SC-110
Conductivity/ Resistivity Portable Meter

Operation Manual

SUNTEX

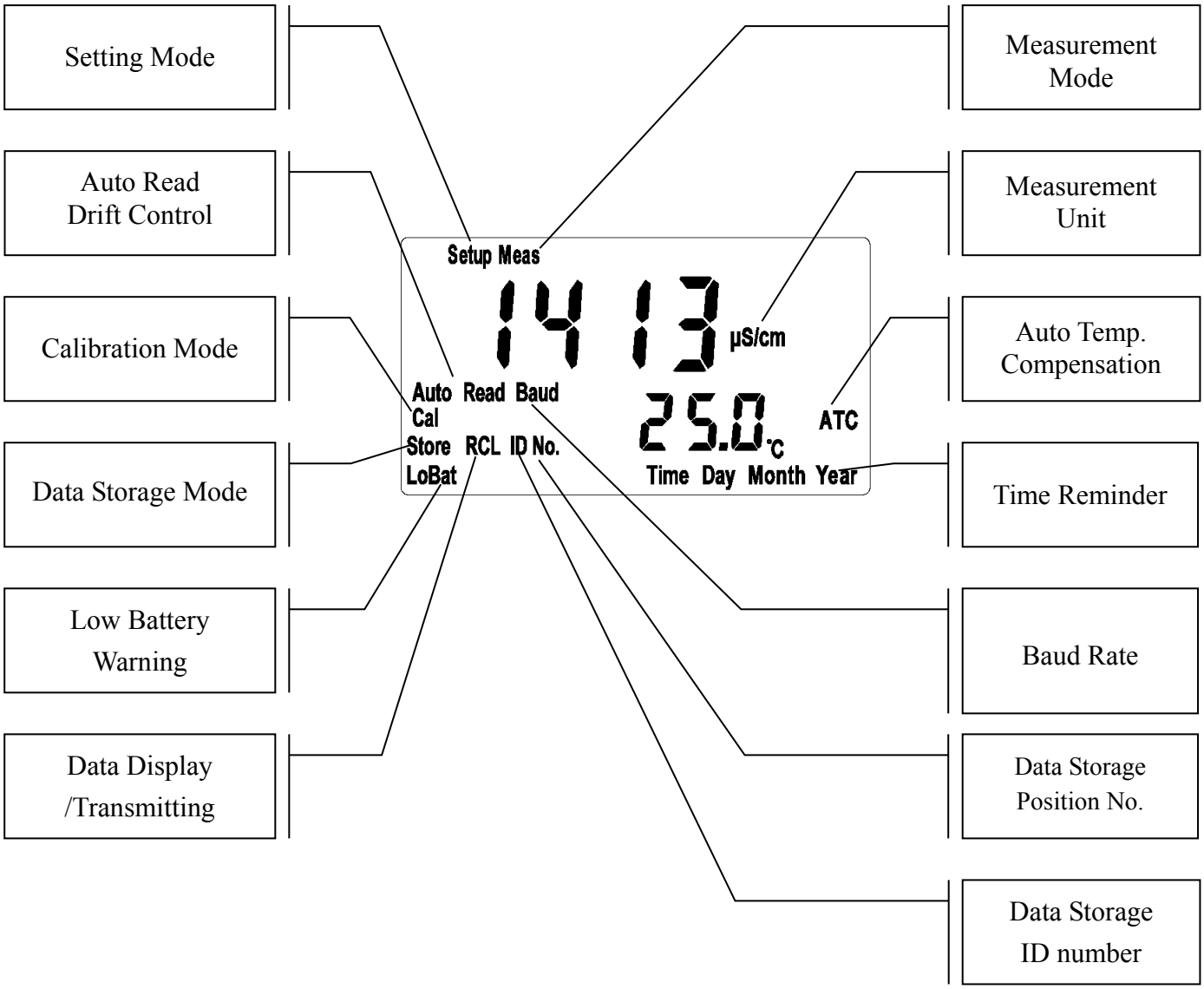
CONTENTS

1. Specifications

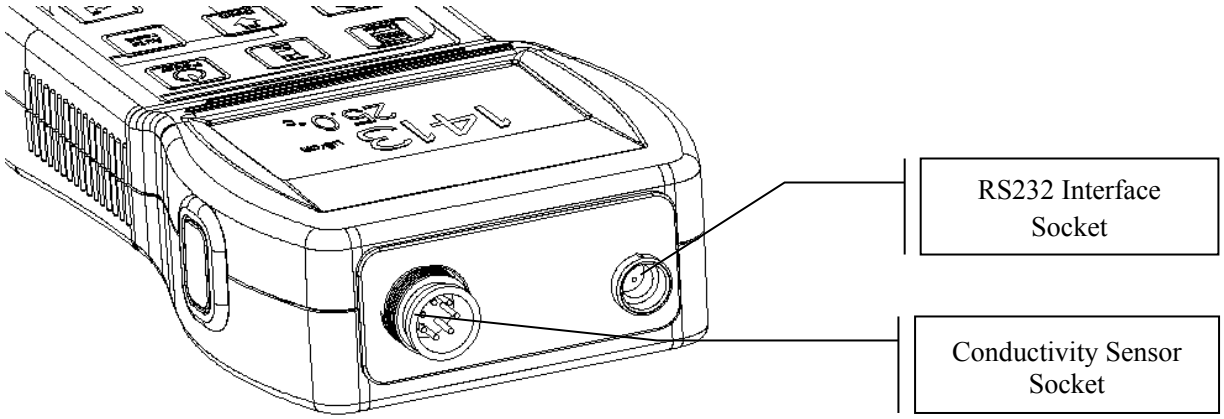
Mode		SC-110
Measuring Parameter		Conductivity / Resistivity / Salinity / TDS / Temp.
Range	**Cond.**	0.00μS/cm ~ 200.0 mS/cm 5 measuring ranges for manual or auto range
	Res.	0.00~100.00 MΩ·cm
	Salinity	0.0~70.0 ppt
	TDS	0~2000 ppm
	Temp.	-10.0~110.0°C
Resolution	**Cond.**	0.01 μS/cm
	Res.	0.01 MΩ·cm
	Salinity	0.1 ppt
	TDS	1 ppm
	Temp.	0.1°C
Accuracy	**Cond.**	±0.5%(±1Digit)
	Res.	±1%(±1Digit)
	Salt.	±0.5%(±1Digit)
	TDS	±0.5%(±1Digit)
	Temp.	±0.2°C(±1Digit)
Temperature Compensation		PT-1000 or NTC 30K auto recognition
		Auto / Manual selectable
Temperature Coefficient		Non-linear / Linear (compensation from 0.00 ~ 10.00 %)
Ref. Temperature		$\mathbf{T_{ref}}$ 25˚C
Manual calibration		Single point known standard solution or cell constant calibration
Standard solution calibration		Single or up to 5-point known standard solution calibration; (10 / 84 / 1,413 μS/cm, 12.88 / 100 mS/cm)
RS232 interface		Yes
Output Data logging		450 sets (measuring value, temp., date, time & ID)
Ambient temperature		0~50°C
Storage Temperature		-20~70°C
Display		LCD Display
Power		4 x AA battery
Battery		Around 350 ~ 1000 hours according to measuring range Programmable auto shut-down
Protection		IP65
Dimension		185mm x 98mm x 38mm (L x W x H)
Weight		0.35Kg

2. Configuration

2.1 Display:



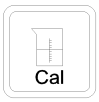
2.2 Socket:



2.3 Keypad：

: Power switch

: Conductivity/Salinity/TDS measurement shift key; press it at any time will allow back to the measurement mode



: Enter calibration mode

: Key for auto read in measurement mode. Press one time for startup and press again for cancellation

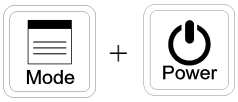
: Increase value / Scroll upward or leftward

: Decrease value / Scroll downward or rightward

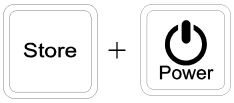
: Confirm input / Execute / Transmitting data manually via RS-232 in measuring mode

: Manual data display, and roll up for next data transmitting function (See Chapter 4.6)

: Manual data storage

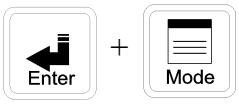


: Enter system parameter settings. (**Cond.** / **Res.** mode selection, auto turn-off, etc) (See Chapter 4.1)

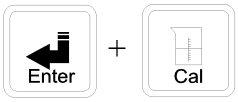


: Delete all of stored data (See Chapter 4.2)

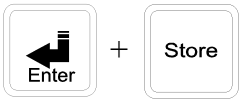
: System Reset (See Chapter 4.3)



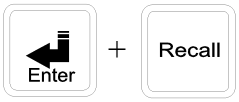
: Shift among the five conductivity measurement manual range & auto range (See Chapter 3.2)



: Enter setting of calibration (See Chapter 4.4)



: Enter time-interval auto data storage menu (See Chapter 4.5.1)



: Enter time-interval auto data transmitting (See Chapter 4.6.1)

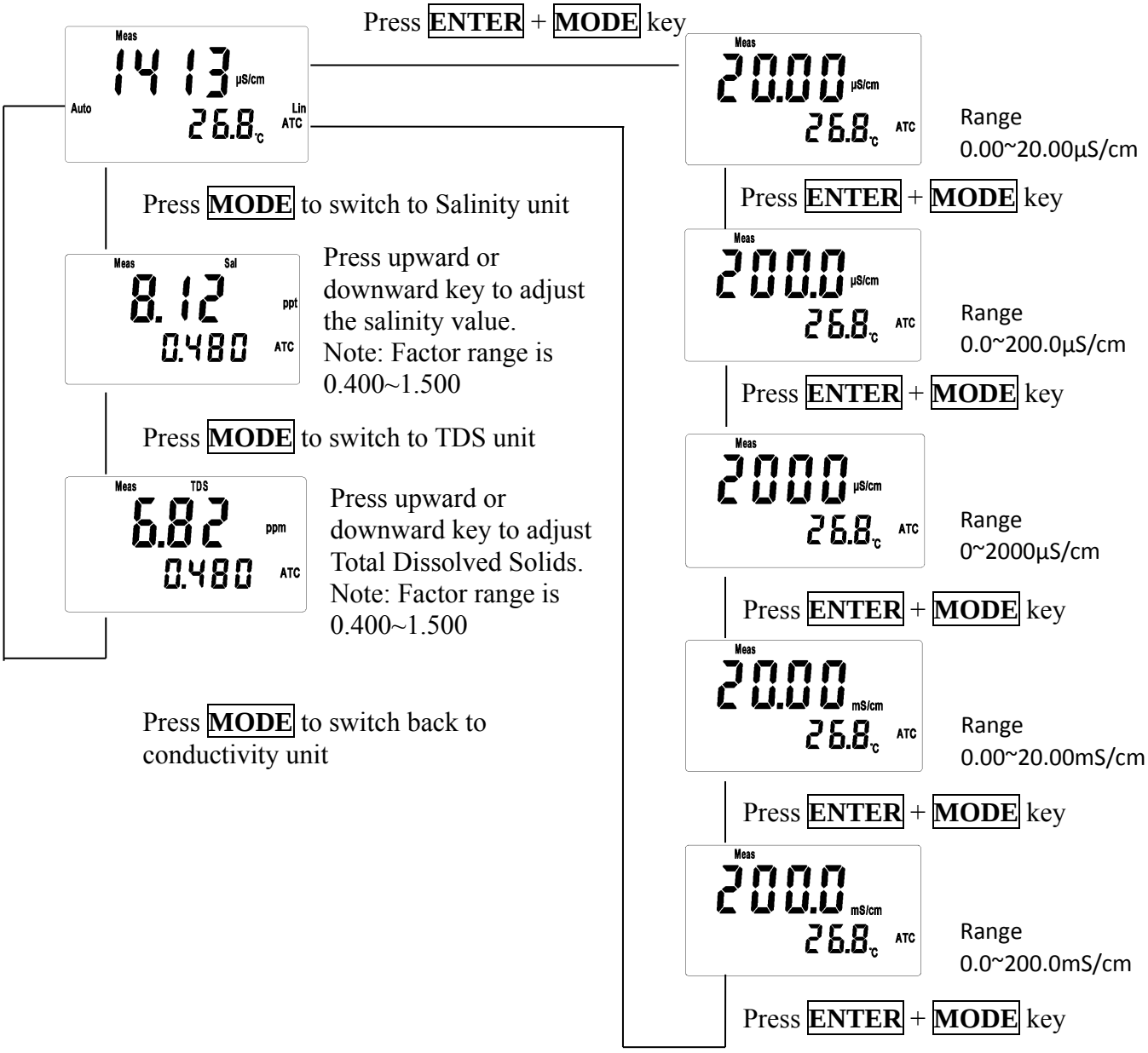
3. Operation

3.1 Measurement:

Press **POWER** key to start up the instrument. It will automatically enter the measurement mode of final operation and begin to measure.

3.2 Measurement unit and measurement range switch

1. Press **MODE** key to switch among Conductivity, Salinity, and TDS in **Cond.** Mode. This function is unavailable in **Res.** mode.
2. Press **ENTER** + **MODE** keys to shift among the five manual ranges and the auto-range. After entering auto mode, AUTO characters will disappear in 3 seconds.



Remark: Before measuring salt and TDS, please finish the calibration according to the conductivity calibration steps, and then set the factor value according to the standard solution of salt and TDS.

3.3 Temperature function and compensation

1. **ATC:** Auto judgment of whether there is temperature probe and recognition of NTC30K or PT1000. Press **UP** or **DOWN** key to adjust the temperature within ±5.0˚C.
   Press **UP** + **DOWN** key simultaneously to back to the original value.
2. **MTC:** Enter MTC 25˚C automatically when there is no temperature probe. Press **UP** key or **DOWN** key to adjust the temperature. Press **UP** + **DOWN** key simultaneously to back to the default value 25.0˚C.
3. **Temperature compensation:**
   Because the temperature of the sample solution may not be 25˚C, for standardization, the conductivity value of solution not at the temperature of 25˚C will be calculated to that of solution at the temperature of 25˚C. This is temperature compensation.
4. According to the temperature coefficient required by the measurement, three kinds of temperature compensation can be applied: Lin, nLin, and non compensation (0.00%). See the setting method in 4.3.3, and the user can set as needed.
5. **Temp. Coefficient** (called as TC for short), the conductivity value of the solution will increase as the temperature rises at a different rate. See the relations as follows:

C_{25}	Conductivity at 25˚C	Formula 1: $Ct = C_{25} \{ 1+\beta(T - 25) \}$
Ct	Conductivity at T˚C	
T	Temp. of the sample solution	Formula 2: $\beta = (Ct - C_{25}) / \{ C_{25} (T - 25) \}$
β	Temp. Coefficient	

6. How to measure the TC of the tested solution: If the user wants to get a more accurate value, the above formula can be applied to measure the TC of the tested solution and set an appropriate TC on the machine. Take 0.01N KCl as an instance, set the TC as non compensation (0.00%) in the machine. Control the same tested solution respectively at 5˚C and 20˚C. The value 1413μS tested at C25 is just the conductivity of the solution at 25˚C; and the value 1278μS tested at Ct is just the conductivity of the solution at 20˚C. According to formula 2, β＝1.91%.

3.4 Auto Read:

Under measurement mode, press **AUTO READ** key to hold the present reading(HOLD), and press **ENTER** key to confirm the Auto-Read function and to activate new measurement. Wait until the measurement is stable, the instrument holds the value automatically(HOLD) to finish the procedure. To cancel the hold value, press **AUTO READ** key or **MODE** key to relieve the Auto-Read hold value.

Auto Read symbol twinkles for about 10 seconds.

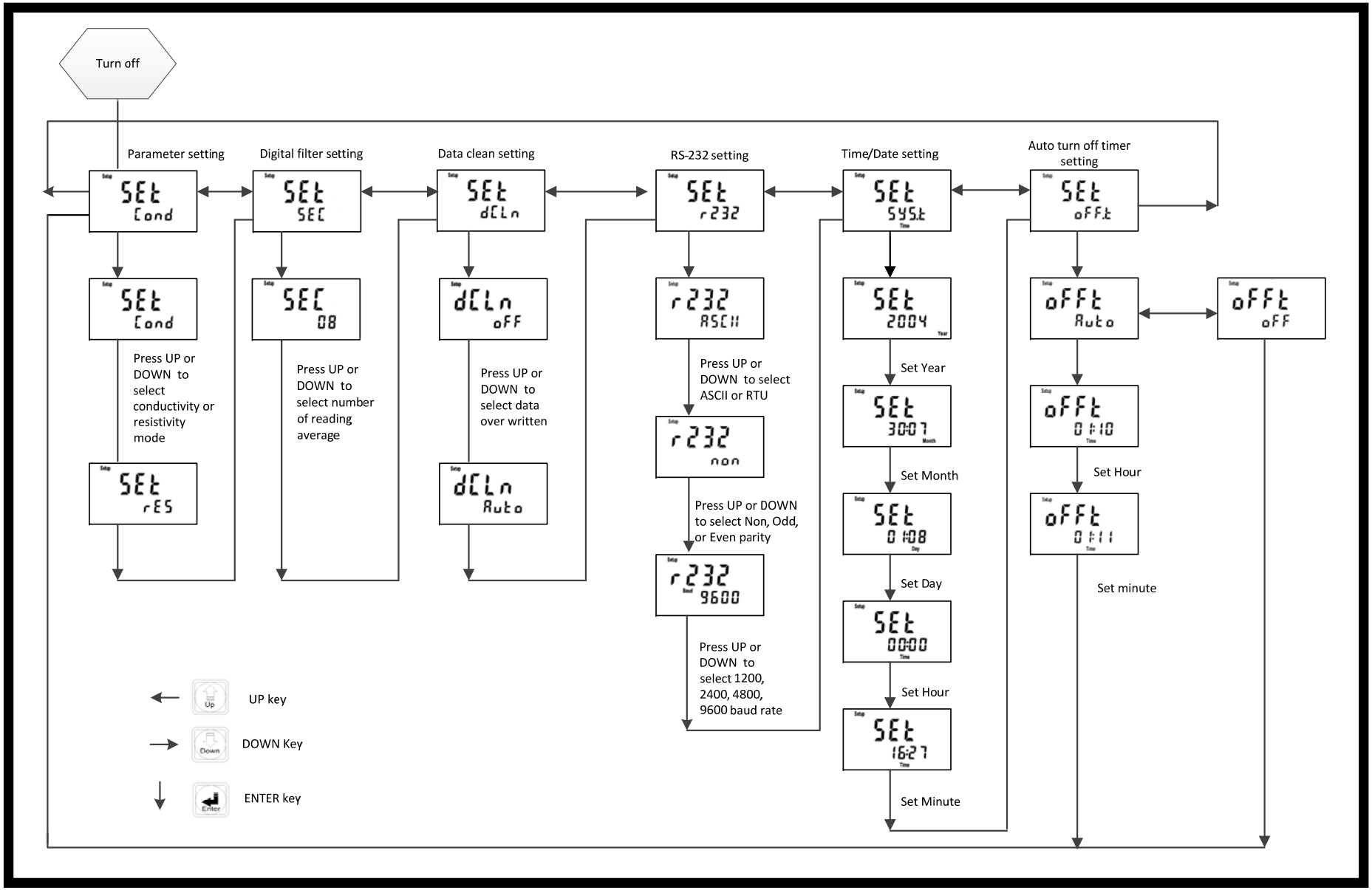
Auto Read symbol stop twinkling and a value will appear after the measurement is stable.

Press **AUTO READ** key or **MODE** key

Back to the measurement mode

4. Settings

Block diagram of settings

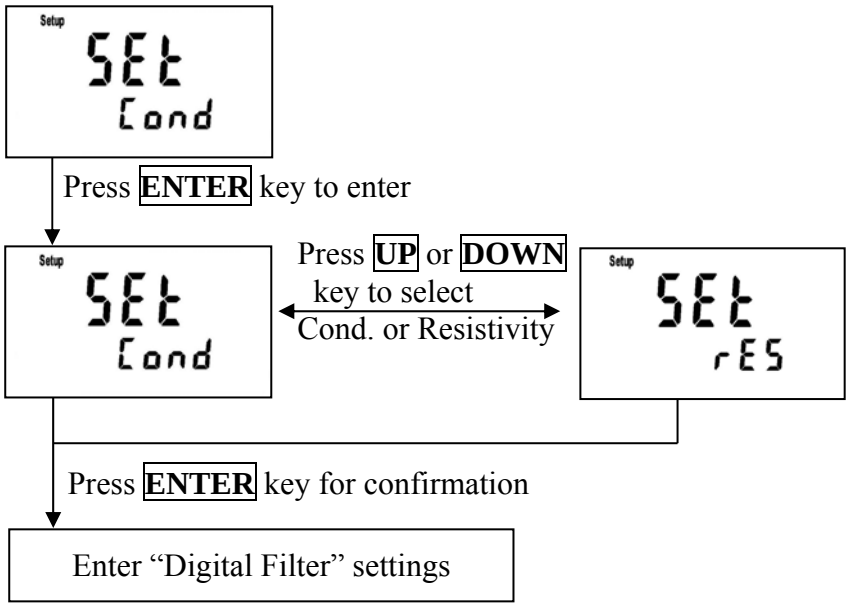


4.1 Parameter settings:

4.1.1 Entry of set-up mode:

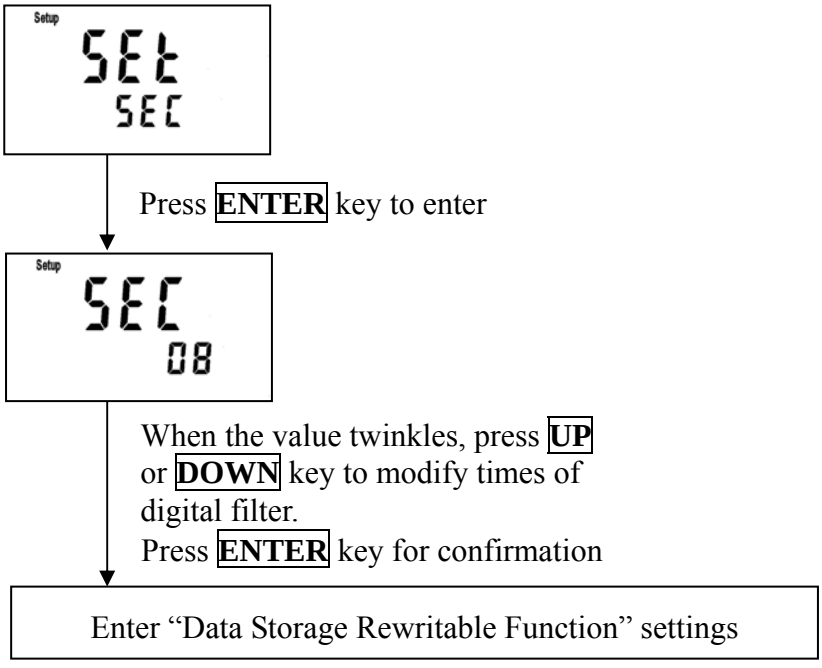
While the instrument's power is off, press **MODE** key and hold the pressing continuously, and press **POWER** key until the display shows model of the instrument. Release the **POWER** key and wait until the menu display enter into parameter settings mode, and then release **MODE** key. Press upward or downward key to select setting menu. To exit the parameter settings mode, press **MODE** key to back to measurement mode.

4.1.2 Settings of measurement mode:



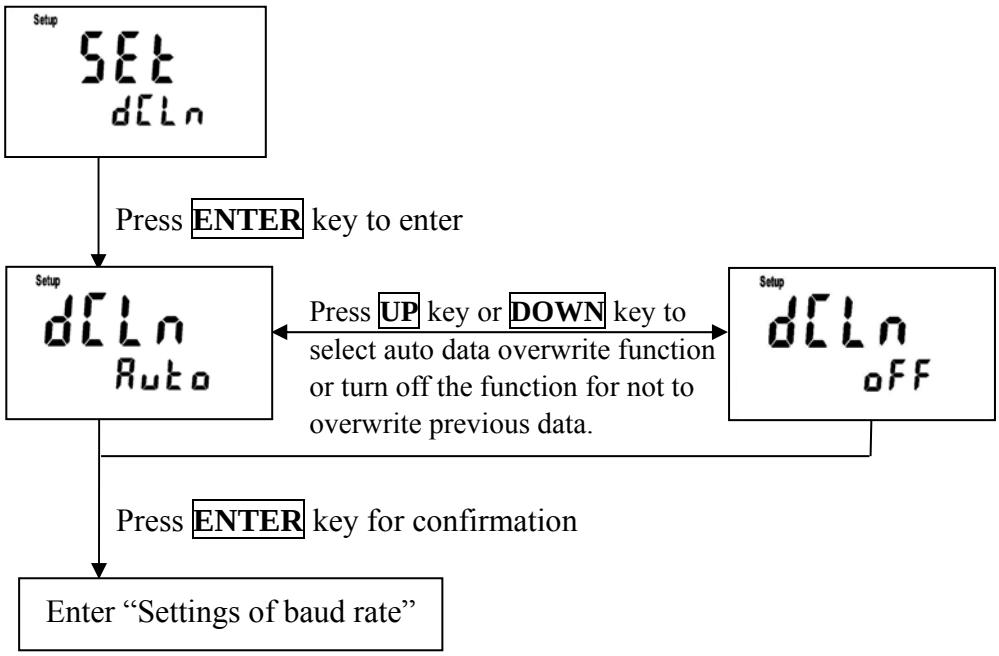
4.1.3 Digital filter settings (Sample average of measurements)

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.



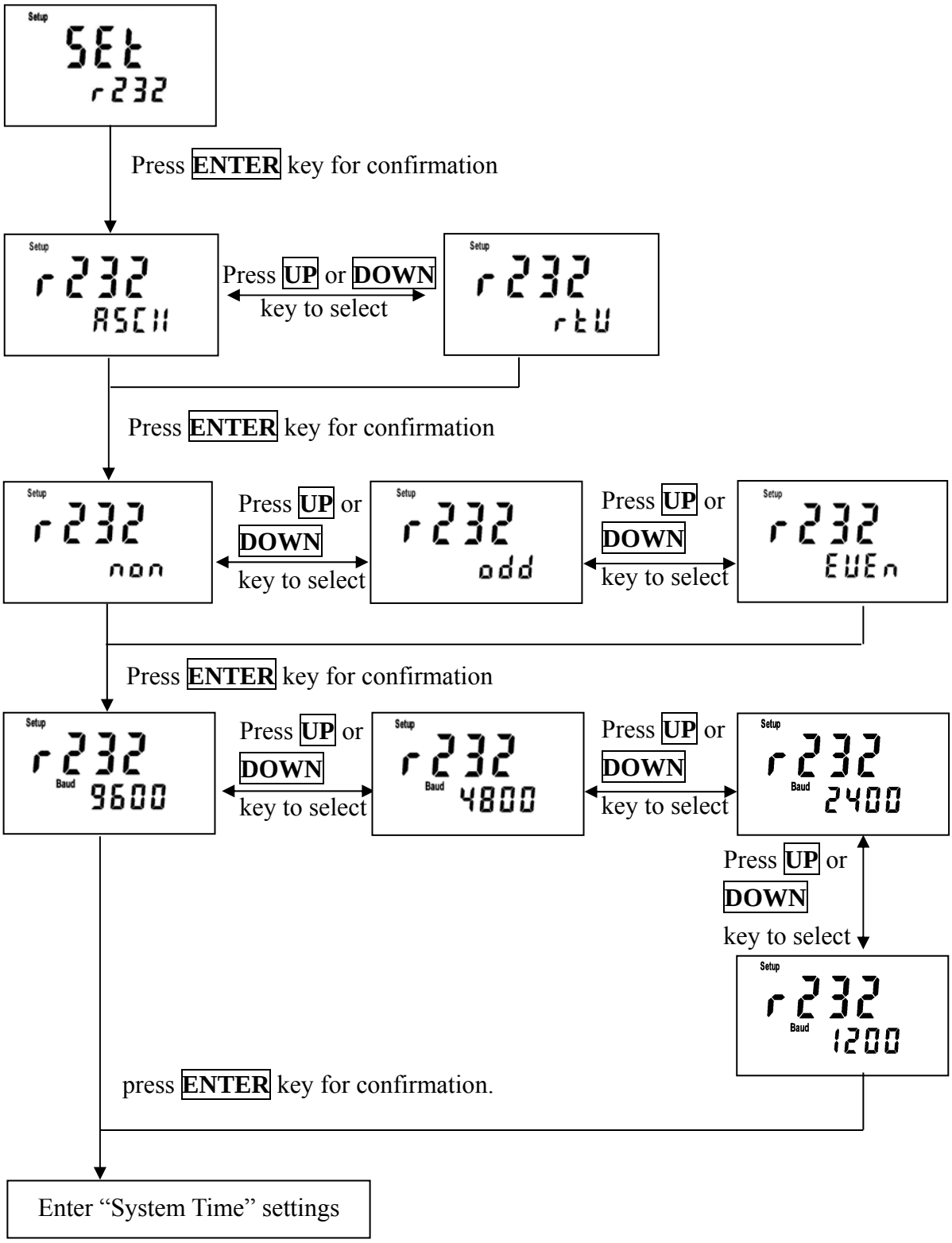
4.1.4 Data overwriting function

Enter “Data overwriting function” settings



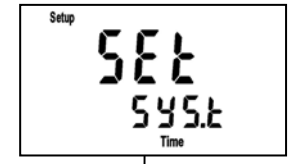
4.1.5 Settings of RS-232 digital communication:

Enter “Settings of RS-232”

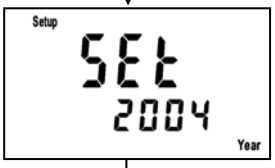


4.1.6 System time settings

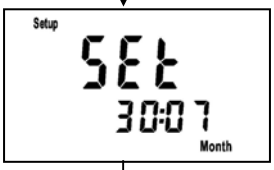
Users may set the year, month, date, hour, and minute. When replacing the batteries, it is necessary to enter to the setting to update the system time.



Press **ENTER** key to enter



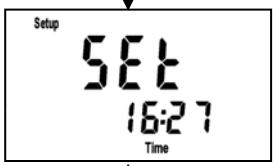
When the value twinkles, press **UP** or **DOWN** key to modify year. Press **ENTER** key to confirm it.



When the value twinkles, press **UP** or **DOWN** key to modify month. Press **ENTER** key to confirm it.

When the value twinkles, press **UP** or **DOWN** key to modify day. Press **ENTER** key to confirm it.

When the value twinkles, press **UP** or **DOWN** key to modify hour. Press **ENTER** key to confirm it.

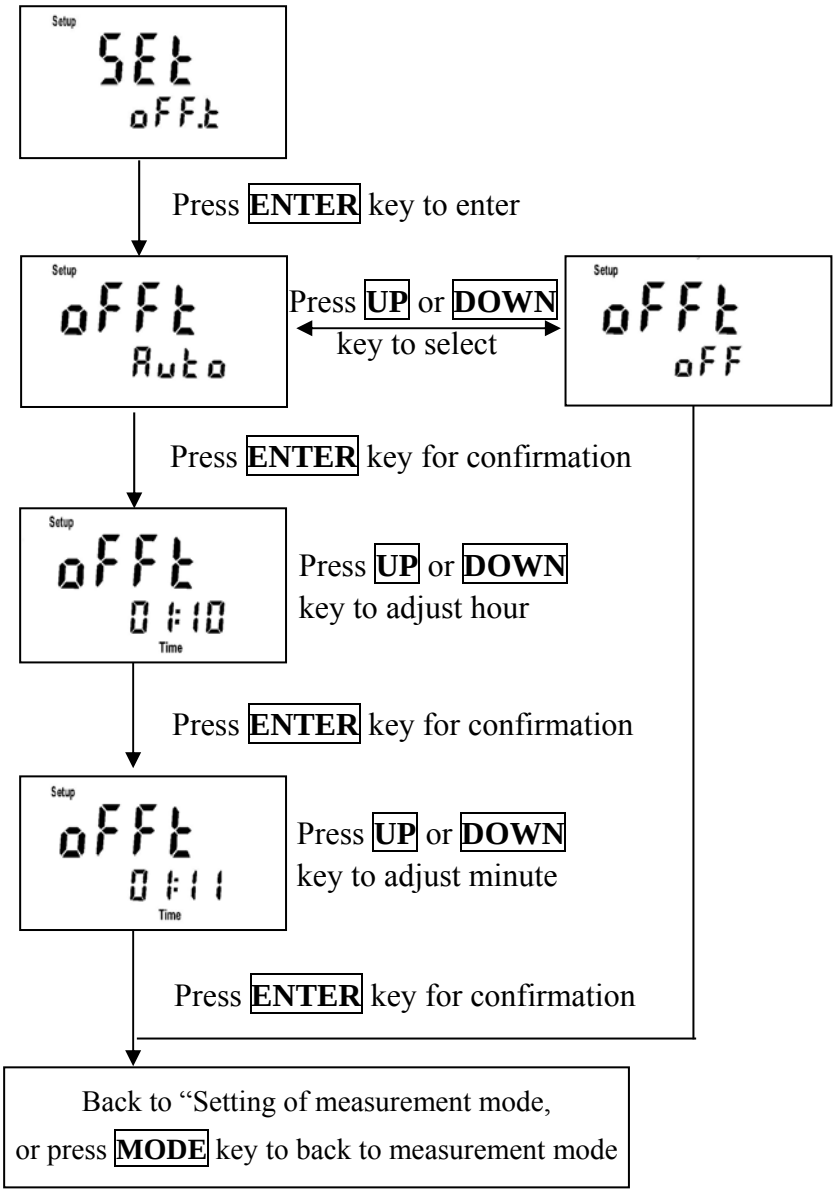


When the value twinkles, press **UP** or **DOWN** key to modify minute. Press **ENTER** key to confirm it.

Enter auto power-off setting

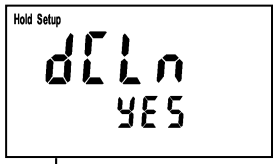
4.1.7 Auto power-off settings

The auto power off timer setting range: 10 minutes minimum, 23 hours and 59 minutes maximum.



4.2 Delete all of the data

Under power off status, press & hold **STORE** key and then press & hold **POWER** key until the display shows the model of instrument. Release **POWER** key. While the menu display shows data clean text, release **STORE** key.

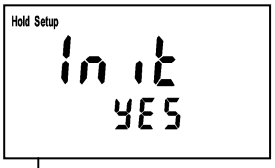


Press **ENTER** key to confirm to delete all stored data or press **MODE** key to back to the measurement mode

Back to the measurement

4.3 System Reset

In the power-off status, push **CAL** first and then **POWER**; after that, release **POWER** first and then release **CAL** to enter the system reset page.



(Initial Setting)

Push **ENTER** to confirm the system reset; or push **MODE** to back to the measurement mode

Back to the measurement mode

Factory defaults:

Parameter: Conductivity

Digital filter: 6

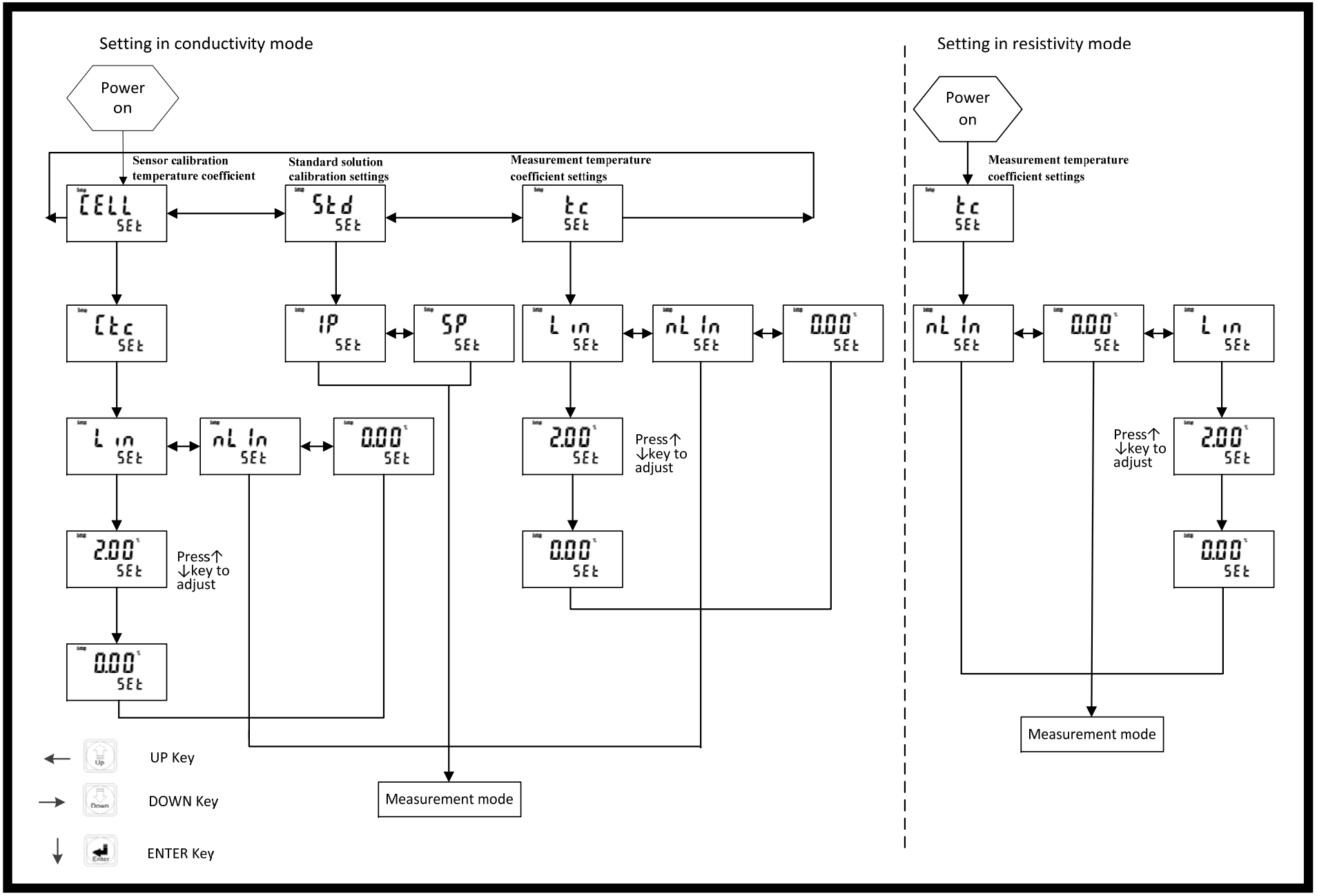
Data over-writing: Auto

RS-232: ASCII, non, 9600

System time: 2000, 1/1, 00:00

Auto power-off: Auto, 10 minutes

Block diagram of calibration and temperature compensation settings

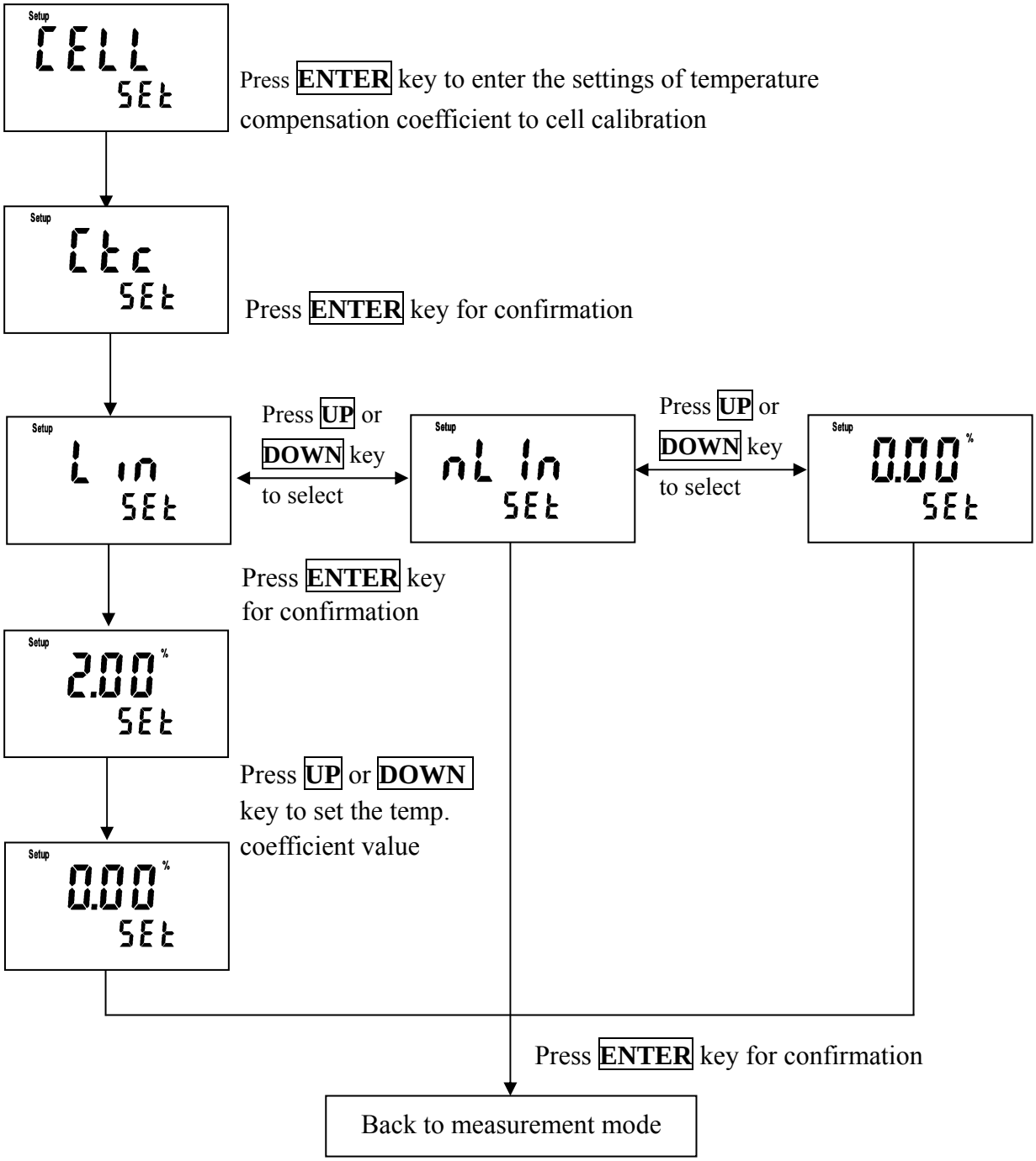


4.4 Settings of calibration parameter:

In the power-on status, press and hold **ENTER** key first and then press **CAL** key to enter set-up mode of calibration parameter. Use upward key or downward key to select the menu.

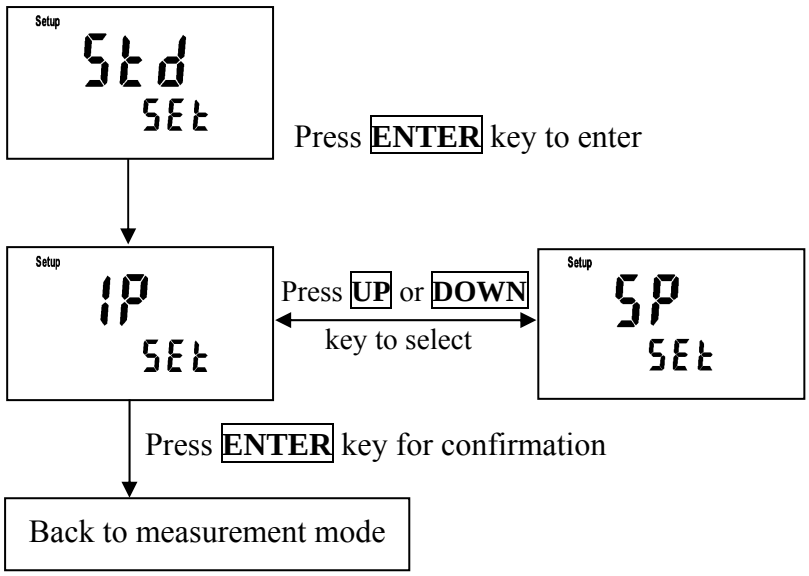
4.4.1 Temperature compensation coefficient setting for cell constant calibration

(Only suitable when the measurement unit is conductivity)

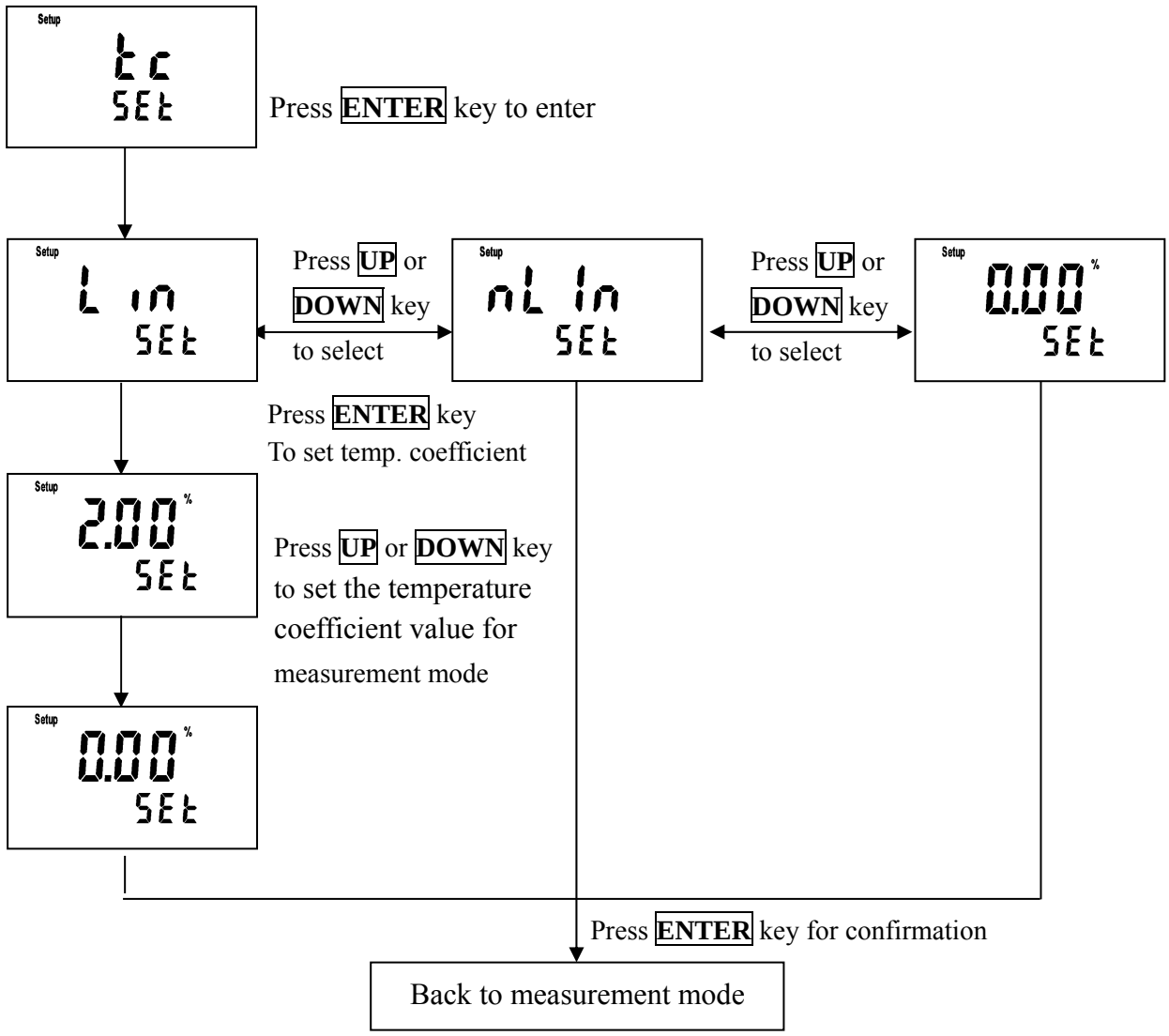


4.4.2 Multi-point of standard solution calibration setting

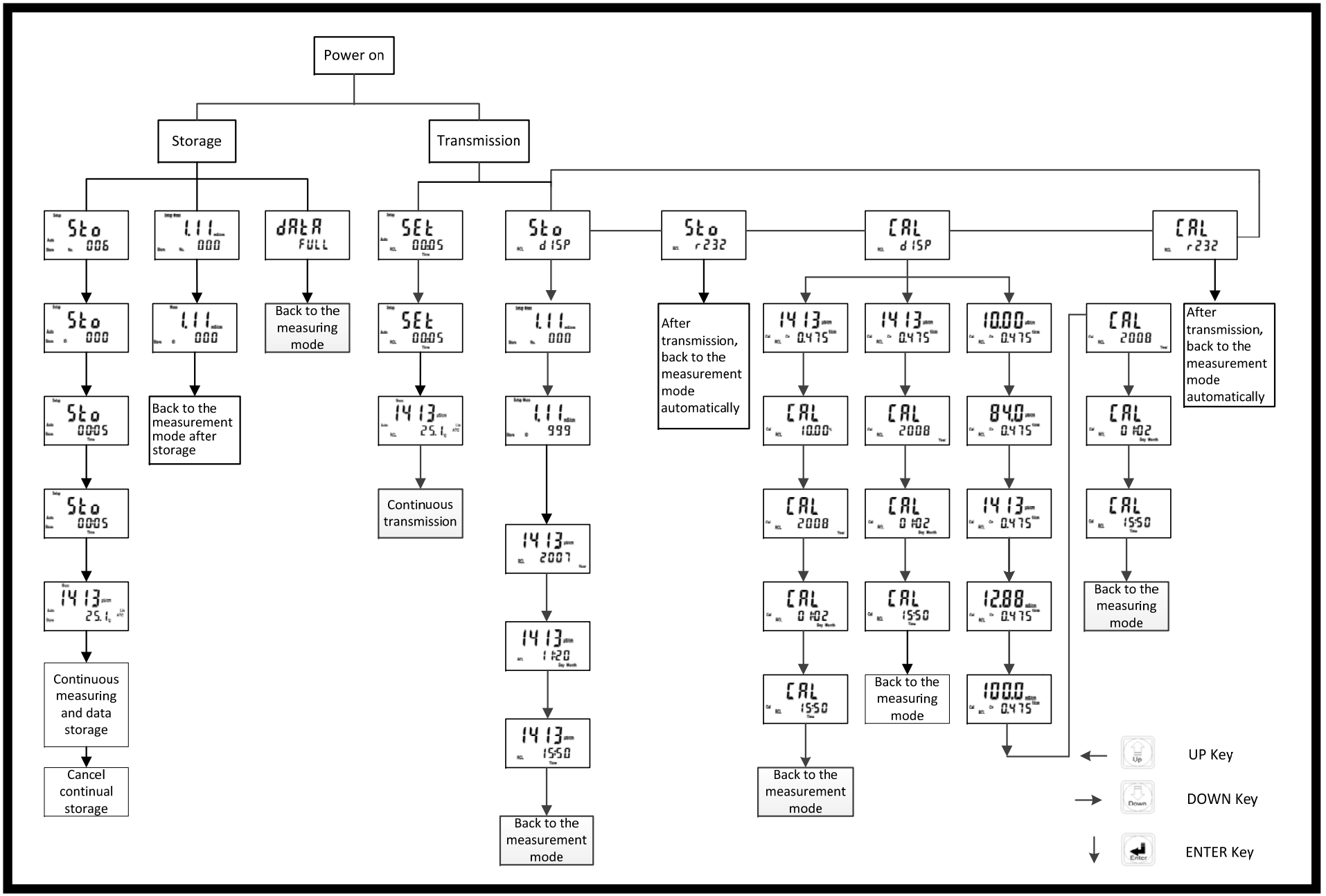
(Only suitable when the measurement unit is conductivity)



4.4.3 Temperature compensation coefficient setting for measurement mode



Block diagram of data storage and transmitting

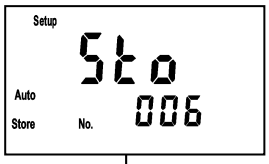


4.5 Data storage

Under data storage mode, users may store conductivity or resistivity or TDS or Salinity measurement with both No.(numbering) and ID (two kinds of classification). The "Number." represents the order of storage sequence. When data is stored to the 450th data, the display will shows "Full" to represent there is no more space for data logger memory. While ID category 1~1000 is for grouping the samples which the user may require. The Auto data storage can be set according to the time interval setting, the minimum interval is 5 seconds. If turn on the Data Rewritable Function, when the data memory is full the data logger will overwrite the new data.

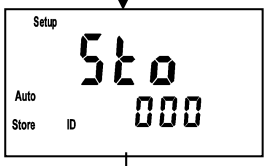
4.5.1 Time-interval auto data storage

Under the measurement mode, press and hold **ENTER** key and press **STORE** key simultaneously to enter the auto storage setting.



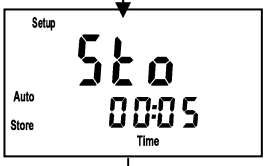
Display the starting storage number

Press **ENTER** key to enter



Press **UP** or **DOWN** key to modify the grouping ID. Press **ENTER** key to confirm it.

When the value twinkles, press **UP** or **DOWN** key to set the minute interval of auto storage. Press **ENTER** key to confirm it.



When the value twinkles, press **UP** or **DOWN** key to set the second interval of auto storage. Press **ENTER** key to confirm it.

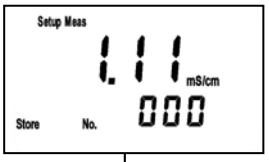
"Auto Store" twinkling represents the auto storage is activating.

Press **ENTER** + **STORE** key, or press **MODE** key to stop auto storage

Back to measurement mode

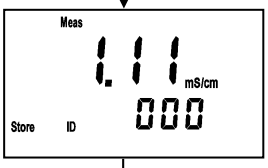
4.5.2 Manual data storage

In the measurement mode, press **STORE** key to enter manual store page. Press **MODE** key to exit at any time.



Display the starting storage number

Press **ENTER** key to enter



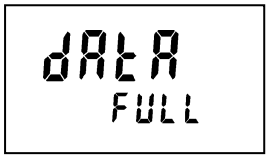
Press **UP** or **DOWN** key to modify the grouping ID.

Press **ENTER** key to confirm it.

Back to measurement mode

4.5.3 Overflow of data storage

When the data is full to store, the display will shine as a reminder, and five seconds later, it will back to the original measurement mode.

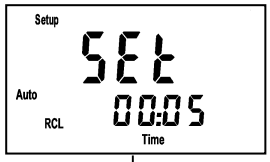


Users may delete all of the data according to the ch 4.2 instruction by pressing **STORE** + **POWER** key while power off. (When auto rewritable function is turned on, there is no this data full display reminder.)

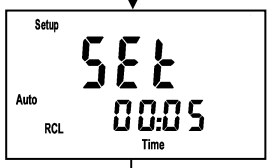
4.6 Data transmitting and display

4.6.1 Time interval auto transmitting

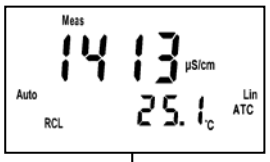
Transmit the real-time measurement to a computer or a printer through RS-232) Under measurement mode, press and hold **ENTER** key and then press **RECALL** key to enter auto transmitting menu display. After finishing setting, the data is transmitted through RS-232 interface.



Press **UP** or **DOWN** key to set the minute interval of auto transmitting, and press **ENTER** key to confirm it.



Press **UP** or **DOWN** key to set the second interval of auto transmitting, and press **ENTER** key to confirm it.
(The minimum value is 5 seconds)



When "**Auto RCL"** twinkles, it represents the auto transmitting function has been activated.

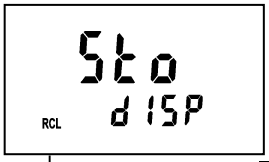
Press **ENTER**+ **RECALL** or press **MODE** key to stop auto transmitting.

Back to measurement mode

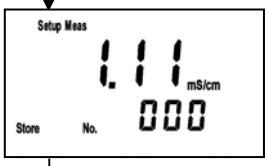
4.6.2 Data display & manual transmitting

In the measurement mode, press **RECALL** key to roll up the data display & manual transmitting menu, and press **ENTER** to enter.

1. Display the stored data

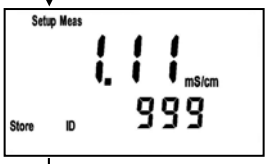


Press **ENTER** key to enter recent stored data menu display.



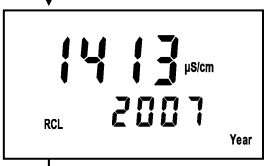
Press **UP** or **DOWN** key to select storage position.

Press **ENTER** key to confirm it.

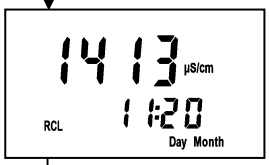


Display the data and its ID grouping. Press **UP** or **DOWN** key to directly look up other data and their ID grouping.

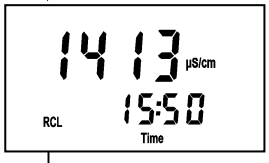
Press **ENTER** key to confirm to display this data of measurement value, storage year, date, and time.



Press **ENTER** key.



Press **ENTER** key.



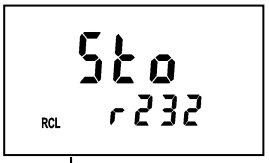
Press **ENTER** key.

Back to measurement mode

2. Manual stored data transmitting

Transmit all stored data through RS-232

In the measurement mode, press **RECALL** 2 times to find the menu.



Press **ENTER** key to transmit

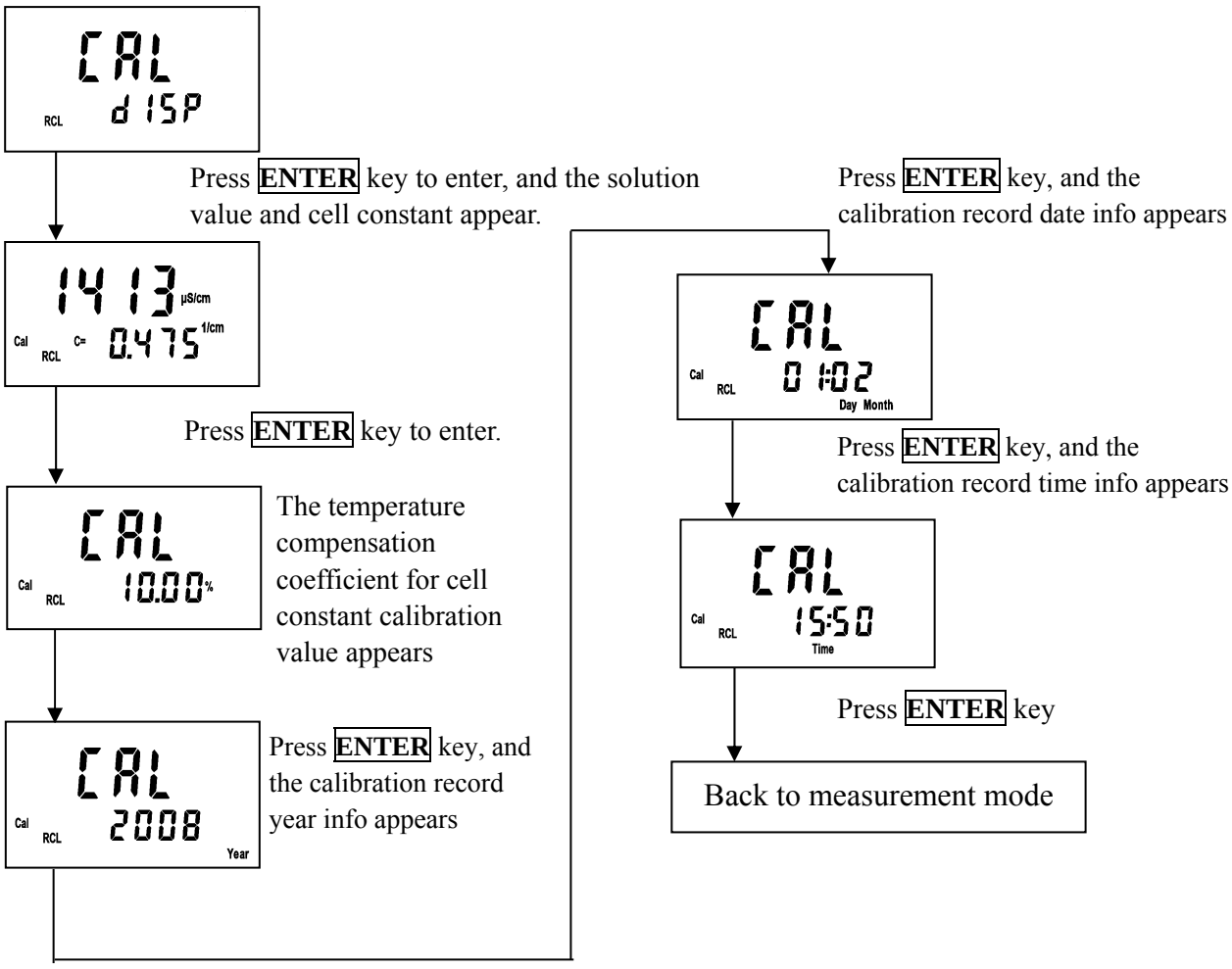
Transmission completed
Back to measurement mode

3. Display the last calibration data

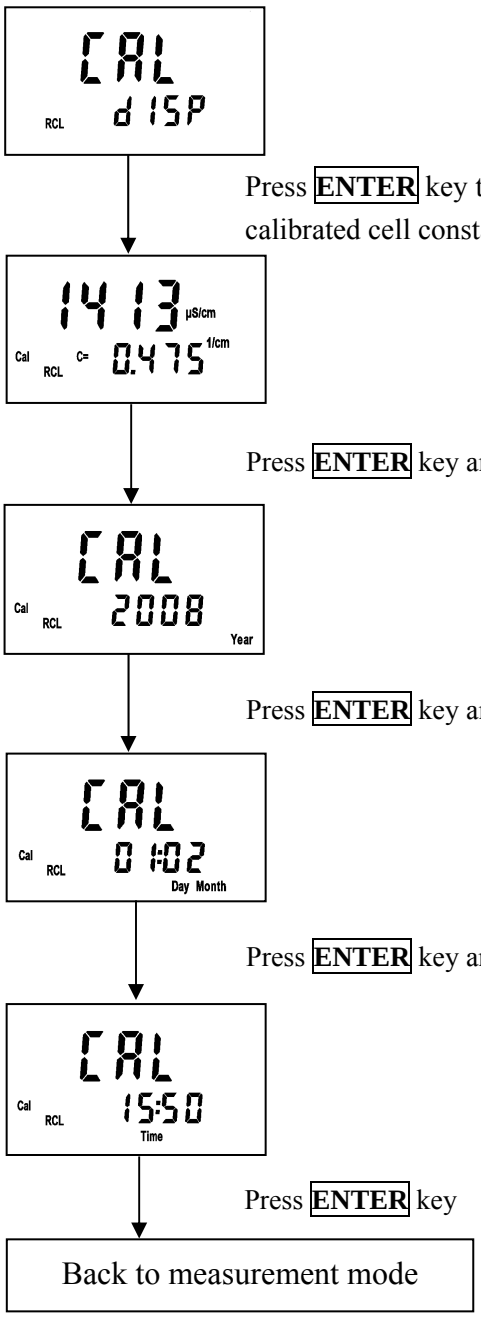
In the measurement mode, press **RECALL** key 3 times to find the menu.

(1). Read the CELL constant calibration data

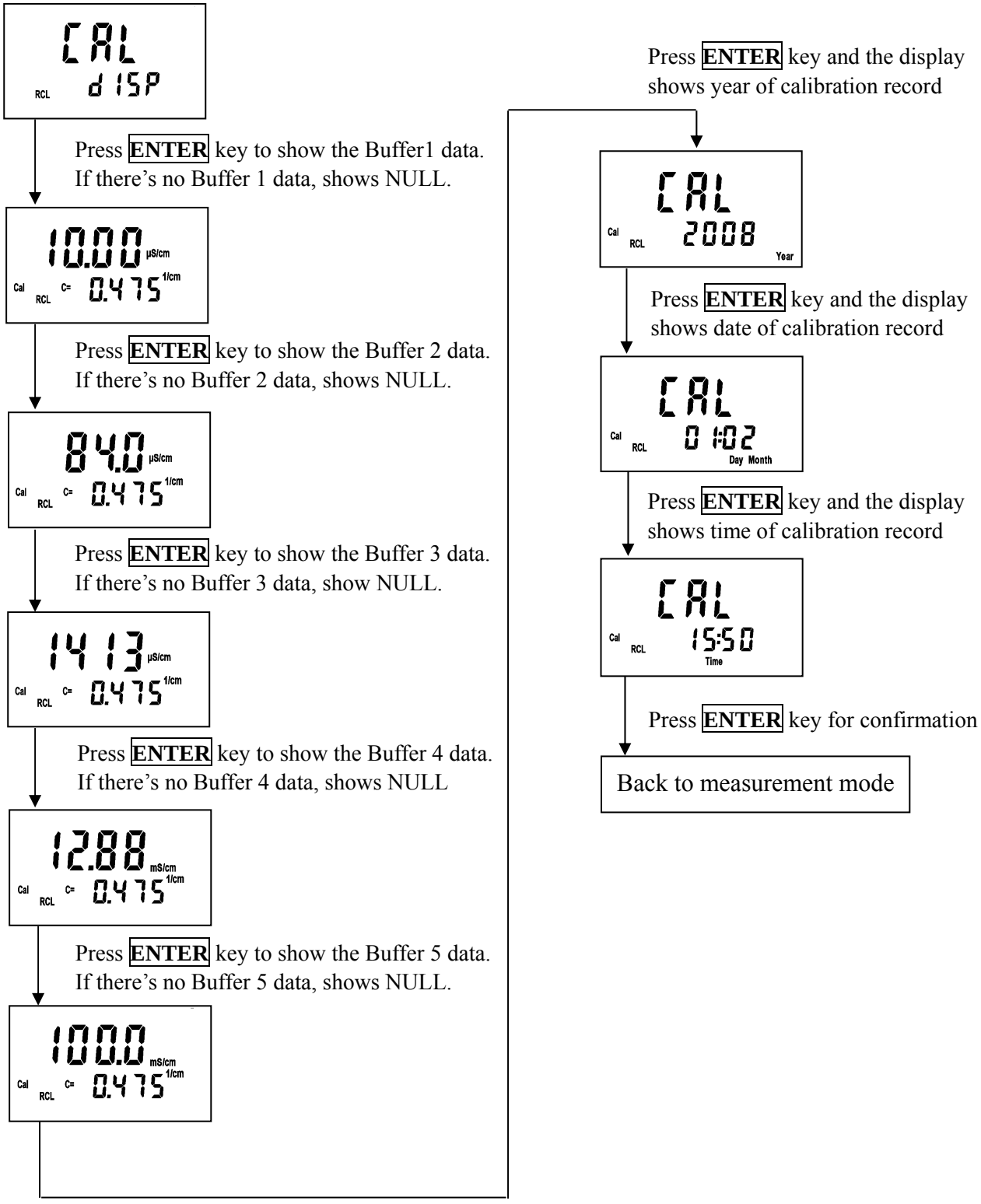
(when the calibration parameter is set as CELL constant calibration)



(2). Read single-point calibration data of standard solution (when the calibration parameter is set as Std 1P calibration)



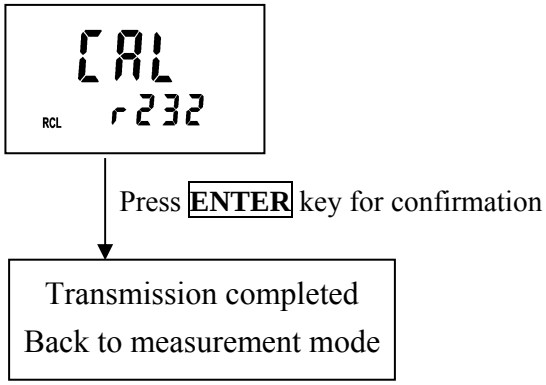
(3). Read five-point calibration data of standard solution
(when the calibration parameter is set as Std 5P calibration).



4. Calibration data transmitting

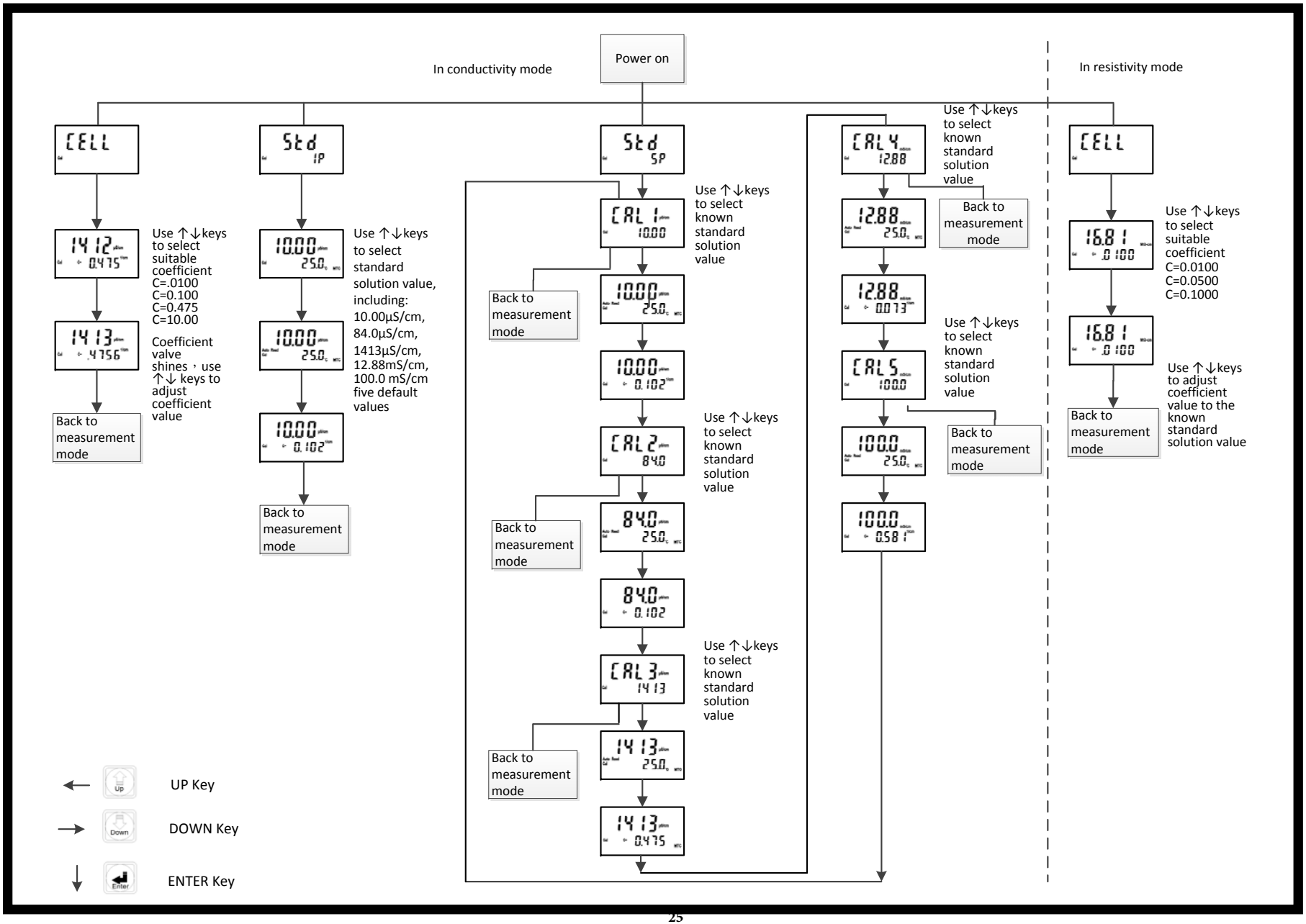
Transmit the stored cal. data through RS-232.

In the measurement mode, press **RECALL** 4 times to find the menu.



5. Calibration

Block diagram of Calibration



5.1 Standard solution preparation:

Put the reagent potassium chloride in an oven of 150˚C ~ 180˚C for 5 hours, and then put it in a dry container until it cools to the room temperature. Dissolve 0.7456g potassium chloride into 1 litre pure water to be 0.01N potassium chloride standard solution (1,413μS/cm).

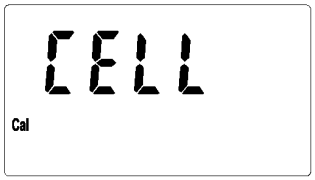
5.2 Calibration mode:

Parameter	Calibration method	Preset temperature compensation method
Conductivity	Set CELL CONSTANT	(Lin) 2.00% adjustable
	Std 1P Prepare 5 selectable kinds of Buffer	According to standard solution default
	Std 5P Prepare 5 selectable kinds of Buffer	According to standard solution default
Resistivity	Set CELL CONSTANT	(nLin) non-liner temp. compensation

5.3 Entry of calibration mode

Temperature coefficient produces a great influence on measurement of conductivity, so it is suggested to control the temperature of standard solution within 25 ±3˚C during the calibration.

5.3.1 Cell constant calibration:



1. When the calibration parameter is set as cell constant calibration mode (see ch4.4), press **CAL** key to enter the electrode coefficient set-up page, and then press **ENTER** key to enter the next page.

2. Press upward key or downward key to select cell constant default 0.475, 0.100 or 0.010, 10.00$^{1/cm}$ (resistivity only includes 0.010, 0.050, .0100$^{1/cm}$), in order to select a suitable cell constant value. After selecting the suitable default, press **ENTER** key to enter the next page.

3. Then, the cell constant value begins to twinkle. Press upward key or downward key to adjust the cell constant value until the measurement value in the display equal to the buffer's standard. Then, press **ENTER** key to back to the measurement mode.

5.3.2 Standard solution single-point calibration:

1. When the calibration parameter is set as single-point calibration (see ch4.4), press **CAL** key to enter Standard solution single-point calibration, and then press **ENTER** key to enter the calibration solution selection page.

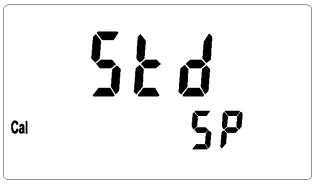
2. Show the first known buffer's standard and temperature. Press **UP** or **DOWN** key to adjust the known buffer's standard, including five default values 10.00μS/cm, 84.0μS/cm, 1413μS/cm, 12.88mS/cm and 100.0mS/cm. After selecting the suitable default, press **ENTER** key to enter the next page.

3. The symbol Auto Read begins to twinkle, indicating that the instrument begins auto calibration.

4. After the calibration, the display shows the calibrated electrode coefficient automatically. Press **ENTER** key to back to the measurement mode.

5.3.3 Standard solution five-point calibration:

1. When the calibration parameter is set as **five-point calibration** (see ch4.4), press **CAL** key to enter **Standard solution five-point calibration**, and then press **ENTER** key to enter the first CAL1 page. Press **MODE** key at any time will allow you intermit the calibration and back to the measurement mode.



2. Press upward key or downward key to select calibration point CAL1~5. Their default values are respectively 10.00uS, 84.0uS, 1413uS, 12.88mS and 100.0mS. You can select any calibration point to make single-point, two-point, three-point, four-point, and five-point calibration. After that, clean and dry the sensor before putting it into the buffer solution. Press **ENTER** key to enter the calibration page.

3. The symbol Auto Read begins to twinkle, indicating that the instrument begins auto calibration. After the calibration, the display shows the calibrated electrode coefficient automatically.

4. After the calibration, the display shows the calibrated electrode coefficient automatically.

5. Press **ENTER** key to enter the second calibration (CAL2) and finish the first point calibration. Press **MODE** key to store the calibration data and the system will exit calibration mode and back to measurement mode.

6. Other CAL2~CAL5 calibration applies the same steps as CAL1.

NOTE: The design of this instrument has no limit of the calibration sequence, so after finishing any point calibration, you can press ENTER key to enter the next point calibration, and press MODE key to store the calibration data. Then, exit the calibration mode and back to the measurement mode to finish the calibration of any one or a few points.

5.3.4 Error messages

In case of any error messages when the calibration fails, please refer to chapter 9, Trouble Shooting, to solve the problem and restart the calibration.

6. Instruction set for RS-232

The communication between the instrument and the Windows Hyper Terminal is set as follows:

1. Click 【Start】 on the lower left, and select 【All Programs】→【Accessories】→【Communication】 →【Hyper Terminal】, and the display will show a window of "Hyper Terminal".
2. Set icon and online name for Hyper Terminal before entering the "ONLINE" window.
3. Select communication terminal (for example, select 「connect COM1」) in 「Use online (N):」 in "ONLINE" window, and then enter the window "COM1 content".
4. In「transmission bit per second (B):」in "COM1 content", select baud rate=9600 (It should be consistent with conductivity meter settings), data bit (D)=8(compulsory), parity check(P)=non-parity, stop bit (S)= 2, flow control (E) =none.
5. Click 【disconnet】
6. Click 【file】→【content】, and enter the window "XXX content".
7. Click 【setting value】→【ASCII setting】to enter "ASCII setting" window.
8. In "ASCII setting" window, select 「newline at the end of each line (S)」,「Respond to the input characters (E)」,「Add LF at the end of each input line (A)」 and 「newline if exceeding the width of terminal (W)」, and then leave "ASCII setting" window by pushing 【confirm】.
9. Push 【confirm】to leave "XXX content" window.
10. Push 【call】to link the communication.

Note:

COM 1 content setup	
ASCII Setting	
Baud rate	9600
Data bit	8 (compulsory)
Parity	None
Stop bit	2
Flow control	None

7. Modbus protocol and instructions

7.1 Introduction

The SC-110 meter applies standard MODBUS protocol, and supports RTU transmission mode, even parity, and it allows Modbus protocol compatible Master or a controlling software from the third party to proceed in data transmission. With the ability of the meter, you only need to add a set of central communication controlling display software to establish a set of controlling communication network system. It will be convenient to the system monitoring and controlling and for data collection.

The default setting:

ID: 01

Transmission frame mode: ASCII

Parity type: Non-parity

Baud rate: 9600

7.2 Modbus rule

1. All the RS-232 communication loops follow Master/Slave way. According to this way, data can be transmitted from a Master (ex: PC) to a Slave (ex: SC-110).
2. The master can initialize and control all the information transmission within the RS-232 loop.
3. All the communication cannot start from a Slave.
4. All the communication within the RS-232 loop is necessary to match the Modbus information frame.
5. If the Master or the slave receives the information frame which is included unknown command, the master or the slave does not respond. Which message format is a byte (data frame) composed of a string.

7.3 Data frame format and data command

The communication transmission is in an asynchronous way, and the unit of it is byte (data frame). Each data frame is in an 11 bits (MODBUS RTU) or 10 bits (MODBUS ASCII) sequence data procedure.

Data frame format (byte):

BIT	Modbus RTU	Modbus ASCII
Start bit	1 start bit	1 start bit
Data bits	8 data bits	7 data bits
Parity bit	1 bit for even/odd parity, no bit for no parity	
Stop bits	1 stop bit if even/odd parity is used, 2 bits if no parity	

7.4 SC-110 communication protocol

When a communication command which is sent by a Master is received by the meter (slave), only the corresponding address code of the device accepts the communication command. If not wrong, then the meter performs the corresponding task; then the meter sends the implementation result back to the sender (Master). The returned information includes an address code, a function code which performs actions, data after performing actions, a check code (CRC or LRC) which checks errors. If there is an error, the meter will send corresponding error message.

7.4.1 Message Framing

RTU

Start	Address	Function	Data	CRC	End
≥3.5 byte time	Address code 1 byte	Function code 1 byte	Data field N bytes	Check code 2 bytes	≥3.5 byte time

Under RTU mode, the max. length of the info data is 256 bytes.

ASCII

Start	Address	Function	Data	LRC	End
: 1 bit	Address code 2 bits	Function code 2 bits	Data field N bits	Check code 2 bits	CRLF 2 bits

Under ASCII mode, the maximum length of the info data is 513 bits (char).

7.4.2 Address code

Each slave has its one and only address code. That the master sends the address indicates only the slave with the specific address code can receive the message and responds to the master. The slave returns the address to prove where the slave belongs.

Note: The fault setting of address code for SC-110 is 01 and cannot be revised.

7.4.3 Function code

The range of function code is 1~255; the function codes within 1~127 are normal, but the function codes 128~255 are defined as abnormal responding function code. SC-110 only supports some of the function codes. When starting communication, the Master sends the request through function code to tell the Slave to perform which actions. The Slave responds function which is the same as that sent by the Master to indicate the Slave has already responded to the Master and has performed the action.

The function codes which the slaves normally respond are the same as those from the Master. When the slaves respond abnormal message, the highest bit (MSB) of the function codes are set to be 1. It means that there occurs an error when executing the function codes.

The following table lists the function codes supported by SC-110

Function code	Definition	Operation
01H Read Coil Status	Reads the ON/OFF status of discrete coils in the slave	Read the status of one or more discrete contacts
03H Read Holding Register	Read the binary contents of holding registers in the slave	Read one or more data register value
05H Write Single Coil	Writes a single coil to either ON or OFF.	Set the status of discrete individual contacts to the specified address
06H Write Single Register	Writes a value into a single holding register	Set a single 16-bit data register
0FH Write Multiple Coils	Writes each coil in a sequence of coils to either ON or OFF	Set the status of multiple discrete continuous contacts to the specified address

10H Write Multiple Registe	Writes values into a sequence of holding registers	Set multiple sequence of 16-bit data register
08H Diagnostics	Diagnostics function	The assessment of network communication capability

7.4.3.1 Function code 01H (Read Coil Status)

The function code is for reading the consecutive contact state discrete volume from the slave. 01H does not support broadcast mode.

Sending format:

Type		RTU	ASCII	Example (RTU)	
Function		1 byte	2 Characters	01H	Read the contact state discrete volume
DATA Field	The starting address of the contact number	2 bytes	4 Characters	0070H	The contact numbers to read the starting address is 0070H
	The number of contact	2 bytes	4 Characters	0003H	Start to read three consecutive contact state discrete volume from 0070H

Normal response format:

Type		RTU	ASCII	Example (RTU)	
Function		1 byte	2 Characters	01H	Response to the function code
DATA Field	Number of bytes	1 byte	2 Characters	01H	The number of data bytes
	The contact state discrete value	N bytes	2*N Characters	03H	Set of state of contact discrete value. Ex: 03H. If the number of contacts is not a multiple of 8, it will be times 10(add 0 in the back) until it is of 8.

For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SC-110, please refer to the corresponding address list of function code 01H.

7.4.3.2 Function code 03H (Read Holding Registers)

The function code is for reading the consecutive 16 bits register data of the slave. 03H does not support broadcast mode.

Sending format:

Type		RTU	ASCII	Example (RTU)
Function		1 byte	2 Characters	03H Read register data
DATA Field	The starting address of the register	2 bytes	4 Characters	0004H Read the starting address of register address 0004H
	Number of registers	2 bytes	4 Characters	0003H Start from 0004H to read three consecutive 16 bits register data

Normal response format:

Type		RTU	ASCII	Example (RTU)
Function		1 byte	2 Characters	03H Response Function Code
DATA Field	Number of bytes	1 byte	2 Characters	06H The number of data bytes
	Register value	N bytes	2*N Characters	030605040303H Returns three 16-bit register data

For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SC-110, please refer to the corresponding address list of function code 03H.

Note: Due to all the floating-point data of the SC-110 are in a 32 bits IEEE 754 format. The high bit is in front, and the low bit in post.

7.4.3.3 Function code 05H (Write Single Coil)

The function code is for setting single state discrete contacts to the slave. 05H does not support broadcast mode.

Sending format:

Type		RTU	ASCII	Example (RTU)
Function code		1 byte	2 Characters	05H set the status of discrete individual contacts
DATA Field	Contact number address	2 bytes	4 Characters	0076H set single contact number address as 0076H
	The discrete status of contact	2 bytes	4 Characters	0000H or FF00H: 0000H indicates OFF, FF00H indicates ON

Normal response format is the copy of the sending format. It returns when successfully set the discrete status of contact. For abnormal response please refer to abnormal data format.

7.4.3.4 Function code 06H (Write Single Register)

The function code is for setting single register value to the slave. 06H supports broadcast mode.

Sending format:

Type		RTU	ASCII	Example (RTU)
Function code		1 byte	2 Characters	06H Set the value of a single register
DATA Field	Register address	2 bytes	4 Characters	000AH Set a single register address as 000AH
	Register data	2 bytes	4 Characters	0003H Set a single register address as 0003H

Normal response format is the copy of the sending format. It returns when successfully set the discrete status of contact. For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SC-110, please refer to the corresponding address list of function code 06H.

7.4.3.5 Function code 0FH(Write Multiple Coils)

The function code is for setting continuous state discrete contacts to the slave. 0FH does not support broadcast mode.

Sending format:

Type		RTU	ASCII	Example（RTU）
Function code		1 byte	2 Characters	0FH Set the status of discrete individual contacts
DATA Field	Contact starting address	2 bytes	4 Characters	0076H Set multiple consecutive contacts starting address as 0076H
	The number of contact	2 bytes	4 Characters	0003H To indicate to set three numbers of contact
	The number of bytes	1 byte	2 Characters	01H To set the number of information byte of contact discrete status
	The discrete status of multi-contact	N bytes	2*N Characters	03H Set of discrete contact state information. If the number of contacts is not a multiple of 8, it will be times 10(add 0 in the back) until it is of 8

Normal response format is the copy of the sending format. It returns when successfully set the discrete status of contact. For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SC-110, please refer to the corresponding address list of function code 0FH.

7.4.3.6 Function code 10H (Write Multiple Registers)

The function code is for setting multi-consecutive register value to the slave. 10H supports broadcast mode.

Sending format:

Type		RTU	ASCII	Example (RTU)
Function		1 byte	2 Characters	10H To set multi-consecutive register data
DATA Field	Register starting address	2 bytes	4 Characters	0007H Set multiple consecutive contacts starting address as 0007H
	The number of register	2 bytes	4 Characters	0003H To indicate to set three consecutive 16 bits register numbers
	The number of bytes	1 byte	2 Characters	06H To set the information bytes number of multi-consecutive register
	Register data values	N bytes	2*N Characters	030505030303H To set the input of three 16 bits data 0305H, 0503H, 0303H

Normal response format is the copy of the sending format. It returns when successfully set the discrete status of contact. For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SC-110, please refer to the corresponding address list of function code 10H.

7.4.3.7 Function code 08H (Diagnostics)

The function code, 08H, is for diagnostic function. It can be counted packets of every state to evaluate transmission capacity of RS-232 communication.

The function code 08H provides a series of sub-function code. The SC-110 supports sub-function code 0A-12H. The function code 08H does not support broadcast mode.

Sending format:

Type		RTU	ASCII	Example（RTU）
Function code （CS）		1 byte	2 Characters	08H Diagnostic function
DATA Field	Sub-function code	2 bytes	4 Characters	000AH Clear counters
	Data	2 bytes	4 Characters	0000H Sub-function code 0A-12H is fixed to 0

Normal response format:

Type		RTU	ASCII	Example（RTU）
Function code		1 byte	2 Characters	08H Response function code
DATA Field	2 bytes	2 bytes	4 Characters	000AH Response sub-function code
	2 bytes	2 bytes	4 Characters	0000H Back to the counter value Only sub-function code 0A is able to copy the data and to send the information

For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SC-110, please refer to the corresponding diagnostics function of function code 08H.

7.4.4 Data field

Data field varies with the function code. Whether address or register, the information is high byte first and low byte in the post. The byte sets of the ASCII are twice than those of RTU mode.

7.4.5 Check code

Check code is used to detect whether data frame is error or not. If the data frame is error, the data does not work. It ensures the safety and efficiency of the system. RTU mode uses CRC (loop redundant) to check. ASCII mode uses (Longitudinal Redundancy) LRC to check.

7.4.6 Abnormal procedure

SC-110 will response abnormal information frame when it detects error which except verification error and length of byte error. The minimum byte(LSB) of function code is the same as it of the master, however, the maximum byte (MSB) of function code is 1. It means that the function code which is responded by remote equipment occur has errors. is based on the function code which is sent by master add 128.

Abnormal response frame:

Function code	Abnormal code
MSB: 1	01 or 02 or 03 or 04

Abnormal code 01: illegal function code

The SC-110 does not support the function code received.

Abnormal code 02: illegal data address

The SC-110 do not support the designated data address.

Abnormal code 03: illegal statistics value

The data which is input to designated address of SC-110 is illegal value.

Abnormal code 04: abnormal data input

Failed to input data to SC-110, and it result to unrecoverable error.

7.5 Communication connection

The RS-232 communication port of the meter features with electronic isolation protection, lightning protection, and to provide internal independent ground solution. It is allowed to use normal twisted-pair (segregation double-stranded twisted pair cable) cable connections. All devices are in contact with a double-stranded, and then all together, and another line will be connected with all the negative contacts, and the isolated shield wire must be connected to 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.

7.6 MODBUS name and address table

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

Logic address	Item	Number of Byte	Information type	Description of data transmission	Default value	Note
0001H	Equipment's ID	2	USHORT	1-247	1	
0002H	Meter model	6	USHORT	ASCII Code	SC110	
0005H	Communication protocol	2	USHORT	0: RTU 1: ASCII	0	
0006H	Serial transmission speed (Baud rate)	2	USHORT	0: 2400 1: 4800 2: 9600 3: 19200	3	
0007H	Parity	2	USHORT	0: None 1: Even 2: Odd	1	
0008H	Real-time clock*	12	USHORT	Second	2000-01-01, 00:00:00	
0009H			USHORT	Minute		
000AH			USHORT	Hour		
000BH			USHORT	Day		
000CH			USHORT	Month		
000DH			USHORT	Year		
000EH	Factory reserved					
000FH	Temperature mode*	2	USHORT	0: MTC 1: PTC 2: NTC	0	
0010H	Factory reserved					
0011H						
0012H						
0014H						
0015H						

Function code: 03H Modbus response (measurement parameter)

Logic address	Item	Number of Byte	Information type	Description of data transmission	Default value	Note
0031H	Number of measurement channels	2	USHORT	SC-110 only has one channel	1	
0032H	Sign byte	6	CHAR	μS/cm		ASCII code
0035H	Residual chlorine /Ozone measurement	4	FLOAT	Cond/Res/Salt /TDS measurement		Data affected by sign byte

0037H	Temperature measurement	4	FLOAT	Temperature measurement		
0039H-0050H	Factory reserved					

Function code: 08H Correlated diagnostic function

Sub function code	Name of Counter	Note
0AH	Clear all the counters	Clear Counters and Diagnostic Register
0BH	Return Bus Message Count	The response data field returns the quantity of message that the slave has detected on the communications system since its last restart or last clear counters operation, or being powered-up. It counts whether the address comes from the remote equipment or not,
0CH	Return Bus Communication Error Count	The response data field returns the quantity of CRC errors encountered by the slave since its last restart, clear counters operation, or power-up. It counts whether the address comes from the remote equipment or not,
0DH	Return Bus Exception Error Count	The response data field returns the quantity of Modbus exception responses returned by the slave since its last restart, clear counters operation, or power-up. It only counts when the address comes from the remote equipment.
0EH	Return Slave Message Count	The response data field returns the quantity of messages addressed to the slave, or broadcast, that the slave has processed since its last restart, clear counters operation, or power-up. It only counts when the address comes from that remote equipment.
0FH	Return Slave No Response Count	The response data field returns the quantity of message addressed to the slave for which it returned no response (neither a normal responses nor an exception response), since its last restart, clear counters operation, or power-up. It is said that the counter will calculate the quantity of none-error broadcast messages.
10H	Return Slave NAK Count	The response data field returns the quantity of message addressed to the slave for which it returned a Negative Acknowledge (NAK) exception response since its last restart, clear counters operation, or power-up.
11H	Return Slave Busy Count	The response data field returns the quantity of message addressed to the slave for it returned a Slave Device Busy exception response, since its last restart, clear counters operation, or power-up.
12H	Return Bus Character overrun Count	The response data field returns the quantity of messages addressed to the slave that it could not handle due to a character overrun condition, since its last restart, clear counters operation, or power-up.

8. Optional accessories

Product Name	Order Number
4-electrode conductivity probe, C≒0.475	8-243
Ultra pure water resistivity probe, C≒0.01	8-221-01
Pure water resistivity probe, C≒0.05	8-222-01
3/4"NPT bypass chamber for 8-22X-01 resistivity probe	8-TF-02
Cable for 8-22X-01 resistivity probe, 1.15M	8-101D
Cable for 8-22X-01 resistivity probe, 3M	8-103D
RS-232 Connection Cable for PC	8-30
Carrying Case for SC-110	8-32-1
Conductivity Calibration Solutions, 1,413μS/cm, 500ml	8-EC1413-2
Conductivity Calibration Solutions, 84μS/cm, 500ml	8-EC84-2

9. Trouble shooting

Failure phenomenon	Possible reason	Disposition
ERR1	The electrode coefficient bears a large deviation when use the standard solution in calibration.	Replace new standard solution for another calibration. For others, please refer to the disposition of measurement deviation in the following.
ERR2	The measurement is unstable when use the standard solution in calibration.	Please refer to the disposition of unstable measurement in the following.
Measurement deviation	The electrode is polluted.	Clean and wash the electrode
	The electrode coefficient (C) is wrongly set.	Modify the electrode coefficient
	The temperature coefficient (TC) is wrongly set.	Modify the temperature compensation coefficient.
	The electrode is damaged or broken-down.	Readjust the coefficient
	There are air bubbles on the electrode.	Churn up to remove the bubbles.
	The battery is low.	Replace with new battery.
	Instrument fault	Send to the original factory for repair.
Unstable measurement	The electrode is disturbed by the bubbles.	Churn up to remove the bubbles.
	The electrode is polluted.	Clean and wash the electrode.
	Electrode fault	Replace the electrode.
	The battery is low.	Replace with new battery.
	Instrument fault	Send to the original factory for repair.
The conductivity value is zero or the special resistivity value is out of the range.	The electrode plugs is not inserted into the required place.	Check the electrode plugs and reinsert it into the required place.
	The electrode is broken.	Replace the electrode.
Temperature deviation	Not soak deeply enough.	Deepen the soaked length to ensure the accuracy of temperature.
	Deviation of standard comparison	Use standard thermometer comparison to correct the difference in temperature
	The temperature sensor is broken	Replace the electrode.
	The battery is low.	Replace with new battery.
	Instrument fault	Send to the original factory for repair.
Temperature is wrongly displayed.	The electrode plugs is not inserted into the required place.	Check the electrode plugs and reinsert it into the required place.
	The temperature sensor is broken	Replace the electrode.
	Instrument fault	Send to the original factory for repair.

10. Maintenance

10.1 Maintenance of instrument machine

Please keep it in dry and ventilated environment. Use wrong soft wet cloth to wipe the generally polluted surface. For pollution by grease, please remove the stain with waxed soft wet cloth. Solvent is strictly prohibited.

10.2 Battery replacement

a. When the display shows Lo Bat during the instrument works, please replace with alkali dry cells.

b. First power off the instrument, and then use cross head screwdriver to dismantle the four screws on the back of the instrument.

c. Open the back cover and remove the battery protection cover.

d. Take out the old battery and put in 4 new AA batteries in correct directions.

e. Reinstall the battery cover and back cover, and lock the 4 screws to finish the battery replacement.

f. Caution! The battery replacement should be finished within 20 seconds; otherwise the date data will disappear and should be reset.

10.3 Maintenance of sensor

The substances on the measuring side of sensor will influence the measurement value and cause deviation. Please clean and maintain it regularly. Use soft brush or cotton stick to clean the graphite surface of sensor.

Pollution types	**Cleaning methods**
Pollution by grease	Use mild degreasing agent to clean the electrode.
Pollution by dirt	Soak in 2~5% HCl for about 5 minutes.

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