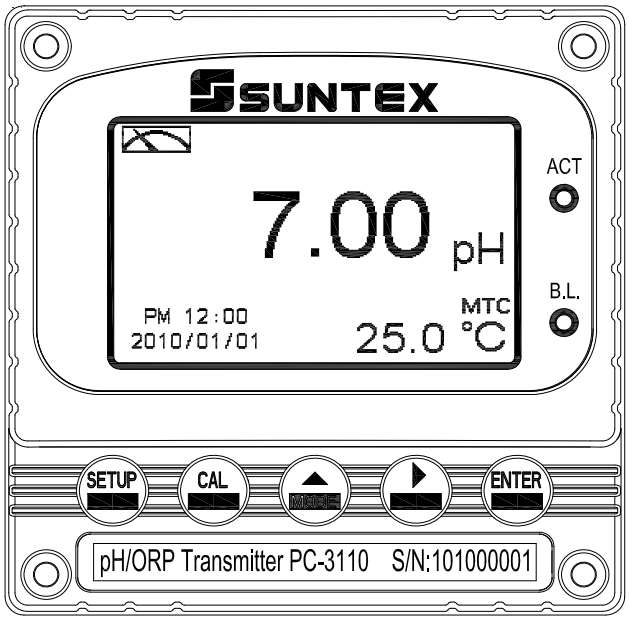
PC-3110-P Intelligent pH/ORP Transmitter

Operation Manual



SUNTEX

CONTENTS

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 controller before wiring input, output connections, and remove it before opening the controller housing.
- The installation site of the controller 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.
- The internal relay contact of the instruments is for alarm or control function. Due to safety, please must connect to external relay which can stand enough ampere to make sure the safety operation of the instruments.（Please refer to chapter 3.7“Illustration of electrical connection”）

Brief Instruction

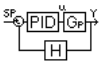
Description of set-up settings (see chapter 7 for details)

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 choose pH or ORP measurement
Multi-Cal.		Multi-point calibration, to choose 1, 2, or 3 points calibration
PID		PID setting, available for Pulse Length, Pulse Frequency, Analogout, totally three output mode
Temperature		Temperature measurement and compensation, including MTC, PTC, NTC (3 types total). MTC---Manual temperature compensation, PTC/NTC--- auto temperature compensation
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 pH or ORP setting range
Analog 2		Current output according to temperature/PID setting range
Clock		Clock setting **(When out of power and reboot it, the instrument's time setting will return to the factory default setting)**
Black-light		Backlight setting, to set Auto/ON/OFF backlight, brightness, and sensitivity
Contrast		Contrast of screen setting
Digital Filter		Take every serial 1~60 measurements, average them continuously, and make it as the readings
Return		Setting of returning to the measurement mode
Code		Security code of set-up mode. The factory default is 1111, and a designated user can change the code. 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 (up to three-point calibration)

keypad	Accordingly item	Description
Code		Security code of calibration mode. The factory default is 1100.
Return		Time interval setting of returning to the measurement mode
TECH	TECH	Use tech buffer as standard solution for calibration
NIST	NIST	Use NIST standard buffers(DIN 19266) as standard solution for calibration
Any	Any	Use any buffer solution by users' definition for calibration

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		**PC-3110-P**
Measuring modes		pH / ORP / Temp.
Ranges	pH	-2.00~16.00 pH
	ORP	-1999~1999 mV
	Temp.	-30.0~130.0 °C
Resolutions	pH	0.01 pH
	ORP	1 mV
	Temp.	0.1 °C
Accuracy	pH	±0.01 pH ± 1 Digit
	ORP	±0.1% ± 1 Digit
	Temp.	±0.2°C± 1 Digit
Temperature Compensation		NTC30K/ PT 1000 auto temperature compensation
		Manual adjustment temperature compensation
Calibration mode		Tech., NIST., Any mode, up to three point calibration
Ambient Temp.		0~50°C
Storage Temp.		-20~70°C
Input Impedance		> 10^{12} Ω
Display		Large LCM display with environment light sensor auto/manual illumination function
Analog output 1		Isolated DC 0/4~20mA corresponding to main measurement, max. load 500Ω
Analog output 2		Isolated DC 0/4~20mA corresponding to Temp., max. load 500Ω
Settings	Contact	RELAY contact，240VAC 0.5A Max.(recommend)
	Activate	Two sets of individual HIGH or LOW programmable control or PID Pulse Length, Pulse Frequency, control contact
PID control mode		Pulse Length, Pulse Frequency, Analogout(current)
Wash		RELAY contact: ON 0~99min. 59sec. / OFF 0~999hr 59min.
Voltage Output		DC±12V，1W max.
Certification		IP65
Power Supply		100V~240VAC±10%，4W max.，50/60Hz
Installation		Wall or Pipe or Panel Mounting
Dimensions		96m × 96mm × 132mm (H×W×D)
Cut off Dimensions		93 mm × 93 mm (H×W)
Weight		0.5Kg

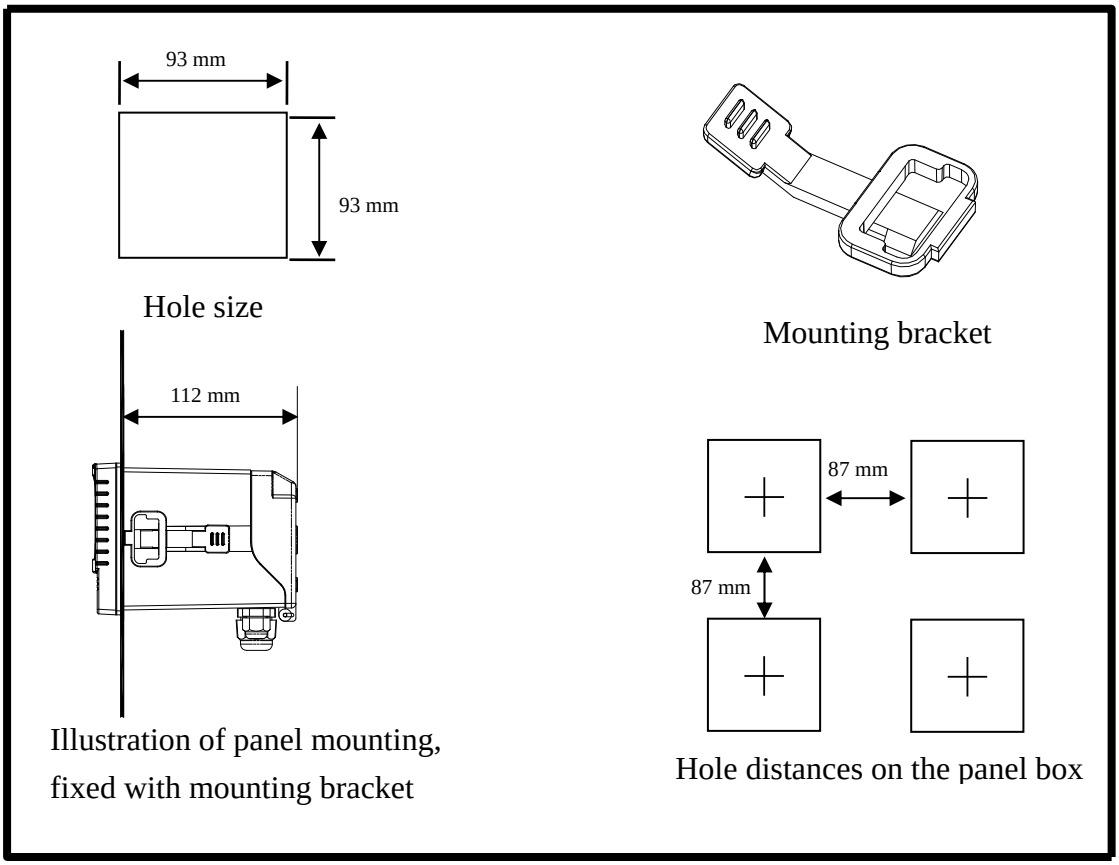
Note: The specifications are subject to change without notice.

2. Assembly and installation

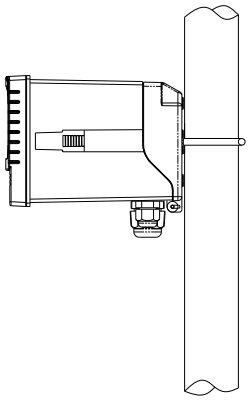
2.1 Transmitter installation: This Transmitter can be installed through panel mounting, wall mounting and pipe mounting.

Installation of panel mounting: First, prepare a square hole of 93 x 93mm on the panel box, and then insert the controller directly into the panel box. Insert the accessorial mounting bracket from the rear, and make it be fixed in to pickup groove.

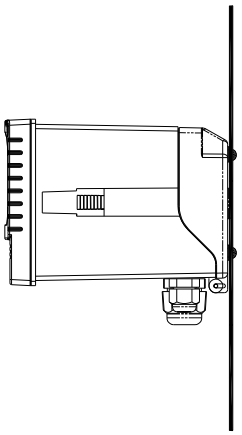
2.2 Illustration of panel mounting:



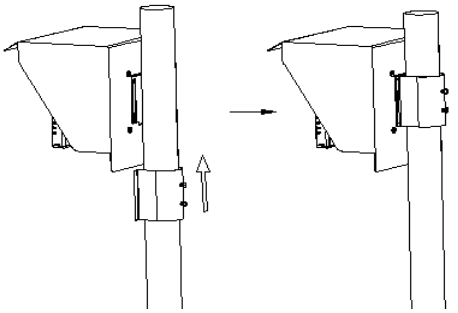
2.3 Illustration of Wall mounting and pipe mounting



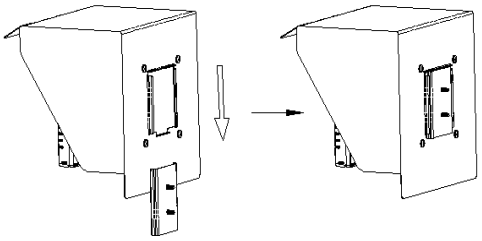
Installation of pipe mounting
Fixed with U-shaped pipe clip. The distance between screw holes is 60mm



Installation of wall mounting
Fixed with 4 x M4 screws



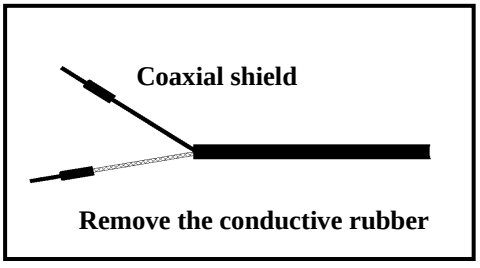
Sun Shield (Pipe mounting)
Order No.: 8-35 and 8-35-1



Sun Shield (Wall mounting)
Order No.: 8-35 and 8-35-2

2.4 Assembly of electrode and housing

2.4.1 Cable set-up:

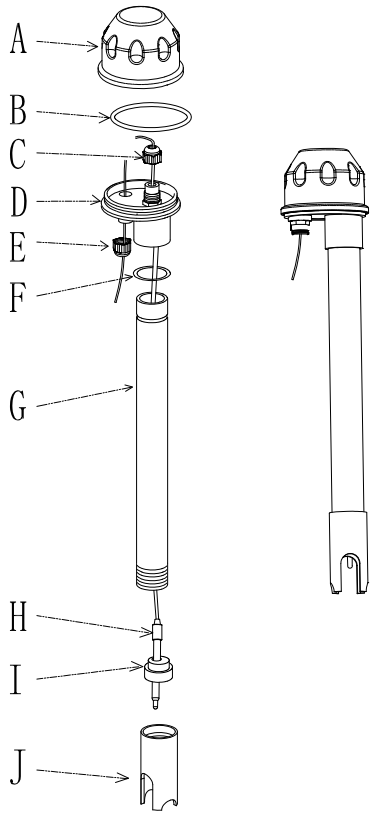


Set-up diagram of coaxial cable:
See the correct set-up method on the left:

Note: The black conductive rubber covering on the coaxial inner should be removed for use.

a. Make sure to remove the conductive rubber or aluminum-foil paper between the electrode signal wire and the coaxial shield.
b. Extend the cable to the controller without any joint except specific junction box. Connect the coaxial inner directly to the Glass contact on the back of controller and connect coaxial shield to Ref. contact.

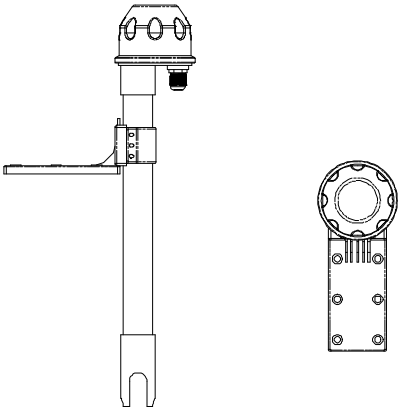
2.4.2 Assembly of housing PP-100A



A------ Upper cover of round joint box
B------ O-ring
C------ Cable fixing point MG16A
D------ Lower cover of round joint box
E------ Cable fixing point MG16A
F------ O-ring
G------ PP Electrode Protective Housing
H------ Electrode (Sensor)
I------- Rubber electrode holder
J------- PP pipe protective cover

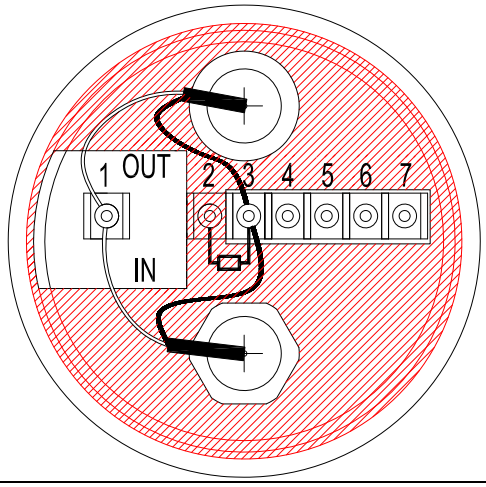
1. Insert **(H)** Electrode through **(G)** PP Electrode Protective Housing
2. Rinse **(H)** Electrode properly, so that it can be easily pass through **(I)** Rubber electrode holder, leave about 5cm bellow.
3. Install the prepared **(I)** Rubber electrode holder into **(G)** PP Electrode Protective Housing and lock **(J)** PP pipe protective cover tightly.
4. Insert **(H)** Electrode cable through **(D)** Lower cover of round junction box and **(C)** Cable fixing point, and use **(D)** Lower cover of round junction box to lock **(G)** PP Electrode Protective Housing tightly.
5. Prepare 15cm cable in the PP pipe, and then lock **(C)** Cable fixing point MG16A tightly. Leave **(H)** Sensing electrode cable for about 12-14cm, and split it carefully.
6. Fix the terminal of electrode coaxial inner on terminal block 1 of round holder; Fix the terminal of electrode coaxial shield on terminal block 3. (See the instruction of junction box)
7. Extend the cable to pass through **(E)** Cable fixing point on **(D)** Lower cover of round junction box, and lock **(E)** Cable fixing point MG16A tightly, leaving 12-14cm in the box for split.
8. Extend the lead coaxial inner and electrode coaxial inner to connect them; extend the lead coaxial shield to fix on the terminal block 3. Lock **(A)** Upper cover of round junction box to finish the installation.

Mounting bracket:



Our company use L-shaped mounting bracket as electrode mounting bracket. According to the site necessity, fix the bracket with steel nails or expansion bolts at proper locations by pool.

2.5 Illustration and description of junction box :(Two kinds of link distributing system)



〔1〕Two-wire distributing system			
INPUT terminals	Terminal No.	OUTPUT terminals	Terminals on controller
Coaxial inner	1	Coaxial inner's extending wire for electrode	GLASS
Shield (forbidden)	2	Shield (forbidden)	------
Coaxial shield	3	Coaxial shield's extending wire for electrode	REF
Temperature probes red wire	4	Red wire's extending wire for electrode	T/P
Temperature probes green wire	5	Green wire's extending wire for electrode	GND
Alternative	6、7	Alternative	------

Note: 1. Our company's extending wire for electrode material No. is 7202-F94009-BK and 7202-RG-58

1.) If temperature probe is not used, the Order No. is 7202-RG-58.

2.) If temperature probe is used, the Order No. is 7202-F94009-BK.

2. If temperatures probe 8-26-3(NTC30K) or 8-26-8(PT1000) is used for two-wire distribution, the black wire terminal should be forbidden.

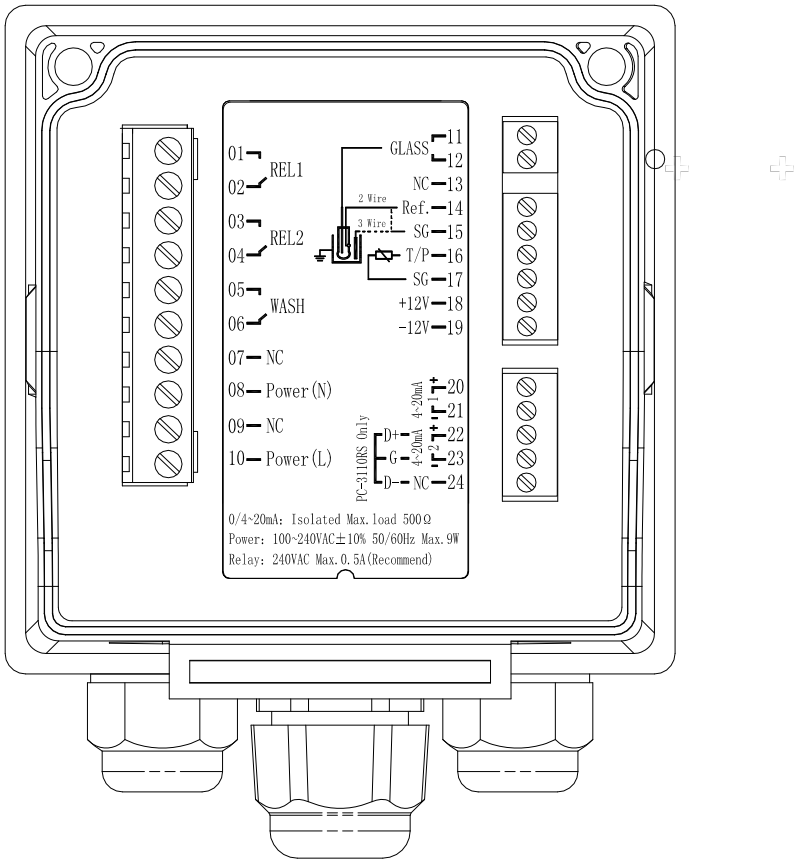
（2）**Three-wire distributing system**			
IN terminals	Terminal No.	OUT terminals	Terminals on controller
Coaxial inner	1	Coaxial inner's extending wire for electrode	GLASS
Ground Rods	2	GND	GND
Coaxial Shield	3	Coaxial Shield's extending wire for electrode	REF
Temperature probes red wire	4	Red wire's extending wire for electrode	T/P
Temperature probes green wire	5	Green wire's extending wire for electrode	GND
Alternative	6、7	Alternative	----

Note: 1. The black wire on the temperature probes of 8-26-3(NTC30K) or 8-26-8(PT1000) is used as special wire for Ground Rods to be connected at terminal 2.

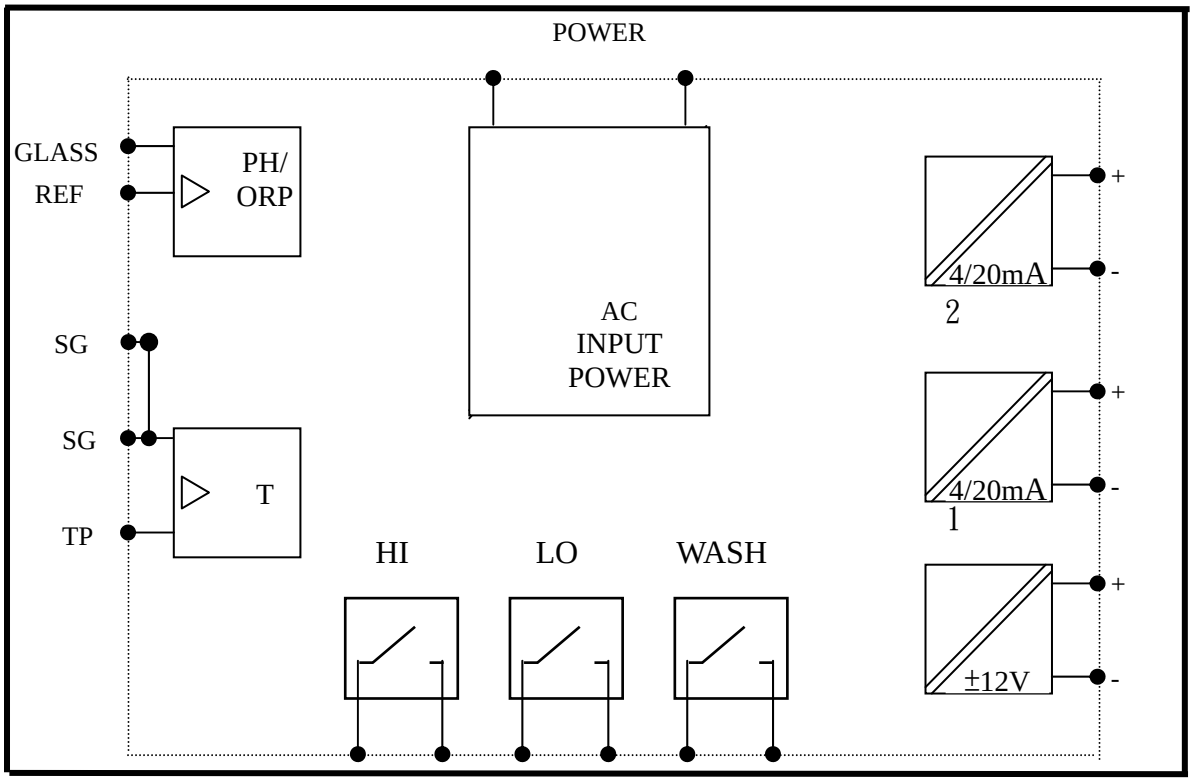
2. The extending wire for electrode that has a temperature probe or ground rod is marked with material number 7202-F94009-BK.

3. Overview of pH transmitter PC-3110-P

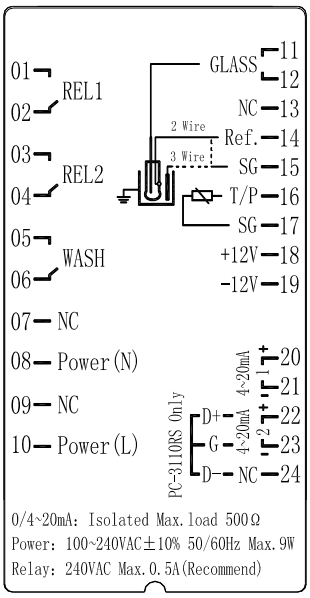
3.1 Illustration of rear panel:



3.2 Illustration of terminal function:



3.3 Description of terminal function:



01, 02 — **REL1**: First external relay terminal control; or PID Direct control

03, 04 — **REL2**: Second external relay terminal control; or PID Reverse control

05, 06 — **WASH:** External wash relay terminal

07 — **NC:** None contact

08 — **100~240AC:** Power supply terminal

09 — **NC:** None contact

10 — **100~240AC:** Power supply terminal

11, 12 — **GLASS:** Coaxial inner connecting pH/ORP electrode signal wire

13 — **NC:** None contact

14 — **REF:** Coaxial shield connecting pH/ORP electrode signal wire

15 — **SG:** The terminal connecting temperature probe, or used as ±12V ground potential. **In two-wire distributing system, there should be a short circuit between this terminal and REF (a short circuit slice is attached when going out the factory)**

16 — **T/P:** Connect the other end of temperature probe

17 — **SG:** The other terminal connecting temperature probe, or used as ±12V ground potential.

18, 19 — **DC±12V**: Output terminal of direct current voltage ±12V **(PH-300T only)**

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

21 — **4~20mA – terminal:** Master measure current output terminal -, for external recorder or PLC control

22 — **4~20mA +terminal:** Temperature current output terminal -, for external recorder or PLC control, or PID Direct/Reverse control

23 — **4~20mA – terminal:** Temperature current output terminal -, for external recorder or PLC control, or PID Direct/Reverse control

24 — **NC / D-(A）:** None contact

3.4 Installation of transmitter PH-300T: (alternative equipment)

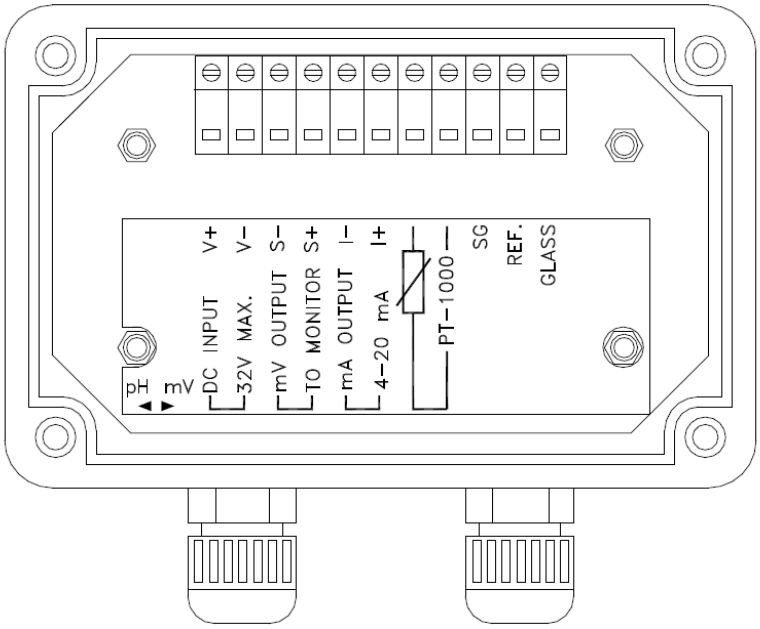
PH-300T transmitter is mainly installed on the electrode protective pipe, but also can apply wall mounting and pipe mounting. For long distance transmission (100m), if PC-3110 is more than 30m far away from the electrode, PH-300T transmitter is recommended to avoid the attenuation of electrode signal, and for the convenience of onsite observation, measurement, and calibration.

3.5 Connection of transmitter PC-3110 and transmitter PH-300T:

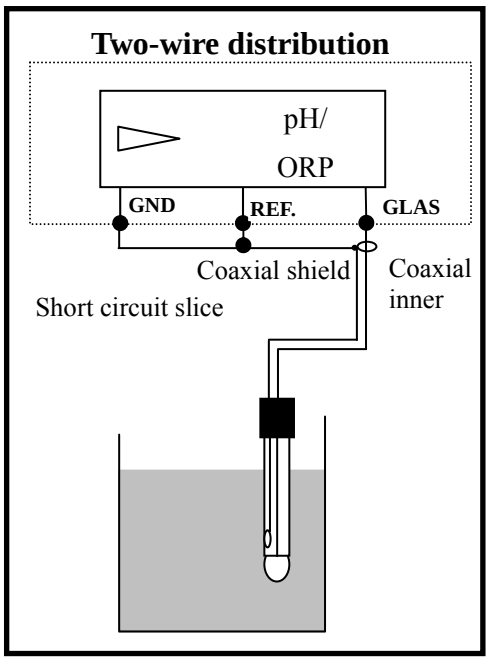
A. Connect the GLASS point of transmitter PH-300T's terminal to the electrode coaxial inner. (Note: Remove the black conductive rubber); connect the REF point of transmitter PH-300T's terminal to the electrode coaxial shield.
B. See the two-wire distributing system and three-wire distributing system in the following page.
C. Sign "PT-1000" on transmitter PH-300T's terminal is the connector for automatic temperature compensation probe, PT-1000, or applies a fixed temperature compensation resistance.
D. The V+ and V- of transmitter PH-300T's terminal respectively connect to DC12V+ and – of the controller.
E. The S+ and S- on transmitter PH-300T's terminal respectively connect to GLASS and REF of the controller.
F. The I+ and I- on transmitter PH-300T's terminal are output (4-20mA), which can connect to devices that receive current signals. **(Note: The current output signal of this transmitter is not insulating, so use it with much care!)**

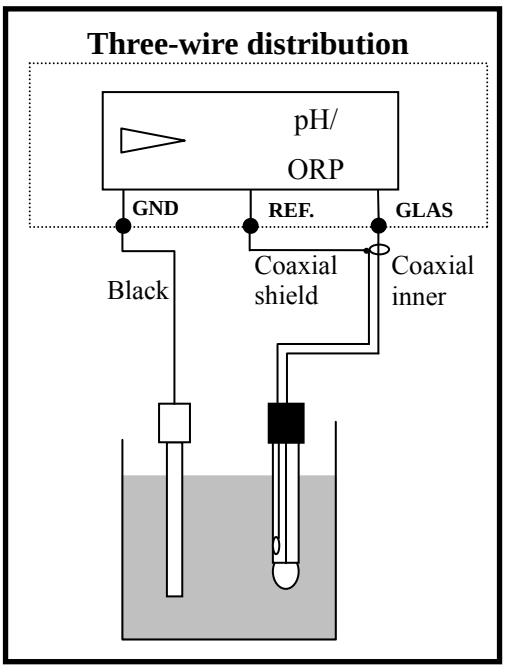
Note: Refer to the following table for proper fixed temperature compensation resistance

Temperature	0℃	5℃	10℃	15℃	20℃
R value	1000Ω	1019.25Ω	1038.5Ω	1057.75Ω	1077Ω
Temperature	25℃	30℃	35℃	40℃	45℃
R value	1096.25Ω	1115.5Ω	1134.75Ω	1154Ω	1173.25Ω
Temperature	50℃	55℃	60℃	65℃	70℃
R value	1192.5Ω	1211.75Ω	1231Ω	1250.25Ω	1269.5Ω
Temperature	75℃	80℃	85℃	90℃	100℃
R value	1288.75Ω	1308Ω	1327.25Ω	1346.5Ω	1385Ω

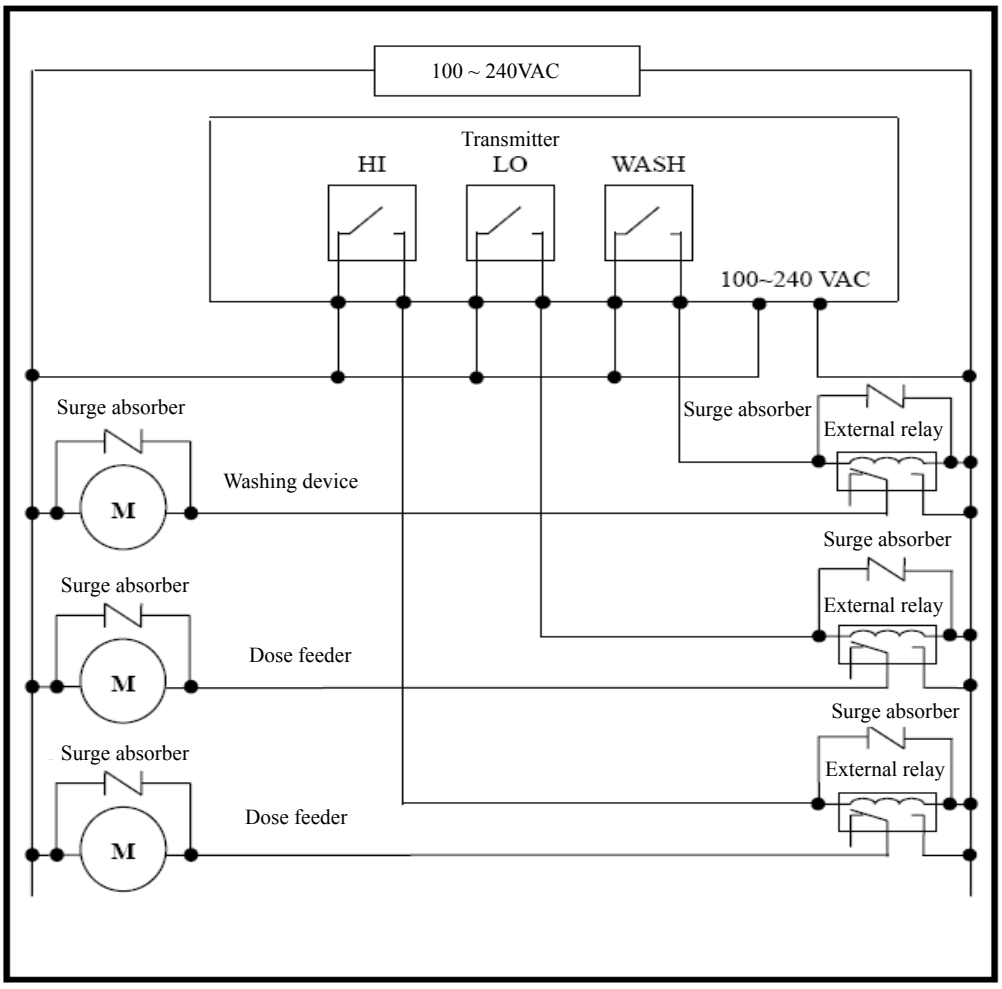


3.6 Typical wirings:



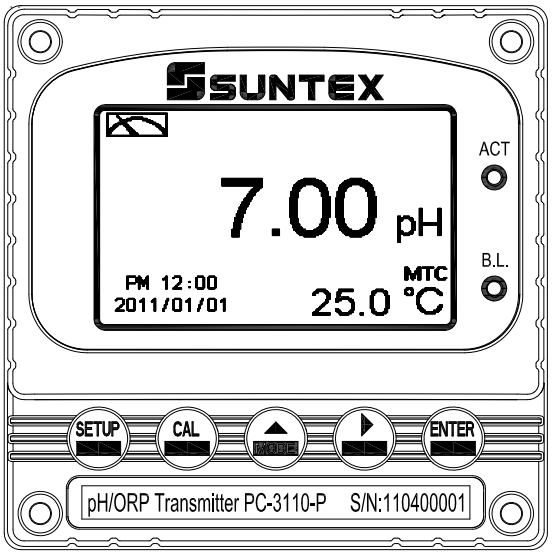


3.7 Illustration of electrical connection:



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:

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

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

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.

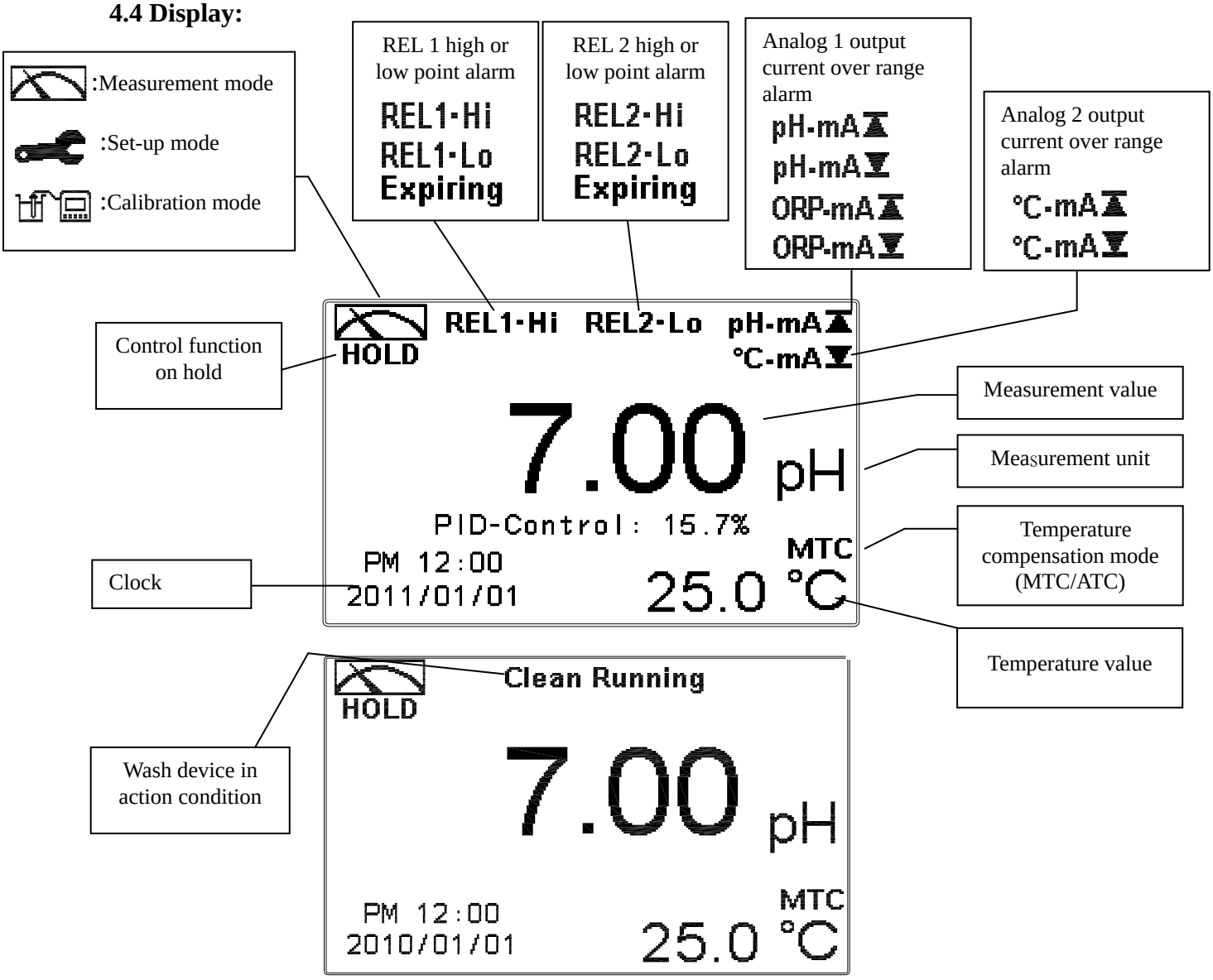
ENTER：Key for confirmation; pressing this key is essential when modifying data value or selecting the parameter setting items in the window.

4.3 LED indicators:

ACT: Washing device operation indicator and controlling operation indicator (Relay 1, Relay 2)

B.L. : Light sensor; in the automatic display backlit mode, the lamp will light or go out as the change of environmental brightness.

4.4 Display:



Note: 1. When the wash device is turned on, 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/ Relay 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/ Relay 2_Lo”, and ACT indicator LED lights up.

3. When Analog 1 current output exceeds the upper/lower setting range, the display shows and twinkles the symbol ”pH-mA▲ / pH-mA▼” or ”ORP-mA▲ / ORP-mA▼”. When Analog 2 current output exceeds the upper/lower setting range, the display shows and twinkles the symbol ” ˚C-mA▲ / ˚C -mA▼”.

4. When PID using Relay 1/Analog 2 as Direct control, the display twinkles the description: “REL1-Lo/ pH(ORP)-mA▼; When PID using Relay 2/Analog 2 as Reverse control, the display twinkles the description: “REL2-Hi/ pH(ORP)-mA▲ .

5. When PID continually makes 100% out and exceeds Expiring time, the display twinkles the description: “Expiring”.

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 6. 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 7. 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 or ▶ to adjust MTC temperature value.

2. In the measurement mode, if PID set as "Manual Output", press MODE or ▶ to adjust the PID output value.

5.5 Factory Default value

5.5.1 System setting default value

Measurement mode: pH
Multi-Cal：2 points pre-setting
Temperature compensation: MTC 25°C
PID setup: OFF
Relay 1：High point alarm: AUTO，SP1= 10.00 pH，Hys1= 0.10 pH
Relay 2：Low point alarm: AUTO，SP2 =04.00 pH，Hys2= 0.10 pH
Wash time: OFF
Analog 1 current output (pH/ORP)：4~20 mA，2.00~12.00pH
Analog 2 current output (Temp)：4~20 mA，0~100.0℃
Digital Filter: OFF
Display backlit: OFF
Code set-up: OFF
Date & Time：2010/1/1　00:00:00
Contrast: 0
Auto back: Auto, 3 minutes

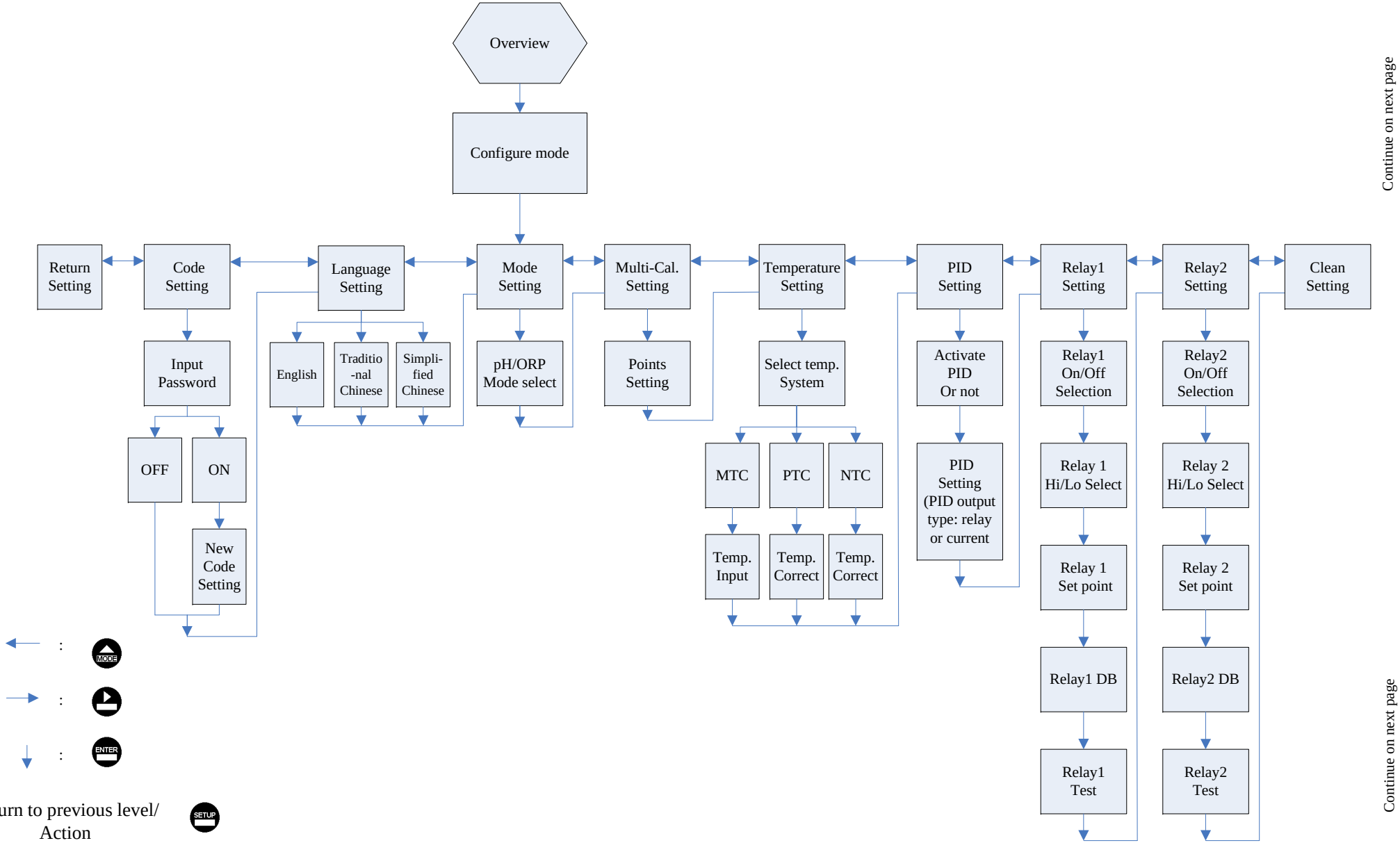
5.5.2 Calibration default value

Asy：0 mV
Slope：-59.15 mV/pH @ 25.0℃
Calibration type：TECH-No Cal
Calibration value: None data
Auto back: Auto, 3 minutes

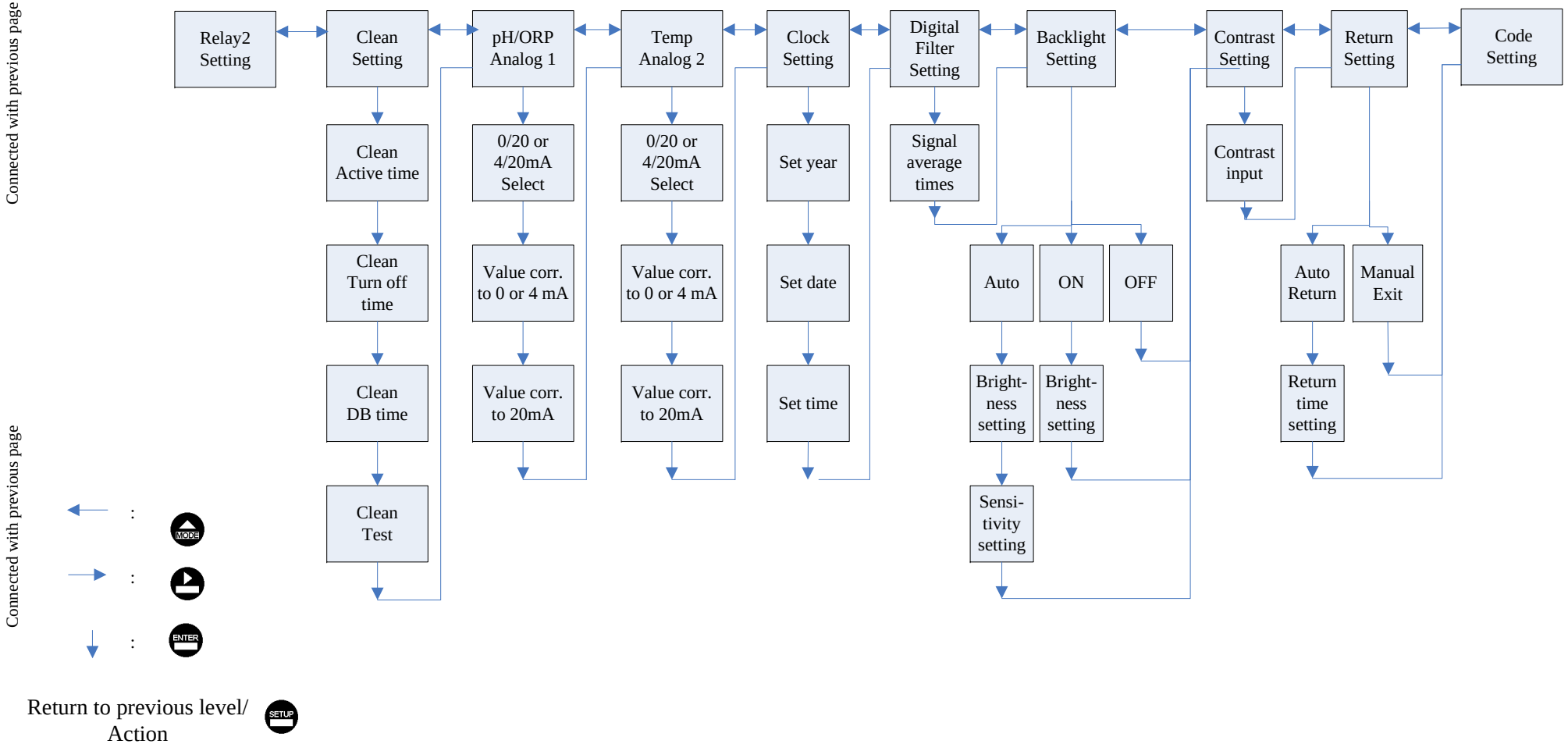
Note: The factory default of calibration presetting is "No Cal", and the calibration value is "None". It means that the user has not calibrated the sensor with the transmitter yet. After finishing every calibration, the display shows the calibration mode and the calibration value. If the equipments have not been calibrated yet, the measurement takes pre-set Asy and Slope into calculation.

6. Settings

Block diagram of settings 1

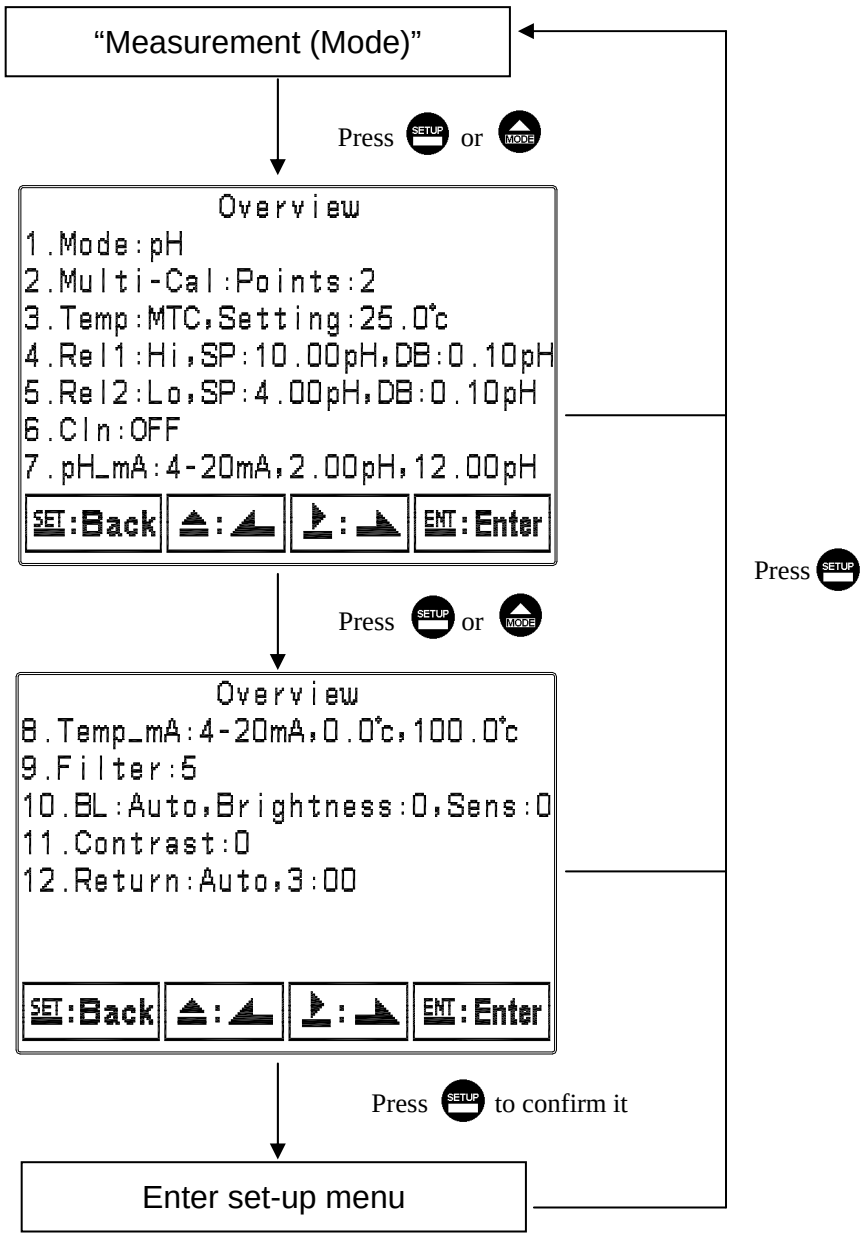


Block diagram of settings 2



6.1 Entry of set-up menu

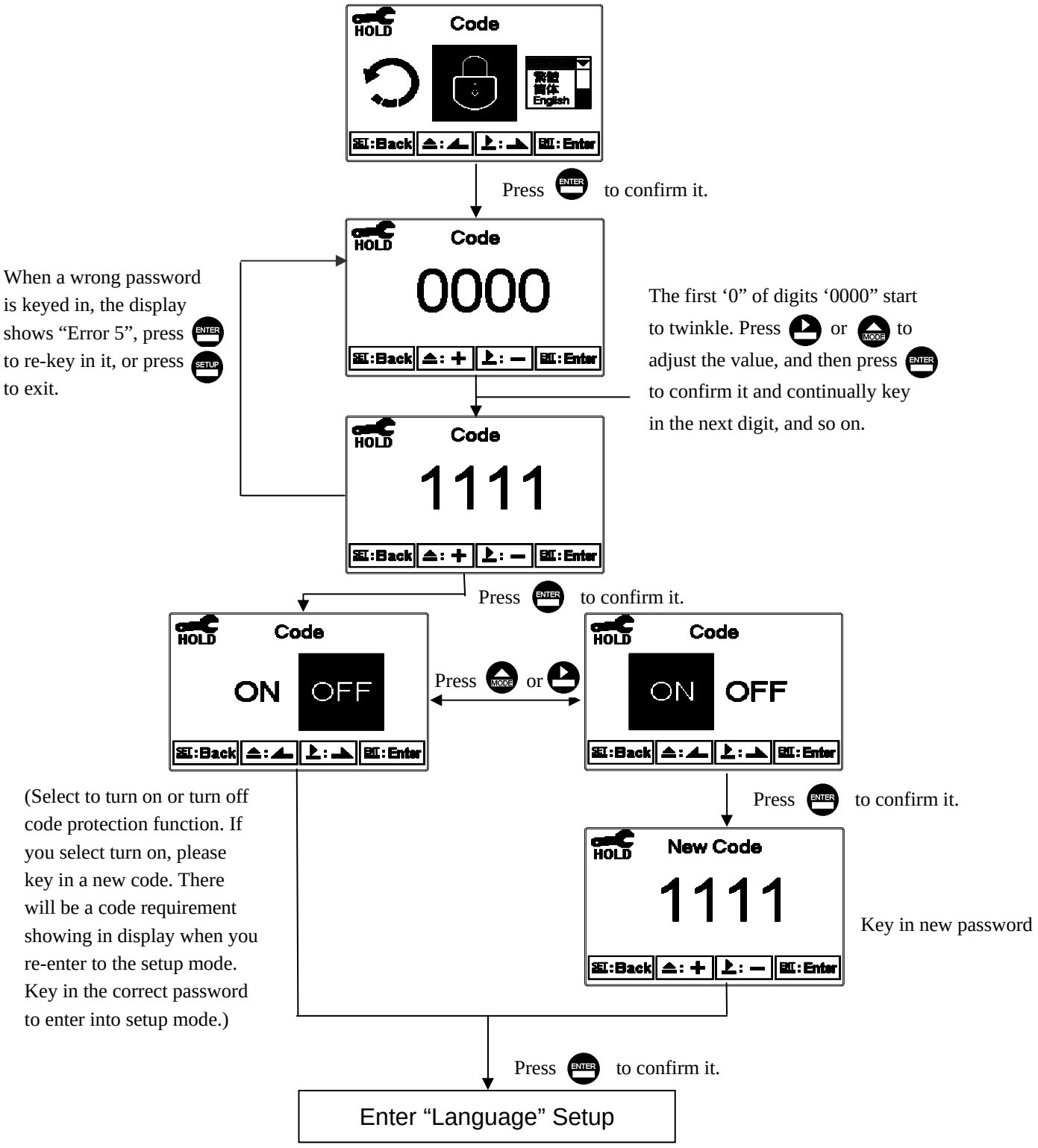
In the measurement mode, pressing the two keys SETUP and MODE simultaneously allows you enter the overview of current setting, and press ENTER to enter the set-up mode to modify the setting if necessary.



6.2 Security code of settings

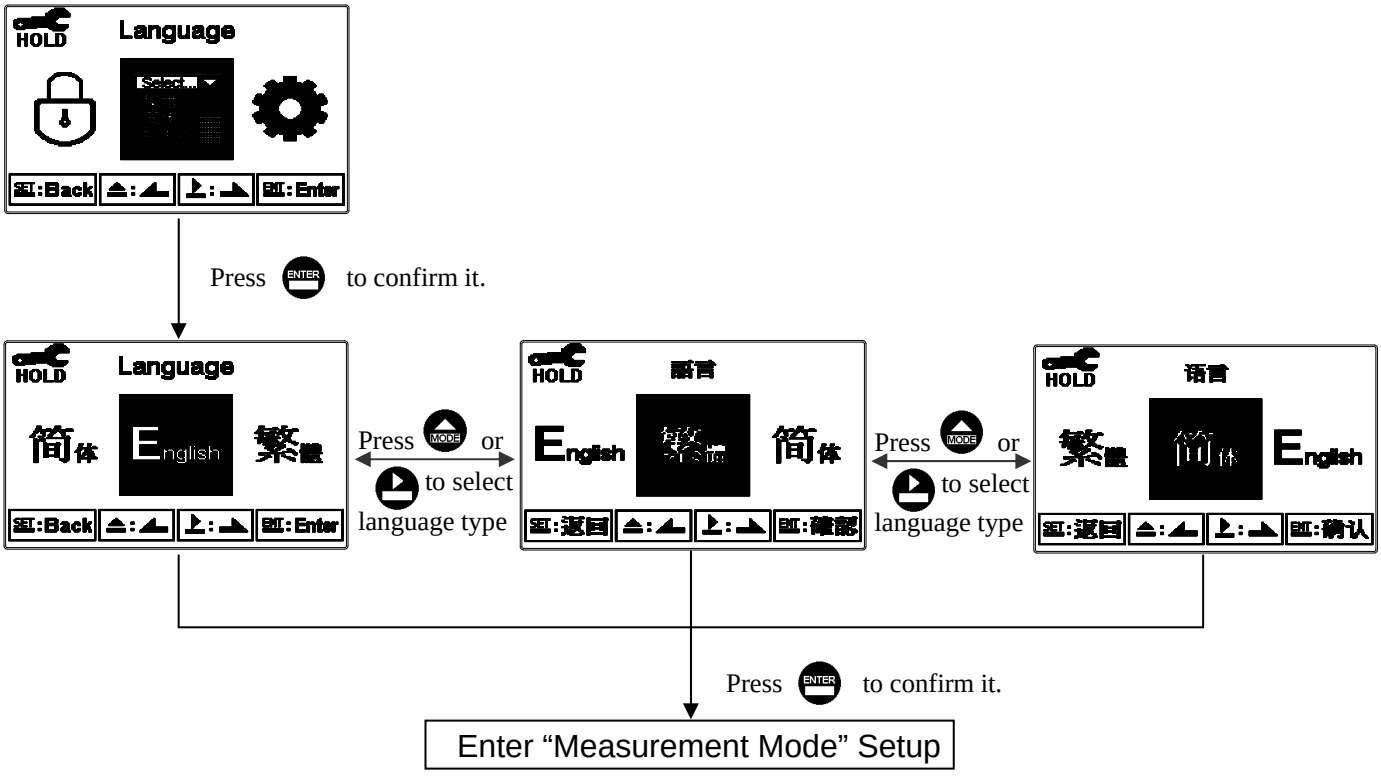
After entering set-up mode, select “code” item, press ENTER to enter into code procedure. **The code pre-setting is 1111.**

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.



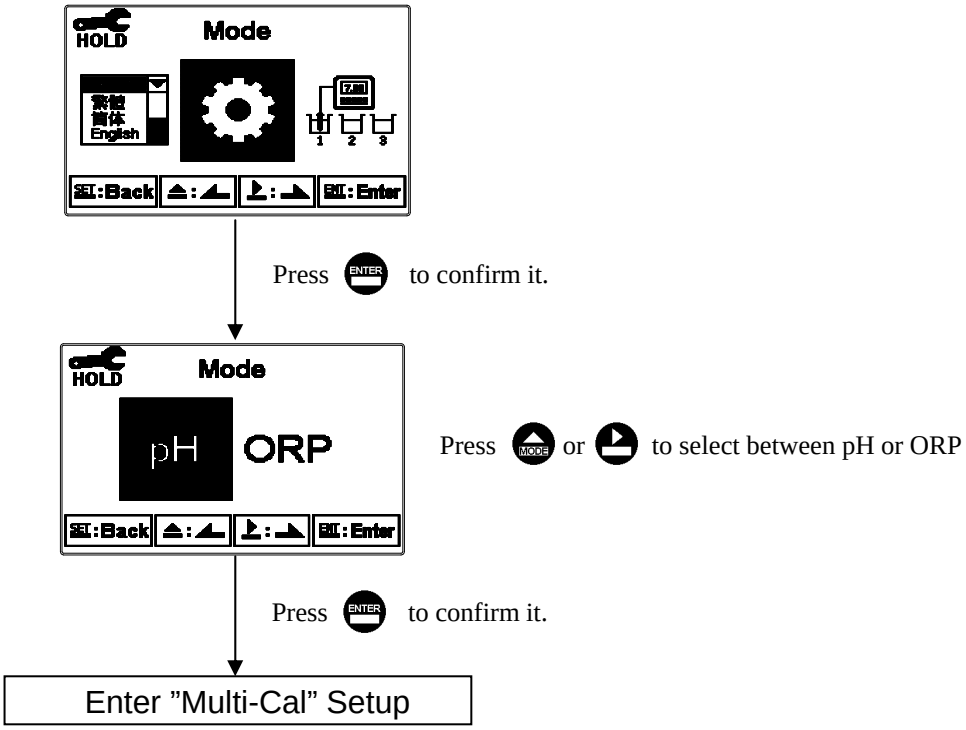
6.3 Language

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



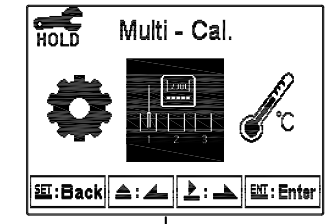
6.4 Mode

Enter setup of “Mode”. Select between “pH” or “ORP” measurement.

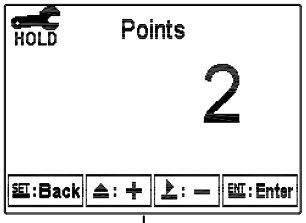


6.5 Multi-Cal

Enter setup of multi-points calibration to set the number of calibration points.



Press ENTER to confirm it.



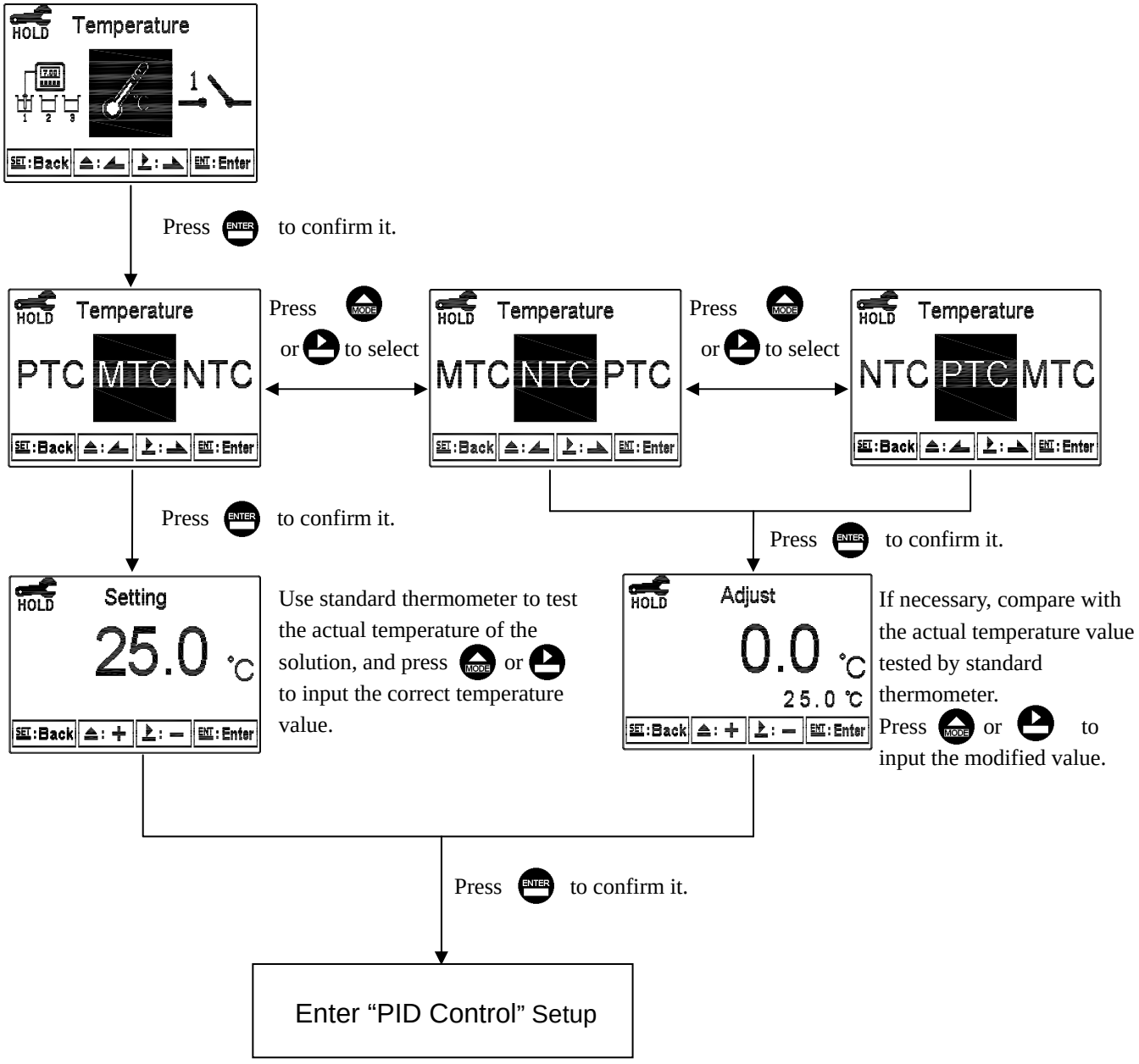
Press MODE or ▶ to select the number of calibration points. There are 1~3 points to choose from. The factory default is 2 points. When the calibration reaches the number of setting points, the calibration procedure will automatically be terminated and display the calibration result.

Press ENTER to confirm it.

Enter ”Temperature” Setup

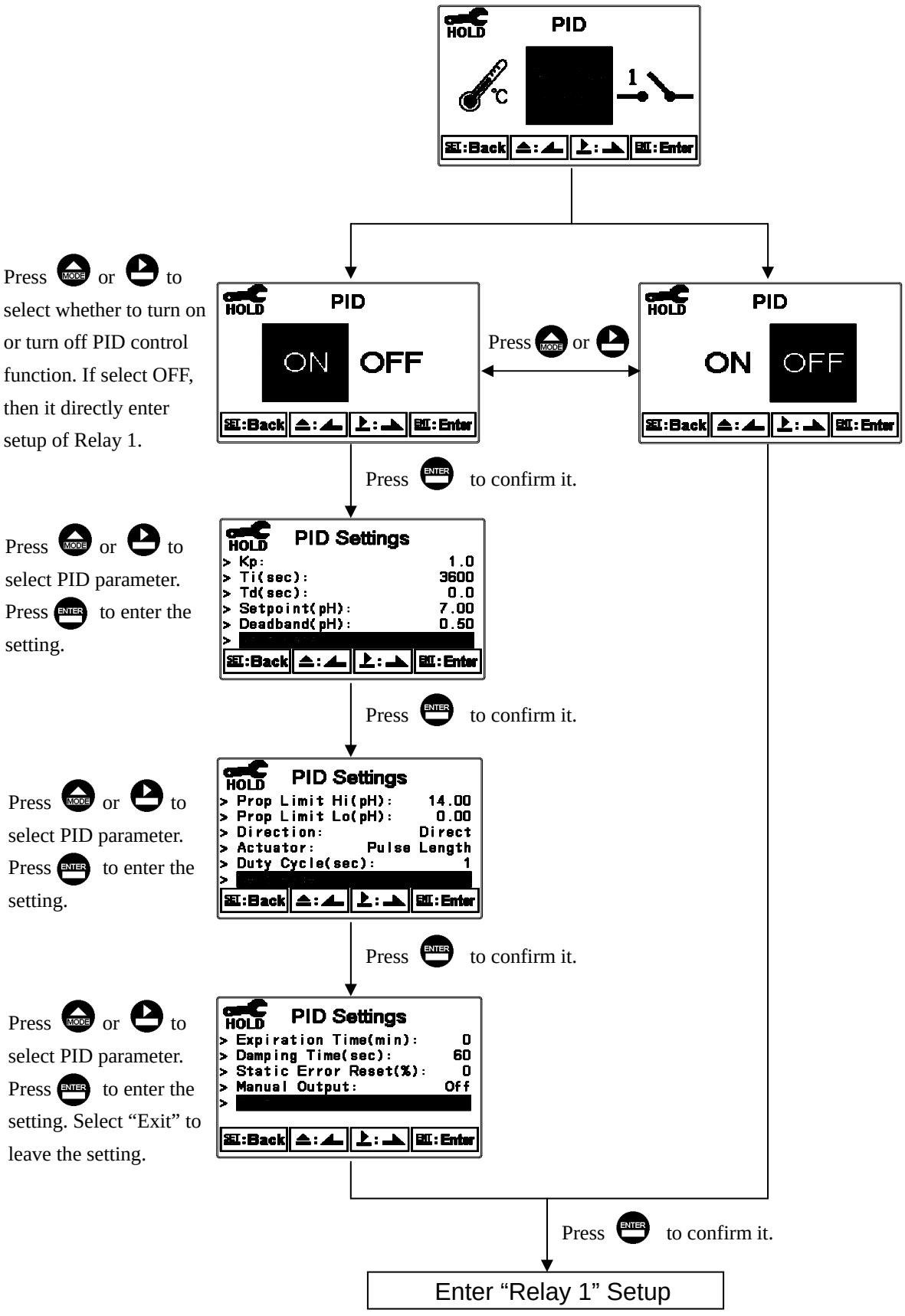
6.6 Temperature

Enter setup of “Temperature” to select temperature compensation mode. Select from NTC(NTC 30K), PTC(PT 1K) or MTC(Manual adjustment).



6.7 PID Control

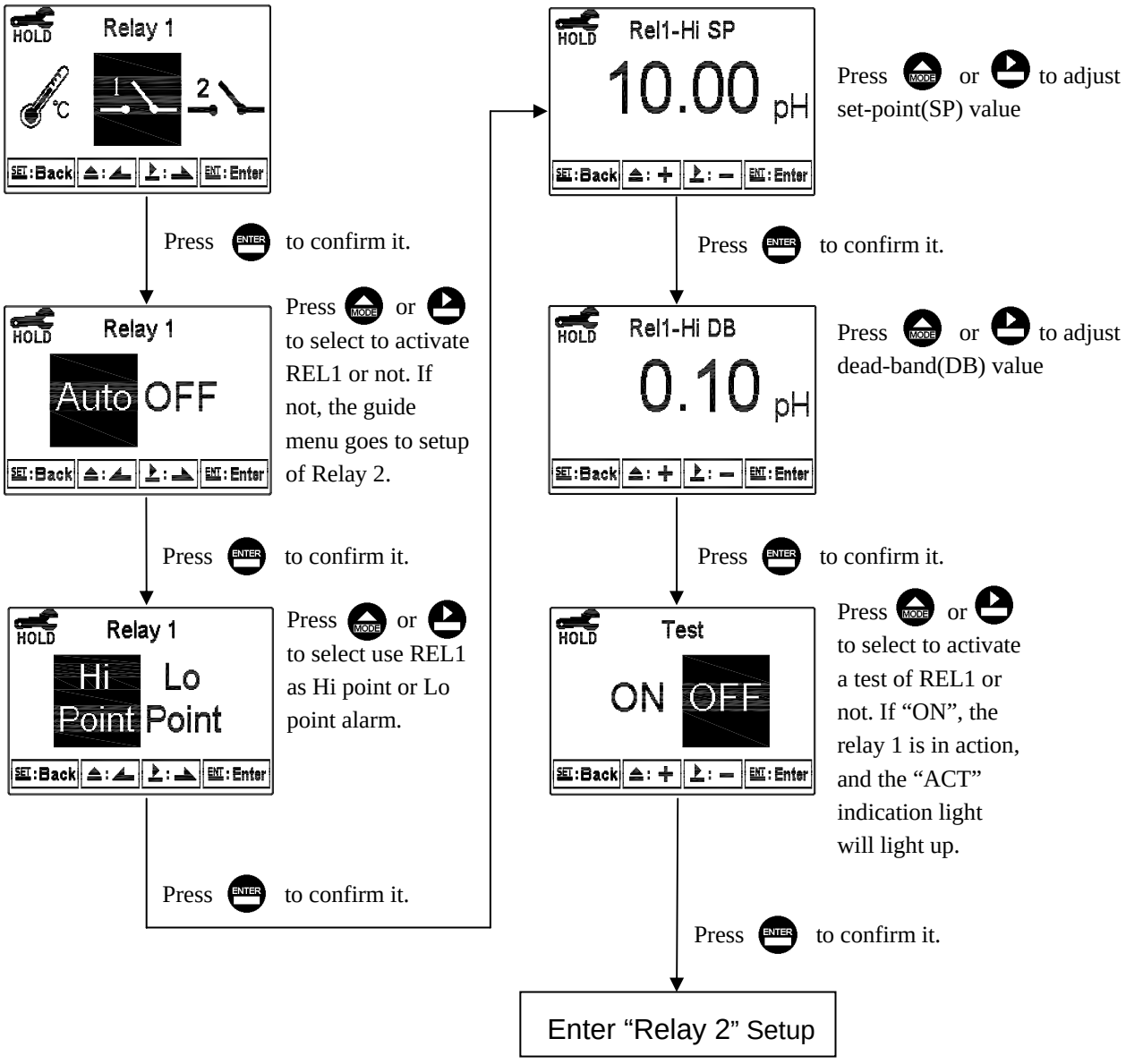
Enter setup of PID to set PID controlling parameters. The parameters related definitions please refer to Chapter 8 of the PID control. If select to turn on PID control, the relays or analog outputs may be turned off according to PID output type.



6.8 Relay 1

Enter setup of Relay 1. Select the item to turn on or turn of the relay 1 function. If you select to turn on the relay 1, then select for using relay 1 as “Hi set-point” alarm or “Low set-point” alarm. Set the value of set-point (SP) and dead-band (DB). The range for set-point is -2.00~16.00pH/-1999~1999mV; while the range for DB is 0.00~2.00pH /0~200mV.

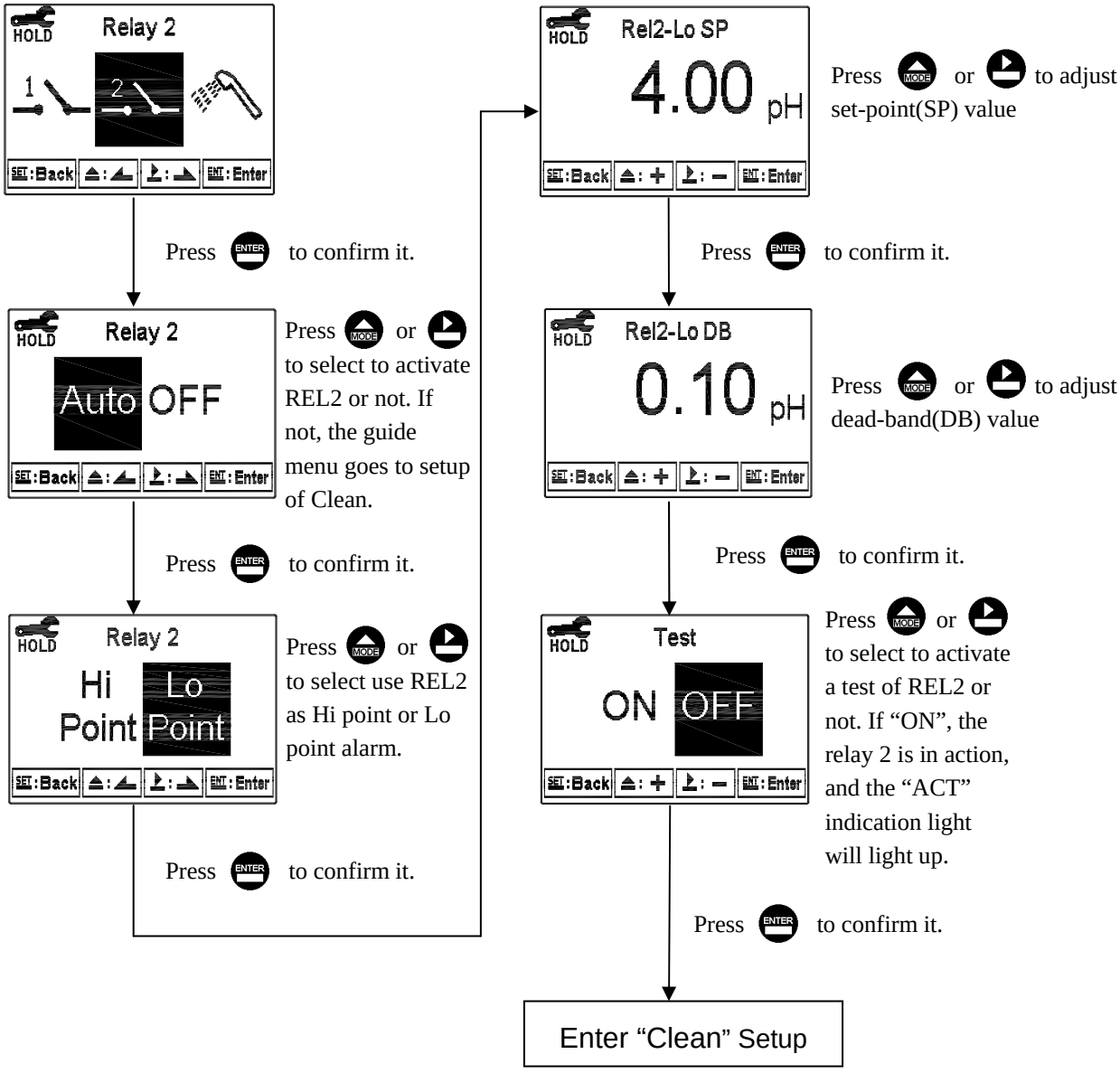
Note: When PID is set as “Pulse Length” or “Pulse Frequency” control, and the control way is set as “Direct”, the transmitter uses Relay 1 as PID output control device. At the time, the relay 1 setting function is turned off.



6.9 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 “Hi set-point” alarm or “Low set-point” alarm. Set the value of set-point (SP) and dead-band (DB). The range for set-point is -2.00~16.00pH/-1999~1999mV; while the range for DB is 0.00~2.00pH /0~200mV.

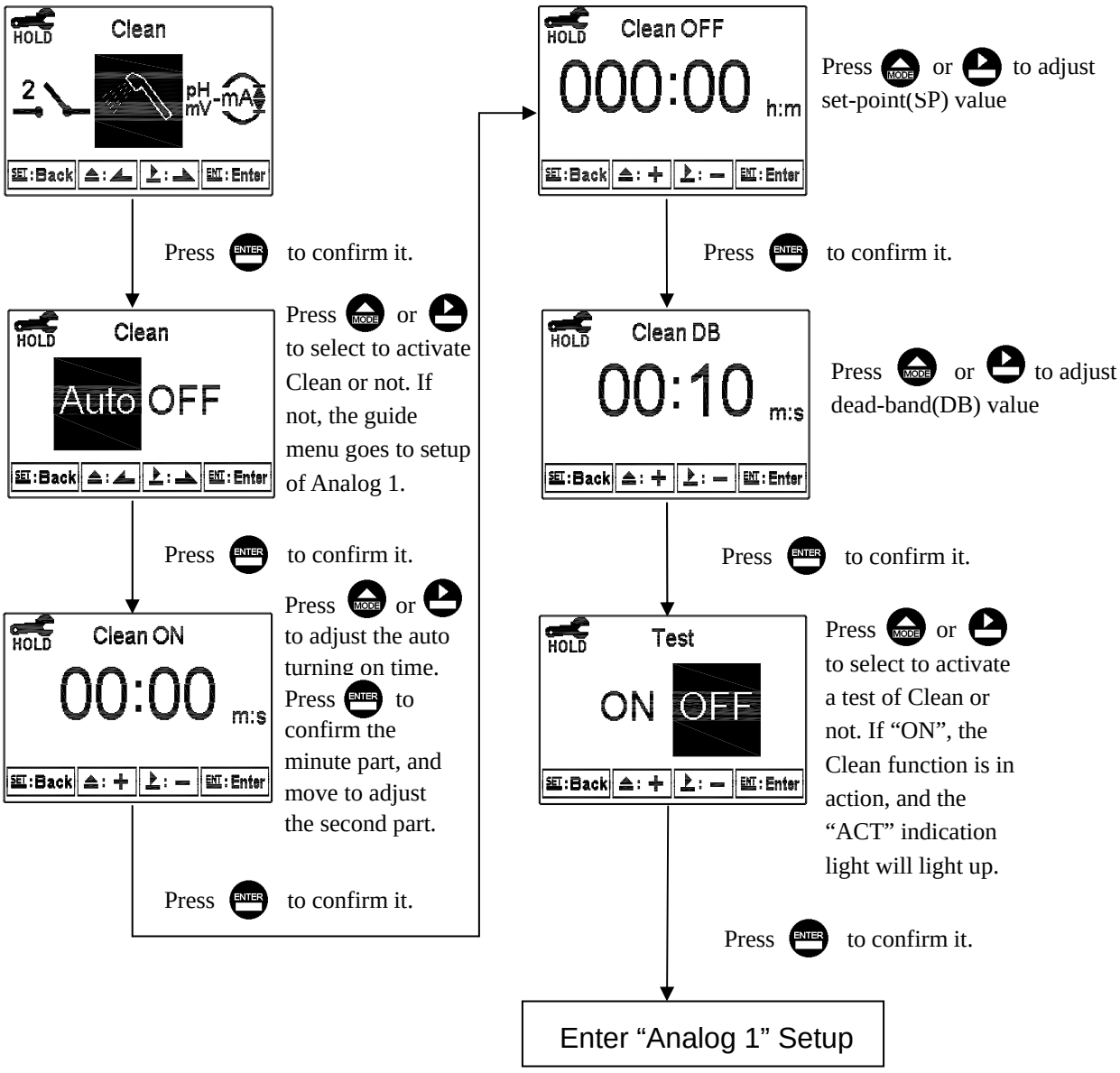
Note: When PID is set as “Pulse Length” or “Pulse Frequency” control, and the control way is set as “Reverse”, the transmitter uses Relay 2 as PID output control device. At the time, the relay 2 setting function is turned off.



6.10 Clean

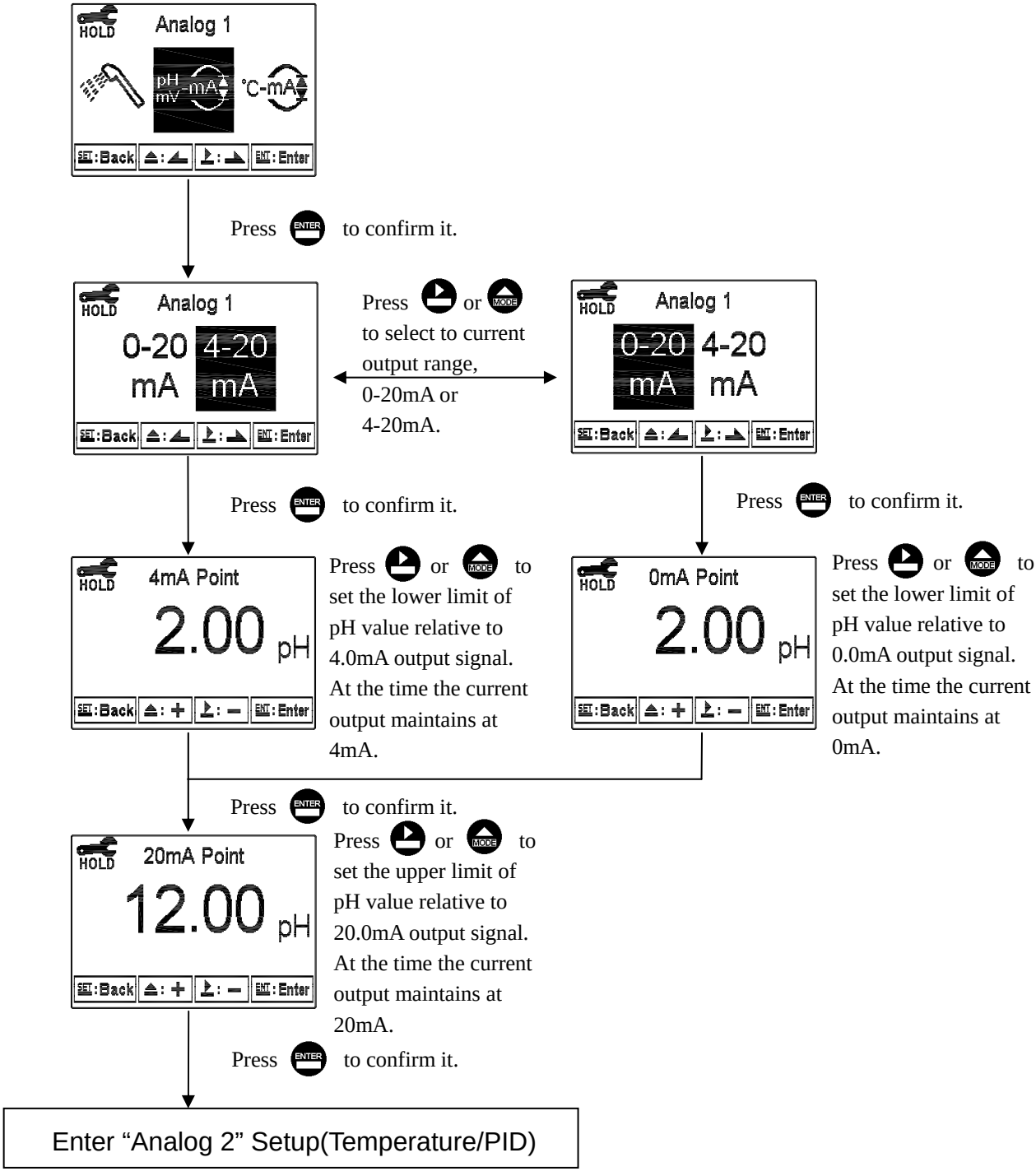
Enter setup of “Clean” function. Select the icon to turn on or turn off the clean function. If you select “Auto” turning on, and set the timer of the clean function including automatically turning on time and turning off time, and set the bead-band value(DB).

Note: When the clean function is turned on, if any value is set to be 0, the instrument will automatically turn off this function.



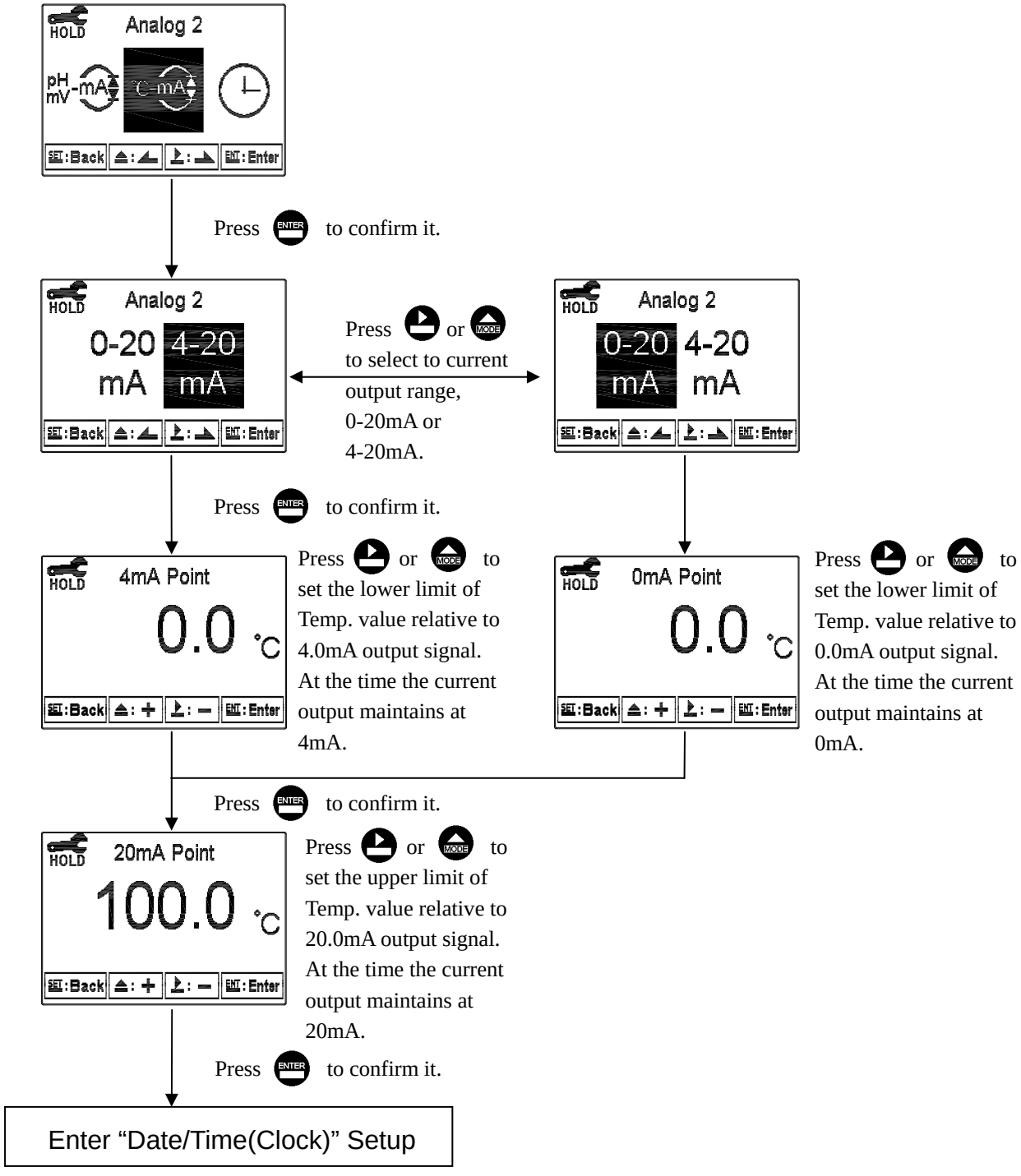
6.11 Analog output 1 (pH/ORP):

Enter setup of Analog 1. Select 0~20mA or 4~20mA current output. Set the related value to the range of pH/ORP measurement. If the range or the pH/ORP measurement is 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 maintain the last output value before HOLD status. However, in order for 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.



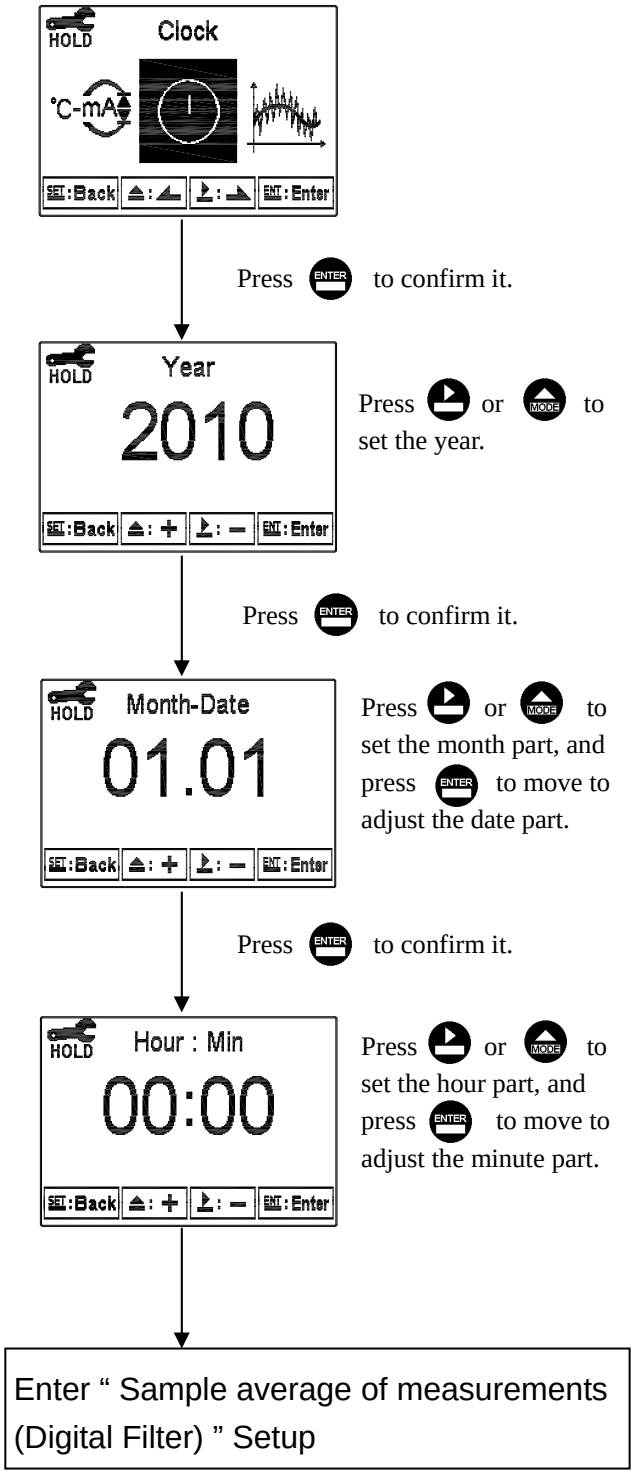
6.12 Analog output 2 (Temperature/PID):

Enter setup of Analog 2. Select 0~20mA or 4~20mA current output. Set the related value to the range of temperature measurement. If the range or the temperature measurement is 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 maintain the last output value before HOLD status. However, in order for 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. Note: **When PID is set as "Analogout" control, the transmitter uses Analog output 2 as PID output control device. At the time, the Analog 2 setting function is turned off.**



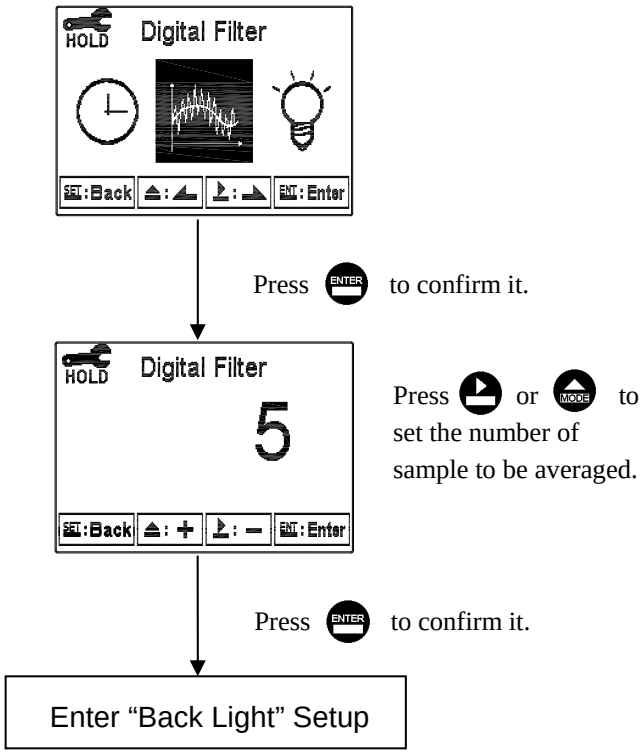
6.13 Date/Time(Clock)

Enter setup of Date/Time(Clock). Set the “Year”, “Month”, “Date”, “Hour”, and “Minute” time. Note: The clock needs to be reset once encounters power failure.



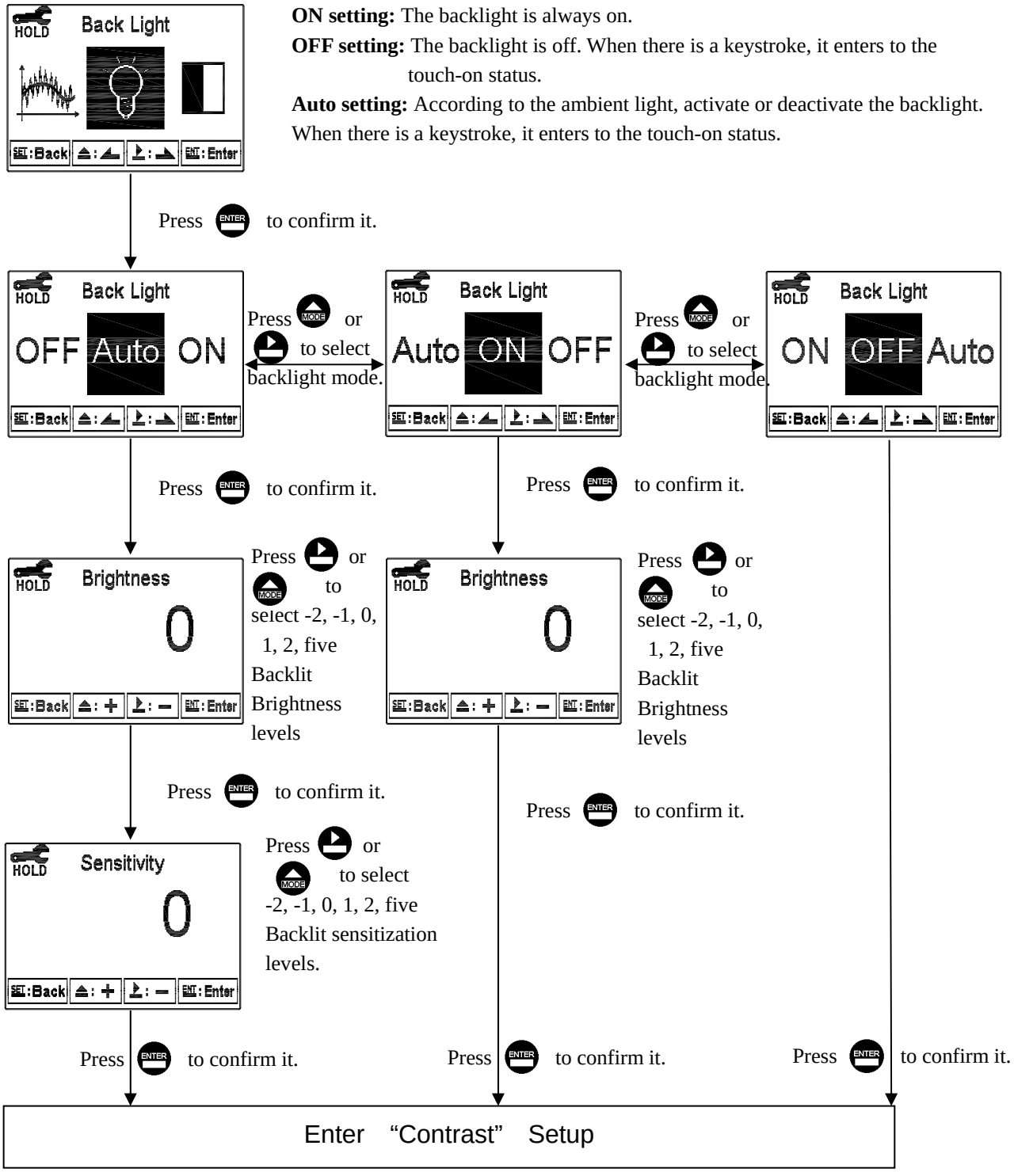
6.14 Sample average of measurements (Digital Filter)

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.



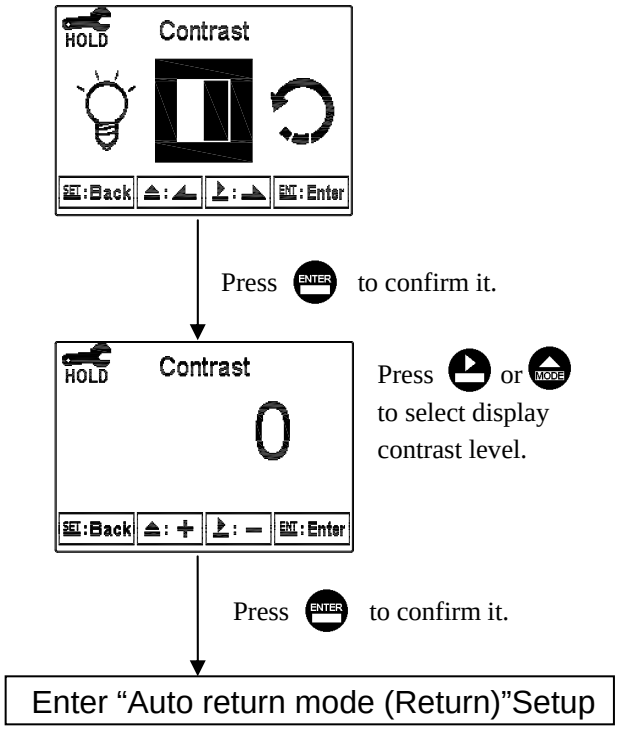
6.15 Backlight settings

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.



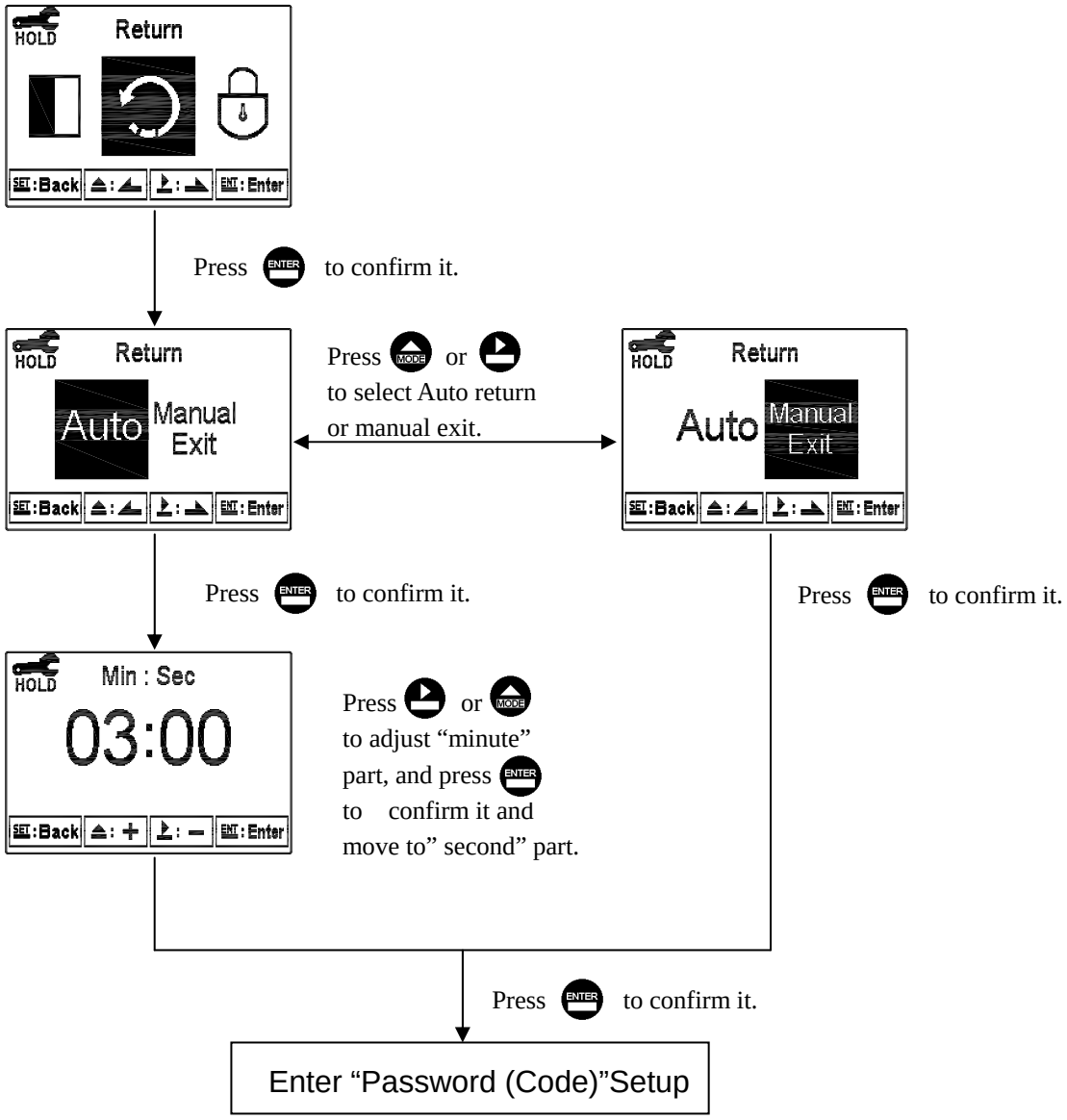
6.16 Contrast settings

Enter setup of display contrast. You can set the contrast of display according to your need.



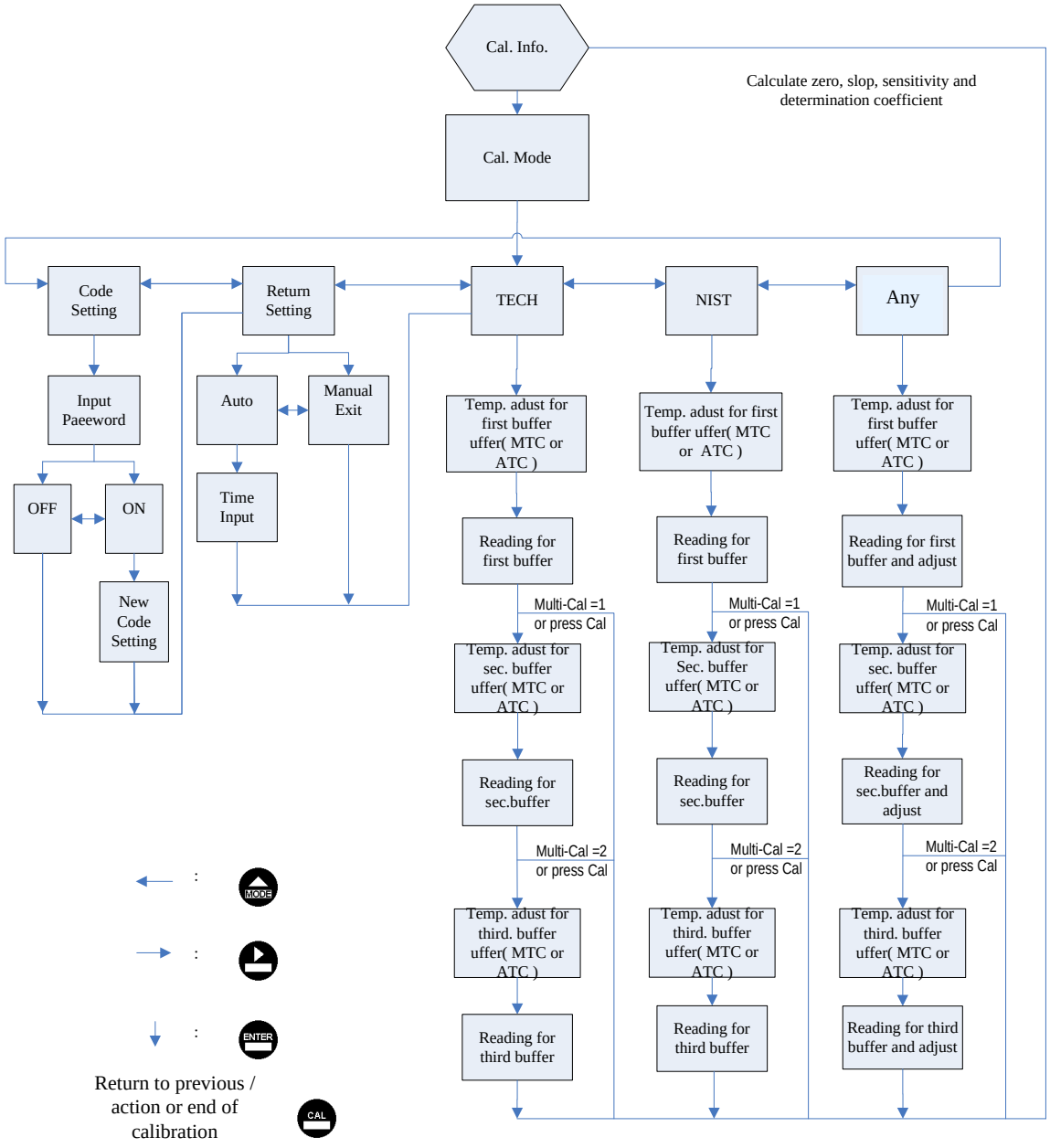
6.17 Return

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.



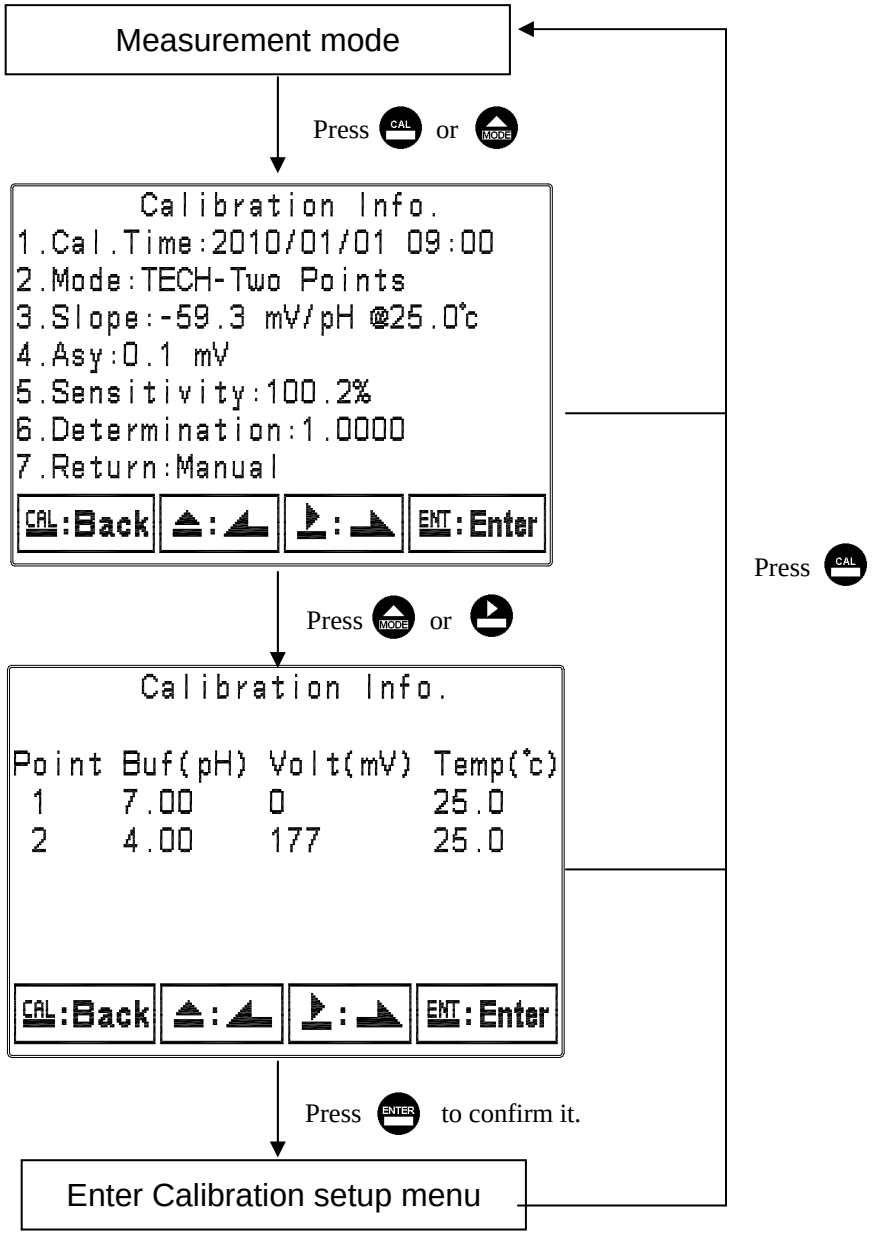
7. Calibration

Block diagram of Calibration



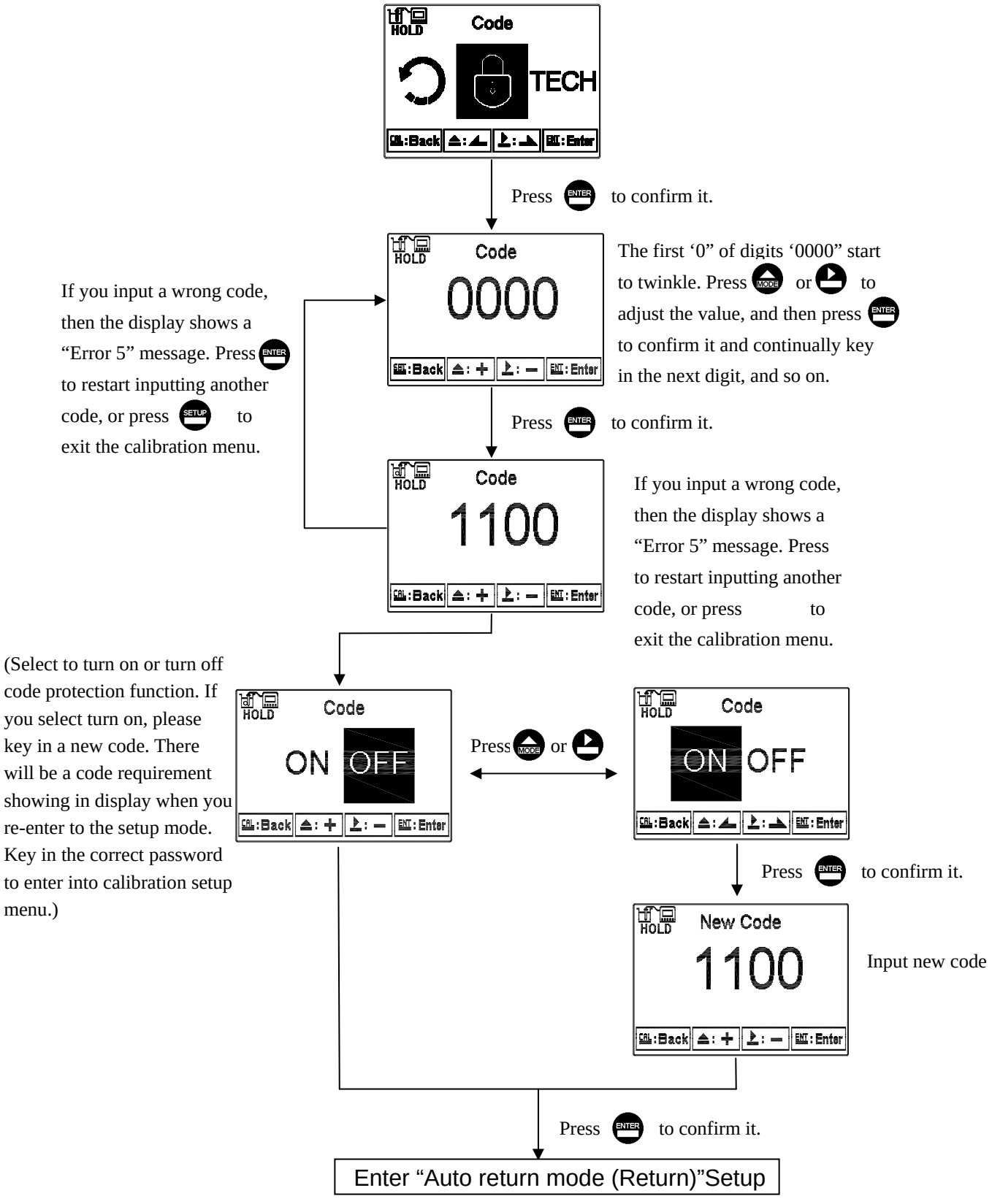
7.1 Enter calibration setup menu

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 to the calibration setup menu.



7.2 Security password of calibration (Code)

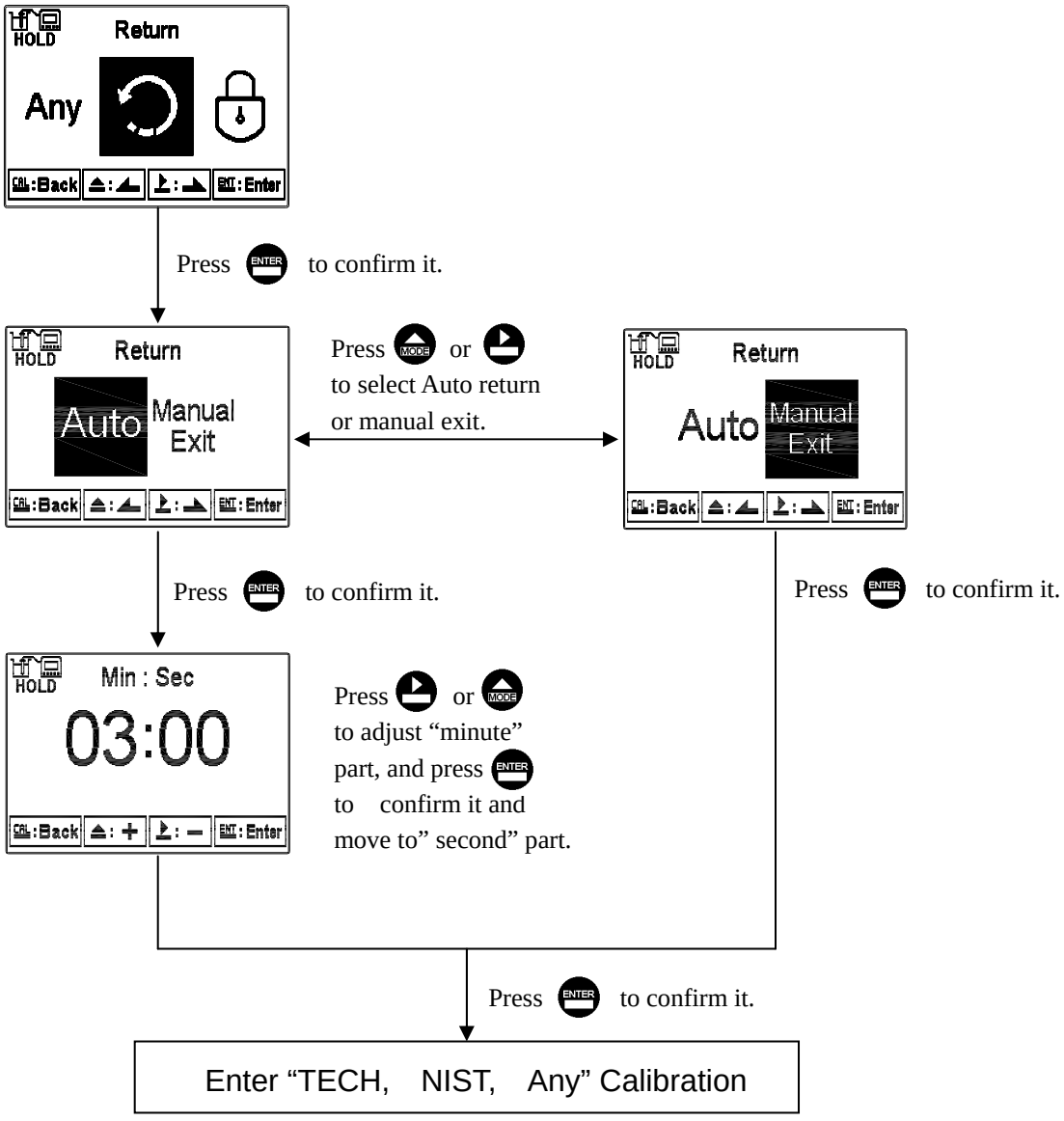
Select the Code (password) icon after entering calibration setup mode. Select to activate code function or not. The default Calibration setting code is “1100”.



7.3 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 calibration setup menu manually, while “Auto” means that the display automatically exit the calibration setup menu and 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.



7.4 pH Calibration

The instrument provides multi-point standard buffer solution calibration. You may decide how many points to calibrate the measurement system(up to 3-point). The principle is according to “Method of Least Squares”. Apply linear regression to calibration the electrode’s slope and zero point (Asy, Offset or Zero point).
When calibrating a electrode, you may calibrate 1 to 3 point by any sequence to provide linear regression for mV and pH multi-calibration of a electrode, and to show the electrode’s slope and zero point(Asy, offset or Zero point) at 25°C. The electrode’s slope rate which is actual slope divided by theoretical slope and the sensitivity shows in percentage in the display. In addition, the display shows the linear regression determination coefficient, R2, of the electrode and buffer solution to provide you an estimation of an electrode’s regression suitability. According to different combination of standard buffers, the TECH, NIST, Any buffer solution calibration modes are provided.

7.4.1 TECH mode (Up to 3-point calibration)

The electrode is automatically calibrated according to pH value and temperature of TECH standard buffers. The range of zero point and slope of the electrode is also determined. If one of them is over the range, the display shows error message of zero point and slope failure. (See appendix Table 1, pH/temperature table of TECH standard buffers)

7.4.2 NIST mode (Up to 3-point calibration)

The electrode is automatically calibrated according to pH value and temperature of NIST standard buffers. The range of zero point and slope of the electrode is also determined. If one of them is over the range, the display shows error message of zero point and slope failure. (See appendix Table 2, pH/temperature table of NIST standard buffers)

7.4.3 Any mode (Up to 3-point calibration)

The electrode measures mV value of different standard solutions. According to theoretic slope and the temperature of standard solutions, the display shows a approximate pH value. Then, you can calibrate the electrode by freely adjust the pH value as those of the standard solutions’. There is not a zero point range failure determination by the instrument but only the slope range determination. If the slope is over the range, the display shows error message of slope failure.

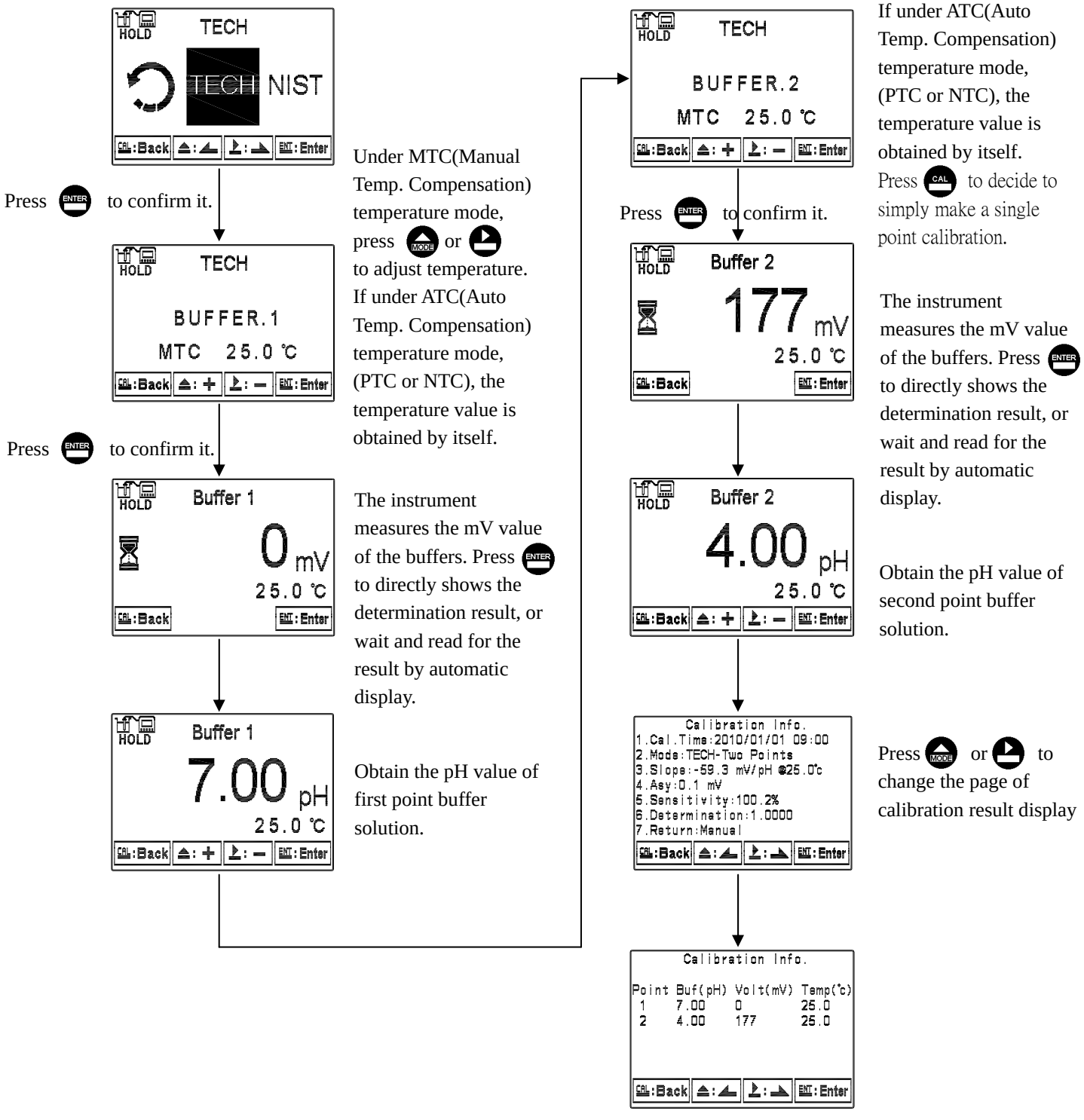
7.4.4 Definition of calibration parameter

You can calibrate the electrode by one point or up to three points of standard solutions by any sequence. As different calibration point method is applied, the definition of the zero point and slope different.

Calibration point	Determination	The showed calibration value
One point calibration	Asy	Zero point (Asy, offset or Zero point)= Asy 1.If not calibrated, Slope = Theoretical slope 2.If calibrated, Slope = Slope of last calibration
Two or three point calibration	Asy Slope	Zero point (Asy, offset or Zero point)= Asy Slope = Slope* Note: To obtain a new zero point(Asy) and Slope by applying linear regression.

7.4.5 TECH, NIST buffer Calibration

The procedure below is two points calibration of TECH buffer. (The procedure is same as NIST buffer mode.) First, enter the setup of Multi-points calibration and set the number of calibration point for 2. (See chapter 6.4 Multi-Cal) Then, go to Calibration menu and select TECH mode. Operate the instrument as follow procedure diagram.



Under MTC(Manual Temp. Compensation) temperature mode, press MODE or to adjust temperature. If under ATC(Auto Temp. Compensation) temperature mode, (PTC or NTC), the temperature value is obtained by itself.

The instrument measures the mV value of the buffers. Press ENTER to directly shows the determination result, or wait and read for the result by automatic display.

Obtain the pH value of first point buffer solution.

Under MTC(Manual Temp. Compensation) temperature mode, press MODE or to adjust temperature. If under ATC(Auto Temp. Compensation) temperature mode, (PTC or NTC), the temperature value is obtained by itself. Press CAL to decide to simply make a single point calibration.

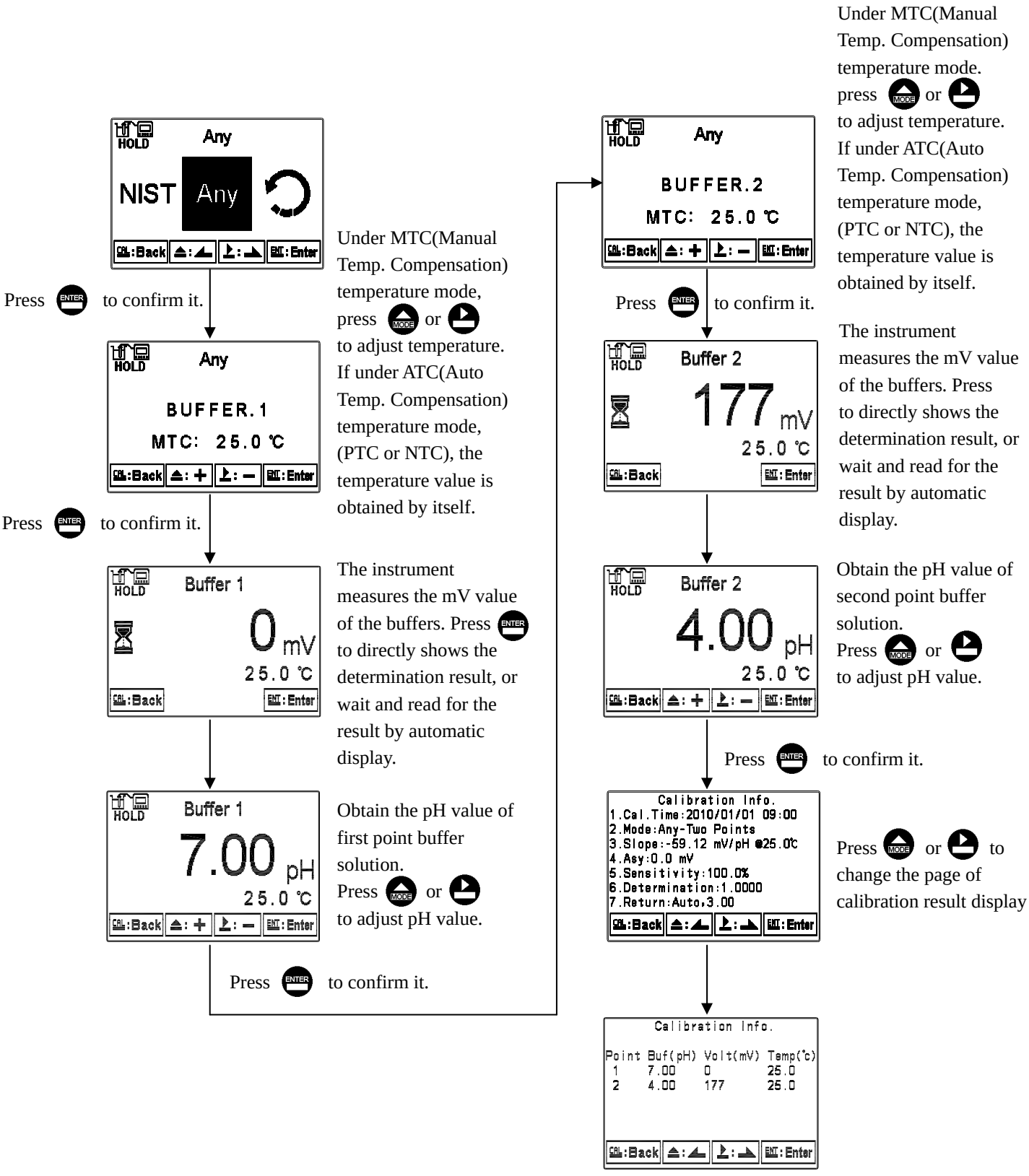
The instrument measures the mV value of the buffers. Press ENTER to directly shows the determination result, or wait and read for the result by automatic display.

Obtain the pH value of second point buffer solution.

Press MODE or to change the page of calibration result display

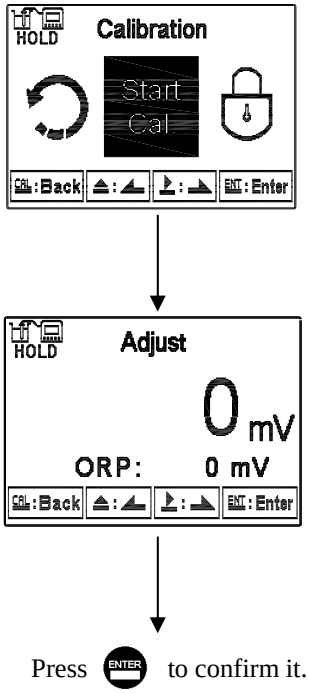
7.4.6 Any Calibration

The procedure below is two points calibration of Any mode. First, enter the setup of Multi-points calibration and set the number of calibration point for 2. (See chapter 6.4 Multi-Cal) Then, go to Calibration menu and select “Any” mode. Operate the instrument as follow procedure diagram.



7.5 ORP Calibration

Under ORP measurement mode, enter calibration setup menu. Select Calibration icon, and adjust mV value. The adjustable range is from -300mV to 300mV.



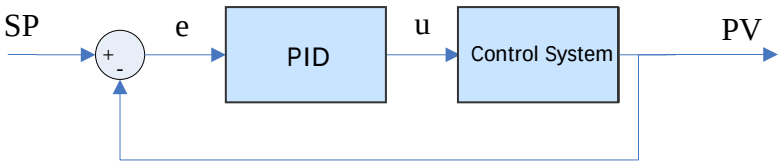
Put the ORP electrode into ORP standard solution. Press MODE or ▶ to adjust the main display value until it is equal to the desirable mV value.

Press ENTER to confirm it.

8. PID Control

8.1 The fundamental principle

PID control block diagram shown below. The PV value(Process Variable) of control system is obtained by a pH/ORP sensor. The gap between PV and SV(Set point) is e. Feedback it to the PID controller, and then the PID controller calculate the control output volume, u, to decide the dosing volume. After dosing, the control system measure the new PV value and calculate the new gap (e). Re-enter to the PID controller. So, continue to repeat this cycle until the pH value of the control object reaches the set value.



The PID control can be showed by following equations:

$$u = Y_e + \frac{1}{T_i}\int Y_e \cdot dt + T_d \cdot \frac{dY_e}{dt}\ , \qquad Y_e = K_p \cdot \frac{e}{Range}$$

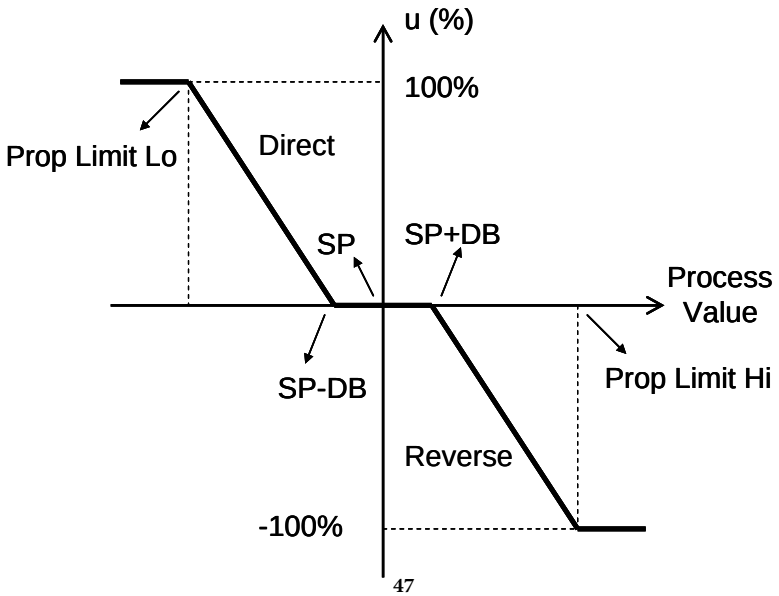
Range represents the width of proportional band.

Under “Direct” control mode, “Range = (SP–DB) – Prop Limit Lo.”

Under “Reverse” control mode, “Range = Prop Limit Hi – (SP+DB)”.

8.2 PID control actions and parameters

We explain the relationship between control output “u” and process variable ”PV” by a simple proportional control which is illustrated as shown below. If the PV exceed the proportional upper or lower limit(Pro Limit Hi/Lo), then the control output “u” is for 100% output. If the PV is between proportional upper or lower limit(Pro Limit Hi/Lo) and SP±DB, then the control output “u” is activate according to the error volume to make a proportional output. IF the PV is in between SP±DB, then the control output “u” is for 0% output. For the relevant definitions of each parameter, please see the next page.



PID parameter description and setting range:

Parameter	Description	Range
Kp	Set the proportional control. The control output u and the error e is proportional to multiples. The greater the Kp value, the faster the system response. However, too large Kp easily makes output shocks. Use proportional control alone can not eliminate steady state error. The error can be eliminated by setting “Static Error Reset” and “Damping Time.”	0.1~9999.9 (Default: 1)
Ti	The setting of integral control needs to combine the use of the proportion of control. The control output u and the error e is proportional to the time integral. The use of integral control can eliminate the steady state error. The smaller the “Ti”, the stronger integral action, but it will also reduce the stability of the system. When u is out of range (less than -5% or greater than 105%), the integral control of the output section will be frozen to avoid the termination of integral (Windup) happens.	0~3600 sec (Default:3600 sec Note: If set “0”, it represents turning off the integral control)
Td	The setting of differential control needs to combine the use of the proportional control. The control output u and the error e is proportional to the time integral. The use of differential control can improve the transient response of the system. However, it is not conducive to the steady state error. The greater the Td, the stronger the differential effect. But it is easy to make the magnify the interference.	0.0~60.0 sec (Default:0 sec, it represents turning off the differential control)
Setpoint (SP)	Set the control set point.	-2.00~16.00 pH / -1999~1999mV (Default:7 pH / 0 mV)
Deadband (DB)	Set control stop zone. When the pH/mV value reaches SP±DB, it stops the control.	0.00~3.00 pH / 0~300mV (Default:0.5 pH / 30 mV)
Prop Limit Hi	Set the proportional upper limit.	-2~16 pH / -2000~2000mV (Default:14 pH / 1000 mV)
Prop Limit Lo	Set the proportional lower limit.	-2~16 pH/ -2000~2000mV (Default:0 pH / -1000 mV)
Direction	Set the process control direction. “Direct” means that to control the output (ex. dosing) until the PV(ex. pH value) increases to SP(Set point); “Reverse” means that to control the output until the PV(ex. pH value) decrease to the SP (Set point); “Both” means that it can proceed the dual way control to control PV	Direct / Reverse / Both (Default: Direct) **Note:** When the PID is set as Direct or Reverse, one way control. The device

	until SP.	can use as upper limit or lower limit control of PV.
Actuator	Set type of actuator control signal. Select from Pulse Length, Pulse Frequency, or Analogout.	Pulse Length / Pulse Frequency / Analogout (Default: Pulse Length)
Duty Cycle	When selecting Pulse length, the Duty Cycle set the period of time proportion for Relay ON/OFF.	1~1800 sec (Default:1 sec)
Max Frequency	When selecting pulse frequency, the Max frequency sets the maximum frequency of relay ON/OFF	1~150 pulse/min (Default:60 pulse/min)
Analogout Type	When selecting Analogout, the 0~20mA or 4~20mA current output can be selected.	0-20 mA / 4-20 mA (Default:4-20 mA)
Expiration Time	To set the end time. When control output value u with 100% continual output and the set end time, the u value will reset as 0% which the display will shows and twinkles the alarm text as “Expiring”. Users may enter the setup of setting/calibration mode to reboot the PID control function.	0~9999 min (Default: 0 min, it means to turn off the function)
Static Error Reset	To set the static error reset value. When using proportional control alone, with the use of Damping Time to eliminate the static error.	0~100% (Default: 0%, it means to turn off the function)
Damping Time	To set the damping time. When using proportional control alone, with the static error reset to eliminate the static error. Damping time has two meanings: 1.When Process measurement value(PV) reaches SP±30%, it starts to count the time. If within damping time the value cannot reach SP±DB, then it reset the control output value u to static error reset value. 2. When Process measurement value(PV) exceeds SP±DB range, it starts to count the time. If within damping time the value cannot reach SP±DB, then it reset the control output value u to static error reset value.	0~3600 sec (Default:60 sec)
Manual Output	To set the actuator control signal by manual output. Select ON, and go back to the measurement mode. Users may adjust the control output volume u manually or simulate the control signal output(At the time, MTC manual adjust function is turned off.) The function can be only provided under “Direct” or “Reverse” control.	On / Off (Default:Off) Note: When selecting ON, at the time the control output volume u completely proceeds output according to user’s setting no longer through PID control.

8.3 PID control signal

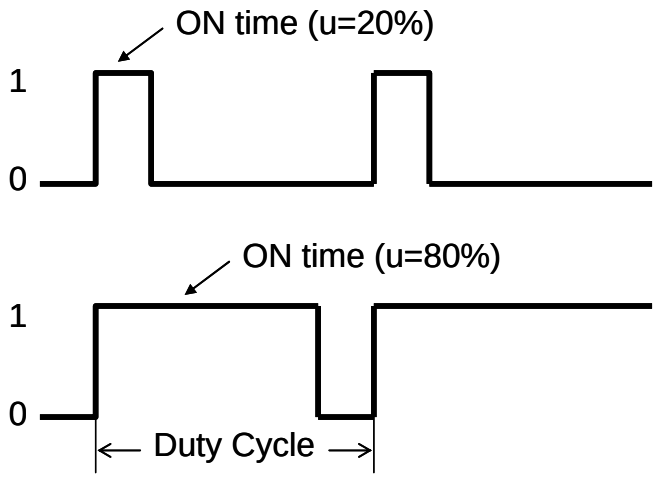
When using relay as PID control device, the presetting of relay 1 is Direct control, while relay 2 as Reverse control. The summary is showed as following table. When as Direct or Reverse single way control, the other relay can be used as PV upper or lower limitation control. When using it as Both(dual) way control, the PID uses both relays for control. **While the PID control is turned off, if users would like to recover to original relay output condition, the relay function needs to be activated once again.** The relay output type can be divided by "Pulse Length" or "Pulse Frequency" control. If using analog output 2 as PID control, the current output 2 can be set as Direct or Reverse, single way control, but it cannot be set as Both(dual) way control. The current output type can be divided by 0~20 mA or 4~20 mA output control. **While the PID control is turned off, the current output function will recover to the original pH/ORP correlation current output condition. Thus, it is necessary to remove the related external equipment in order to prevent from wrong action.**

Output	Relay 1	Relay 2	Current output 1
Control direction	Direct	On/Off	Direct/Reverse
	On/Off	Reverse	
	Direct	Reverse	
Signal type	Pulse Length / Pulse Frequency		0~20 mA / 4~20 mA

The following description furthering illustrates the relationship of the control signal and the control output u.

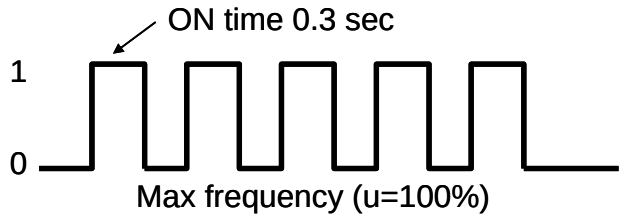
1. Pulse length control

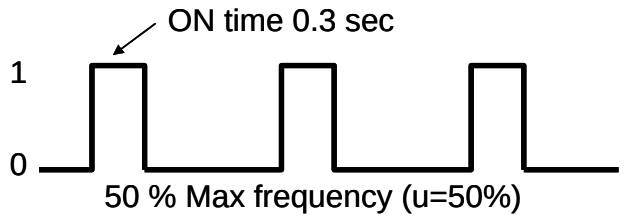
   The illustration of pulse length control is as follows. The relay makes time proportion ON/OFF control according to control output volume u. For example, when u=20%, the relay ON time is 20% duty cycle, and its OFF time is 80% duty cycle, vice versa.



2. Pulse Frequency control

The illustration of pulse frequency control as follows. The relay makes frequency proportion ON/OFF control according to control output volume u. When ON time is fixed as 0.3 sec, the OFF time is related to the setting of maximum frequency. For example, the maximum frequency is set as 60 p/min. When u=100%, the action frequency of relay is 60 p/min. It represents that each second the device finishes one ON/OFF control. Thus, the OFF time is: (1 - 0.3) = 0.7sec.. While u=50%, the maximum frequency is set as 30 p/min. It represents that every two seconds the device finishes one ON/OFF control, and thus the OFF time is: (2 - 0.3) = 1.7 sec.





3. Analogout control (0/4~20 mA)

The current output and control output u value are set as corresponding proportional relationship. The relationship is described as follows: Under 0~20mA mode, the current output = u*20 mA; under 4~20mA mode, the current output = 4 + u*(20–4)mA. Take “u=50%” for an example, under0~20 mA mode, the current output is 10 mA; while under 4~20 mA mode, the current output is 12mA.

9. Error messages (Error code)

Messages	Reason	Dispositions
Error9	Serious error that does not permit any further measuring	Please call service engineer.
Error5	Wrong password input	Please input the correct password.
Error4	1. During calibration, the buffer solution temperature exceeds a range of 5~50˚C 2. The buffer can not be identified.	1. Please adjust the buffer solution temperature to the appropriate temperature range and make another calibration. 2. Please replace the buffer, or maintain or replace the electrode and make another calibration.
Error3	The readout is unstable	Please check whether there is bubble or air in the glass end of the electrode; maintain the electrode or change a new electrode, and make another calibration.
Error2	SLOPE value exceeds the upper or lower limit	1. Replace the buffer solutions. 2. Maintain the electrode or replace a new electrode, and make another calibration.
Error1	OFFSET(zero-point electric potential) value≥60mv	Maintain the electrode or replace the new electrode, and make another calibration.

10. Maintenance

Generally speaking, under normal operation, the controller produced by our company need no maintenance expect regular cleaning and calibration of the electrode to ensure accurate and stable measurement and system operation.

The cleaning cycle for the electrode depends on the pollution degree of the measurement sample. Generally speaking, it is recommended to make weekly cleaning. The following chart gives introductions of different cleaning methods according to different type of contaminations to provide the operators with reference for cleaning and maintenance.

Type of Contaminations	Cleaning methods
Measuring solutions containing proteins.（Contamination of the junction）	The electrode should be soaked in Pepsin/HCl for several hours. METTLER-TOLEDO 9891 Electrode Cleaner is recommended.
Measuring solution containing sulfides.（The junction becomes black）	The junction should be soaked in Thiourea/HCl solution until being bleached. METTLER-TOLEDO 9892 Electrode Cleaner is recommended.
Contamination by grease or organic substance	Short rinsing of the electrode with acetone and ethanol.
Acid and alkaline soluble contaminations	Rinsing the electrode with 0.1mol/l NaOH or 0.1mol/l HCl for a few minutes.
Apply clean water to flash the electrode after above cleaning steps and immerse theelectrode in 3M KCl solution for 15 minutes at least, and then calibrate the electrode.	
The electrode should only be rinsed and never rubbed or otherwise mechanicallycleaned, since this would lead to electrostatic charges. This could cause an increase in the response time.	
In cleaning the platinum electrode, the platinum ring of the electrode can be rubbed gently with a wet soft piece of cloth.	

※ The frequency of electrode cleaning depends on the type and degree of contamination. However it is recommended that the electrode be cleaned once a week.

Appendix

Table 1

TECH Mode	TECH buffers		
TEMP℃	Buffer 4.01	Buffer 7	Buffer 10
5	3.999	7.087	10.241
10	3.998	7.053	10.155
15	3.999	7.031	10.116
20	4.002	7.011	10.047
25	4.006	6.996	9.998
30	4.011	6.985	9.952
35	4.018	6.976	9.925
40	4.031	6.971	9.874
45	4.047	6.969	9.843
50	4.055	6.969	9.810

Table 2

NIST Mode	NIST standard buffers(DIN 19266)				
TEMP℃	Buffer 1.68	Buffer 4.01	Buffer 6.86	Buffer 9.18	Buffer 12.45
5	1.668	4.004	6.951	9.395	13.207
10	1.670	4.000	6.923	9.332	13.003
15	1.672	3.999	6.900	9.276	12.810
20	1.675	4.001	6.881	9.225	12.627
25	1.679	4.006	6.865	9.180	12.454
30	1.683	4.012	6.853	9.139	12.289
35	1.688	4.021	6.844	9.102	12.133
40	1.694	4.031	6.838	9.068	11.984
45	1.700	4.043	6.834	9.038	11.410
50	1.707	4.057	6.833	9.011	11.705

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