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AUTHOR : DG

Model HP2

Hydroponics Controller

1. Introduction

Congratulations! You have chosen the latest in Control Systems for Conductivity or TDS plus pH or Redox. This manual is intended to make it easy to install and use the HP2 controller.

Please take the time to read it completely.

If you have any questions, please feel free to contact your TPS distributor, or the TPS factory in Brisbane.

1.1 Overview

The HP2 Hydroponics Controller is a combination pH and Conductivity controller. It is designed to measure and automatically control the nutrient solution used in Hydroponic Cultivation Systems.

Plant Nutrients in solution dissolve into the Ionic form, that is, into Positive and Negative Ions. These are charged atoms and molecules which carry electric charges, that is, they are electrically conductive.

An increase in the number of Ions in a solution causes an increase in the Conductivity. Changes in the Nutrient Concetration can be measured by the change in Conductivity of the solution.

Note that this is a BULK measurement of ALL the ions in solution. You cannot distinguish the relative changes in the particular nutrients.

1.2 Nutrient Conductivity Control:

Changes in Conductivity of Nutrient Solutions are caused by different effects.

1: Changes in the Nutrient Concentration
(Caused by consumption of the nutrients by the plants.)

2: Changes in the ratio of water to nutrients.
(Either by evaporation of water or by Rain.)

3: Changes in Temperature of the solution

Item 1 - Changes in Nutrient Concentration.
This is the job of the HP2 controller. As the plants consume nutrients, the conductivity of the nutrient solution decreases. The HP2 senses this decrease, and automatically adds more of the A and B nutrients to correct the level.

Item 2 - Changes in the ratio of water to nutrients.
Ratio of water to nutrient is correct by water level control in the main holding tank. This is usually by float valve control, to make up for loss by evaporation, OR, overflow control to allow excess rainwater to run off

Item 3 - Changes in Temperature.
The HP2 controller has special electronic circuitry to compensate for the effect of Temperature variation on the Conductivity readings from the Nutrient solutions. This provides far more accurate control of the Nutrient Concentration.

1.3 Nutrient pH Control

pH is usually by controlled addition of phosphoric acid, where the pH is tending to rise, or by addition of Potassium Hydroxide or Lime, where the pH is tending to fall. For a given type of crop, and Nutrient Mixture, the pH will usually tend to change in only one direction, and can be compensated y the addition of only one type of chemical, generally Phosphoric Acid.

NOTE: The HP2 is supplied configure for Acid Addition. That is, the pH relay changes over if the pH is above the ":LIMIT" set-point.

If pH needs to be controlled by ALKALI addition at a "too low" limit, then this can be changed by the user as follows:

1. **There is a jumper link which sets the direction of the pH control behind the pH display. Locate this jumper link (it is a small black header mounted on two pins).**
2. **For a standard HP2, this jumper link will be shorting the two pins (ie: it will be connected to both pins). This is set up for "too high" control.**
3. **Remove and re-install the jumper link so that it is connected to just one of the two pins. This avoids losing the jumper pin if it needs to be re-configured later.**
4. **The HP2 is now set up to control at a "too low" pH limit.**

1.4 Control Method:

The HP2 continuously measures the pH and Conductivity of the solution. When either value changes away from the "LIMIT" value as set on the front panel controls, the appropriate relay output is switched on. This then controls the addition of chemical. When the chemical value returns to be equal to the setting of the control on the panel, the output function is switched off again.

1.5 Timed Addition

The HP2 also has the facility of "TIMED ADDITION". This is a variable timer with a front-panel control setting.

EXAMPLE: If the Timer control is set to 2 minutes, then at approximately every 15 minutes, the HP2 will check the pH and Conductivity of the solution. If correction of pH or Conductivity is required, the HP2 will add solution for up to this 2 Minutes, then stop adding (or before if the data becomes correct). It then waits for approx. 15 less this 2 mins (ie 13 minutes) checking again. The minimum setting for the TIMER is approx. 20 seconds.

This prevents overshoot of control action if the electrodes have not been placed correctly.

NOTE: When the TIMER control is turned fully counter-clockwise, there is a switch "CLICK" position. In this position, the timer function is disabled, and reagent will be added on "DEMAND". In this mode, the relays will operate as soon as the relevant "LIMIT" value is exceeded, and will operate continuously, until the pH or Conductivity value returns to normal.

2. Planning The Installation

2.1 Power Requirements

The HP2 controller requires a standard 240 Volt AC power supply. This should be wired by your local electrical contractor, in accordance with local supply authority requirements. The power requirements for the controller are very small (only 5 watts). You may require single or 3 phase power for pumps etc, depending, on your particular installation. It this case, external contactors must be used and these controlled by the HP2.

2.2 Main Tank

Either plastic or concrete. If concrete, the inner surface must be sealed with an epoxy paint, or similar, to prevent chemical contamination from the concrete. Septic tanks are suitable and cost-effective.

2.2.1 Location

Lowest point of the installation to allow gravity return from the crop. The tank should be in the ground. This has a number advantages:

Ease of addition of chemicals.
Insulation for minimum heat loss at night.

2.2.2 Volume

Sufficient to fill crop trays and 25% volume left in the tank for the pump.

2.2.3 Stirring

The output pipe from the Nutrient Pump should have a tap to allow some output to be diverted back into the tank. This should be directed back into the tank to provide stirring, and also re-oxygenation of the nutrient.

2.2.4 Water Level Control

By ball-valve or float switch control from the feed-water supply. The height of this should be adjustable to allow for changes in number of trays being fed.

2.3 Nutrient Tanks

Plastic Chemical tanks are ideal. The volume depends on particular installations and usage rates, however, 100 Litre tanks are suitable for most applications.

Three tanks are required, 1 each of A & B solutions, and 1 for the acid solution.

The tanks are connected with plastic tubing to the airpumps or solenoid valves to form and economical and reliable nutrient concentrate delivery system.

2.3.1 For Air Pump use

Drill 2 holes in the lids of two of the tanks, and 3 holes in the third lid. These should be a tight fit on the pipe to be used.

The “Balance Pipe” shown maintains pressure balance between the 2 tanks for the A & B nutrient solutions. The nutrient pipes should be weighted to hold them down in the solution. Seal around the pipes on the inside and outside of the lids with “SILASTIC” Silicon sealant to ensure a fully air-tight seal. Ensure that the output ends of the pipes are above the top of the level of the nutrient to prevent “siphoning” of the solutions after the airpumps stop.

Check the system after assembly using water in the tanks, and plugging the pumps directly into a power point for convenience. Any problems are generally caused by small air leaks.

Finally connect the airpumps as per the connection diagram.

2.3.2 For solenoid valve use
The nutrient A and B tanks must be above the holding tank to allow gravity feed via the Solenoid Valves to the addition point. Ensure that the valve used is suitable for the solutions being handled.

TPS can supply suitable Solenodi valves etc.

2.3.3 Location
Tanks should be adjacent to main tank, with ease of access for refilling.

2.3.4 Stirring
The concentrate solution in the tanks should be stirred if chemicals tend to settle out of the solution. This can be done very economically using Air-Pumps as used in Aquariums.

2.3.5 Nutrient Level Checking
Nutrient level in the storage tanks should be checked regularly to ensure that there is always sufficient nutrient. This can be using float switches, a clear plastic “sight-tube” on the side of the tanks, or simply dip-stick methods.

2.4 Pumping
The main nutrient pump should be chosen for volume of supply, and head pressure required (depends on slope of the site). Swimming-pool pumps are ideal. In particular, the pump should be self-priming, and the outlet pipe from the pump should include a one-way valve to prevent loss of prime by nutrient flowing back into the holding tank.

3. Injection Methods
Acid and A-B nutrient addition can be achieved in a number of ways:

3.1 Solenoid Valves
The HP2 can also be used t switch solenoid valves to control nutrient addition using gravity-feed from storage containers. if the sensors are in a flow through assembly, delivery of the nutrients should be adjacent to the inlet of the crop pump in the holding tank so that agin, the sensors detect the addition of the nutrient soon enough to avoid overshoot of the pH or conductivity values.

3.2 Air Pumps
The HP2 can be used to control simple air pumps which pressurise the nutrient containers. This air pressure forces nutrients into the holding tank. If the sensors are in the holding tank itself, delivery of the nutrients should be ADJACENT to the sensors to avoid overshoot of the pH or conductivity values.

3.3 Chemical Feeder Pumps
Most accurate - but more expensive. These are electrically driven positive displacement pumps. The rate of addition can be adjusted on each pump. This has the advantage that the ratio of A and B concentrates can be varied manually throug the growing cycle if required. The HP2 controller turns power on and off to the pumps to control the length of time that the pumps operate, and therefore the Conductivity of the solution. The mixture, however, can be varied by setting each of the pump flow rates.

3.4 Nutrient Injection Position:
The correct placement of sensors versus nutrient delivery as discussed above is very important. The controller is working most economically and most precisely when it is starting and stopping, proceeding in small increments to correct the pH and nutrient balance.

To achieve this, the injection points of the Nutrients and Acid should be within 50 cm of the electrodes, and positioned so that the flow is directed towards the electrodes.

Alternatively, the electrodes should be DOWNSTREAM from the injection point where the probes are inserted into the feed pump bypass pipeline used for stirring of the Main Tank.

Some installations may require the main pump to cycle on and off on a time switch. If a bypass from the Main Pump is used for circulation of the main tank, this means that for the period when the pump is not running, the the tank will not be mixed properly.

Injection of the make-up Nutrient into the main tank should only occur while the tank is being agitated. If this is not done, the probes may not accurately sense the addition of nutrient, and poor accuracy of control will occur.

To make sure the nutrient will only be added while the main pump is running and mixing, use power from the pump circuit to power the solenoids for nutrient addition. (The controller itself should be powered continuously.) In this way, the valve will only add while the pump is running.

4. Probe Installation

The pH and Conductivity sensors can be installed in the main supply tank as the ball cock will provide the essential constant immersion level. The probes should be positioned so that they remain immersed at all times, including when the pumps is operating. Alternatively, if PVC pipe is being used (as is often the case), the probes can be fitted into the pipe lines themselves. The pH probe is supplied with an adaptor fitting to suit installation into 40 mm PVC pipe. This saddle adaptor should be glued onto the wall of the pipe so that the electrode can screw into it. The angle from vertical of the probe (with the tip DOWN) when installed should be no greater than 80 Degrees for correct operation. That is, the probe can be mounted at any angle between near-horizontal and vertical with the bulb DOWN.

The Conductivity probe supplied with the HP2 has a ¾" BSP thread. This screws directly into standard PVC 20 mm Pressure fittings. A suitable method of installation would be to use a 40 mm PVC "T" fitting with a 40 to 20 mm threaded reducing adaptor glued into one side of the "T". The probe then screws into this female socket, and the "T" fitting is used as an elbow joint in the pipe system. Avoid air traps inside the cover of the Conductivity /TDS probe.

5. Controls

5.1 Conductivity Section

SPAN: This screwdriver set control is used to adjust the conductivity section to a known standard. The Conductivity calibration needs only very infrequent readjustment as it is very stable long term. See Commissioning.

ZERO: This screwdriver set control is used to adjust the zero of the Conductivity section with the probe dry and in air. It is a one-off adjustment done at commissioning only.

LIMIT: This control determines the value of conductivity below which nutrient is to be added into the holding tank to increase the conductivity. setting is related to the reading of the precalibrated meter readout above. When the meter readout of Conductivity falls below the limit set, the Conductivity relay will activate (depending on the TIMER control), and add concentrate to the solution. The "**:**" sign on the Conductivity display is switched on when the relay is activated.

5.2 pH Section

LIMIT: This control determines the value of pH above which acid is to be pumped into the holding tank to reduce the pH value. The pH section must be correctly calibrated (See “Set Buffer 6.9”) for this control to operate accurately. When the pH reading exceeds this control setting, the “**:**” sign on the pH display is switched on, and the pH relay is activated (depending also on the TIMER setting). The reverse action occurs if the factory has configured the HP2 for ALKALI. The contacts on the pH relay are then used to control the Acid Pump or solenoid.

ZERO: This screwdriver set control is used to calibrate the pH section and pH sensor to the known pH value of the standard buffer. See Commissioning.

SPAN: This screwdriver set control is used to calibrate the pH section and pH sensor to read the correct pH when the probe is placed in pH buffer 4.00 (or other buffer away from pH 6.88 (or pH 7). See Commissioning.

5.3 Addition Timer

This is a timer adjustment which can be set from approx. 20 seconds minimum to approx. 10 minutes maximum. This timer sets the length of time the output relays operate. The timer permits addition on a 15 minute cycle.

> FOR EXAMPLE, If the timer is set to 2 minutes, then addition can take place for 2 minutes (if the LIMIT: value is exceeded), and then the controller will turn off for 13 minutes (ie: 15 minute cycle less 2 minutes ON = 13 minutes OFF)
>
> If the control is switched fully counter-clockwise to the "DEMAND" position the timer is disabled, and the relays operate immediately when required.

6. Connectors

Connections are made to the HP2 controller on 2 sets of terminal connectors. These are conveniently located under a separate waterproof cover at the bottom of the unit.

From Left to right, the connections are:

TERMINAL STRIP 1 (left)

1: Mains Power Input ACTIVE	240 V AC	BROWN
1: Mains Power Input ACTIVE	240 V AC	(spare for wiring)
1: Mains Power Input ACTIVE	240 V AC	(spare for wiring)
2: Mains Power Input GROUND		YELLOW/GREEN
2: Mains Power Input GROUND		(spare for wiring)
2: Mains Power Input GROUND		(spare for wiring)
3: Mains Power Input NEUTRAL	240 V AC	BLUE
3: Mains Power Input NEUTRAL	240 V AC	(spare for wiring)
3: Mains Power Input NEUTRAL	240 V AC	(spare for wiring)

4: Conductivity Relay Contact Normally Closed
5: Conductivity Relay Contact Common
6: Conductivity Relay Contact Normally Open
7: pH Control Relay Contact Normally Closed
8: pH Control Relay Contact Common
9: pH Control Relay Contact Normally Open
10: Recorder Output Common
11: Recorder Output for Conductivity 0 to -2.5v for 0 to 2000 display
12: Recorder Output for pH 0 to -2.5v for 0 to 2000 display

TERMINAL STRIP 2 (right)

1: Cond Probe		RED
2: Cond Probe		BLACK
3: Auto Temp Compensator (ATC)		BLUE
4: Auto Temp Compensator (ATC)		WHITE
5: n/c		
6: n/c		
7: n/c		
8: n/c		
9: pH Solution ground wire		

	Coax Cable	**OR**	**(1 pair + shield)**
10: pH reference	Braid of cable (BLACK)		(BLACK)
11: pH Shield (if fitted)	Not Fitted		Braid (GREEN)
12: pH Signal	Centre core of coax (CLEAR)		(CLEAR or WHITE)

The solution guard terminal is most important for elimination of noise pick up in the system. It should be connected to the holding tank (if metal) or to a stainless steel rod or bolt in the solution. This connection prevents the solution becoming charged and effecting the pH reading. When removing the pH electrode to do a buffer calibration, this lead MUST accompany the pH electrode. It is sufficient to simply dangle a wire (from the guard terminal) into the buffer beaker. The wire will corrode in the long term.

7. Power

The unit requires 240v 5 Watts. The outputs provide contact changeovers ONLY. The contacts are rated at 240v 1A with a 1 Amp fuse. The air pumps or Solenoids require less than this current. Larger pumps require a repeating contactor. Please consult your installation electrician, or TPS.

8. Commissioning

8.1 Calibrate the pH Section:

1: Set to "CALIB". **The output relays are disabled in this mode.**
2: Place the pH Electrode in a small amount of buffer 6.88.
Immerse the probe tip to half an inch or more.

3: **The following step is essential!**
Add a solution guard wire from the buffer solution to the guard terminal.

4: Adjust pH screwdriver "ZERO" control for 6.88 pH.
This step should be performed once a week.

5: Rinse the pH electrode and place in a small amount of buffer 4.00.

6: Adjust pH screwdriver “SPAN” control for 4.00 pH.
This step should be performed once a month.

7: Now switch the function switch to "LIMIT".
Both pH and Conductivity display are now showing the value at which the output relays will operate. The pH "LIMIT" setting is the pH value at which acid is to be added to prevent further pH rise. The reverse occurs if the factory has configured the HP2 for ALKALI.

The output relays are disabled when the HP2 function switch is set to “LIMIT”.

8: Return the pH Electrode to the tank (or flow cell) and reconnect the Solution Guard. Discard the used buffer solution sample.

9: Return to "AUTO"

8.2 Calibrate the Conductivity Section:

1: Set to "CALIB". **The output relays are disabled in this mode.**
2: Rinse the Conductivity electrode and allow to dry.

3: Adjust the COND screwdriver “ZERO” control for zero on the display.
This step should be performed once a month.

4: Place the Conductivity Probe in some 2.76 mS Standard Solution. ("mS" is milli-siemens per centimetre of Conductivity.) (2.76 mS is the same as 27.6 "CF UNITS", the old English units.)
Wait 2 minutes until the Temperature Compensator (in the probe) reaches the final temperature.

5: Adjust the screwdriver “SPAN” control for until the display reads 2.76.
This step should be performed once a week.

6: Switch the function switch to "LIMIT".
Both pH and Conductivity display are now showing the value at which the output relays will operate. Set the Conductivity Limit knob to the value at which A and B nutrient is to be added to prevent further conductivity fall.

7: Return the Conductivity Probe to the tank (or flow cell).

8: Return to "AUTO"

9. Spares And Accessories:

Standard Kit Includes

	Part No.
pH Electrode (Screw-In Type) with 5 Metre cable	111244
Conductivity Probe with 5 Metre cable	112206
pH 4.00 Standard pH solution	121381
pH 6.88 Standard pH solution	121306
Standard Conductivity Solution 2.76 mS (27.6 CF)	122306
Handbook	130050

Options

ABS nutrient containers 25 Ltr	130063
Spare Air Pumps	130066
Spare Solenoid valve 240 Volt, ABS plastic body	130067
Spare Solenoid valve 24 Volt, ABS plastic body	130064
Power supply, 240 Volt to 24 Volt AC	130065

10. pH Electrode Appendix

10.1 Sensor Maintenance

The pH Sensor is a sealed unit and needs no maintenance other than periodic gentle cleaning. A weak acid soak followed by a fresh water wash of half an hour is recommended. If the bulb is cracked or if the "Set 6.9" adjustment is impossible, the electrode probably requires replacement.

- If the electrode has been left dry in air for several days, its immediate use will sometimes give a slow response. If the pH electrode has been received without its plastic "wetting cap" over the pH bulb, the electrode should be immersed in a standard solution or in distilled water for about 24 hours before its use. Immersing the electrode in about 1/10N hydrochloric acid for a few minutes serves as an expedient.

- The HP2 is supplied with a sealed GEL reference system which needs no filling for its lifetime. Electrodes should be stored wet and disconnected from the meter.
- Cracks in Glass Bulb
  If the meter indicates almost the same value with the electrode in various standard solutions, the trouble may be caused by a crack in the glass membrane. Replace the electrode.
- Insulation and Internal Resistance
  The glass electrode has a membrane resistance of several hundred million ohms and every part of the meter has been carefully insulated. If this insulation value is lowered, the needle will go off scale or become unstable. Great care must be taken not to wet the plug or cap of the electrode nor the meter and connector themselves. Clean with pure alcohol and cotton wool. Blow dry with a heat gun set at a moderate temperature.

10.2 pH Troubleshooting

1: pH reading unstable:

a) Electronics fault ?
   Check controller by disconnecting leads from the pH electrode (Terminal strip 2 (right) 10, 12) Replace with a wire linking the 2 terminals 10,12. If the pH reading is now stable, and can be adjusted between approximately 6 to 8 pH with the ZERO control, the electronics are probably correct. The sensor (or wiring) is probably faulty.

b) ATC sensor **OR** solution earth wire not in solution
   An ATC sensor **OR** a solution earth wire should be immersed in the solution. The braid of the ATC sensor **OR** the solution earth wire should be connected to Terminal strip 2 (right) terminal 9.

c) Clogged pH electrode Reference Junction.
   Check reading stability in pH Buffer solutions. Remember to put solution from the ATC sensor **OR** the into the buffer solution alongside the pH electrode.
   Clean, Refill, or Replace electrode.

d) pH glass bulb dirty.
   Clean electrode bulb with Acetone, or other suitable solvent, considering the solutions being measured.

2. Low or Excessive response to pH change:

a) Check pH sensor in buffers. Clean, Refill, or Replace electrode.

b) Check ATC sensor.
   Measure sensor resistance from black to white wires, (disconnected from the controller). This should be approx 110 Ohms at 25oC. Also check the shield wire is connected to the Stainless Steel barrel of the ATC sensor.

   If this cannot be done, check the cell connections.
   If connections are OK, return the meter and call for service.

11. Conductivity Electrode Appendix

11.1 Sensor Maintenance

The Conductivity Probe (including Temperature Compensator in its barrel) has platinum wire electrodes coated with a special material for stable readings. It should simply be rinsed in dilute Hydrochloric acid occasionally to remove dirt build up which can reduce its reading.

So long as it is mechanically intact, it needs no replacement.

IMPORTANT: The wires should **** NOT **** be rubbed clean. This will remove the "Platinum-Black" coating and give unstable readings. This coating can be replaced by return of the probe to the factory for service.

12. Output Relay Fuse Replacement

Fault : Pump fails to operate when colon on display shows relay operating.
Cause : Pump may have failed. Check using another pump on the same outputs.

Cause : Blown fuse.
Fix : Check/replace fuse.

Method:

1. Ensure unit is turned off and disconnect all power sources
2. Open the front clear plastic cover.
3. Remove the 4 corner screws holding the front panel.
4. Remove the front panel and attached printed circuit card. (Take care- The front and rear card are attached by a connector cable.). **DO NOT DISCONNECT CABLE**.
5. The fuses for each output are visible in a black plastic carrier next to the larger relays. Use a torch to view the glass section of the fuse. A single strand of wire should be visible.
6. If the fuse requires replacement, pry up the ends of the fuse holder and replace with a new fuse of identical size and current rating. (250VAC 1 AMP).
7. Replace fuse holder. Replace the front panel and mounting screws.
8. Check that output/pump is now operating as required.

NOTE: A blown fuse may indicate that the output is being overloaded. Ensure that the load does not exceed 1 AMP. If the fuse is being blown repeatedly please contact the dealer or TPS

13. Warranty

TPS Pty. Ltd. guarantees all instruments and electrodes 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 electrodes 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 electrode. 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 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 electrode 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.)
- **Either $12 for return freight for units under warranty, or $20 to cover inspection costs and return freight. (These amounts are not applicable to full-account customers.)**

Your equipment will be repaired and returned to you, freight paid.

For out-of-warranty units, a repair cost will be calculated from parts and labor 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.**