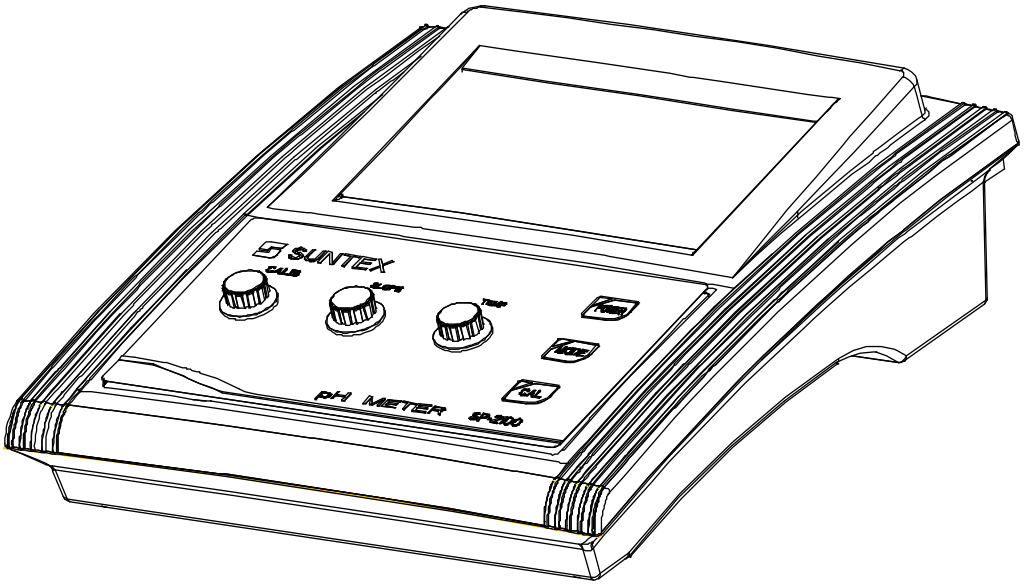
SP-2100 Laboratory pH/mV/Temp. Meter

Operation Manual



SUNTEX

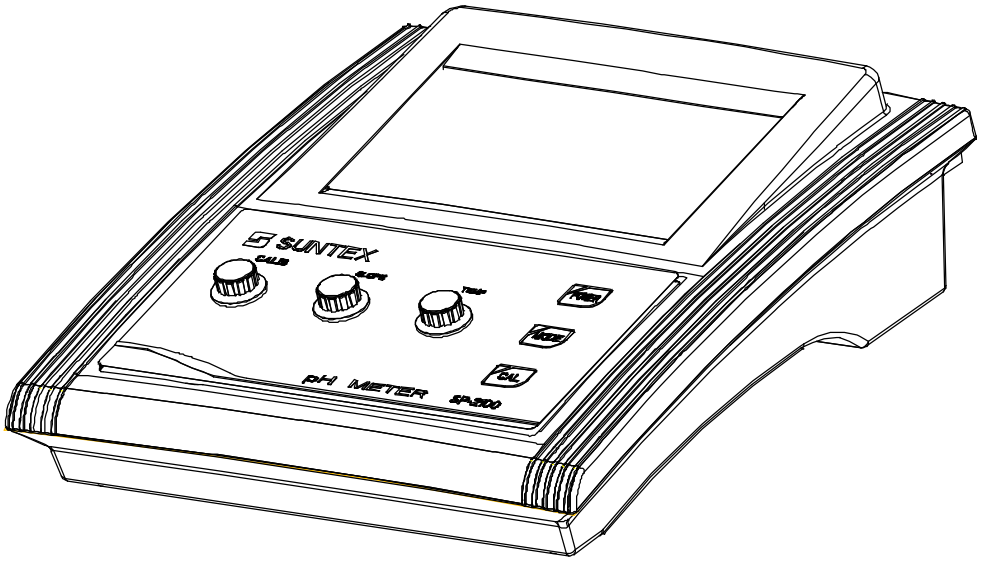
Content

1. Specifications

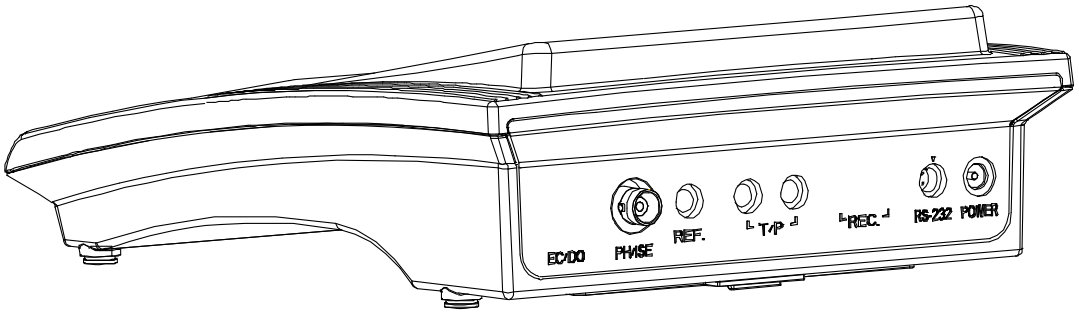
Model		SP-2100
Measuring item		pH / ORP / Temperature
Measuring Range	pH	-2.00~16.00pH
	ORP	-1999~1999mV
	TEMP	-10.0~110.0°C
Resolution	pH	0.01pH
	ORP	1mV
	TEMP	0.1°C
Accuracy	pH	±0.01pH±1Digit
	ORP	±0.05%±1Digit
	TEMP	±0.2°C ±1Digit
Auto-Read		Yes
Calibration		Build in Tech. buffers automatic recognition, up to 3-point auto calibration, showing offset and slope after calibration
		Manual knob-adjustment
Temperature Compensation		PT-1000 or NTC 30K probe with auto recognition and temperature correction function
		Manual adjustment
Ambient Temperature		0~50°C
Storage Temperature		-20~70°C
Impedance Input		$\geqq 10^{12}\Omega$
Display		Large 0.8” LCD display with backlight function
RS232 Interface		RS-232 (Print / MODBUS-RTU)
Power Supply		4 AA batteries or 6V AC/DC adaptor
Power Consumption		1W max.
Dimensions		220×190×70mm (L×W×H)
Weight		0.8Kg

2. Panel Description

2.1 Front panel:

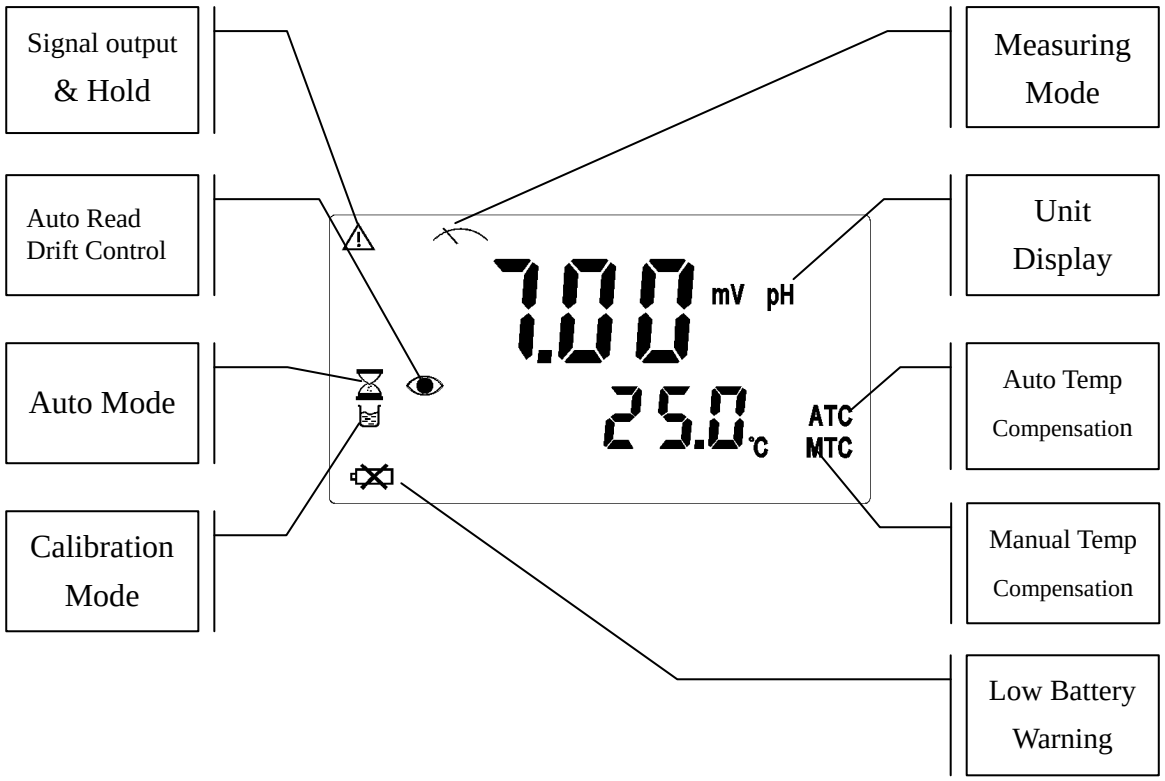


2.2 Sockets:

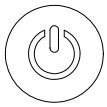


POWER ：DC 6V Adaptor socket
RS-232 ：RS-232 interface for computer connection
T/P ：Temperature probe socket
REF. ：Reference probe socket
pH/ISE ：BNC socket for pH, metal, or specific ion electrode

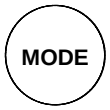
2.3 Display:


Signal output & Hold
Auto Read Drift Control
Auto Mode
Calibration Mode
7.00
mV
pH
25.0
°C
ATC
MTC
Measuring Mode
Unit Display
Auto Temp Compensation
Manual Temp Compensation
Low Battery Warning

2.4 Keypad:



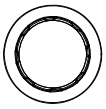
Power ON/OFF



Switch from pH or ORP or Temperature Correctiion mode.

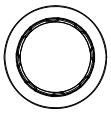
Enter calibration mode / Select buffer type

CALIB



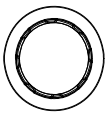
Zero point calibration adjustment knob with press-down safety function. (Please press down before tuning)

SLOPE



Slope calibration adjustment knob with press-down safety function. . (Please press down before tuning)

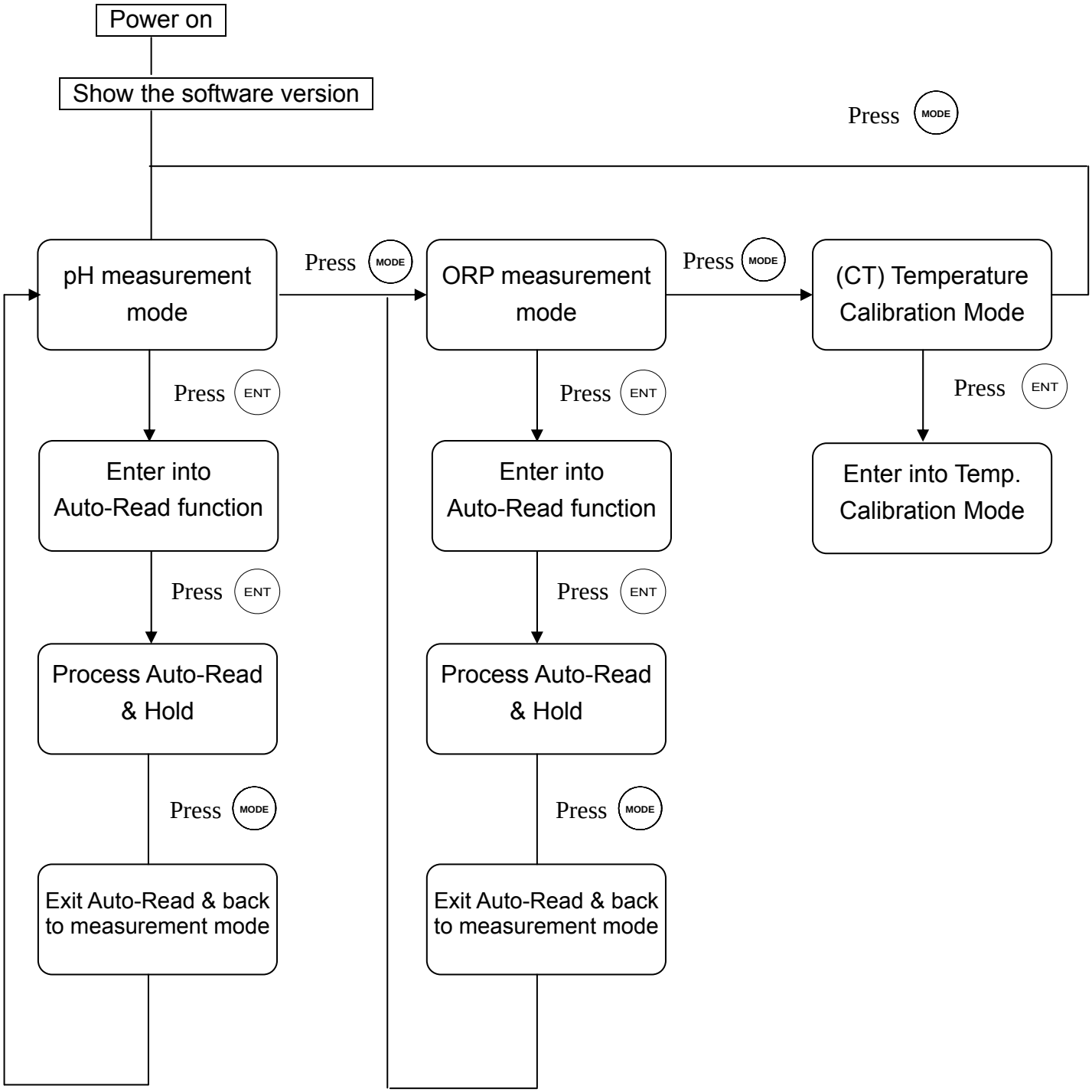
TEMP



Temperature adjustment knob with press-down safety function. . (Please press down before tuning)

3. Operation

3.1 Block diagram of operation



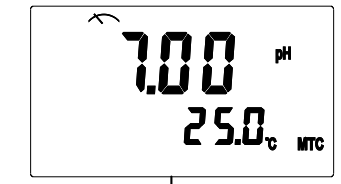
3.2 pH measurement

3.2.1 pH measurement mode

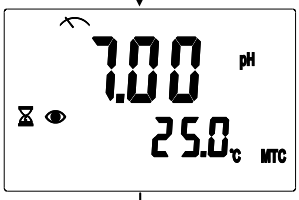
Press ⏻ to power on, and press MODE to enter pH measurement mode which is in a continuously measuring status.

3.2.2 pH Auto-Read Drift Control

Under pH measurement mode, press ENT to activate on Auto-Read function.

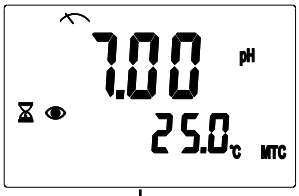


Press ENT

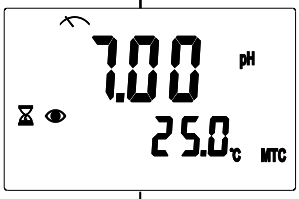


The signs ⧖ 👁 come out, and the measurement reading is hold.

Press ENT



The signs ⧖ 👁 twinkle, and the instrument start to run the Auto-Read function until the reading is stable.



After the reading is stable, the signs ⧖ 👁 stop twinkling, and the measurement is hold.

Press ENT to start next Auto-Read measurement.

Press MODE to exit Auto-Read function and back to pH measurement mode.

3.3 ORP Measurement

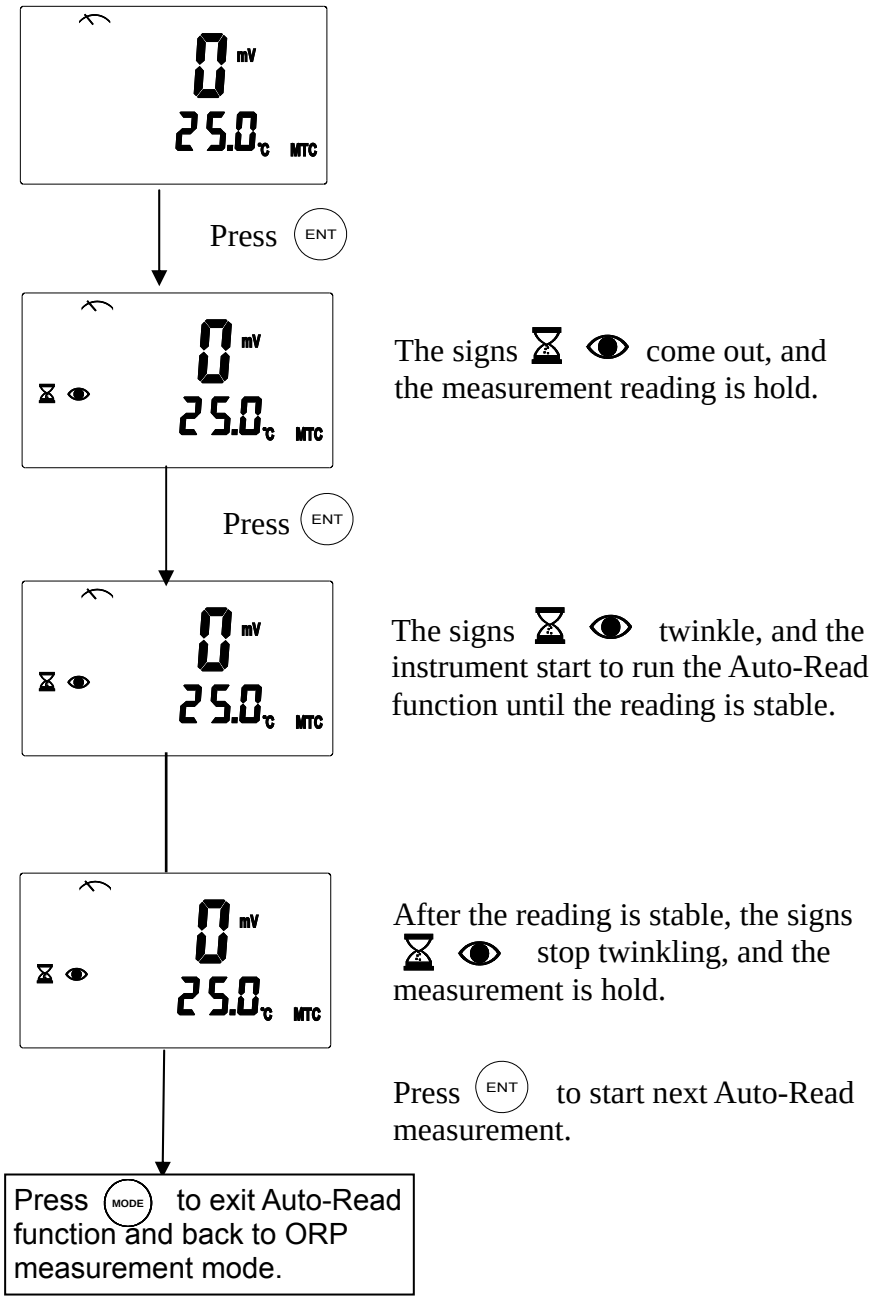
3.3.1 ORP measurement mode

Press ⏻ to power on, and press MODE to enter ORP measurement mode which is in a continuously measuring status.

3.3.2 ORP Auto-Read Drift Control

Under ORP measurement mode, press ENT to activate Auto-Read function.

◦



4. Temperature compensation

Under pH measurement mode, the temperature of sample solution infects the reading of measurement, thus, a temperature compensation to the measurement has to be made in order to correct the pH reading error.

1. **Manual Compensation:** If you do not use a temperature probe, you may press and tune up the “TEMP. knob” (TEMP) until the figure is accorded with the temperature of sample solution before starting a measurement.

2. **Automatic Compensation:** The instrument can automatically recognize whether the temperature probe is a PT1000 or a NTC30K system. Plug in the temperature probe, the instrument can measure the temperature of the sample solution temperature and compensate the main measurement reading automatically. In addition, you may press and tune up the “TEMP. knob” (TEMP) to correct the temperature reading

5. Calibration

5.1 pH calibration

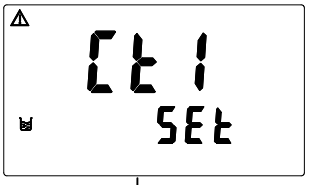
1. The instrument provide two types of calibration including TECH buffer solution automatic calibration and manual calibration

   The preset TECH buffer-solutions' standard values are: pH4.01、pH7.00、pH10.00.

2. The TECH buffer-solution automatic calibration can be done with single-point, dual-point, or three-point calibration.

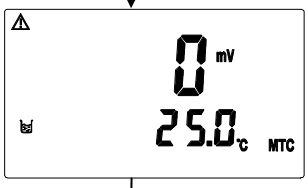
5.1.1 Preset TECH. buffer auto calibration

Press (MODE) to enter "ct1"calibration mode.

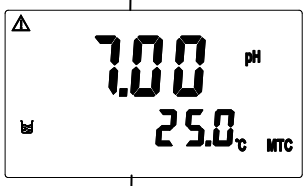


Clean up the pH electrode, and put it into the first TECH buffer solution

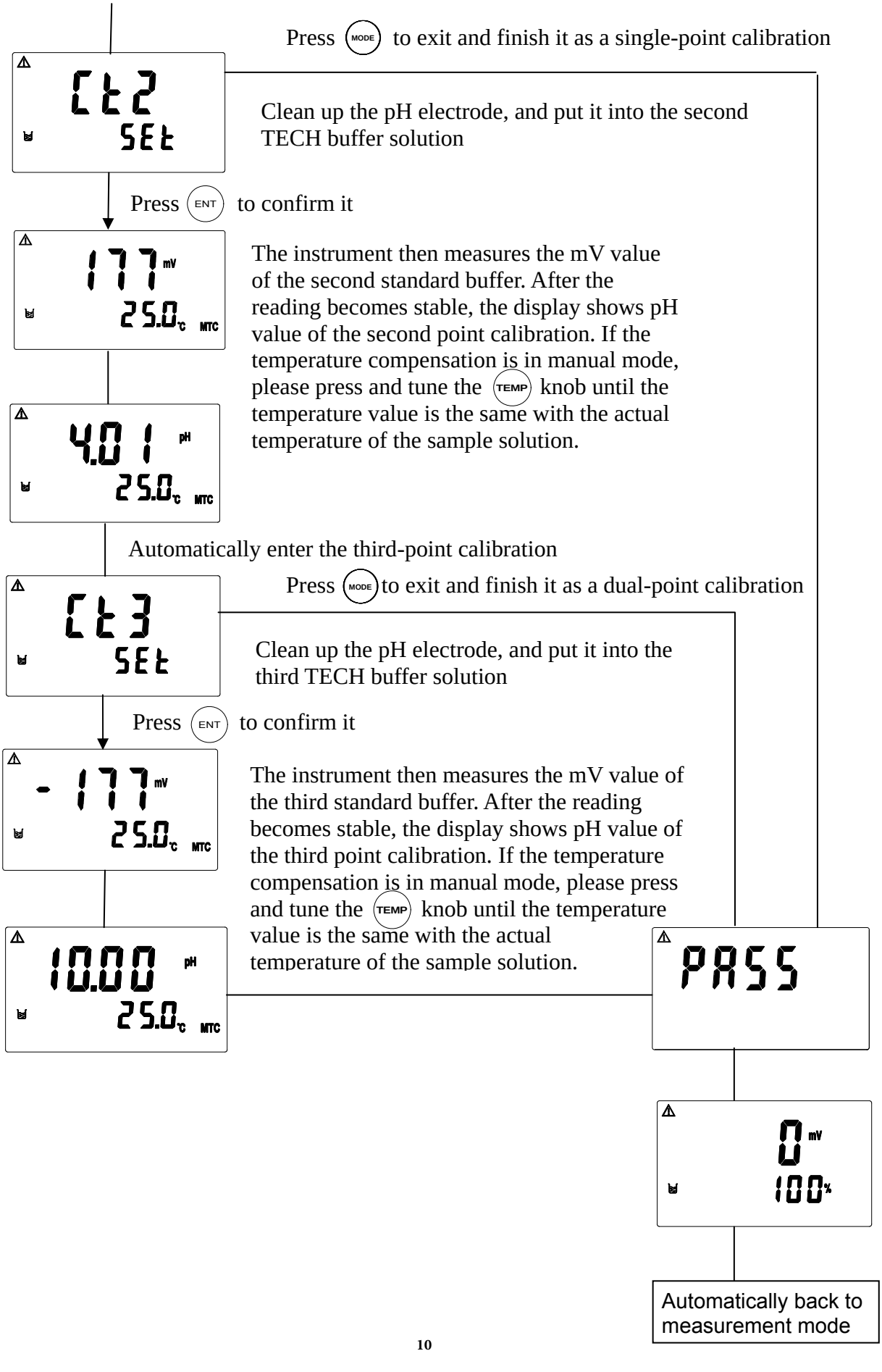
Press (ENT) to confirm it



The instrument then measures the mV value of the standard buffer. After the reading becomes stable, the display shows pH value of the first point calibration. If the temperature compensation is in manual mode, please press and tune the (TEMP) knob until the temperature value is the same with the actual temperature of the sample solution.

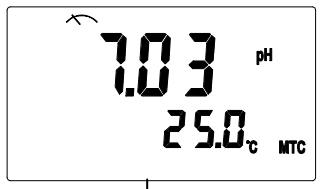


Automatically enter the second-point calibration


Press MODE to exit and finish it as a single-point calibration
Ct2
SEt
Clean up the pH electrode, and put it into the second TECH buffer solution
Press ENT to confirm it
177 mV
25.0°C MTC
The instrument then measures the mV value of the second standard buffer. After the reading becomes stable, the display shows pH value of the second point calibration. If the temperature compensation is in manual mode, please press and tune the TEMP knob until the temperature value is the same with the actual temperature of the sample solution.
4.01 pH
25.0°C MTC
Automatically enter the third-point calibration
Press MODE to exit and finish it as a dual-point calibration
Ct3
SEt
Clean up the pH electrode, and put it into the third TECH buffer solution
Press ENT to confirm it
-177 mV
25.0°C MTC
The instrument then measures the mV value of the third standard buffer. After the reading becomes stable, the display shows pH value of the third point calibration. If the temperature compensation is in manual mode, please press and tune the TEMP knob until the temperature value is the same with the actual temperature of the sample solution.
10.00 pH
25.0°C MTC
PASS
0 mV
100%
Automatically back to measurement mode

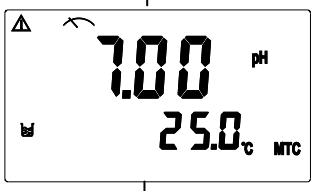
5.1.2 Manual calibration

The pH manual calibration should be proceeded under the pH measurement mode.

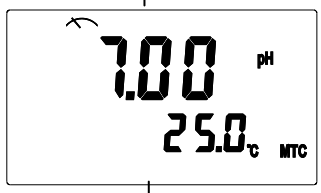


Clean up the pH electrode, and put it into pH 7.00 buffer solution. If the temperature compensation is in manual mode, please press and tune the TEMP knob until the temperature value is the same with the actual temperature of the sample solution.

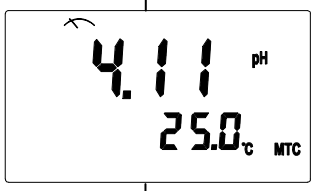
0



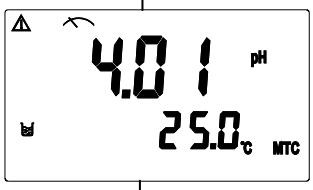
Press & hold the “CALIB” knob until there is a sign on the display. Then, tune the knob to adjust to the “zero point” (pH 7.00).



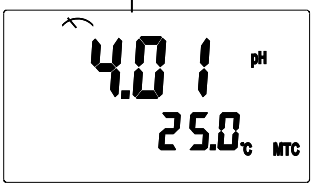
Release the knob. Then, the sign is disappeared. It represents that the zero point calibration has been done.



Clean up the pH electrode, and put it into pH 4.01 buffer solution. If the temperature compensation is in manual mode, please press and tune the TEMP knob until the temperature value is the same with the actual temperature of the sample solution.



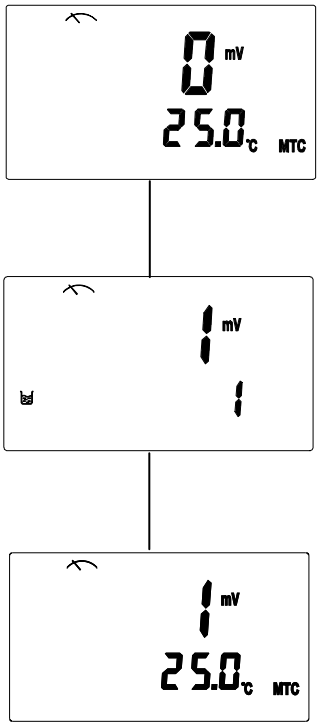
Press & hold the “SLOPE” knob until there is a sign on the display. Then, tune the knob to adjust the “slope” (pH 4.01).



Release the knob. Then, the sign is disappeared. It represents that the slope calibration has been done.

5.2 ORP zero-point calibration

The ORP measurement can be calibrated the mV drift or to adjust the corresponding mV value by applying ORP standard solution. Press (MODE) to enter ORP measurement mode. Proceed the calibration as follows:



Clean up the ORP electrode, and put it into ORP standard solution.

Press & hold the “CALIB” knob until there is a sign on the display. Then, tune the knob to correct the ORP drift until the display value is accordance with the value of the standard solution.

Release the knob. Then, the sign is disappeared. It represents that the offset or corresponding mV calibration has been done.

6. Data Transmission via RS-232

6.1 Introduction

The SP-2100 applies standard MODBUS protocol, and supports RTU transmission mode. It supports even parity verification and allows PLC, RTU, SCADA system or the third parity monitor software which is compatible with MODBUS protocol to proceed practical information and data transmission.

Factory default (Unchangeable):

The address of instrument is 1. The baud rate is 19200. The transmission code mode is RTU. The check type is even parity.

6.2 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: SP2100).
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 transmitted in information frame.
5. If the Master or the slave receives a information frame including unknown command, the master or the slave does not respond.

Note: An information frame is a string (max. 255 bytes) which is based on data frames (Each byte is a data frame).

6.3 Data frame format

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) sequence data procedure.

Data frame format:

BIT	MODBUS RTU
Start bit	1 bit
Data bit	8 bits
Parity bit	1 bit: With parity bit None: Without parity bit
Stop bit	1 bit: With parity bit 2 bits: Without parity bit

6.4 SP2100 communication protocol

When a communication command is sent to the SP2100, the corresponding address code of the device accepts the communication command, reads the information, if not wrong, then performs the appropriate task; then SP2100 sends the implementation result back to the sender. The returned information includes a address code, a function code which performs actions, data after performing actions, a check code (CRC) which checks errors. If there is an error, it does not send any information.

6.4.1 Information frame format

RTU

START	ADD	CS	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

In RTU mode, the maximum length of information frame is 256 bytes.

6.4.2 Address code

This byte indicates that the Slave which of the address code is set by an user will receive the information sent by the Master. In addition, each Slave has the only address code. The Master send an address code to indicate which Slave it sends, and the Slave returns the address code back to indicate the address where the Slave belongs.

The address of SP2100 is set to be 1, while the address 0 is a broadcast mode.

6.4.3 Function code

MODBUS protocol defines function code as 1-127. The SP2100 supports some of the function codes. 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. If the highest bit of responding function code is 1(Function code> 127), then it indicates that the Slave does not respond normally or an error occurs.

The following table lists the function codes supported by SP2100:

Function code	Definition	Operation
01H	Read the status of discrete	Read one or more of the discrete state
03H	Read data register	Read one or more of the data register
08H	Diagnostic function	Use as a evaluation of network communication capability

6.4.3.1 Function code 01H

The function code reads the consecutive discrete status from a remote device. The function code 01H does not support broadcast mode.

Sending format:

Type		RTU	Example（RTU）
Function code（CS）		1 byte	01H Read discrete value
DATA Field	Start address	2 bytes	0070H Start address of read data is 0070H
	The number of discrete	2 bytes	0003H Start to read consecutive 3 discrete from 0070H

Normal response format:

Type		RTU	Example（RTU）
Function code（CS）		1 byte	01H Response function code
DATA Field	The number of bytes	1 byte	01H The byte number of data
	Discrete value	N bytes	03H Response discrete data If the discrete reading is not multiple of 8, it will fill the remaining bit 0 (up to the highest bit).

For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SP2100, please refer to the corresponding address list of function code 01H.

6.4.3.2 Function code 03H

The function code read consecutive 16-bit register data from the remote equipment. The function code 03H does not support broadcast mode.

Sending format:

Type		RTU	Example（RTU）
Function code（CS）		1 byte	03H Read register data
DATA Field	Start address	2 bytes	0004H Start address of read data is 0004H
	The number of discrete	2 bytes	0003H Start to read 3 consecutive 16 bits register data from 0004H

Normal response format:

Type		RTU	Example（RTU）
Function code（CS）		1 byte	03H Response function code
DATA Field	Byte number	1 byte	06H The byte number of data
	Register value	N bytes	030605040303H return three 16 bits register data

For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SP2100, please refer to the corresponding address list of function code 03H.

Note:：Due to all the floating-point data of the SP2100 are in a 32 bits IEEE format which needs to access two 16bits register, the corresponding function code of reading the number of floating-point is 03H.

6.4.3.3 Function code 08H

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 provide a series of sub-function code. The SP2100 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（CS）		1 byte	2 Characters	08H Response function code
DATA Field	Sub-function code	2 bytes	4 Characters	000AH Response sub-function code
	Counter value	2 bytes	4 Characters	0000H Back to the counter value Only sub-function code 0A is to copy the data to send the information

For abnormal response please refer to abnormal data format.

Important: To see the detailed operation address of SP2100, please refer to the corresponding diagnostics function of function code 08H.

6.4.4 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 length of data field bytes cannot larger than 256 bytes under RTU transmission mode.

6.4.5 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.

6.4.6 Abnormal procedure

SP2100 will response abnormal information frame when it detects error which except verification error and length of byte error. The maximum byte (MSB) of function code is 1. It means that the code which is responded by remote equipment 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 SP2100 do not support the function code received.

Abnormal code 02: illegal data address

The SP2100 do not support the designated data address.

Abnormal code 03: illegal statistics value

The data which is input to designated address of SP2100 is illegal value.

Abnormal code 04: abnormal data input

Failed to input data to SP2100, and it result to unrecoverable error.

6.5 Connection of communication

The SP-2100 instrument apply Suntex's RS-232 cable (Order number: 8-30) to connect with a PC.

6.6 MODBUS name and address table

Function Code：03H 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	1	
0002H	Instrument's model	6	USHORT	ASCII	SP2100	
0005H	Communication protocol	2	USHORT	0：RTU	0	
0006H	Serial transmission speed	2	USHORT	3：19200	3	
0007H	Parity	2	USHORT	1：even parity	1	
0008H-0030H	Factory reserved					

Note :USHORT data range from 0 to 65535, SHORT data range from -32768 to 32767.

FLOAT is a 4 data bits IEEE format float. The data range follows is the same.

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	SP2100 only has one channel	1	
0032H	Sign byte	6	CHAR	pH、ORP(mV)、uS/cm、mS/cm、MΩ-cm、ppt、ppm、mg/l、%、mA、˚C、NTU、FNU、FTU		ASCII
0035H	pH/ORP measurement value	4	FLOAT	pH/ORP measurement value		Data affected by sign byte
0037H	Temperature measurement value	4	FLOAT	Temperature measurement value		
0039H-0050H	Factory reserved					

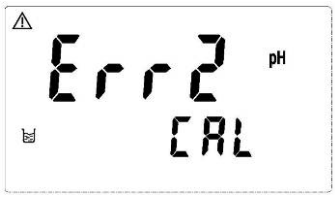
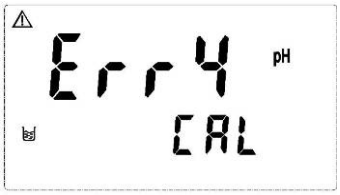
Function code: 01H Modbus response (dispersion parameter)

Logic address	Item	BIT	Description	Default value	Note
0070H		1			
0071H		1			
0072H		1			
0073H		1			
0074H	Temperature is not within the measurement range	1	Valid address	0	
0075H	pH/ORP value is not within the measurement range	1	Valid address	0	
0076H-0090H	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.

7. Error Messages

Messages	Possible Reason	Dispositions
	OFFSET value over range	1. Replace the buffer solution and make another calibration. 2. Replace or maintain the electrode, and make another calibration.
	SLOPE value is over max., or under min. value.	1. Replace the buffer solution and make another calibration. 2. Replace or maintain the electrode, and make another calibration.
	Unstable measured value during calibration	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.
	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.
	Serious error that does not permit any further measuring	Please call service engineer.

8. 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 the electrode 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 mechanically cleaned, 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.	