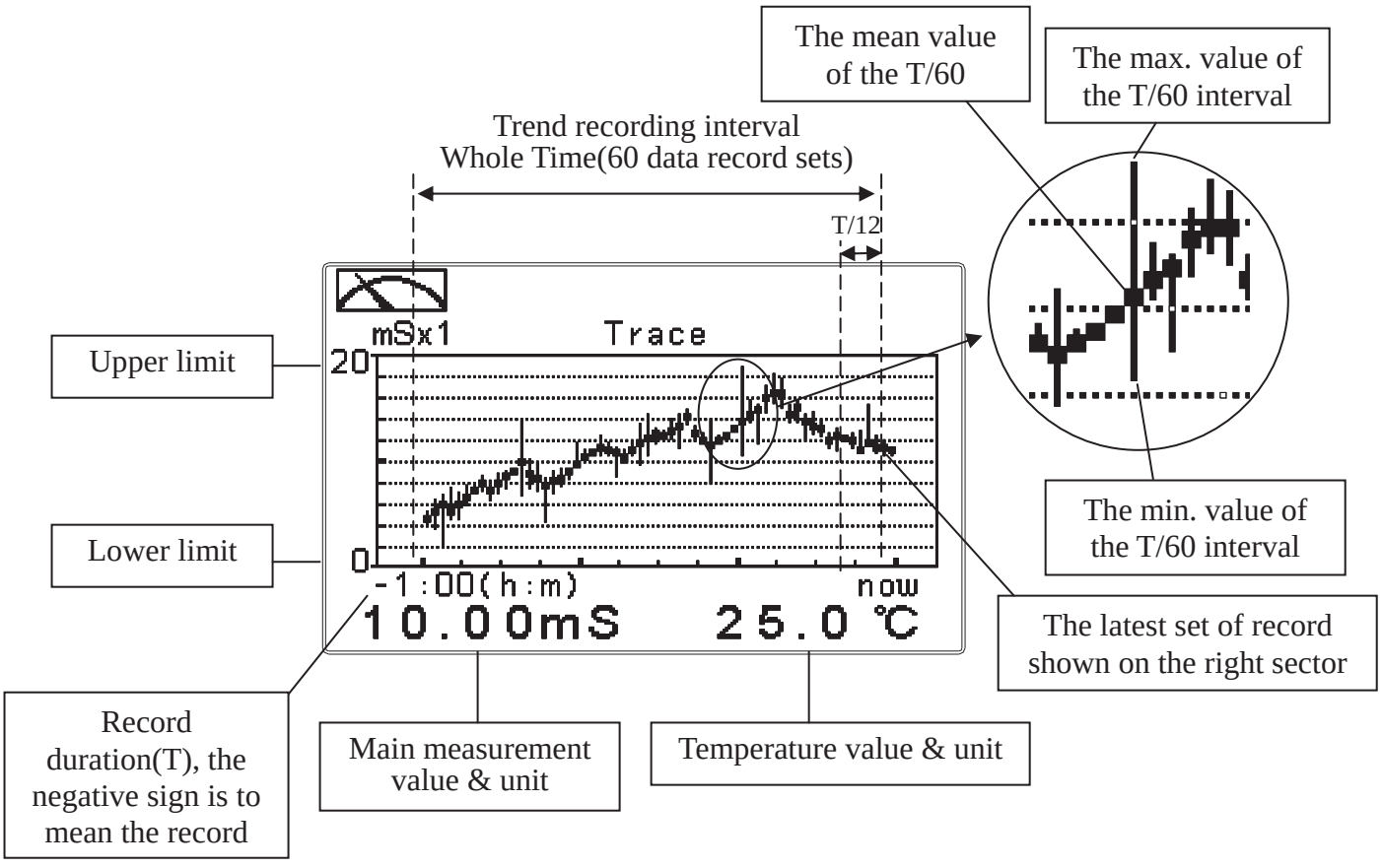


### 6.3 Trace mode

The feature of the trace mode is the record duration which can be set by the user (range from three minutes, up to four weeks). The trend graphic records the measurements in the past T time. The trend is recorded by the 60 group structure. Hence, each group of units is recorded in T/60 time interval. The trend line is constructed by all value data which is calculated to the average (Mean Value), maximum (Max Value) and minimum (Min Value) form. When the latest T/60 record shows in the rightmost of the trend graphic, all the previous record will be moved to the left side of the graphic. For example, T is set to 60 hours, then each set of records will be calculated to the average, the maximum, the minimum values after one hour(T/60 = 1), each time interval. Timeline of trends which is divided into 12 depictions showed on the horizontal axis of the display is on behalf of each characterization interval T/12. So, every depiction has 5 (T/60) sets of records. Users can set the corresponding Cond./Res. measuring range in its set-up menu(see section 7.4). The smaller the range is set, the higher resolution of the display is. The trace mode 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.

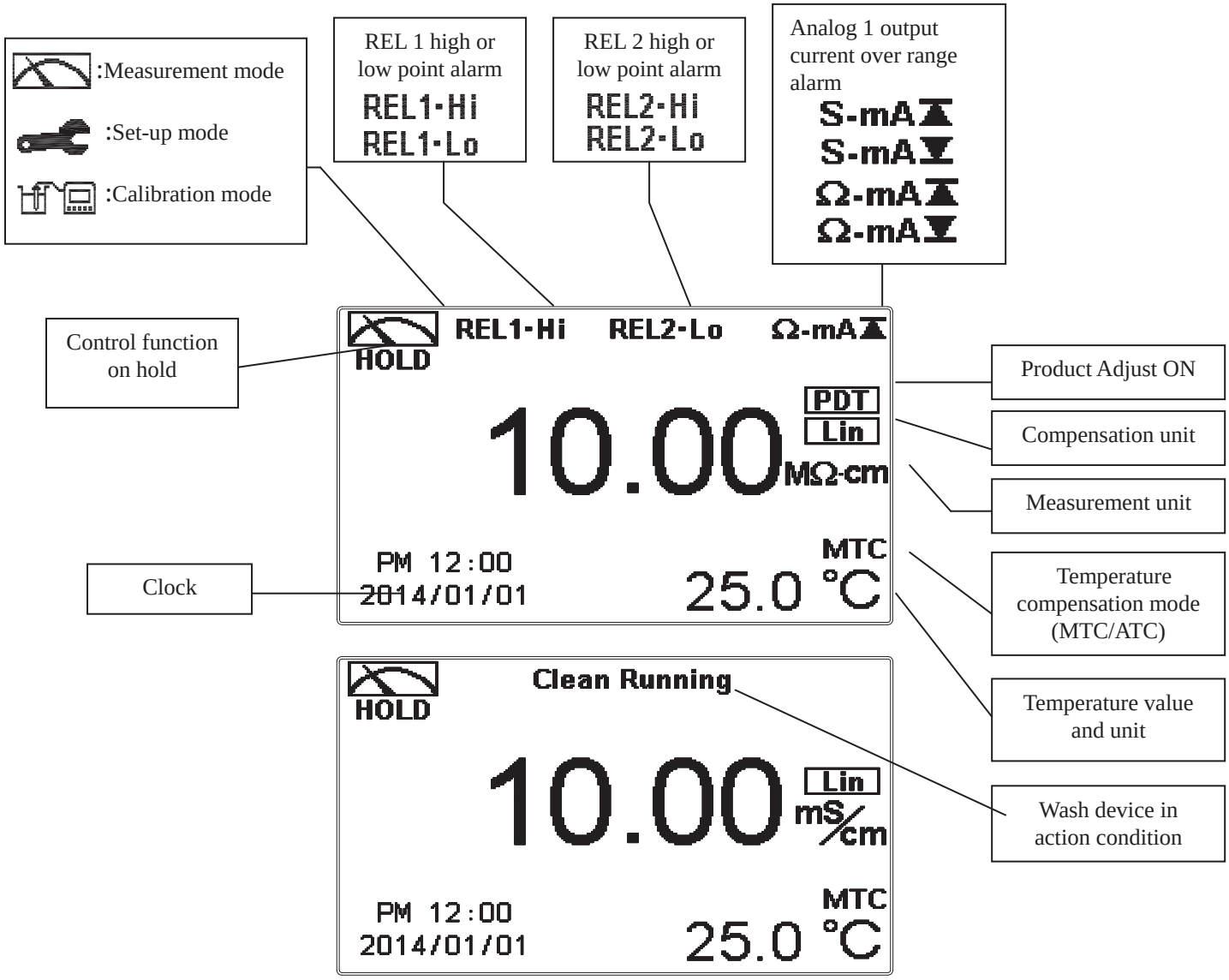
**Attention:** When the time interval has been reset, the trend in the data will not be retained, it will start a new trace record.

**Note:** The time display format (XX: XX) (hr: min), for example, appear as four weeks (672:00).



### 6.4 Warning symbols and text

1. When the clean function is activated, the display shows and twinkles the description, “Clean Running”. At the same time, the ACT indicator LED lights up, and the transmitter automatically turns off Relay 1 and Relay 2 function. After finishing cleaning, the Relay 1 and Relay 2 will automatically back to normal status.
2. When Relay 1/Relay 2 which is set in high setting point is in action, the display shows and twinkles the description, “REL 1-HI/REL 2-HI”, and ACT indicator LED lights up. When Relay 1/Relay 2 which is set in low setting point is in action, the display shows and twinkles the description, “REL 1-Lo/ REL 2-Lo”, and ACT indicator LED lights up.
3. When the Analog 1 current output exceeds the upper/lower limitation, the display twinkles ” S-mA▲ / S-mA▼ ” or ” Ω-mA ▲ /Ω-mA▼ “.

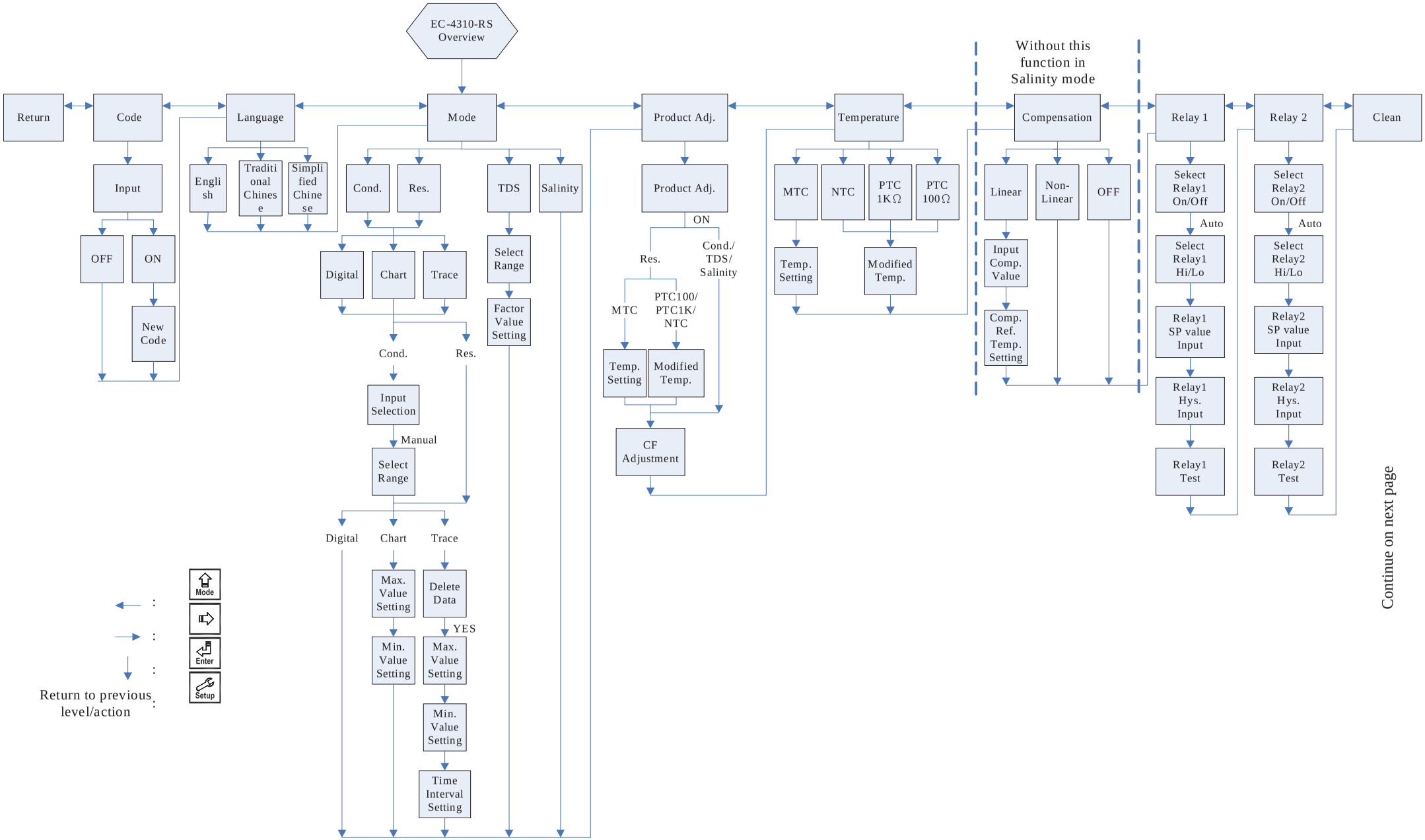



Note: The “HOLD” warning text appears when clean function is activated, or when entering setup menu, or when entering calibration menu. Under HOLD status, the corresponding display and output as follows:

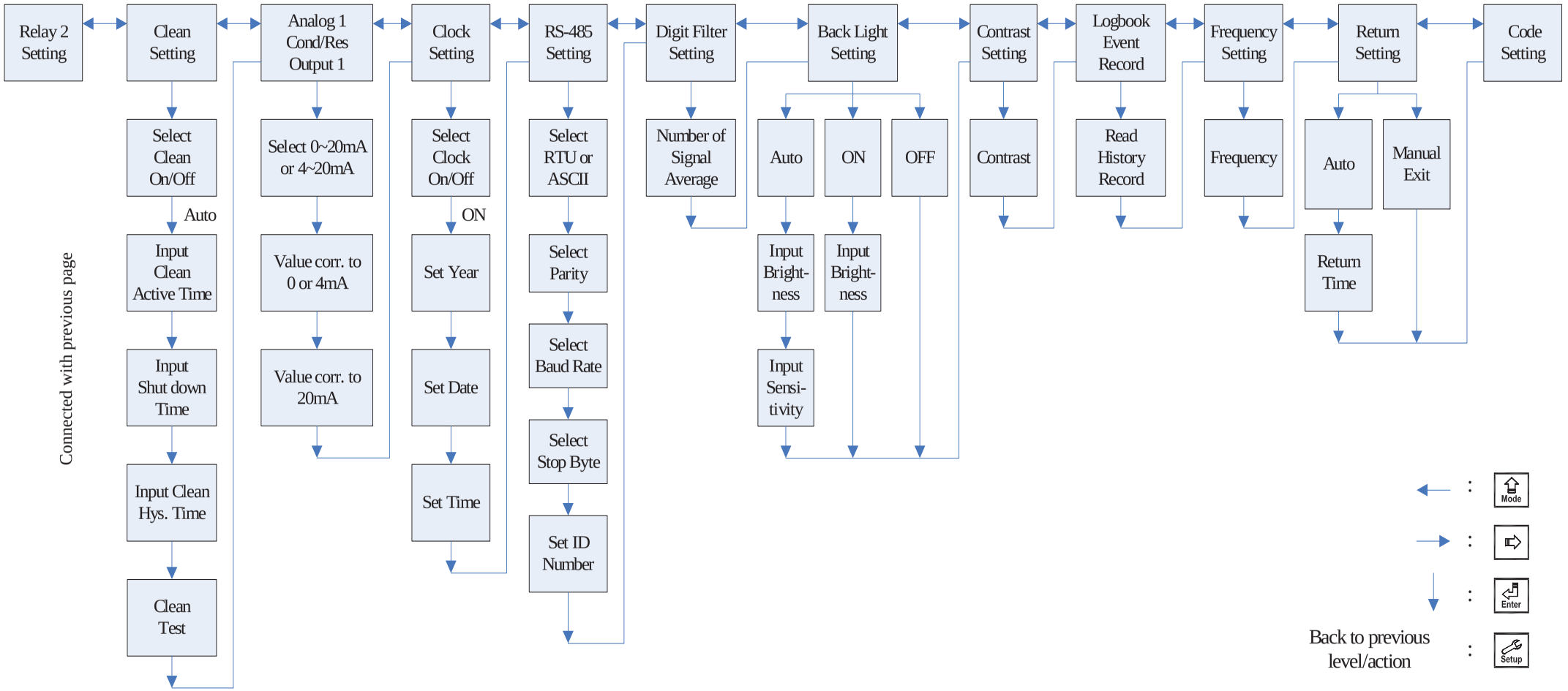
1. Both Relay 1 and Relay 2 cease from action. If enter setting menu or calibration menu under clean status, the instrument will stop clean status automatically.
2. The current output which is corresponding to measurement value remains at the last output value before HOLD status.
3. The last signal output value of RS-485 interface is kept at the last output value before HOLD status.

# 7. Settings

## Block diagram of setting-part 1

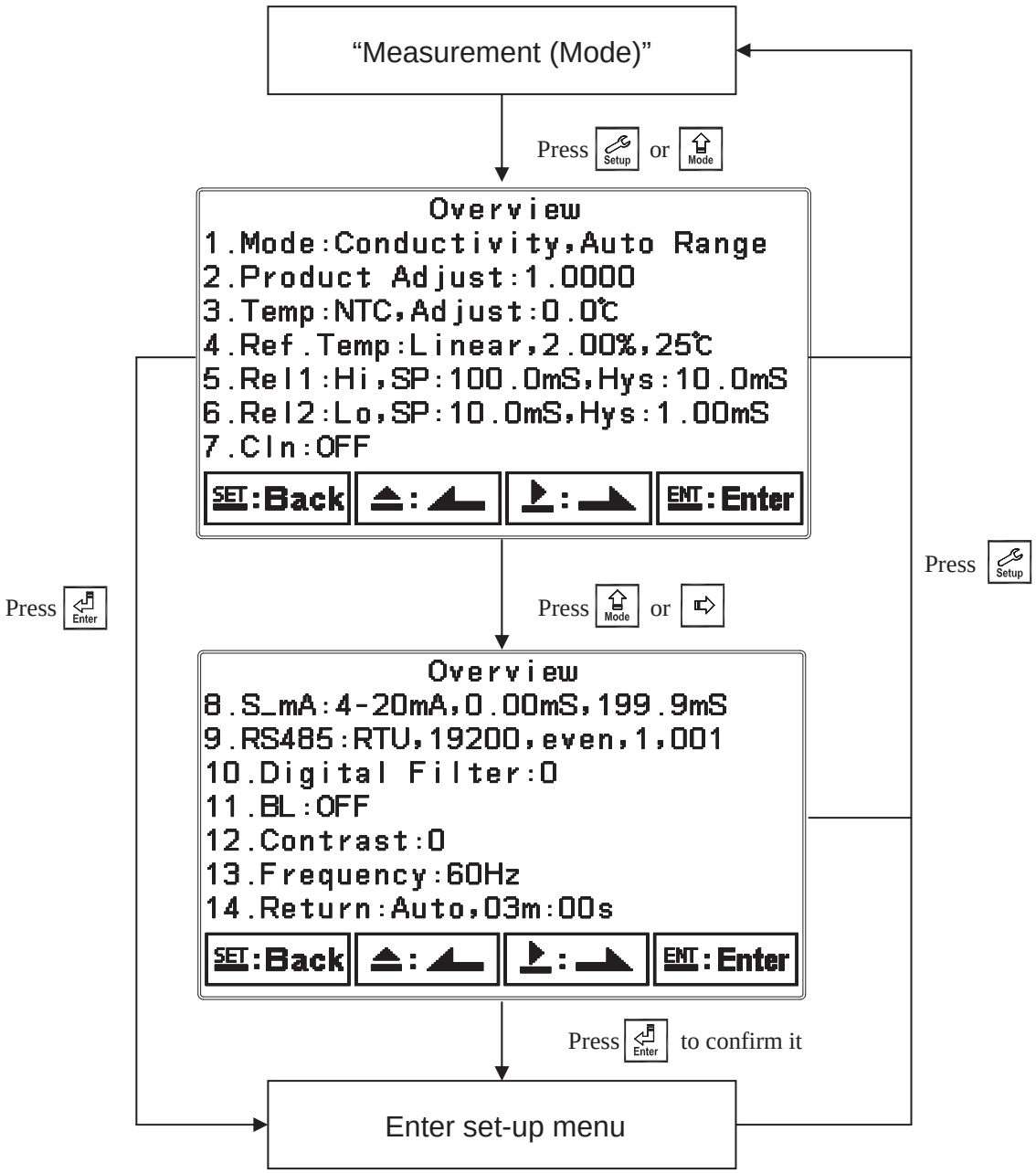


## Block diagram of setting-part 2



### 7.1 Entry of set-up menu

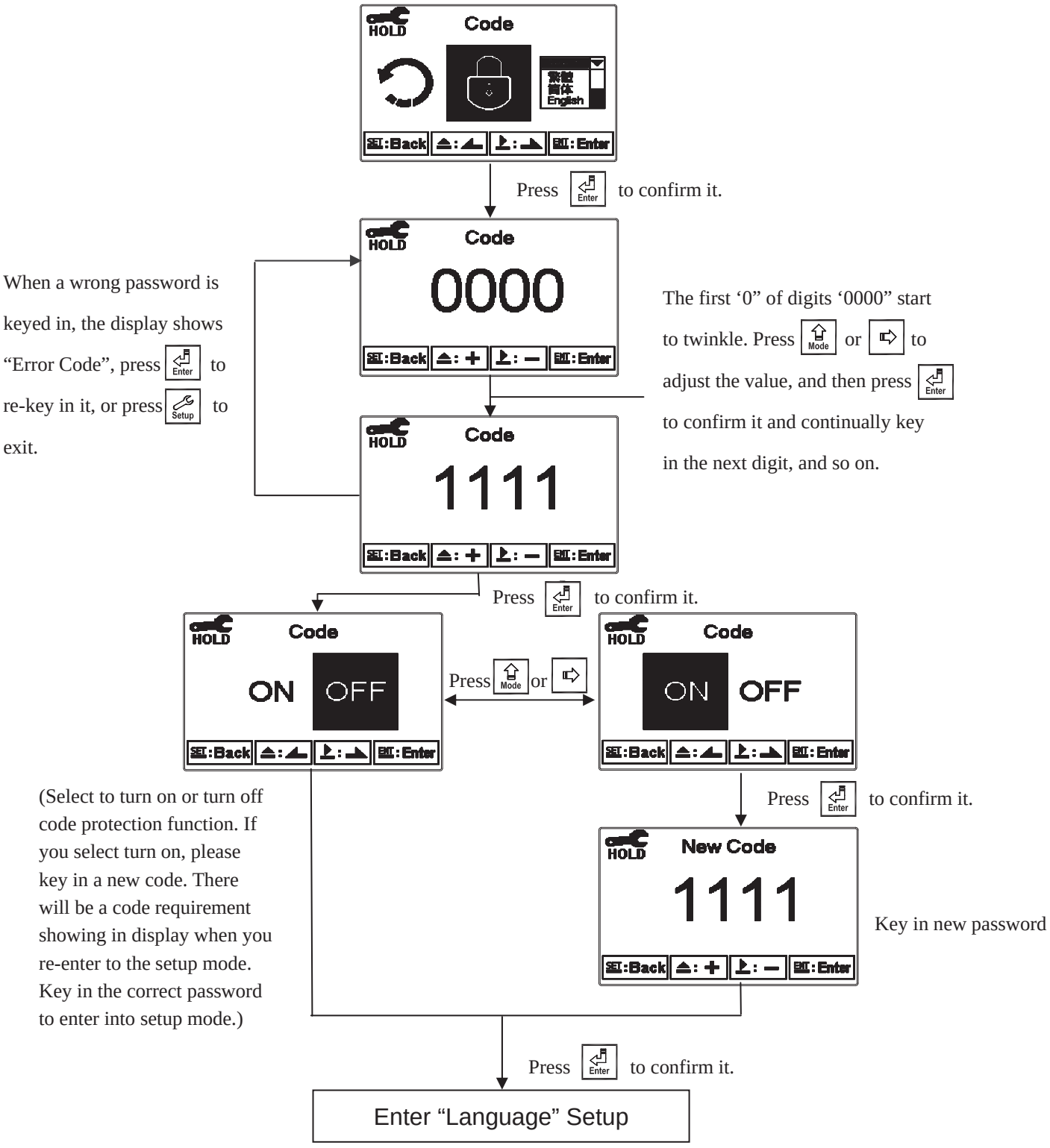
In the measurement mode, pressing the two keys Setup and Mode simultaneously allows you enter the overview of current setting, and press Enter to enter the set-up mode to modify the setting if necessary.



### 7.2 Security code of settings

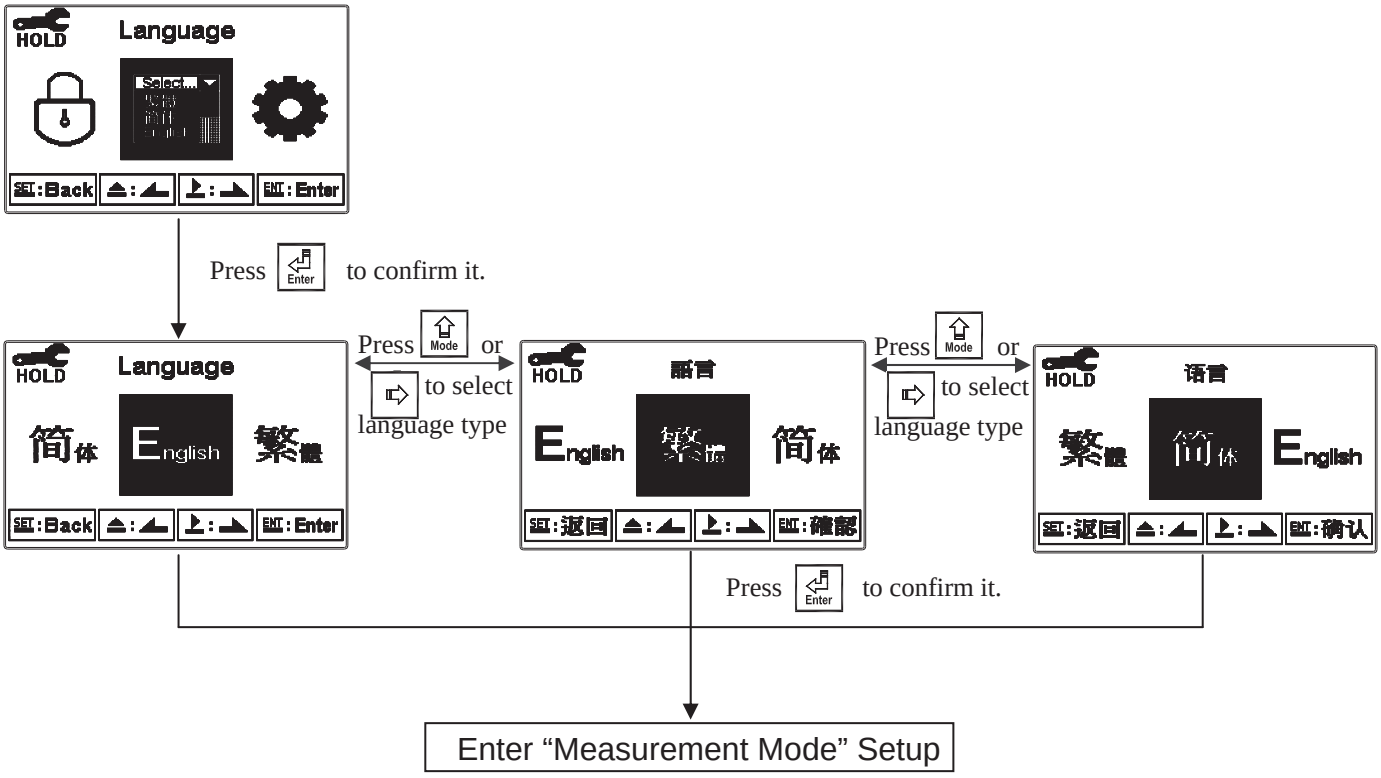
After entering set-up mode, select “code” item, press Enter to enter into code procedure. **The code pre-setting is 1111.**

**Note:** The code of setting mode is prior to the code for calibration. That means that the code of setting mode can be used for the code of calibration mode.



### 7.3 Language

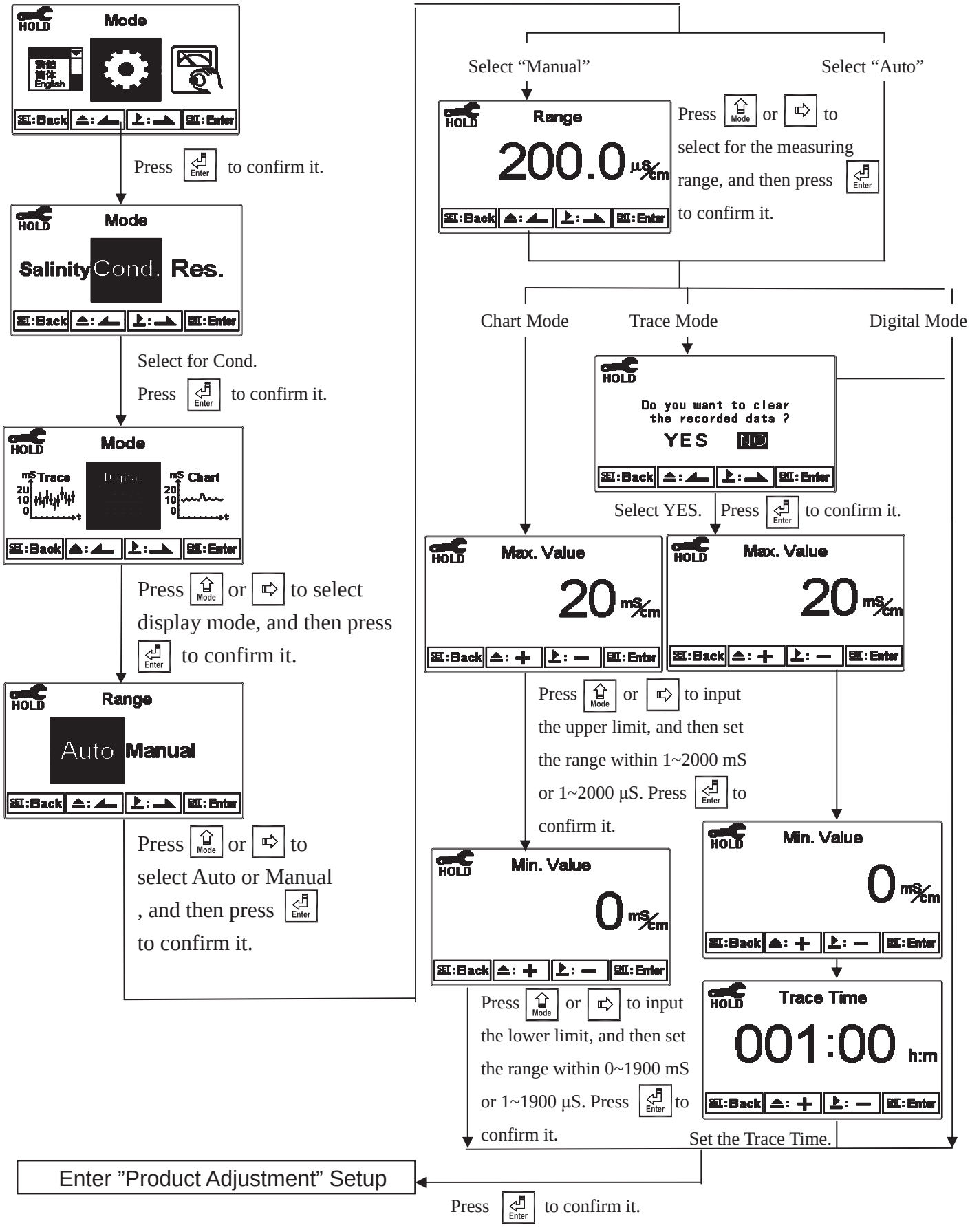
Enter Language setup menu, select the system language from English, Traditional Chinese and Simplified Chinese



### 7.4 Mode

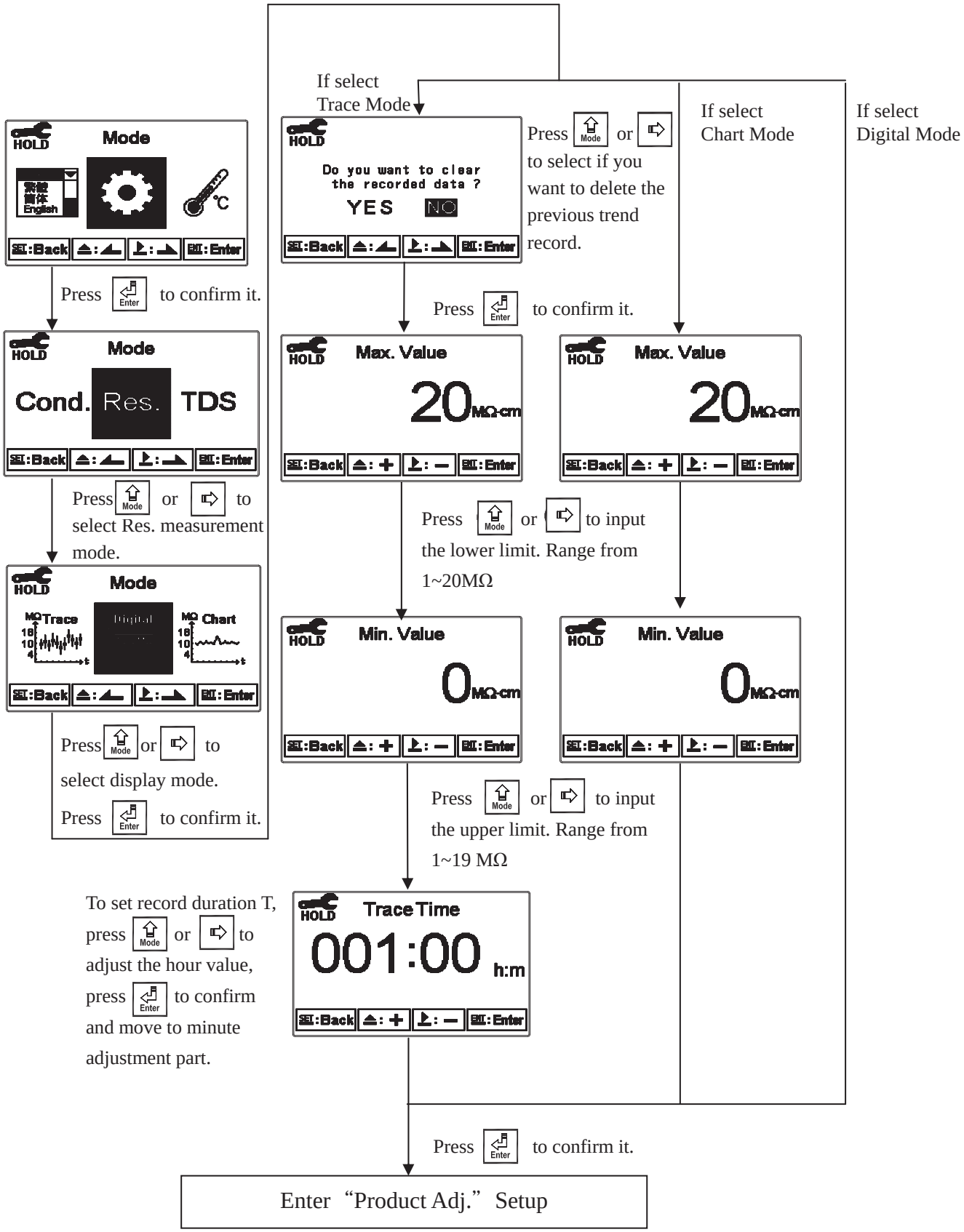
#### 7.4.1 Cond. Measurement Mode

Enter setup of “Mode”. Select for “Conductivity (Cond.)”, and select display mode, Auto Range, or Manual selection for 2.000μS, 20.00μS, 200.0μS, 2000μS, 20.00mS, 200.0mS or 2000mS.



### 7.4.2 Resistivity(Res.) measurement mode

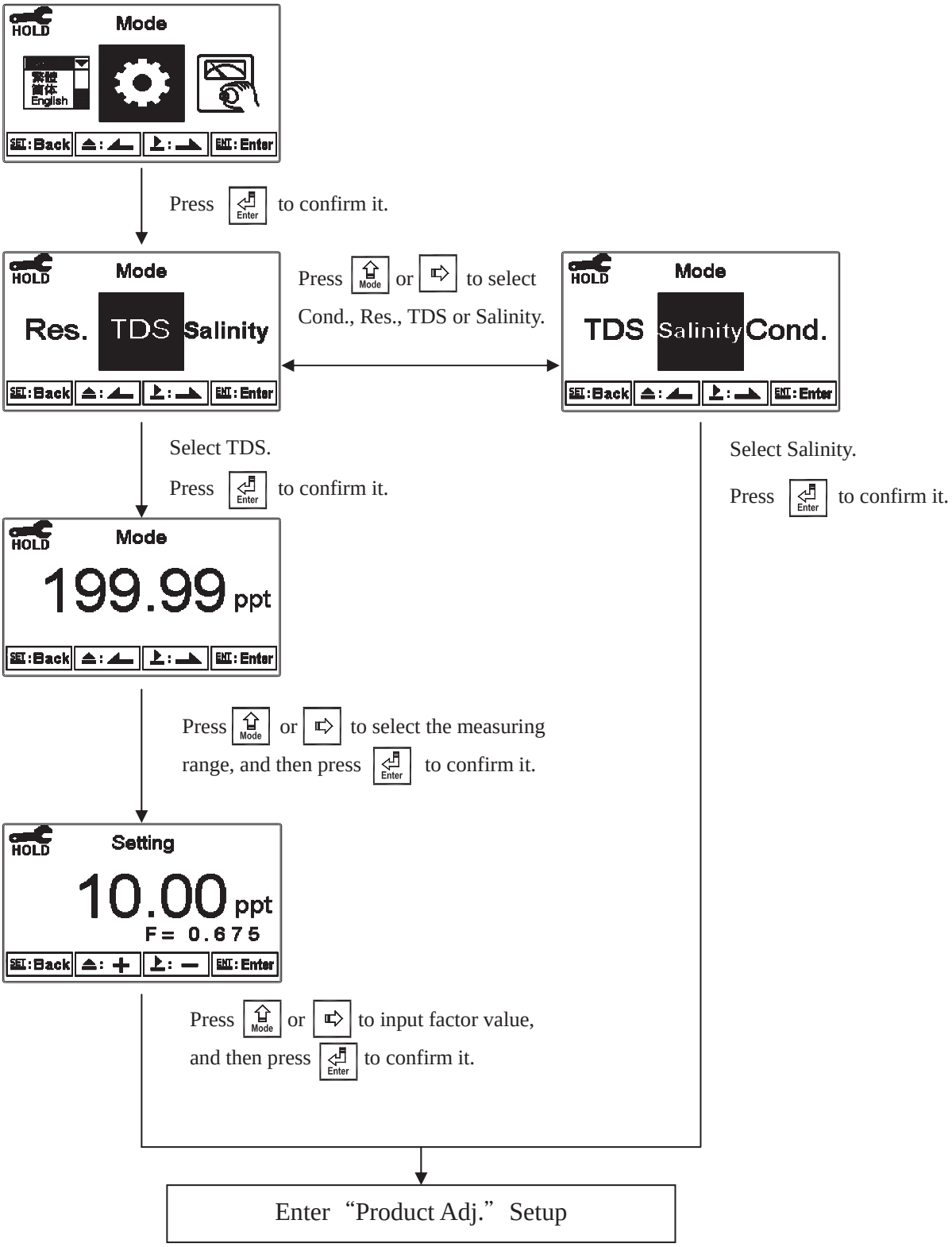
Enter setup of Mode, select Resistivity(Res.) measurement mode and select the display mode.



### 7.4.3 Salinity & TDS Measurement Mode

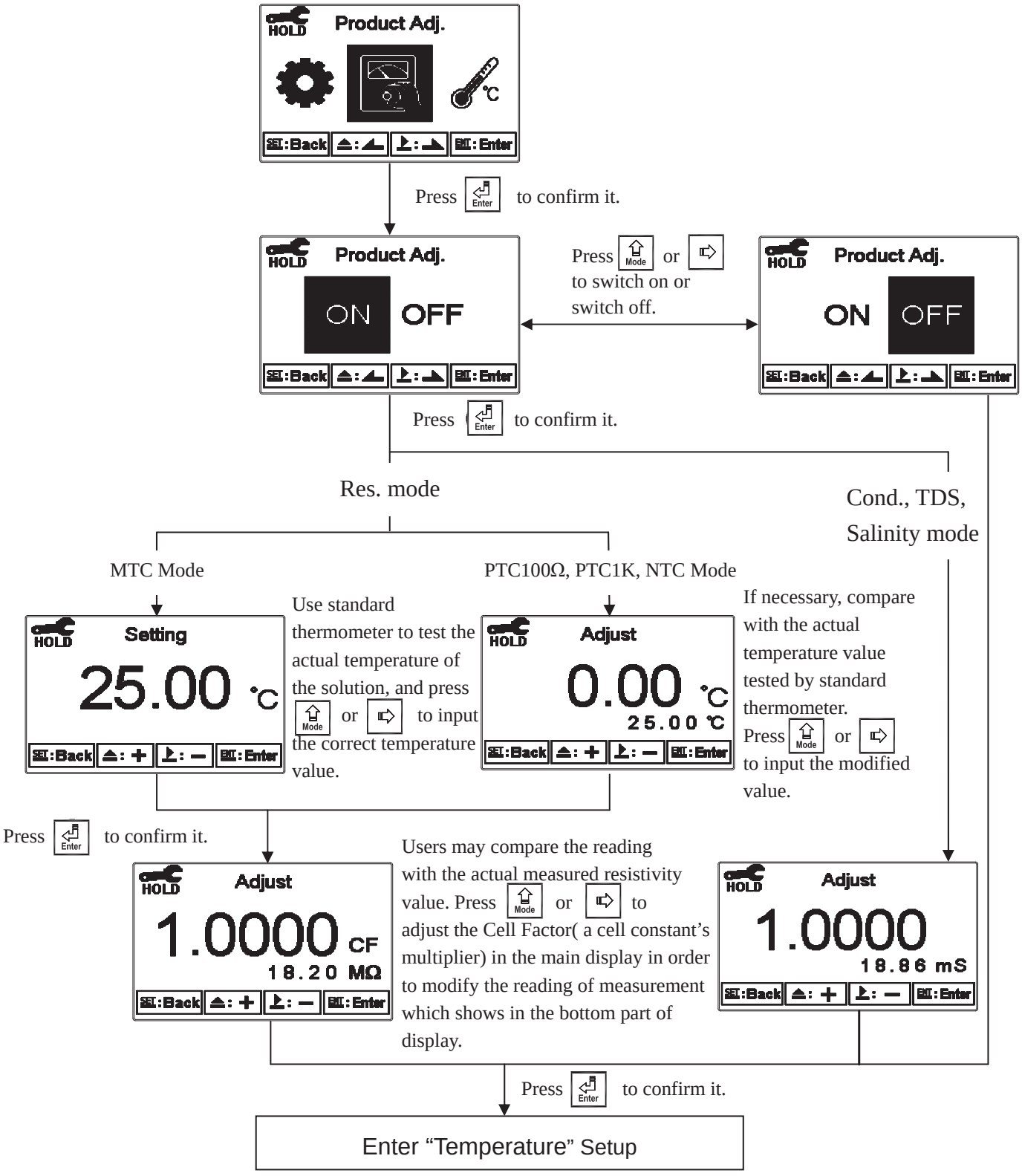
Enter into Mode setup, select Salinity or TDS for measurement.

TDS：Select the range from 0～19999ppm or 0～199.99ppt and set up the conductivity conversion factor.



## 7.5 Product Adjustment

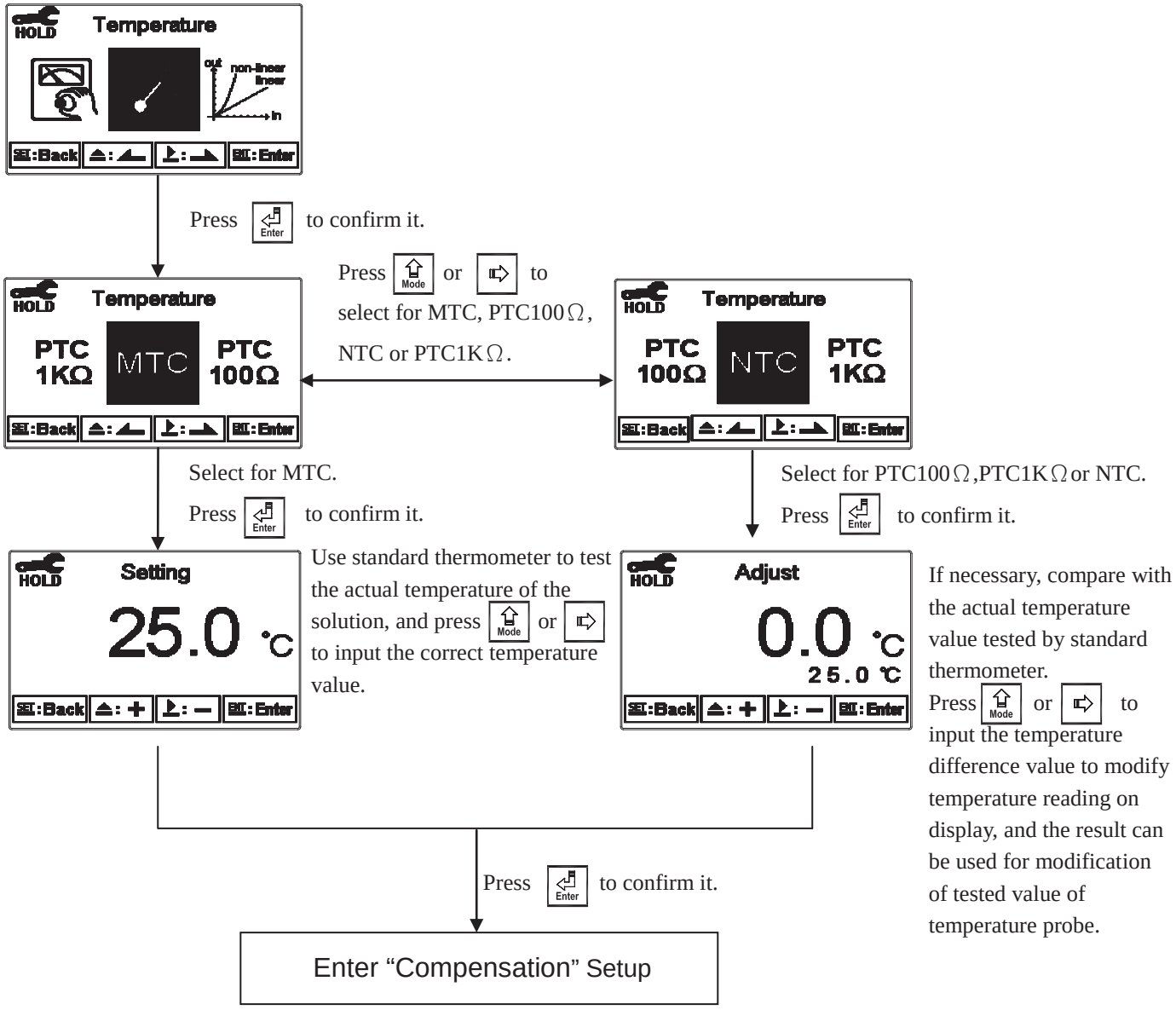
Enter setup of product adjustment to make the fine adjustment of the measurement reading. For ultra-pure water application, the function can increase the resolution of cell constant, and it makes users adjust the cell constant through a cell factor in the field. It also allows two decimal of the temperature display which increases the sensitivity of cell constant and temperature change and achieves the fine adjustment of reading up to 0.01Meg ohm. It helps the users to see the small change of reading or trend in ultra-pure water application.



### 7.6 Temperature

Enter setup of “Temperature” to select temperature compensation mode. Select from NTC(NT30K), PTC1KΩ(PT-1000), PTC100Ω(PT-100) for Auto Temperature Compensation or MTC(Manual adjustment).

Note: Due to two-wiring set-up of temperature circuit, length or thickness of wiring may cause the temperature error between actual temperature & measured temperature when selecting PTC1KΩor PTC100Ω for temperature compensation. After that, the temperature error can be modified by the next step “Adjust”.



## 7.7 Temperature Compensation Coefficient

The instrument's reference temperature of temperature compensation presets 25℃, and the temperature compensation coefficient presets 2.00%.

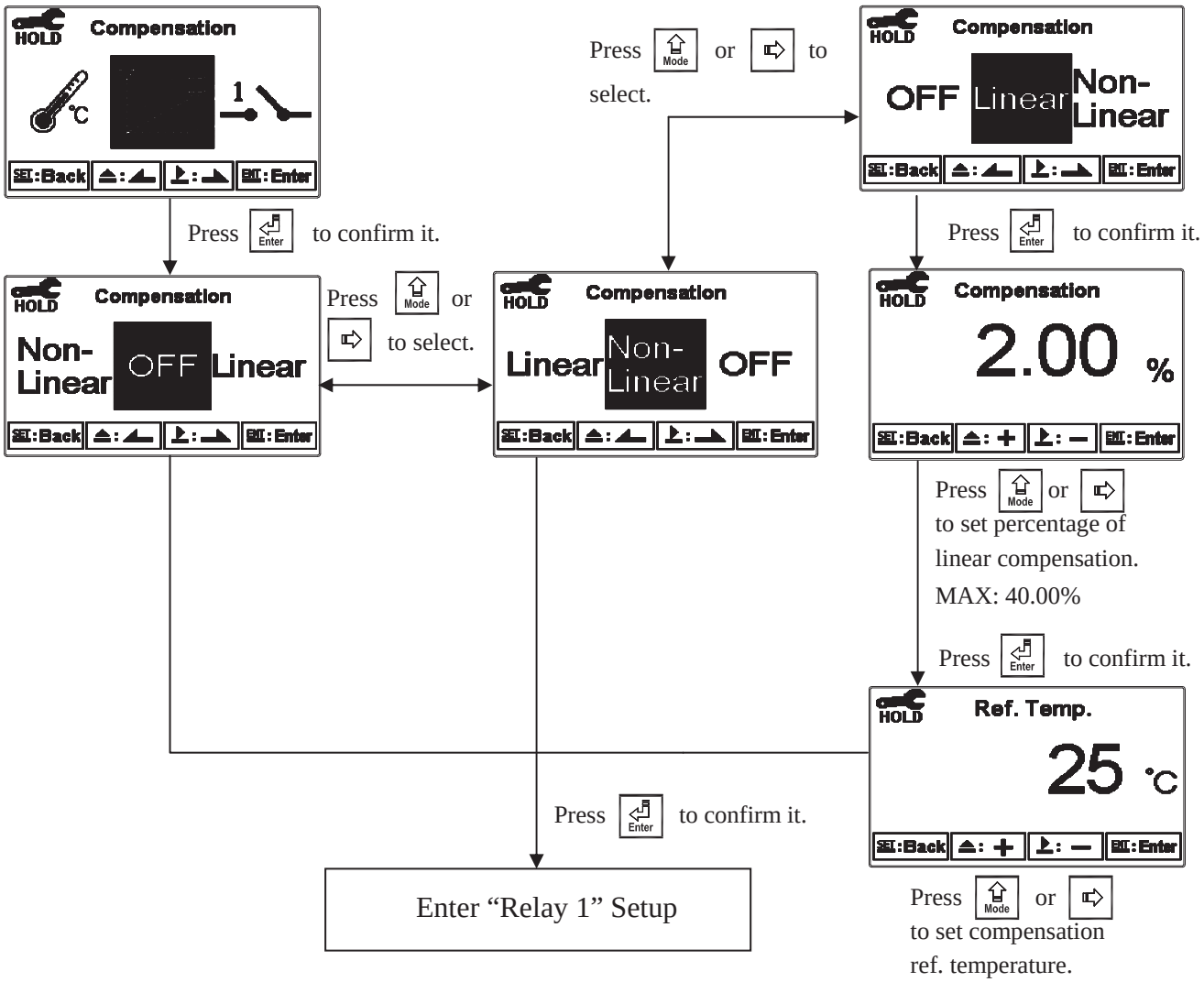
Enter setup of Temperature Compensation Coefficient mode, and select linear (Lin.), non-linear (Non-Lin.), or non-compensated (OFF) according to your measurement need for temperature coefficient. Normally, select linear compensation for conductivity measurement (Cond.), and select non-linear compensation for resistivity measurement.

Temperature Compensation Coefficient (hereinafter referred to as TC): Conductivity of solution increases with rising temperature. The relationship is as follows:

| | | |
|---|---|---|
| $Ct_{,ref}$ | Conductivity at 25˚C | Formula 1：Ct = Ctref { 1+α( T－tref ) } |
| Ct | Conductivity at T˚C | |
| T | Measured solution temperature | Formula 2：α= ( Ct－Ctref) / { Ctref ( T－tref )} |
| α | Temperature compensation coefficient | |

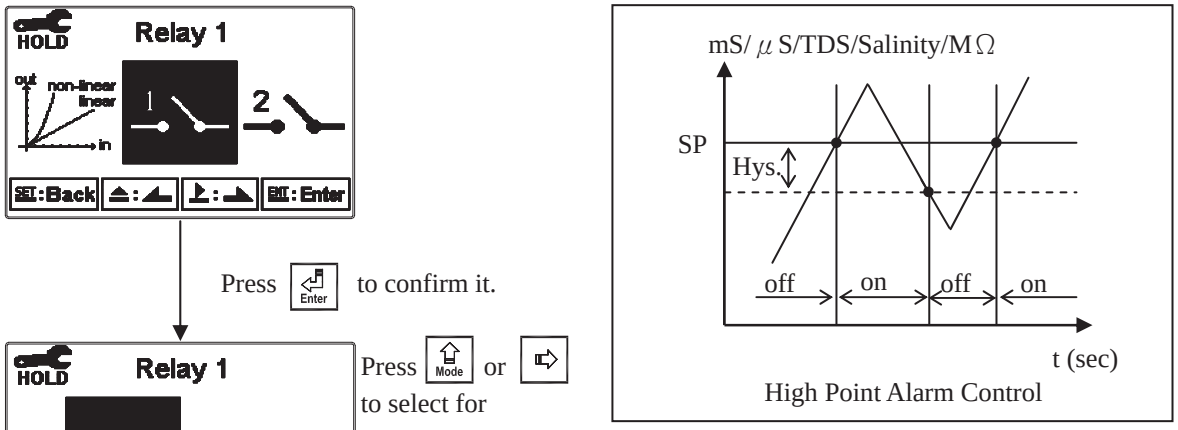
How to get TC of solution:

According to the formulas above, take an example for 0.01MKCl. Set the TC of the instrument to non-compensated（OFF）, and control the temperature at 25˚C and at 20˚C. $Ct_{,ref}$ means the measured value at 25˚C(Such as $C_{t,25}$ = 1413μS). Ct means the measured value at 20˚C(Such as $C_{20}$ = 1278μS). According to both formulas above, α＝1.91%.



### 7.8 Relay 1

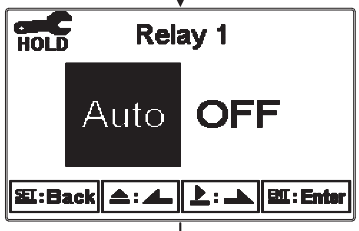
Enter setup of Relay 1. Select the item to turn on or turn off the relay 1 function. If you select to turn on the relay 1, then select for using relay 1 as “High set-point” alarm or “Low set-point” alarm. Set the value of set-point (SP) and Hysteresis (Hys.). The relationship between parameters can refer to an explanatory diagram of the box (as a high point alarm).



High Point Alarm Control

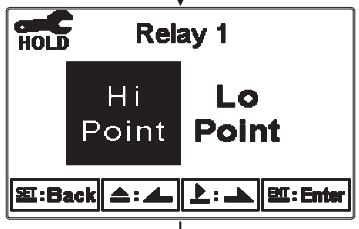



Press Enter to confirm it.



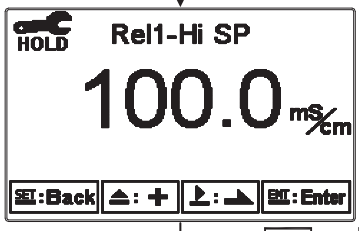

Press Mode or ⇨ to select for activating REL1 or not. If select OFF, the guide menu goes to setup of Relay 2.

Press Enter to confirm it.



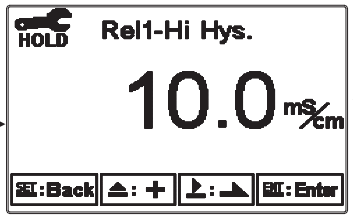

Press Mode or ⇨ to select Hi point or Lo point alarm of REL1.

Press Enter to confirm it.



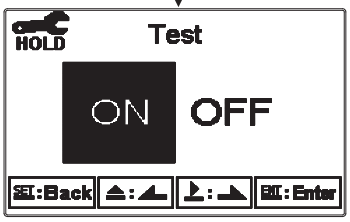

Press Mode or ⇨ to adjust set-point (SP) value.
If the measuring range of conductivity measurement is set as AUTO, then it needs to be set unit(μS/cm or mS/cm), value, and decimal point by order.

Press Enter to confirm it.




Press Mode or ⇨ to adjust Hysteresis (Hys.) value

Press Enter to confirm it.



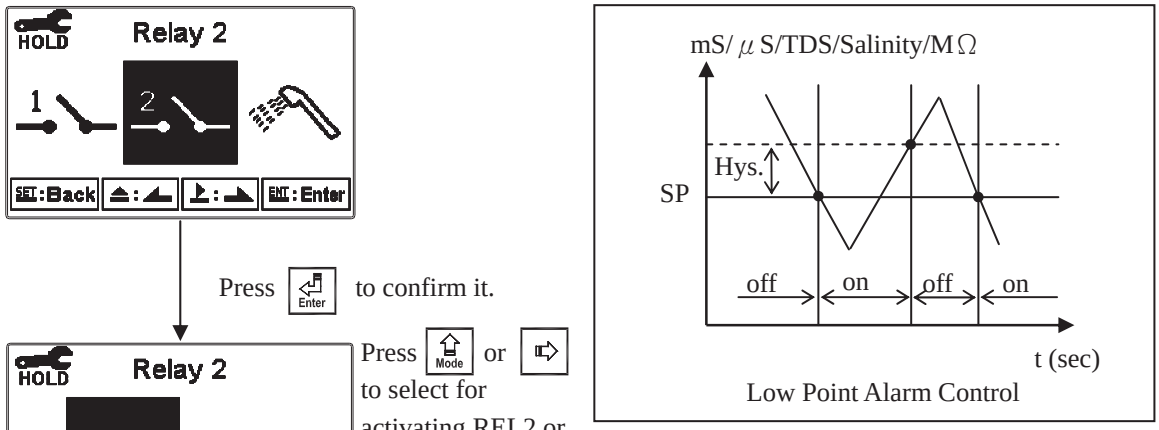

Press Mode or ⇨ to select for activating a test of REL1 or not. If “ON”, the relay 1 is in action, and the “RELAY1” indication light will light up.

Press Enter to confirm it.

Enter “Relay 2” Setup

### 7.9 Relay 2

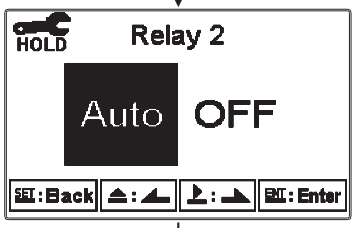
Enter setup of Relay 2. Select the item to turn on or turn of the relay 2 function. If you select to turn on the relay 2, then select for using relay 2 as “High set-point” alarm or “Low set-point” alarm. Set the value of set-point (SP) and Hysteresis (Hys.). The relationship between parameters can refer to an explanatory diagram of the box (as a low point alarm).





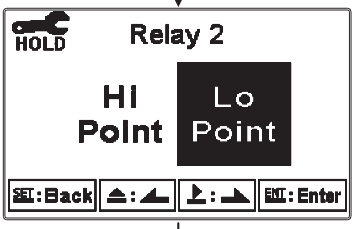


Press Enter to confirm it.



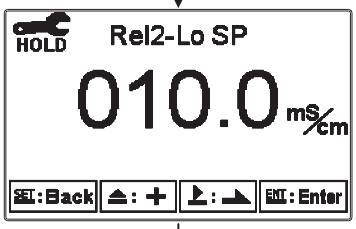

Press Mode or to select for activating REL2 or not. If select OFF, the guide menu goes to setup of clean.

Press Enter to confirm it.



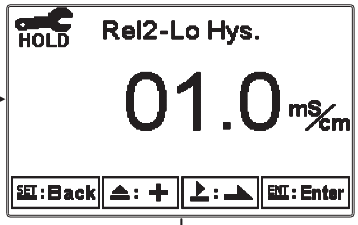

Press Mode or to select Hi point or Lo point alarm of REL2.

Press Enter to confirm it.



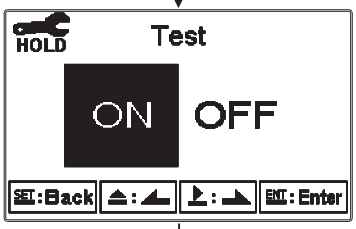

Press Mode or to adjust set-point (SP) value.
If the measuring range of conductivity measurement is set as AUTO, then it needs to be set unit(μS/cm or mS/cm), value, and decimal point by order.

Press Enter to confirm it.




Press Mode or to adjust Hysteresis (Hys.) value

Press Enter to confirm it.




Press Mode or to select for activating a test of REL2 or not. If “ON”, the relay 2 is in action, and the “RELAY2” indication light will light up.

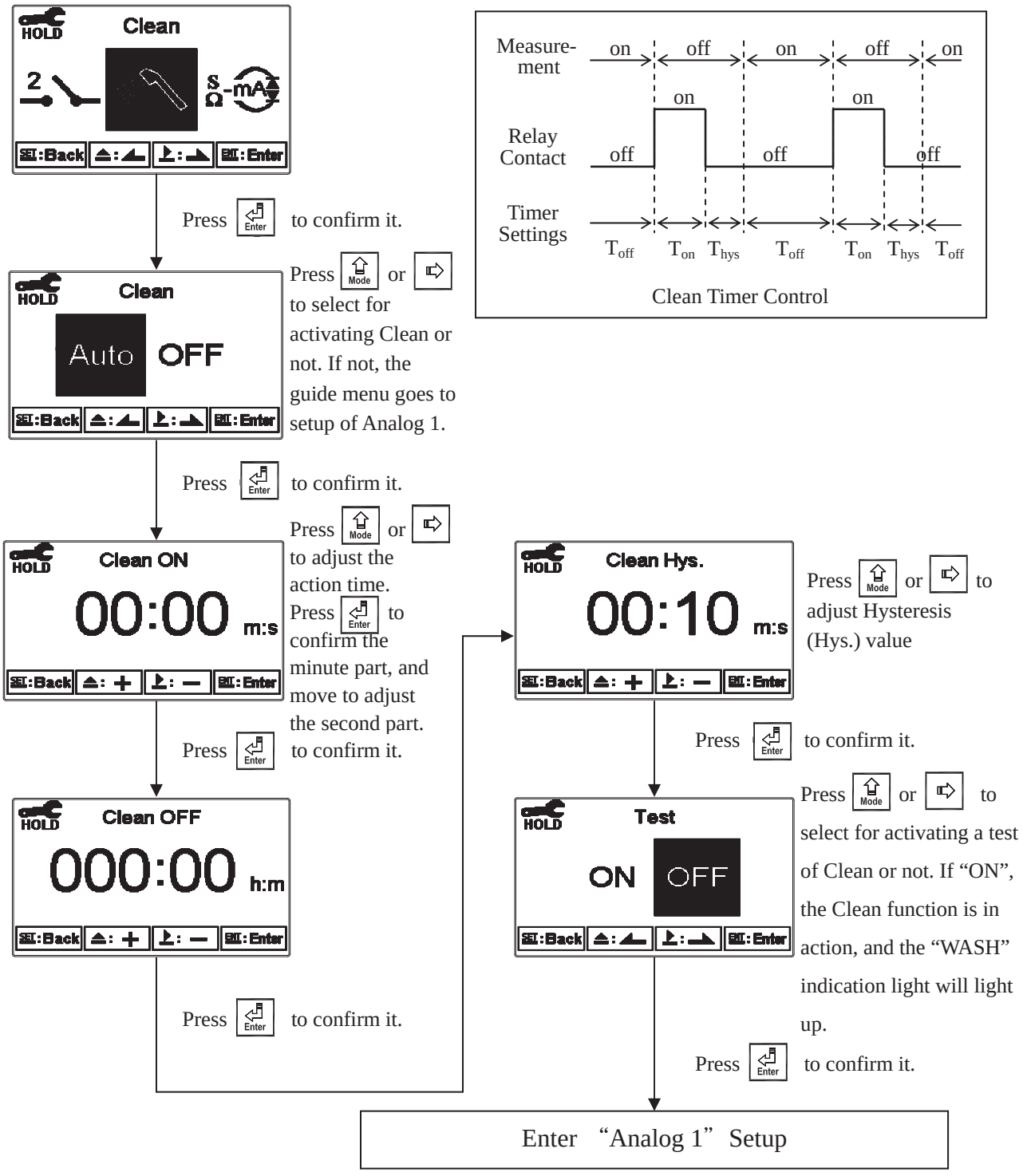
Press Enter to confirm it.

Enter “Clean” Setup

### 7.10 Clean

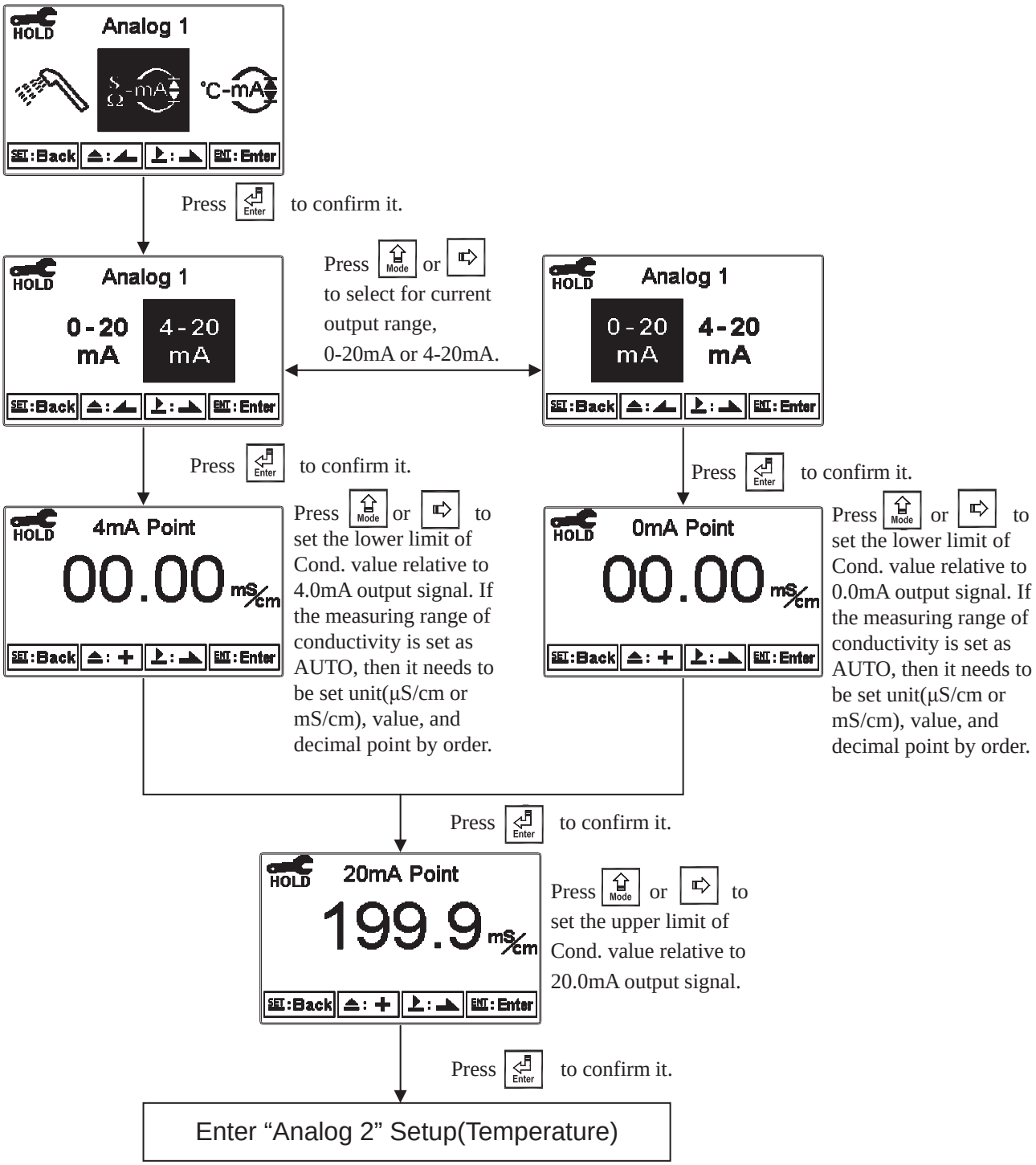
Enter setup of “Clean” function. Select the icon to turn on or turn off the clean function. If you select “Auto” turning on, then set the timer of the clean function including automatically turning on time and turning off time, and set the Hysteresis value(Hys.).

Note: When the clean function is turned on, if any value is set to be 0, the instrument will automatically turn off this function. When the clean function is activated under measurement mode, there is a “Clean Running” message showing on top of the display. The measured value will be remained at the last measured value before cleaning. If enter setting menu or calibration menu under clean status, the instrument will stop clean status automatically.



### 7.11 Analog output 1

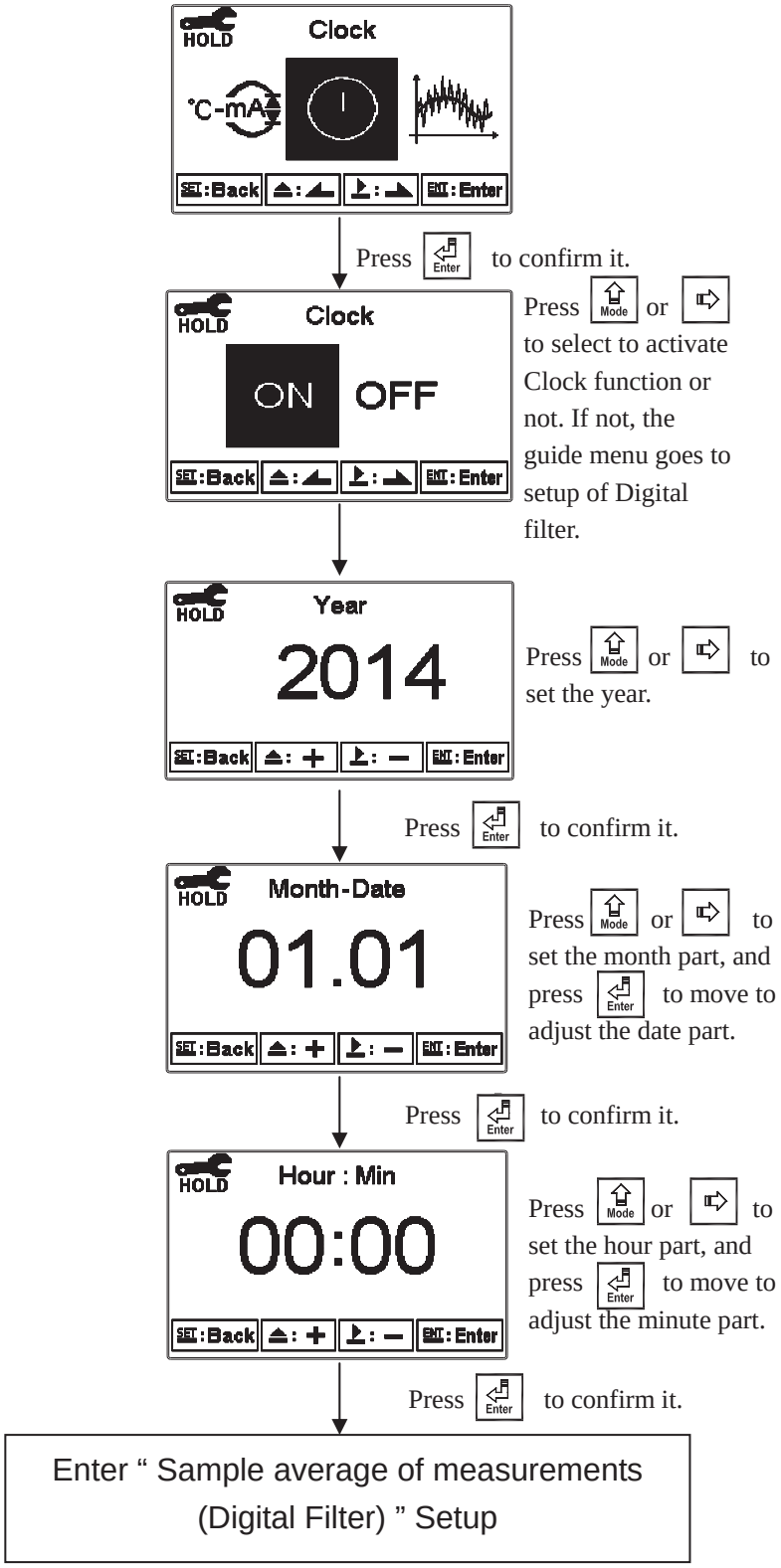
Enter setup of Analog 1. Select 0~20mA or 4~20mA current output and eet the related value to the range of measurement. If the range of measurement is to be set smaller, the resolution of current output is higher. When the measured value exceeds the higher range limit, the current will remain approximately 22mA output. When the measured value exceeds the lower range limit, under 0~20mA mode the current output will remain 0mA output; while under 4~20mA mode the current output will remain approximately 2mA output. 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, in order to keep convenience of insuring the current setting of an external recorder or of a PLC controller, the current output will be 0/4mA or 20mA under the analog output setup menu.



### 7.12 Date/Time(Clock)

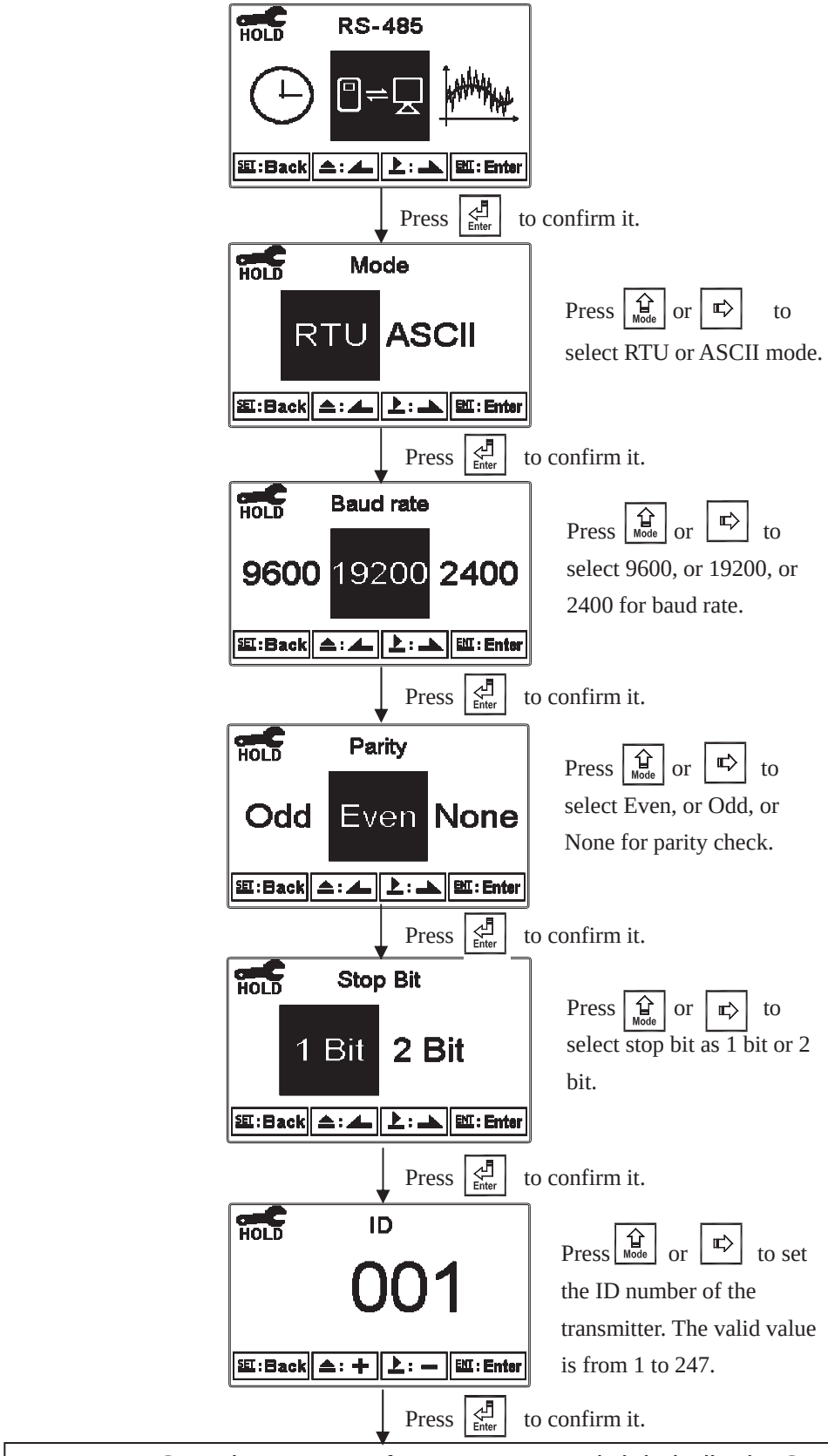
Enter setup of Date/Time(Clock). Set the “Year”, “Month”, “Date”, “Hour”, and “Minute” time. If you select to turn off the clock function, there will not display clock under measurement mode. The calibration time of calibration record will also show ”OFF” under calibration overview display.

Note: The clock of the EC-4310-RS can be able to function still as out of power supply. If the clock is not working, the cell may be out of power, and then please replace it with 3V CR2025 Li cell.



### 7.13 RS485 communication

Enter setup of RS485 communications. According to the Modbus protocol, set the transmitting mode, parity, baud rate, stop bit, and ID number. About the detail of Modbus protocol, please refer to Ch9. If under hold status, the measurement signal output maintains the last output value before hold status.

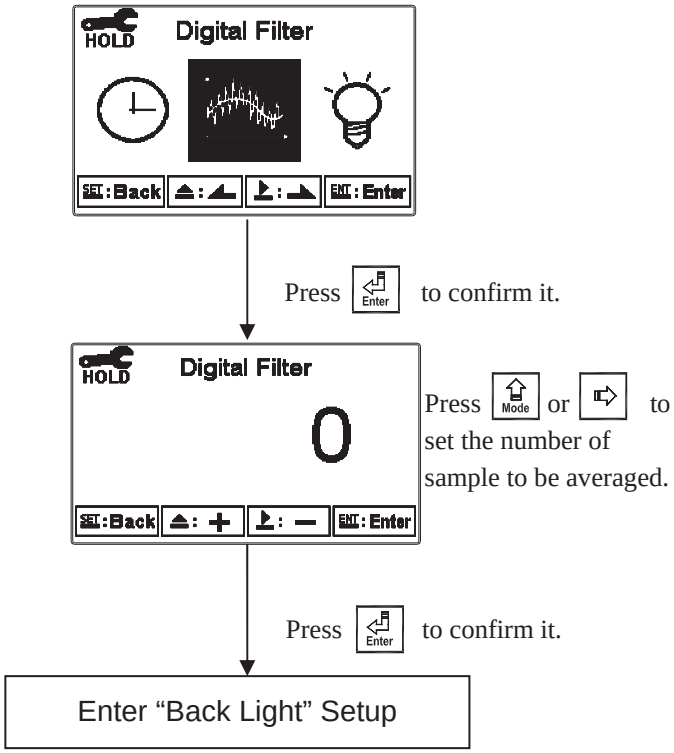



Enter " Sample average of measurements (Digital Filter) " Setup

### 7.14 Sample average of measurements (Digital Filter)

Enter the setup of Digital filter. You may select the number of sample to be averaged each time to become a reading which is gradually counted in order to increase the stability of measurement.

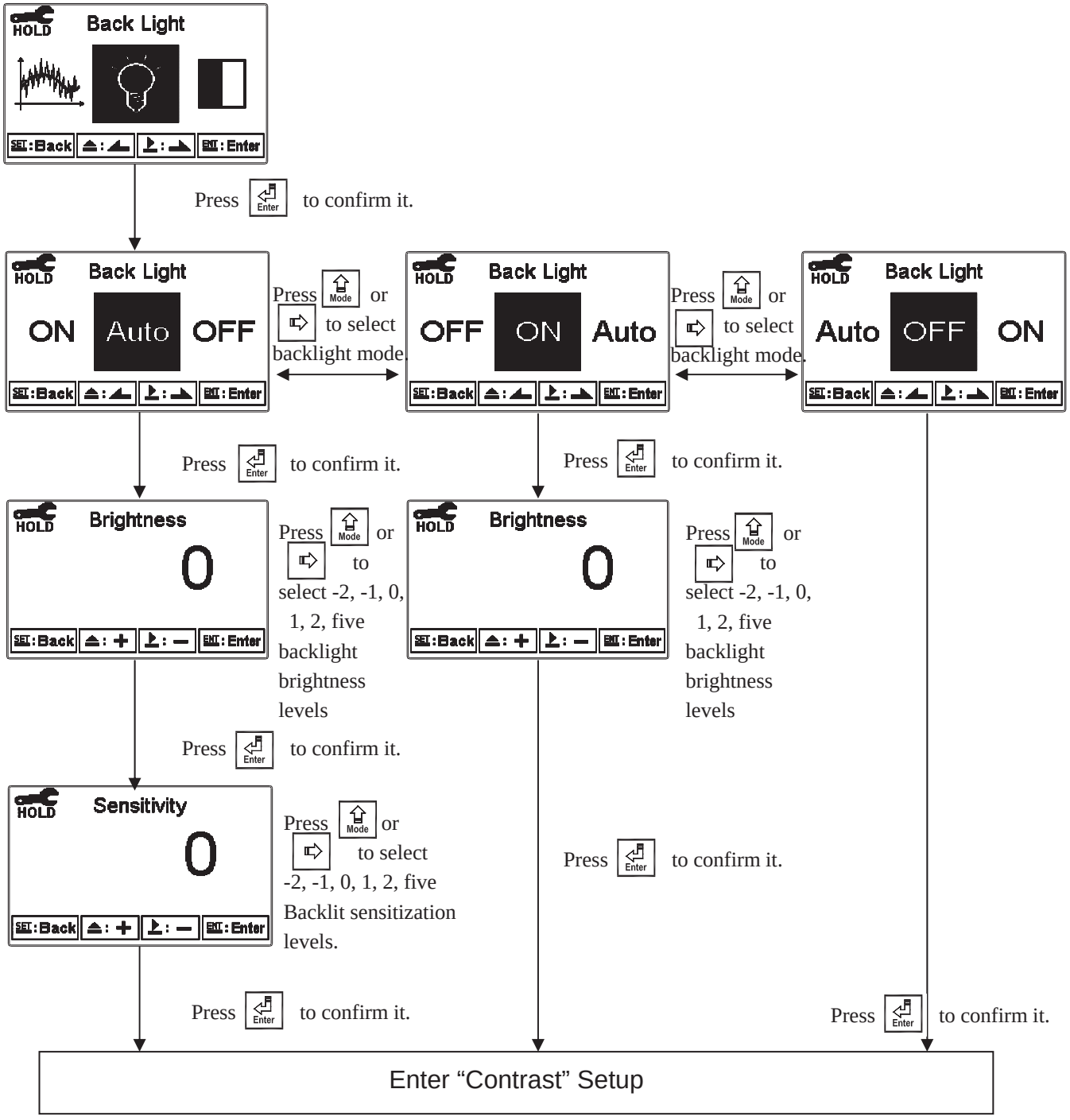
**Note: “0” represents auto setting according to the conductivity measurement.**



### 7.15 Backlight settings

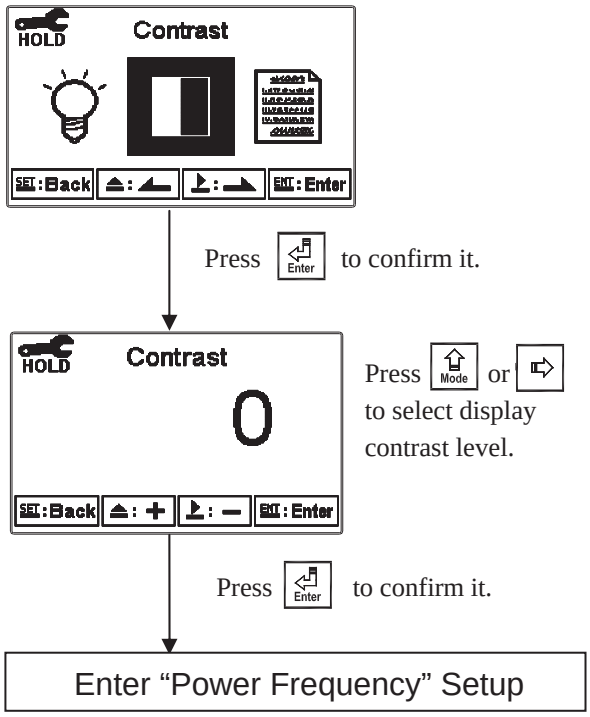
Enter setup of backlight display. According to your need, you can set the brightness of display(-2~2, dark~bright) and sensitivity of the sensitization sensor(-2~2, insensitive~sensitive). Where there is a keystroke, then activate the touch-on backlight function. Regardless of what kind of backlight mode, the touch-on function will activate the backlight. If there is no keystroke for 5 seconds, the display will back to the original backlight setting status.

**ON setting:** The backlight is always on.
**OFF setting:** The backlight is off. When there is a keystroke, it enters to the touch-on status.
**Auto setting:** According to the ambient light, activate or deactivate the backlight. When there is a keystroke, it enters to the touch-on status.



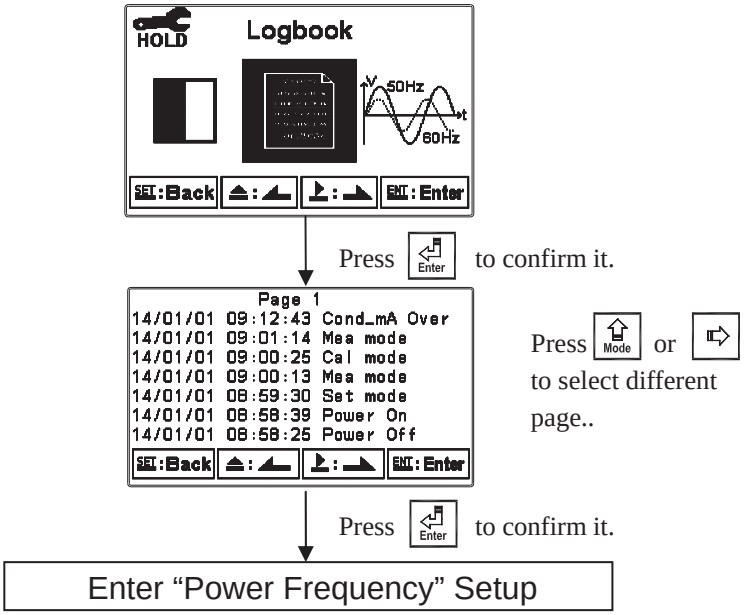
### 7.16 Contrast settings

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



### 7.17 Logbook

Enter setup of Logbook. Users may look up the recently important 50 events and error diagnosis records of the transmitter. Definitions please see as following table, before users may read records of logbook through Modbus, they may need to input logic address, 0028H, and read corresponding data, 0029H~002FH. The latest data record is assigned to #1, and the last data record is assigned to #2 and so on.

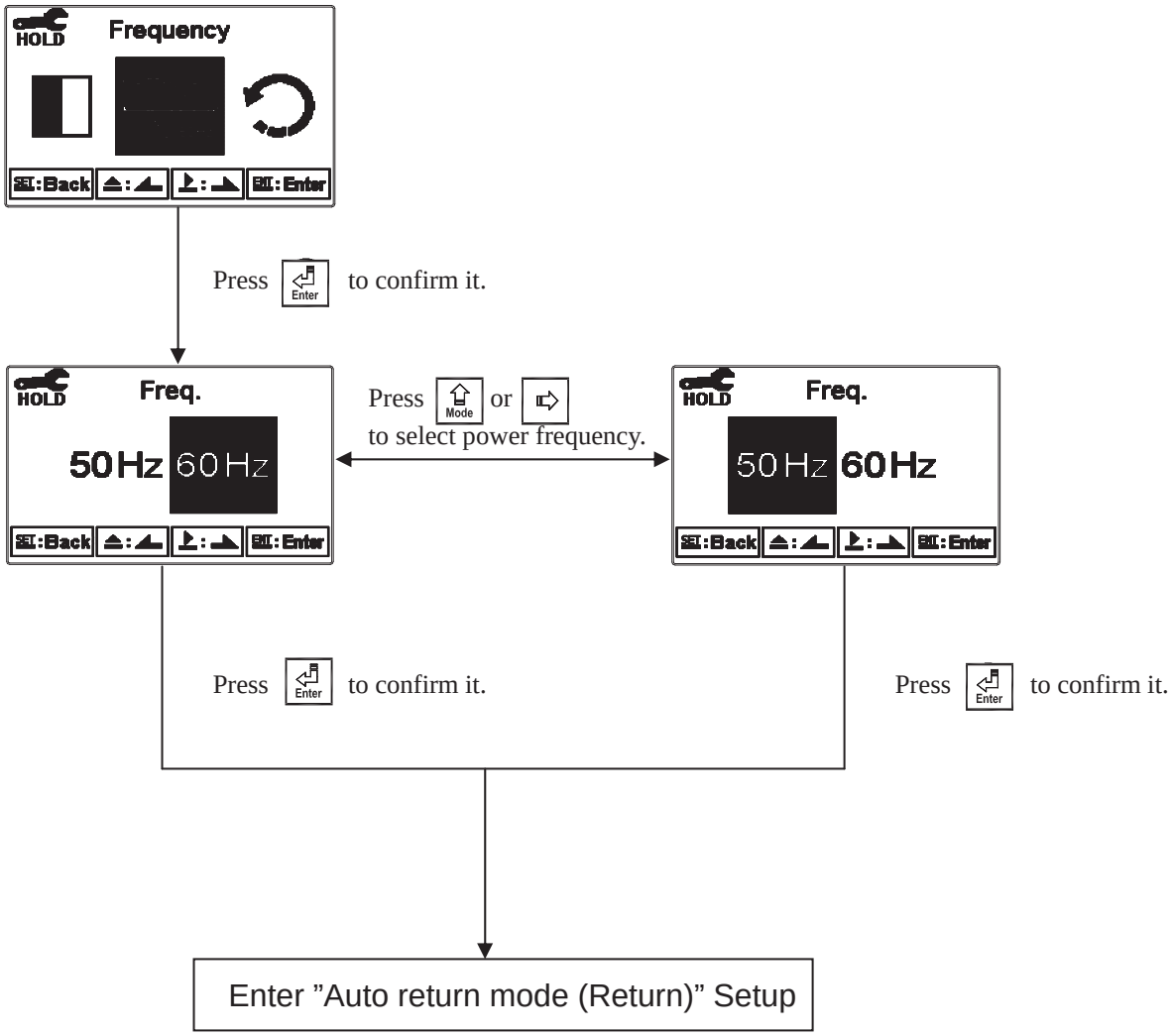



| Events | definitions | Modbus code |
|---|---|---|
| Mea mode | Measurement mode | 00 |
| Set mode | Setting mode | 01 |
| Cal mode | Calibration mode | 02 |
| Power On | With power supply | 03 |
| Power Off | Out of power supply | 04 |
| Cond_mA Over | Current exceeds the upper/lower range | 05 |
| Error 1 | The readings are unstable under calibration mode | 06 |
| Error 2 | 1.Cell constant value exceeds the upper/lower range<br>2.The temperature exceeds the limited range | 07 |
| Error 3 | Error input code | 08 |
| Res_mA Over | Current exceeds the limited range | 09 |
| Error 5 | Malfunction of instrument | 10 |
| TDS_mA Over | Current exceeds the limited range | 11 |
| Salt_mA Over | The current exceeds the limited range | 12 |
| Modbus Write | Modbus demand input | 13 |

### 7.18 Power frequency (Frequency)

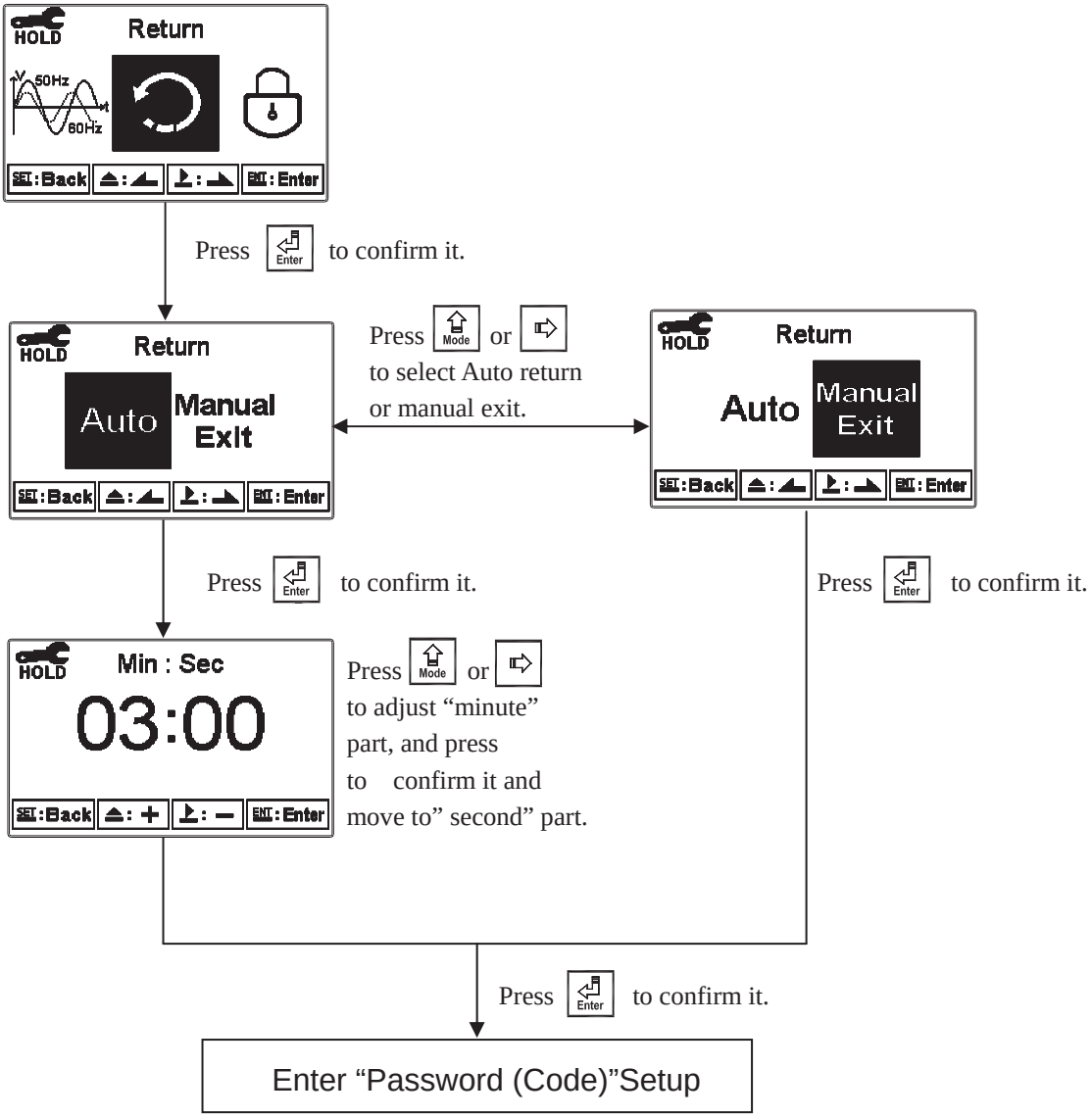
Enter setup of power frequency. You may select power frequency setting of the instrument 50Hz or 60Hz according to the local power frequency.

Note: This setting significantly affects the normal measurement of instrument, thus, be sure to make the setting correctly.



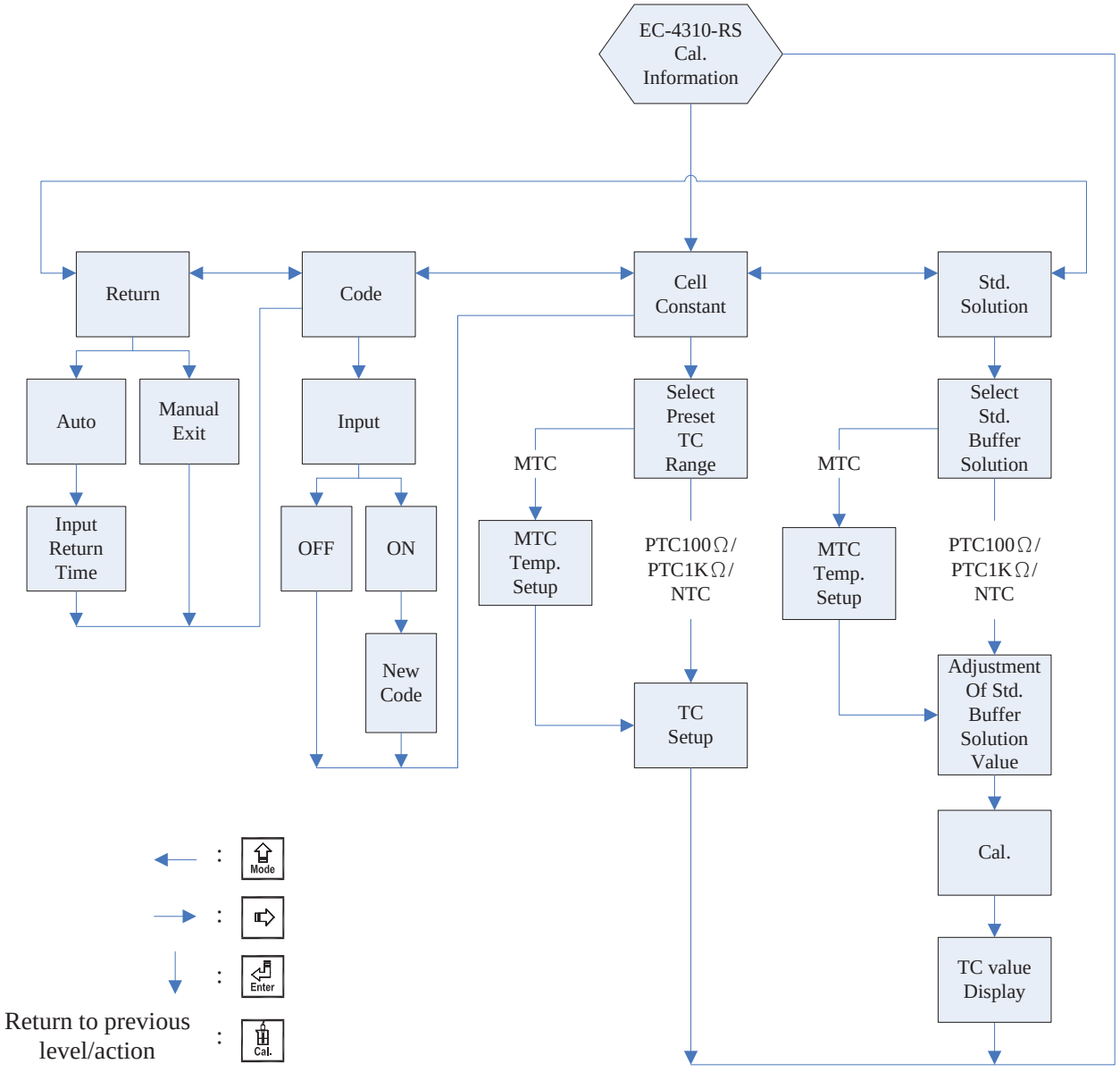
### 7.19 Return

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” means that it needs to exit setup menu manually, while “Auto” means that the display automatically exit the setup menu and back to measurement mode after a period of time without pressing any key.



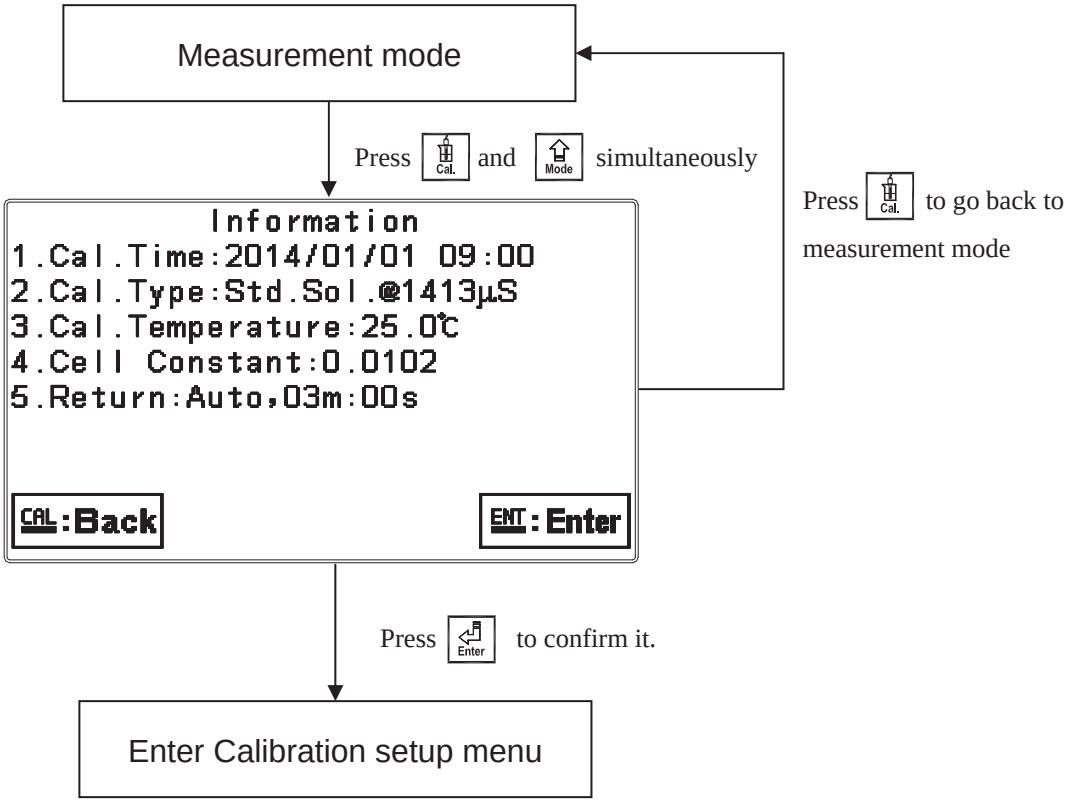
# 8. Calibration

## Block diagram of Calibration



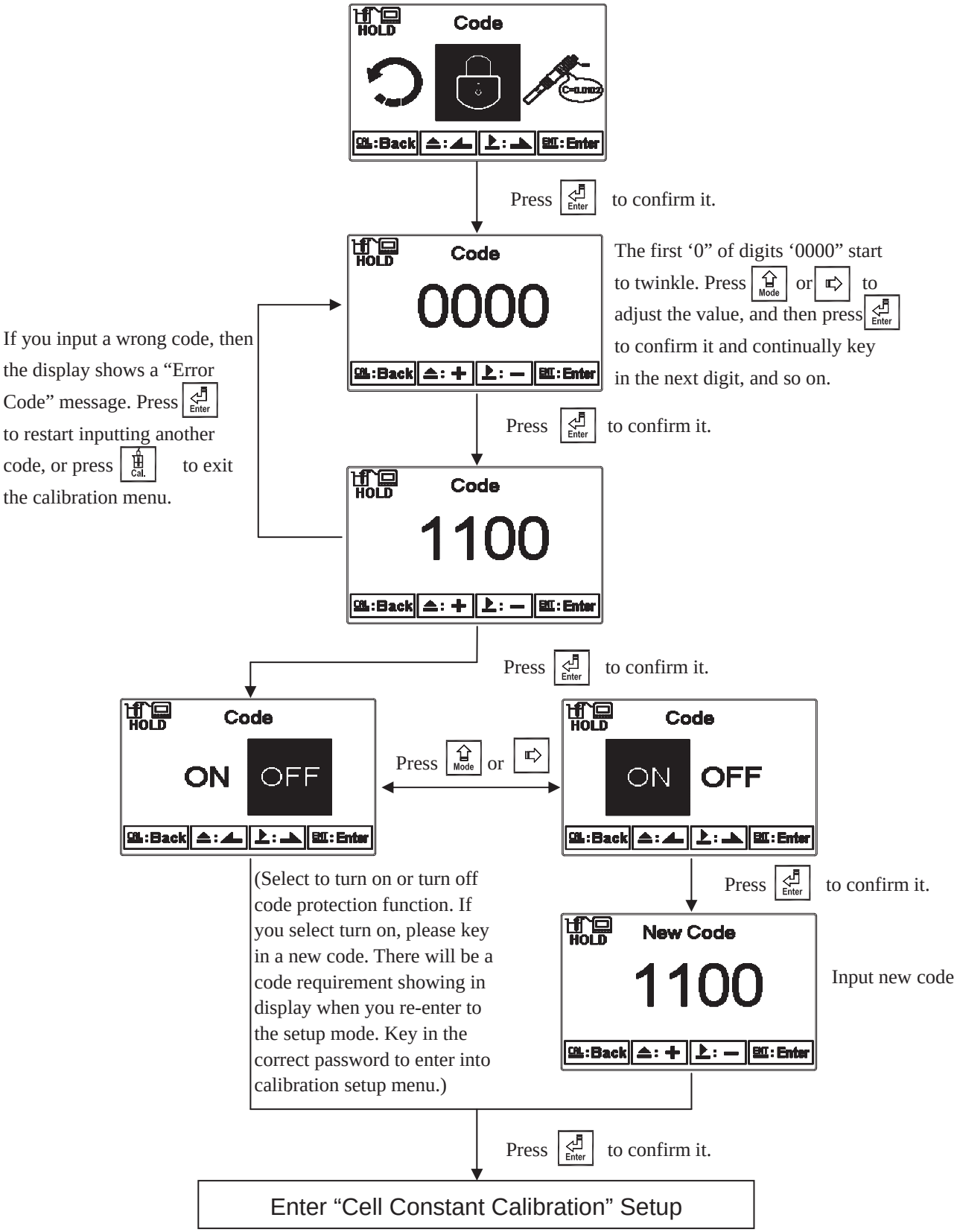
### 8.1 Enter calibration setup menu

In the measurement mode, pressing the two keys Cal. and Mode simultaneously allows you enter the Calibration Information. If you do not need to re-calibrate the measurement system, press Cal. to go back to measurement mode. If you need to re-calibrate the system, press Enter to enter into the calibration setup menu. (If the calibration time shows “OFF”, it represents that the clock function has been turned off.)



### 8.2 Security password of calibration (Code)

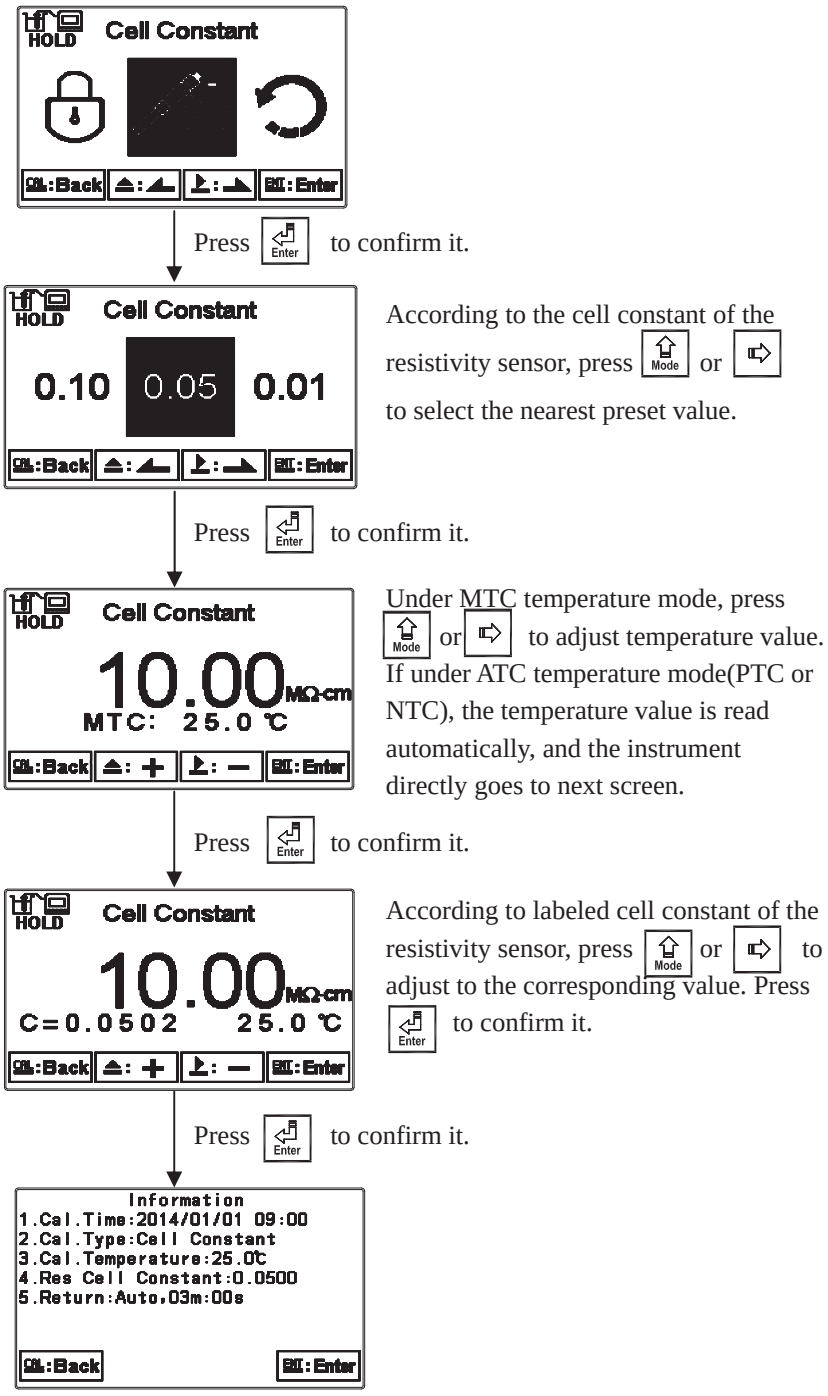
Select the Code (password) icon after entering calibration setup mode. Select to activate code function or not. **The default Calibration setting code is "1100".**



## 8.3 Cell constant calibration

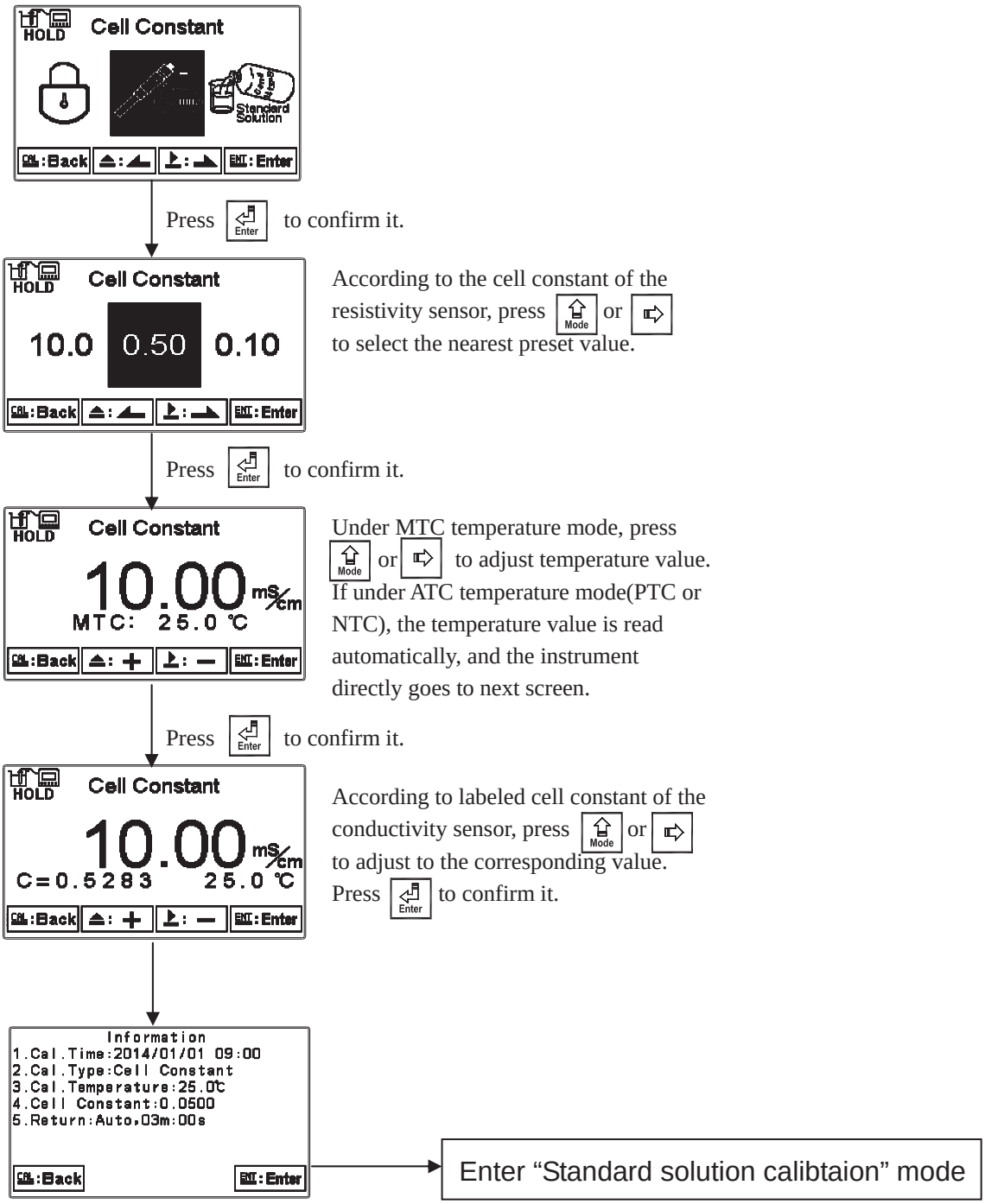
8.3.1 Resistivity (Res.)

Enter setup of cell constant to directly set cell constant. Press Mode or ⇨ to select the preset value to near an appropriate one. There are three sets of preset value (0.01, 0.05, 0.10). Select the most appropriate cell constant value and press Enter to confirm it and enter to the next screen. At the time, the cell constant starts to twinkle. Press Mode or ⇨ to adjust the cell constant value. Correct the measurement value to known standard solution value by adjusting cell constant, or setting the known cell constant directly. Press Enter to confirm it.



8.3.2 Conductivity (Cond.)

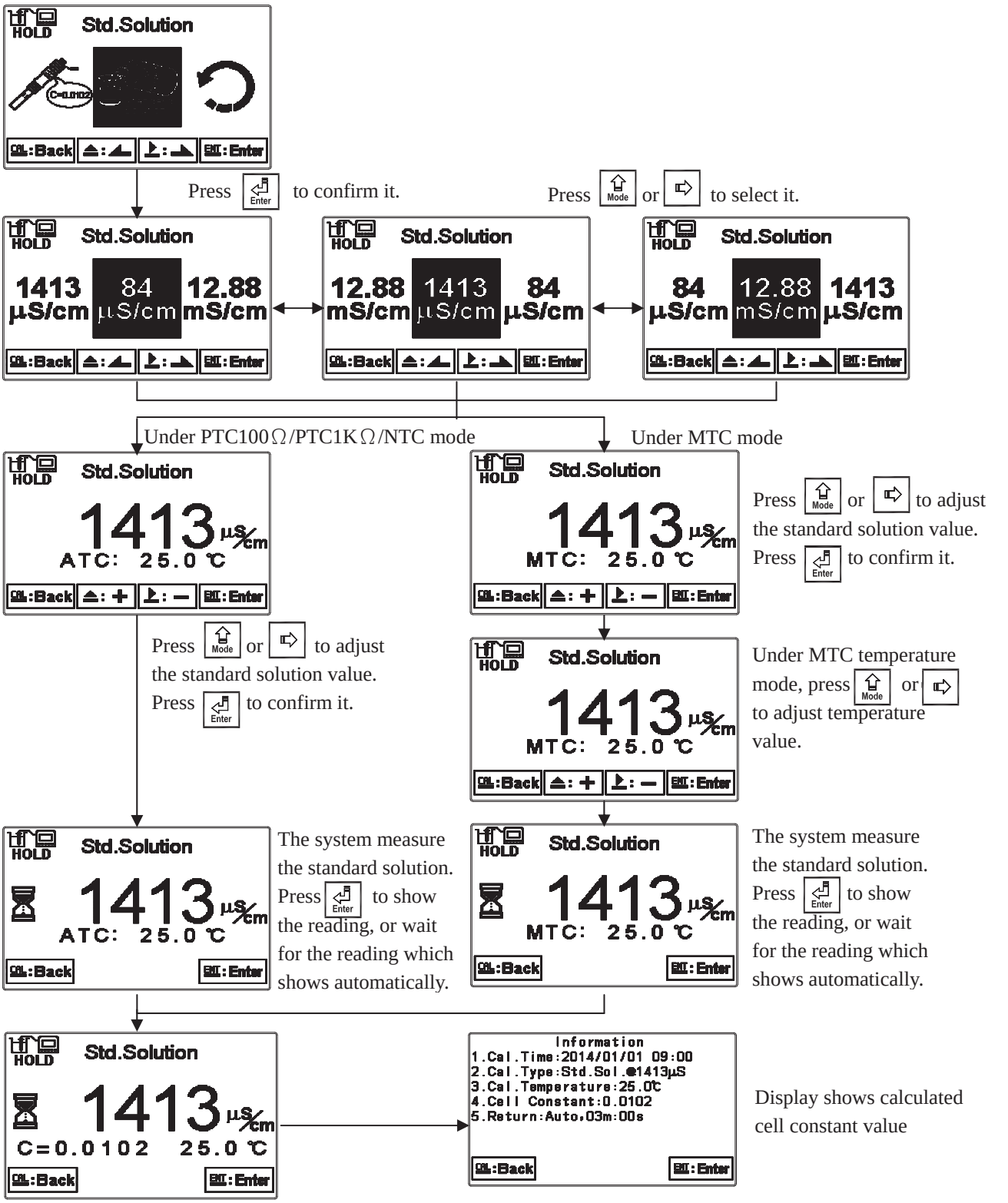
Enter setup of cell constant to directly set cell constant. Press Mode or ⇨ to select the preset value to near an appropriate one. There are four sets of preset value (0.01, 0.10, 0.50, 10.00). Select the most appropriate cell constant value and press Enter to confirm it and enter to the next screen. At the time, the cell constant starts to twinkle. Press Mode or ⇨ to adjust the cell constant value. Correct the measurement value to known standard solution value by adjusting cell constant, or setting the known cell constant directly. Press Enter to confirm it.



### 8.4 Standard solution calibration (Std. Solution)

Applying known standard solution for calibration is only suitable for conductivity measurement mode. Press [Mode] or [⇨] to select from preset standard solution value. There are three preset values from 84.0μS/cm, 1413μS/cm, to 12.88mS/cm. After selecting proper preset value, put the cleaned conductivity sensor into standard solution, and press [Enter] to enter the calibration screen. At the time, the conductivity value can be adjusted according to standard solution value. Press [Enter] to initiate the calibration. The display shows the sign ⌛ , and it starts the auto calibration procedure. After finishing calibration, the display automatically shows the cell constant after calibration. Press [Enter] to exit.

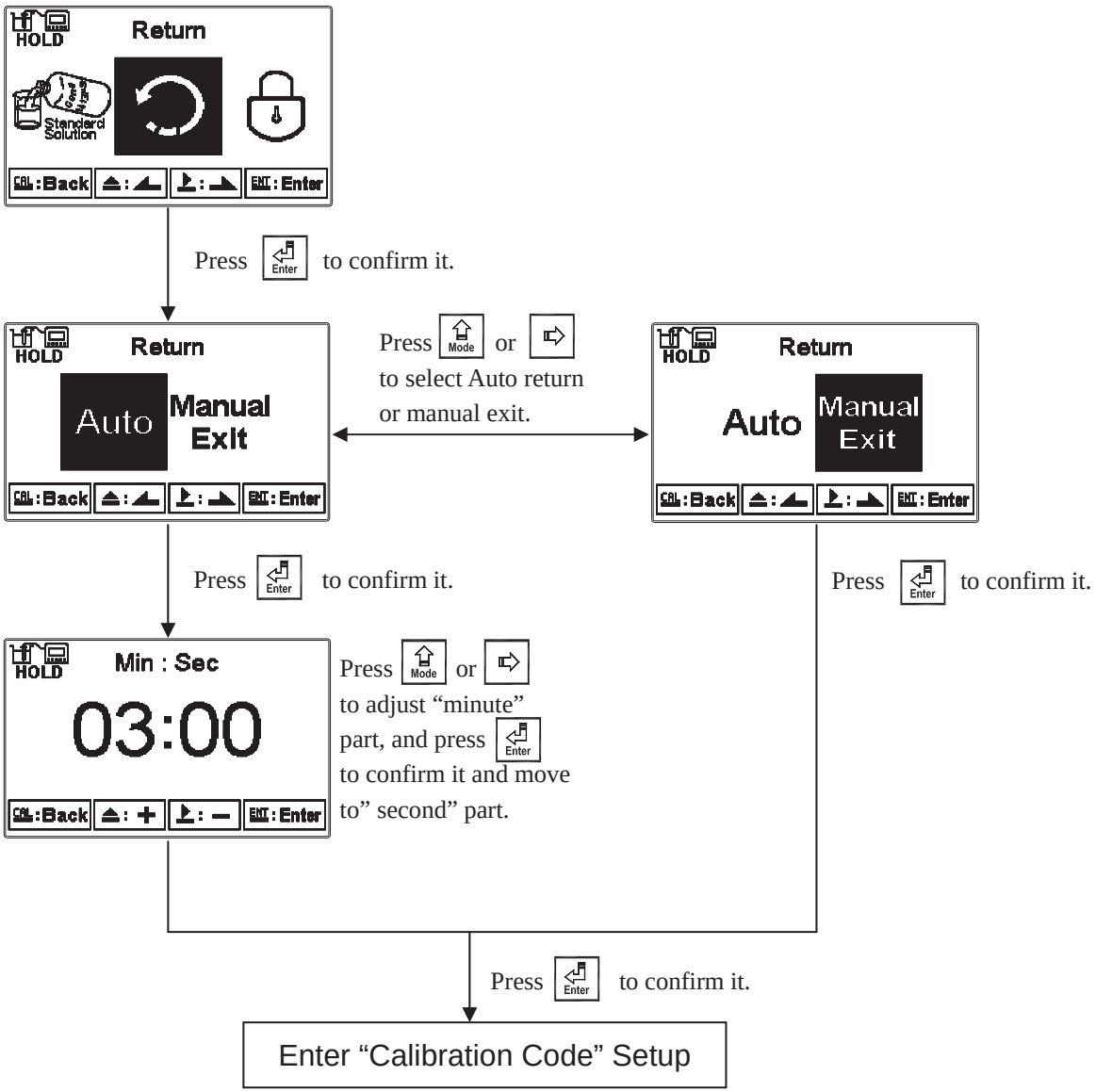
***Note***: there is a temperature range limit within 0℃～31℃ for "Std. Solution Calibration". If exceeding the range, please refer to "8.3.2 Cond. Cell Constant Mode" for calibration.



### 8.5 Return

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

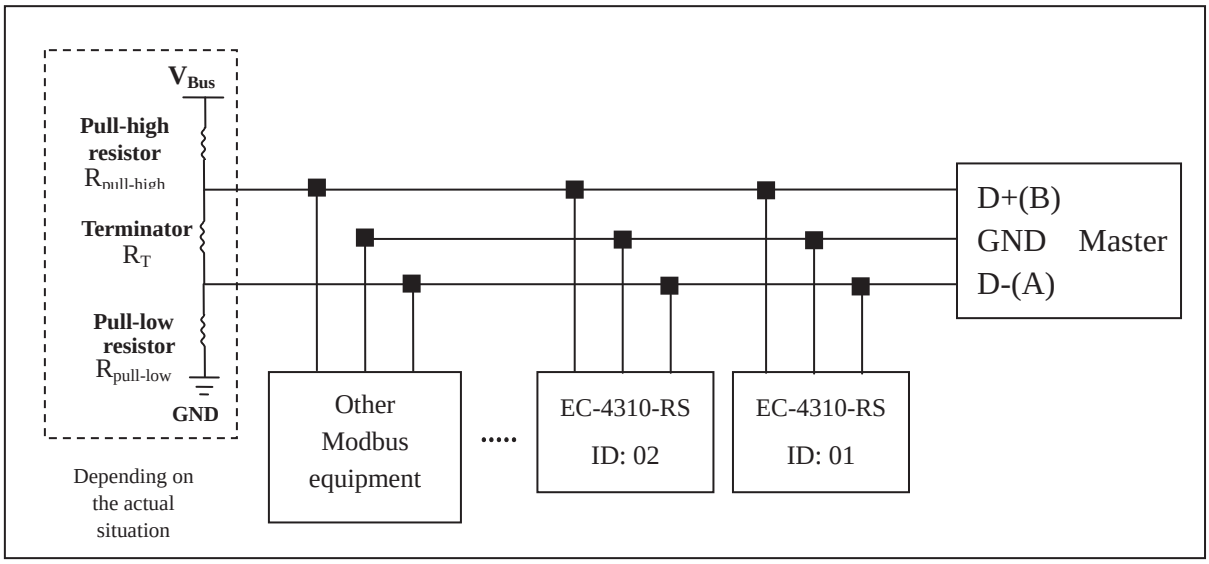
Note: The return function of setup menu and calibration setup menu are independent settings.



# 9. MODBUS protocol and instructions

## 9.1 Communication connection

The RS-485 communication port of the transmitter features electronic isolation protection and lightning protection, and it provides isolated ground solution. It is allowed to use normal twisted-pair (segregation double-stranded twisted pair cable) cable for connection. All devices are in contact with a positive connecting point D+(B) of the double-stranded twisted-pair cable all together, and another line will be connected with all the negative contacts D-(A), and the isolated shield wire must be connected to ground(GND). When we talk about communication in the laboratory, the stand-alone master-slave communication is relatively simple. Hence, it is allowed to consider using the normal cable instead. However, there should be strictly in accordance with the requirements of industrial engineering construction. Wiring diagram is as follows:




**Note:**

1. The RS-485 interface of the transmitter has a protective earth terminal. When communicate with the RS-485, there should use with solution ground to eliminate risk of safety.
2. It is allowed to use an 120 ohm impedance matching resistors at terminal equipment in the transmission lines (D +(B), D-(A)) ends across to effectively reduce or eliminate signal reflection.

   Note: there are three possible situations resulting to failure connection:

   a. Open circuits: the signal cable has open circuits.

   b. Short circuits: the insulation that is insufficient between signal cables causes short circuits.

   c. Idle-bus: there is no data transmission in the Controlbus.

   Based on the previous three situations resulting in unknown state of Controlbus's voltage, the receiver accepts the unexpected signals. Therefore, in some harsh environment like multi-transmitter connection, the Controlbus needs the terminator to avoid reflection of baud rate, and it needs pull-high resistor, pull-low resistor, and biasing circuits made up of $V_{Bus}$ as the block diagrams showing above. Besides, it makes sure that the free voltage between transmission line D+(B) and D-(A) is available for maintaining the completeness of the signals. Due to not each environment being suitable to fixed resistor and $V_{Bus,}$ therefore, users must pay attention to the settings. Some parts of connecting instruments (as parts of RS-485 or modules) provide the terminator, pull-high resistor, pull-low resistor, and settings of $V_{Bus.}$ Please refer to the operation manuals of the connecting instruments.

3. Without repeaters, the RS-485 network cannot exceed a maximum of 32 nodes. The maximum communication transmission distance of RS-485 is up to 1200 meters. For long distance transmission, it is recommended to apply cables which are dedicatedly design for RS-485.
4. When communication, all the equipments of the network should be maintained in the same transfer mode, baud rate, parity consistent. And each of the device address cannot be the same, so as not to conflict resulted in the normal network communications.
5. The Modbus command of the transmitter can only access 50 registers. If it exceeds the length, then it returns abnormal message.
6. The waiting time which a slave instrument response to a master machine is different according to each model. Generally, it shall be longer than 0.5 second. (Some models may require a longer waiting-responding time, please note whether the operation manual specified.)

### 9.2 Modbus address and command table

The following information is the Modbus address and command table. Users who apply a PLC or HMI systems to communicate with this instrument need to pay particular attention to whether if the actual delivery address decrease 1 to deliver. If the above situation happens, it is necessary to add 1 to correspond to this table. For example, the temperature of the table address is 0037H (hexadecimal) or 55 (decimal), if the PLC or HMI system delivers the address which has been decreased 1 and then transmit, then the user must enter the 0038H (hexadecimal) or 56 (decimal) in order to correspond to the correct temperature address code which affected by the PLC or HMI system.

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

| Logic address (Hex) | R/W | Item | Number of Byte | 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 | EC4310 | |
| 0005H | R | Communication protocol | 2 | USHORT | 0: RTU<br>1: ASCII | 0 | |
| 0006H | R | Serial transmission speed (Baud rate) | 2 | USHORT | 0: 2400<br>1: 4800<br>2: 9600<br>3: 19200 | 3 | |
| 0007H | R | Parity | 2 | USHORT | 0: None<br>1: Even<br>2: Odd | 1 | |
| 0008H | R/W | Real-time clock* | 12 | USHORT | Second | 2014-01-01, 00:00:00 | |
| 0009H | R/W | | | USHORT | Minute | | |
| 000AH | R/W | | | USHORT | Hour | | |
| 000BH | R/W | | | USHORT | Day | | |
| 000CH | R/W | | | USHORT | Month | | |
| 000DH | R/W | | | USHORT | Year | | |
| 000EH | R/W | Code setting* | 2 | USHORT | Code setting | 1111 | |
| 000FH | R/W | Temperature mode* | 2 | USHORT | 0: MTC<br>1: PTC-1KΩ<br>2: NTC<br>3:PT100Ω | 2 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0010H | R/W | Clean relay* | 2 | USHORT | 0: OFF | 0 | |
| | | | | USHORT | 1: AUTO | | |
| 0011H | R/W | | 2 | USHORT | ON.S: 0-5999 | 0 | Second |
| 0012H | R/W | | 2 | USHORT | OFF.H: 0-999 | 0 | Hour |
| 0013H | R/W | | 2 | USHORT | OFF.M: 0-59 | 0 | Minute |
| 0014H | R/W | | 2 | USHORT | Hys.S: 0-5999 | 0 | Second |
| 0015H | R/W | Relay 1 * | 2 | USHORT | 0: OFF | 1 | |
| | | | | | 1: AUTO | | |
| 0016H | R/W | | 2 | USHORT | 0: Hi | 0 | |
| | | | | | 1: Lo | | |
| 0017H | R/W | | 4 | FLOAT | SP1 | 100.0mS | Data affected by parameter unit |
| 0019H | R/W | | 4 | FLOAT | Hys1 | 10.0mS | |
| 001BH | R/W | Relay 2 * | 2 | USHORT | 0: OFF | 1 | |
| | | | | | 1: AUTO | | |
| 001CH | R/W | | 2 | USHORT | 0: Hi | 1 | |
| | | | | | 1: Lo | | |
| 001DH | R/W | | 4 | FLOAT | SP2 | 10.0mS | Data affected by parameter unit |
| 001FH | R/W | | 4 | FLOAT | Hys2 | 1.0mS | |
| 0021H | R/W | Backlight Brightness* | 2 | USHORT | 0: AUTO | 2 | |
| | | | | | 1: ON | | |
| | | | | | 2: OFF | | |
| 0022H | R/W | | 2 | SHORT | 2: Highest brightness | 0 | |
| | | | | SHORT | 1: high brightness | | |
| | | | | SHORT | 0: Standard | | |
| | | | | SHORT | -1: Low brightness | | |
| | | | | SHORT | -2: Lowest brightness | | |
| 0023H | R/W | Backlight Sensitivity* | 2 | SHORT | 2: Highest Sensitivity | 0 | |
| | | | | SHORT | 1: High Sensitivity | | |
| | | | | SHORT | 0: Standard | | |
| | | | | SHORT | -1: Low Sensitivity | | |
| | | | | SHORT | -2: Lowest Sensitivity | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0024H | R/W | Sample average of measurements (Digital Filter)* | 2 | USHORT | 0-60 | 5 | |
| 0025H | R/W | Product adjustment* | 2 | USHORT | 0: OFF | 0 | |
| | | | | | 1: ON | | |
| 0026H | | | 4 | FLOAT | 0.7000~1.3000 | 1.0000 | |
| 0028H | R/W | Event Number | 2 | USHORT | 1~50 | 1 | |
| 0029H | R | Event time | 12 | USHORT | Second | 2014-01-01 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 code | 2 | USHORT | 0~13 | 0 | |
| 0030H | Factory reserved | | | | | | |

Note 1 : The actions without * sign only support for function code 03H. The actions with * sign support function code 03H, 06H, 10H.

Note 2 : FLOAT is a 32-bit IEEE 754 format. The above table, for an example, is divided into two 16-bit register data transmission. The back 16-bit register(CC CD) will be transferred first, and then the first 16-bit register (41 C8) will be transferred later. Every 16-bit format is high-bit in the front and low-bit in the post. For example, the temperature now is 25.1$^{o}$C. The 16-bit of FLOAT data(Hexadecimal) will show 41 C8 CC CD. The transmission order is CC CD 41 C8. For detail description, please refer to Ch 9.3 Modbus example description.

Note3 : USHORT means unsigned short integer.

**Function code: 03H Modbus response (measurement parameter)**

| Logic address (Hex) | 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 | | |
| 0032H | R | Parameter unit | 6 | CHAR | $\mu$S/cm | Conductivity Auto | ASCII code |
| | | | | | mS/cm | | |
| | | | | | MΩ-cm | | |
| | | | | | ppm | | |
| | | | | | ppt | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0035H | R | Cond. measurement | 4 | FLOAT | Cond. measurement | | |
| 0037H | R | Temperature measurement | 4 | FLOAT | Temperature measurement | | |
| 0039H-003FH | Factory reserved | | | | | | |
| 0040H | R | Cell constant | 4 | FLOAT | Cell constant | 0.5000 | |
| 0042H | R | Calibration Time | 2 | USHORT | Minute | 2014-01-01 00:00 | |
| 0043H | R | | 2 | USHORT | Hour | | |
| 0044H | R | | 2 | USHORT | Day | | |
| 0045H | R | | 2 | USHORT | Month | | |
| 0046H | R | | 2 | USHORT | Year | | |
| 0047H-0050H | Factory reserved | | | | | | |

**Function code: 01H、05H Modbus response (dispersion parameter)**

| Logic address (Hex) | R/W | Item | BIT | Description | Default value | Note |
|---|---|---|---|---|---|---|
| 0070H | R | LO Alarm | 1 | Contact on | 0 (Contact off) | |
| 0071H | R | HI Alarm | 1 | Contact on | 0 (Contact off) | |
| 0072H | R | mA too high | 1 | Contact on | 0 (Contact off) | |
| 0073H | R | mA too low | 1 | Contact on | 0 (Contact off) | |
| 0074H | R | Exceed temp. range | 1 | Contact on | 0 (Contact off) | |
| 0075H | R | Exceed Cond. range | 1 | Contact on | 0 (Contact off) | |
| 0076H | R | RLY1 Action | 1 | Contact on | 0 (Contact off) | |
| 0077H | R | RLY2 Action | 1 | Contact on | 0 (Contact off) | |
| 0078H | R | Clean Action | 1 | Contact on | 0 (Contact off) | |
| 0079H-008FH | Factory reserved | | | | | |

### 9.3 Modbus example description(ex: function code 03H)

The following description takes the temperature reading(0037H) as an example. Set the temperature at the transmitter at MTC 25.1$^{o}$C, and confirm that host and sub-machine communication format settings are correct. The host according to the following left table to send commands, and then to get the response from sub-machine according to following right table. This example shows the message transmission function code 03H data format. If under other function code, the logic mode is the same.

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 | 37 | Register value Hi | CC |
| No. of Registers Hi | 00 | Register value Lo | CD |
| No. of Registers Lo | 02 | Register value Hi | 41 |
| LRC | C3 | 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 | 37 | 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 | 75 | Register value Lo | C8 |
| CRC Check Hi | C5 | CRC Check Lo | 65 |
| | | CRC Check Hi | 5A |

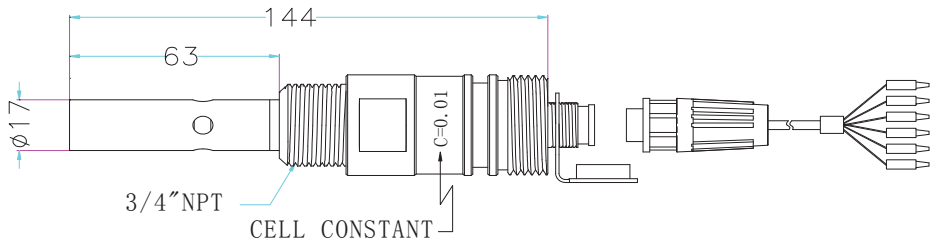
**Note:** FLOAT is a 32-bit IEEE 754 format. The above table, for an example, is divided into two 16-bit register data transmission. The back 16-bit register(CC CD) will be transferred first, and then the first 16-bit register (41 C8) will be transferred later. Every 16-bit format is high-bit in the front and low-bit in the post. For example, the temperature now is 25.1$^{o}$C. The 16-bit of FLOAT data(Hexadecimal) will show 41 C8 CC CD. The transmission order is CC CD 41 C8.

## 10. Error messages (Error code)

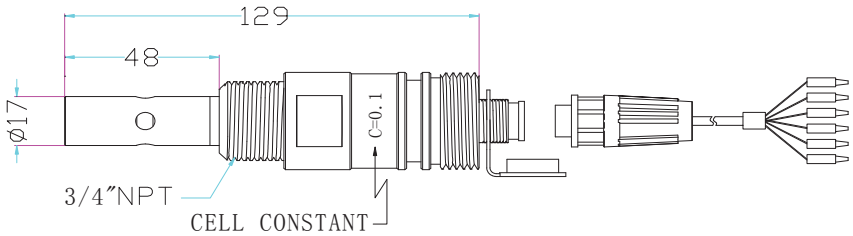
| Messages | Reason | Dispositions |
|---|---|---|
| **Error1** | The reading is unstable when calibration | 1. Replace with new standard solution<br>2. Maintain the electrode or replace a new electrode, and make another calibration |
| **Error2** | 1. Cell constant of the electrode exceeds the upper or lower limit<br>2. Exceed temperature range | 1. Replace with new standard solution<br>2. Maintain the electrode or replace a new electrode, and make another calibration |
| **Error3** | Wrong password<br>**ERROR CODE** | Re-enter a password |
| **Error5** | Serious error that does not permit any further measuring | Please call service engineer. |

# 11. Installation of cells

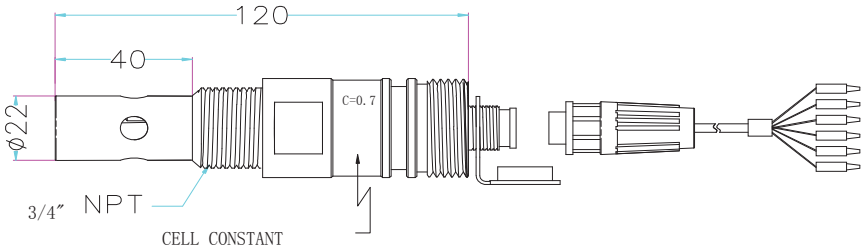
## 11.1 Appearance of cells



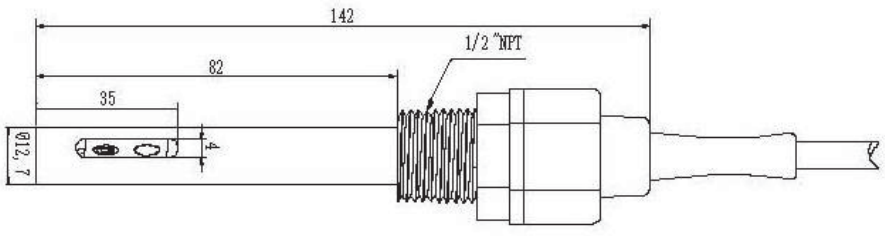

8-221/ 8-222 cell dimensions




8-223 cell dimensions

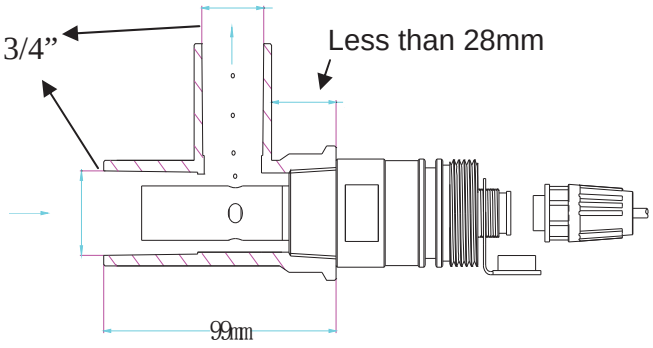


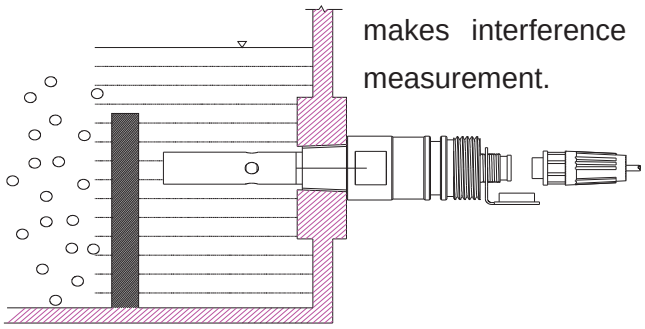

8-241 / 8-241-01 / 8-242 cell dimensions




8-244 cell dimensions

## 11.2 Correct installation

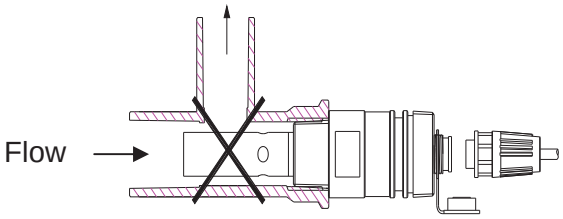


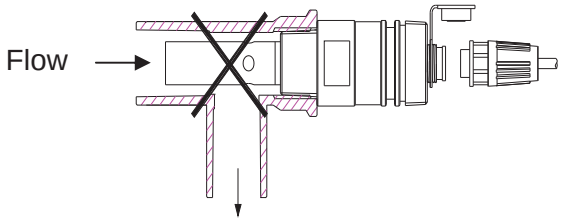
Avoid bubbles that makes interference to measurement.

## 11.3 Incorrect installation

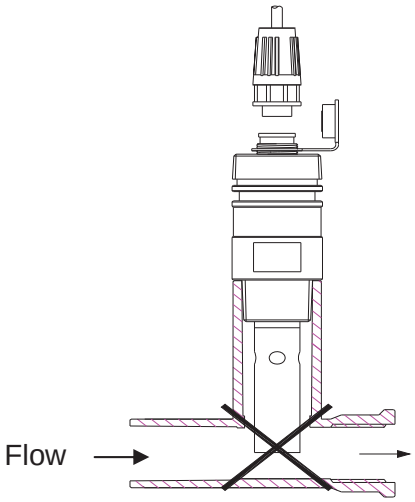
11.3.1 Insufficient immersion: The installation is easy to result in stagnant water inside the cell and thus lead to measurement error.




11.3.2 Insufficient water flow: The installation is prone to error measurement due to insufficient water flow.




11.3.3 Insufficient immersion: The installation is easy to result in stagnant water inside the cell and thus lead to measurement error.



## Appendix: Calibration Solution

| ℃ Conductivity | 84 μs@25℃ | 1413 μS@25℃ | 12.88mS@25℃ |
|---|---|---|---|
| **0** | | 776 | 7.15 |
| **5** | 65 | 896 | 8.22 |
| **10** | 67 | 1020 | 9.33 |
| **15** | 68 | 1147 | 10.48 |
| **16** | 70 | 1173 | 10.72 |
| **17** | 71 | 1199 | 10.95 |
| **18** | 73 | 1225 | 11.19 |
| **19** | 74 | 1251 | 11.43 |
| **20** | 76 | 1278 | 11.67 |
| **21** | 78 | 1305 | 11.91 |
| **22** | 79 | 1332 | 12.15 |
| **23** | 81 | 1359 | 12.39 |
| **24** | 82 | 1386 | 12.64 |
| **25** | 84 | 1413 | 12.88 |
| **26** | 86 | 1440 | 13.13 |
| **27** | 87 | 1467 | 13.37 |
| **28** | 89 | 1494 | 13.62 |
| **29** | 90 | 1521 | 13.87 |
| **30** | 92 | 1548 | 14.12 |
| **31** | 94 | 1575 | 14.37 |

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