Congratulations !
You have purchased the latest in benchtop pH-mV-Temperature instrumentation. We trust that your new ***pH Cube*** will give you many years of reliable service.

The ***pH Cube*** is a breeze to operate. This manual has been designed to help you get started, and also contains some handy application tips. If at any stage you require assistance, please contact either your local TPS representative or the TPS factory in Brisbane.

The manual is divided into the following sections:

1. **Table of Contents**
   Each major section of the handbook is clearly listed. Sub-sections have also been included to enable you to find the information you need at a glance.

2. **Introduction**
   The introduction has a diagram and explanation of the display and controls of the ***pH Cube***. It also contains a full listing of all of the items that you should have received with your ***pH Cube***. Please take the time to read this section, as it explains some of items that are mentioned in subsequent sections.

3. **Main Section**
   The main section of the handbook provides complete details of the ***pH Cube***, including operating modes, calibration, troubleshooting, specifications, and warranty terms.

4. **Appendices**
   Appendices containing background information and application notes are provided at the back of this manual.

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Model *pH Cube*
pH-mV-Temp.
Meter

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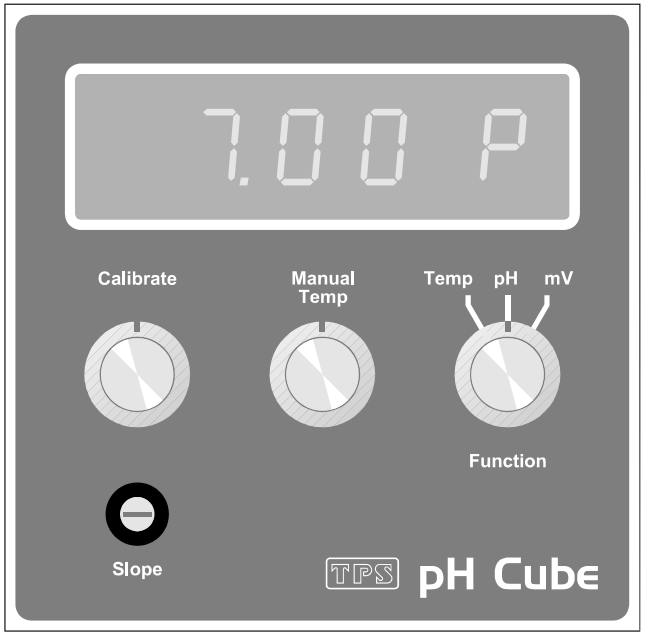
Contents

1. Introduction

1.1 pH Cube Front Panel and Controls



Display

- 12.7mm LED display with mode enunciator.

Function Switch

- Switches between pH, mV and Temperature modes. See section 2.

Calibrate Control

- Used for pH asymmetry calibration in pH6.88 or pH7.00 buffer. See section 3.

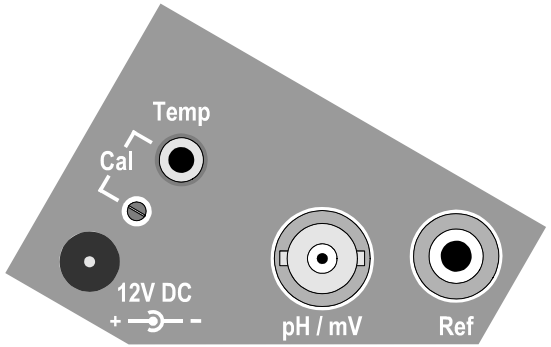
Slope Control

- Used for pH slope calibration in a buffer that is at least 2 to 3 pH away from pH7.00, eg. pH4.00, pH9.23 or pH10.00. See section 3.

Manual Temp Control

- Used to manually set the temperature of the solution for pH temperature compensation. Only active when temperature sensor is unplugged. See section 5.3.

1.2 pH Cube Side Panel and Connectors



pH / mV Connector

- Used to connect pH, Redox (ORP) and Specific Ion sensors.

Ref Connector

- Used to connect Reference sensor when a mono pH, Redox (ORP) or Specific Ion sensor is connected to the **pH / mV** Connector.

Temp Connector

- Used to connect Temperature sensor. This sensor provides temperature readout as well as Automatic Temperature Compensation for pH readings.

Temp Cal Control

- Used for temperature calibration. See section 5.

12V DC Power Connector

- Used to connect 12V AC/DC Adaptor. The ***pH Cube*** can run off any 12V DC source with at least 200mA output. The **12V DC** connector has a positive tip.

1.3 Unpacking Information

Before using your new ***pH Cube***, please check that the following accessories have been included:

		Part No
1.	***pH Cube*** pH-mV-Temperature Instrument	121122
2.	Combination pH Sensor	121207
3.	Temperature/ATC Sensor	121245
4.	pH6.88 Buffer, 200mL	121306
5.	pH4.00 Buffer, 200mL	121381
6.	Rod and Clamp for 2 x 12mm and 1 x 6mm diameter sensor.	121346
7.	AC/DC Power Adaptor	130044
8.	***pH Cube*** Handbook	130050

1.4 Specifications

	Ranges	Resolution	Accuracy
pH	0 to 14.00 pH	0.01 pH	±0.01 pH
mV	0 to ±1999 mV	1 mV	±1 mV
Temperature	-10.0 to 120.0 ^{O}C	0.1 ^{O}C	±0.2 ^{O}C

Input Impedance : >3 x 10^{12} Ω

Asymmetry Range : Approx -1.00 to 1.00 pH

Slope Range : Approx 85.0 to 105.0%

Temperature Compensation : Automatic : 0 to 100.0 ^{o}C
Manual : 5 to 100 ^{o}C

Power : 12V DC by AC/DC power adaptor.

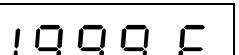
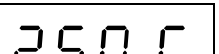
Dimensions : 120 x 120 x 120 mm

Mass : Instrument only : Approx 0.9 kg
Full Kit : Approx 2.1 kg

Environment Temperature : 0 to 45 ^{o}C
Humidity : 0 to 90 % R.H.

2. Operating Modes

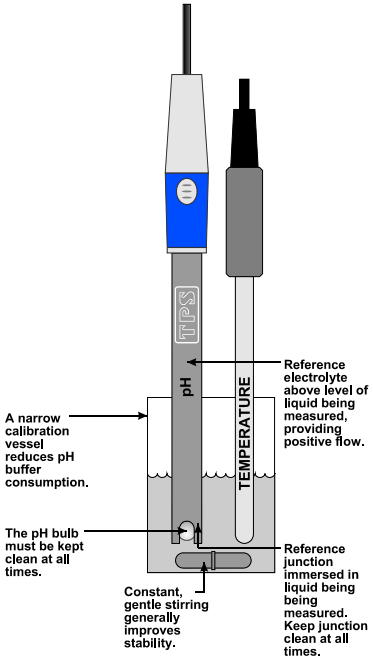
Switch the function switch to any one of the following three operating modes.
Note the mode enunciator – **P** for pH, **E** for EMF (mV), and **C** for ^{O}C.

Function Switch Position	Display example
pH	
mV	
Temp	

3. pH Calibration

3.1 Calibration Procedure

1. Switch the ***pH Cube*** to pH mode (see section 2).
2. Plug the pH sensor into the **Sensor** socket and the temperature sensor into the **Temp** socket.
3. Ensure that temperature has already been calibrated or manually set (see sections 5.1 and 5.3).
4. Remove the wetting cap from the pH sensor.
5. Rinse the pH and Temperature sensors in distilled water and blot them dry.
6. Place both sensors into a small sample of primary buffer that is at or near pH7 (eg. pH6.88 or pH7.00). The bulb and reference junction should both be covered, as per the diagram below.



DO NOT place the sensors directly into the buffer bottle.

7. When the reading has stabilised, adjust the **Calibrate** control until the display shows the value of the buffer at the current temperature. For TPS buffers, this is shown on the bottle. Refer also to the table in section 7.1.

8. Rinse the pH and Temperature sensors in distilled water and blot them dry.

9. Place both sensors into a small sample of secondary buffer (eg. pH4.00, pH9.23 or pH10.00) so that the bulb and reference junction are both covered, as per the diagram in step 6 above.

   DO NOT place the sensor directly into the buffer bottle.

   NOTE: pH9.23 and pH10.00 buffers are highly unstable. Avoid using these buffers if possible. Discard immediately after use.

   When the reading has stabilised, adjust the **Slope** control until the display shows the value of the buffer at the current temperature. For TPS buffers, this is shown on the bottle. Refer also to the table in section 7.1.

10. The ***pH Cube*** is now calibrated and is ready for use.

    Discard the used samples of buffer.

3.2 Calibration Notes

1. A 1-point calibration using the **Calibrate** control in a pH6.88 or pH7.00 buffer should be performed at least weekly. In applications where the sensor junction can become blocked (eg. wines, dairy products, mining slurries etc) a 1-point calibration may have to be done daily.

2. A full 2-point calibration should be performed at least monthly. Of course, more frequent calibration will result in greater confidence in results.

4. mV Calibration

The mV section is factory calibrated. There is no user-calibration facility for this mode.

5. Temperature Calibration

The temperature readout must be calibrated or manually set before attempting pH calibration.

5.1 Calibration Procedure

1. Switch the ***pH Cube*** to Temperature mode (see section 2).
2. Plug the temperature sensor (Part No 121245) into the **Temp** socket.
3. Place the sensor alongside a good quality mercury thermometer into a beaker of room temperature water. Stir the sensor and the thermometer gently to ensure an even temperature throughout the beaker.
4. When the reading has stabilised, adjust the **Temp Cal.** control until the display shows the same temperature as the mercury thermometer.
5. The Temperature function of the ***pH Cube*** is now calibrated and is ready for use.

5.2 Calibration Notes

1. Temperature does not need to be recalibrated unless the Temperature sensor is replaced.

5.3 Manual Temperature Setting

Manual temperature setting is only available if the temperature sensor is not plugged in.

1. Switch the ***pH Cube*** on and select Temperature mode (see section 2).
2. Measure the temperature of the sample solution.
3. Adjust the **Manual Temp** control until the display shows the measured temperature of the sample solution.

6. Troubleshooting

6.1 pH and mV Troubleshooting

Symptom	Possible Causes	Remedy
Meter displays "**-1.** " as a reading.	pH reading is over-ranged.	pH sensor not connected or faulty. Replace sensor if necessary.
Asymmetry calibration with **Calibrate** control in pH6.88 or pH7.00 buffer fails. (Asymmetry is greater than +/-1.00 pH.)	1. Reference junction blocked. (See section 7.3)	Clean reference by immersing the probe in hot water (60°C) for a few minutes. Proteins can be cleaned off using a pepsin solution.
	2. Reference electrolyte contaminated.	Replace electrolyte if using a refillable sensor.
Slope calibration with **Slope** control in low or high buffer fails. (Slope is less than 85.0%.)	1. Glass bulb not clean.	Clean glass bulb as per instructions supplied with the sensor.
	2. Sensor is aged.	Attempt rejuvenation, as per instructions supplied with the sensor. If not successful, replace sensor.
	3. Connector is damp.	Dry in a warm place.
	4. Buffers are inaccurate.	Replace buffers.
Inaccurate readings, even when calibration is successful.	Reference junction blocked. (See section 7.3)	Clean reference junction by immersing the probe in hot water (60°C) for a few minutes.
Displays around pH7.00 for all solutions.	Electrical short in connector.	1. Check connector. Replace if necessary. 2. Replace sensor.
Displays 4-5 pH for all solutions.	Glass bulb or internal stem cracked.	Replace sensor.

pH and mV Troubleshooting, continued…

Unstable readings.	1. Reference junction blocked.	Clean reference junction as per instructions supplied with the sensor.
	2. Glass bulb not clean.	Clean glass bulb as per instructions supplied with the sensor.
	3. Bubble in glass bulb.	Flick the sensor to remove bubble.
	4. Faulty connection to meter.	Check connectors. Replace if necessary.
	5. Reference junction not immersed.	Ensure that the bulb AND the reference junction are fully immersed.
	6. KCl crystals around reference junction, inside the electrolyte chamber.	Rinse electrolyte chamber with warm distilled water until dissolved.

6.2 Temperature Troubleshooting

Symptom	Possible Causes	Remedy
Meter reads "**-1** " in Temperature mode.	Temperature sensor is connected, but is faulty.	Check the temperature sensor connector and replace if necessary. Replace temperature sensor (part no 121245) if problem persists.
Temperature readings do not vary and **Manual Temp** control is active when temperature sensor is plugged in.	1. Faulty connector. 2. Incorrect temperature sensor. 3. Faulty temperature sensor.	Check the connector and replace if necessary. Fit new temperature sensor, part number 121245. Fit new temperature sensor, part number 121245.
Temperature inaccurate and cannot be calibrated.	1. Faulty connector. 2. Faulty temperature sensor.	Check the connector and replace if necessary. Fit new temperature sensor, part number 121245.

7. Appendices

7.1 pH Buffer Values Vs Temperature

The following table lists the pH values of some popular buffers, with respect to Temperature. Any pH meter should always be calibrated to the correct value of the buffers at the current solution temperature.

Temp ^{O}C	pH4.00	pH6.88	pH7.00	pH9.23	pH10.00
0	4.00	6.98	7.13	9.46	10.32
5	4.00	6.95	7.09	9.40	10.25
10	4.00	6.92	7.06	9.33	10.18
15	4.00	6.90	7.04	9.28	10.12
20	4.00	6.88	7.02	9.23	10.06
25	4.01	6.87	7.00	9.18	10.01
30	4.01	6.85	6.99	9.14	9.97
35	4.02	6.84	6.98	9.10	9.93
40	4.03	6.84	6.97	9.07	9.90
45	4.04	6.83	6.97	9.04	9.89
50	4.05	6.83	6.97	9.01	9.83
55	4.06	6.83	6.97	8.99	
60	4.08	6.84	6.97	8.96	
65	4.10	6.84	6.97	8.94	
70	4.12	6.85	6.97	8.92	
75	4.14	6.85	6.97	8.90	
80	4.16	6.86	6.97	8.88	
85	4.18	6.87	6.97	8.87	
90	4.21	6.88	6.96	8.85	
95	4.24	6.89	6.96	8.88	
100	4.27	6.90	6.96	8.82	

7.2 pH Sensor Fundamentals

A combination pH sensor is two sensors in one. The sensing membrane is the round or spear shaped bulb at the tip of the sensor. This produces a voltage that changes with the pH of the Solution. This voltage is measured with respect to the second part of the sensor, the reference section. The reference section makes contact with the sample solution using a salt bridge, which is referred to as the reference junction. A saturated solution of KCl is used to make contact with the sample. It is vital that the KCl solution has an adequate flow rate in order to obtain stable, accurate pH measurements.

7.2.1 Asymmetry of a pH Sensor

An “ideal” pH sensor produces 0 mV output at 7.00 pH. In practice, pH sensors generally produce 0 mV output at slightly above or below 7.00 pH. The amount of variance from 7.00 pH is called the asymmetry. Figure 7-1 illustrates how asymmetry is expressed.

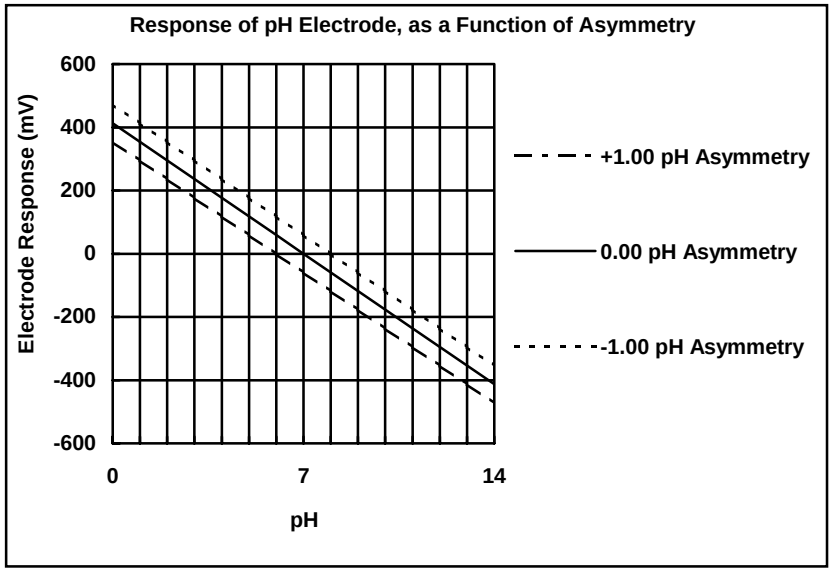


Figure 7-1

7.2.2 The Slope of a pH Sensor

As mentioned above, a pH sensor produces 0 mV output at around 7.00 pH. As the pH goes up, an “ideal” pH sensor produces -59mV/pH unit at 25 ^{o}C As the pH goes down, an ideal pH sensor produces +59mV/pH unit. In practice, pH sensors usually produce slightly less than this. The output of a pH sensor is expressed as a percentage of an ideal sensor. For example, an ideal sensor that produces 59mV/pH unit has “100% Slope”. An sensor that produces 50.15mV/pH unit has “85% Slope” (see Figure 7-2).

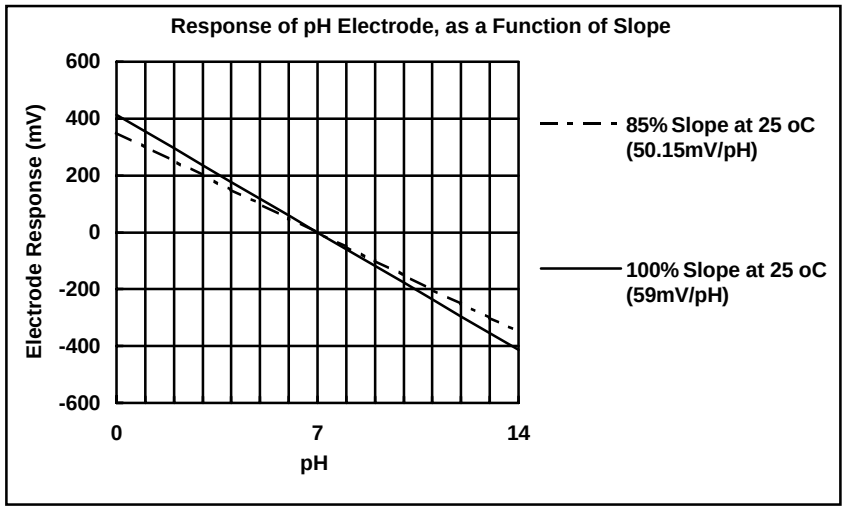


Figure 7-2

7.2.3 Temperature Compensation

The slope of a pH sensor (section 7.2.2) is affected by temperature. This effect is compensated for either by using an Automatic Temperature Compensation (ATC) sensor or by entering the sample temperature manually. Figure 7-3 shows the slope of a pH sensor at various temperatures.

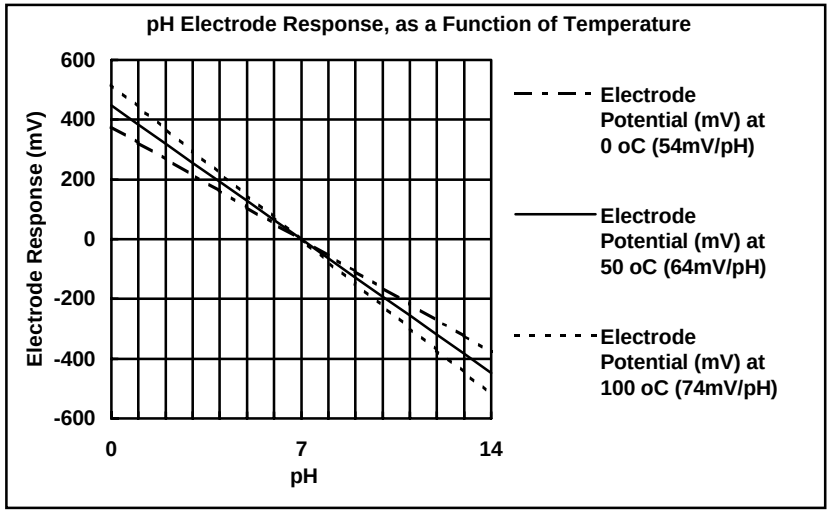


Figure 7-3

7.3 Checking the reference junction of a pH sensor.

If pH readings are inaccurate or unstable, the reference junction of the sensor may be blocked. The following test can be performed to determine if the reference junction of a pH sensor is making adequate contact with the sample solution.

1. Calibrate the ***pH Cube***, as per section 3.
2. Dilute 1 part of pH6.88 buffer with 9 parts of distilled water.
3. Measure the pH of the diluted buffer. The result should be 7.06 +/-0.05 pH.
4. If the value obtained is outside of these limits, then clean the reference junction as per the instructions supplied with the pH sensor.
5. Re-calibrate the ***pH Cube*** and repeat the test.
6. If the value obtained is still outside 7.06 +/-0.05 pH, then the sensor should be replaced.

7.4 Determining if an instrument or sensor is faulty

The following test can be performed to help determine if the ***pH Cube*** or the pH sensor is faulty.

1. Set the **Calibrate** control approximately to the centre (as it is shown in the diagram in section 1.1.
2. Disconnect the pH sensor.
3. Connect the centre pin of the **Sensor** connector with the outside frame of the connector, using a short piece of wire or a paper clip etc.
4. If the ***pH Cube*** is operating correctly, the reading should be totally stable at around pH7.00 with the wire firmly in place. If not, the meter requires servicing.
5. Now carefully disconnect the wire from the centre pin only (make sure the other end of the wire remains connected to the outside frame of the connector).
6. The reading should steadily drift away from 7.00 (either up or down) at a rate of approximately 1 pH or less every 3 seconds. If the drift rate is faster than this, then input circuitry of the ***pH Cube*** may be faulty and could require servicing.

8. Warranty

TPS Pty. Ltd. guarantees all instruments and sensors to be free from defects in material and workmanship when subjected to normal use and service. This guarantee is expressly limited to the servicing and/or adjustment of an instrument returned to the Factory, or Authorised Service Station, freight prepaid, within twelve (12) months from the date of delivery, and to the repairing, replacing, or adjusting of parts which upon inspection are found to be defective. Warranty period on sensors is three (3) months.

There are no express or implied warranties which extend beyond the face hereof, and TPS Pty. Ltd. is not liable for any incidental or consequential damages arising from the use or misuse of this equipment, or from interpretation of information derived from the equipment.

Shipping damage is not covered by this warranty.

PLEASE NOTE:
A guarantee card is packed with the instrument or sensor. This card must be completed at the time of purchase and the registration section returned to TPS Pty. Ltd. within 7 days. No claims will be recognised without the original guarantee card or other proof of purchase. This warranty becomes invalid if modifications or repairs are attempted by unauthorised persons, or the serial number is missing.

PROCEDURE FOR SERVICE
If you feel that this equipment is in need of repair, please re-read the manual. Sometimes, instruments are received for "repair" in perfect working order. This can occur where batteries simply require replacement or re-charging, or where the sensor simply requires cleaning or replacement.

TPS Pty. Ltd. has a fine reputation for prompt and efficient service. In just a few days, our factory service engineers and technicians will examine and repair your equipment to your full satisfaction.

To obtain this service, please follow this procedure:
Return the instrument AND ALL SENSORS to TPS freight pre-paid and insured in its original packing or suitable equivalent. INSIST on a proof of delivery receipt from the carrier for your protection in the case of shipping claims for transit loss or damage. It is your responsibility as the sender to ensure that TPS receives the unit.

Please check that the following is enclosed with your equipment:

- **Your Name and daytime phone number.**
- **Your company name, ORDER number, and return street address.**
- **A description of the fault. (Please be SPECIFIC.)**
  (Note: "Please Repair" does NOT describe a fault.)

Your equipment will be repaired and returned to you by air express where possible.

For out-of-warranty units, a repair cost will be calculated from parts and labour costs. If payment is not received for the additional charges within 30 days, or if you decline to have the equipment repaired, the complete unit will be returned to you freight paid, not repaired. For full-account customers, the repair charges will be debited to your account.

- **Always describe the fault in writing.**
- **Always return the sensors with the meter.**