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AUTHOR : MS

Model HP2-DS
Hydroponics Dosing System

Congratulations !

You have purchased the latest equipment for automatic control of pH and Conductivity in Hydroponics. We trust that your new ***HP2-DS*** will give you many years of reliable service.

The ***HP2-DS*** is supplied fully assembled and ready to install. All electrical connections are either pre-wired or supplied with connectors, so an electrician is not required. 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 displays and controls of the ***HP2-DS***. It also contains a full listing of all of the items that you should have received with your ***HP2-DS***. 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 installation, calibration and operation of the ***HP2-DS***. Troubleshooting, specifications, and warranty terms are also included.

4. **Appendices**
   Appendices containing background information and application notes are provided at the back of this manual. Maintenance details and tips for Run-To-Waste installations are included.

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1. System Illustration and Description

1.1 HP2-DS Panel Illustration

1.2 Description of HP2-DS Panel Components

1 TPS HP2 Controller

The HP2 is a combination controller for Conductivity and pH. Each channel has its own output to automatically control the concentration of nutrient and the pH of a hydroponics system. Separate digital displays are provided, so that both parameters can be checked at a glance. The addition timer can help eliminate over dosing in systems where the nutrient and acid or base injection point cannot be mounted close enough to the take-off for the sample chamber. The HP2 enclosure is fully waterproof to an IP65 rating.

1.1 Function Switch

The function switch is used to select the three operating modes as follows:

CALIB Select this mode when calibrating the HP2. In this mode, output to the pumps are disabled, so that chemicals are not added to the system during the calibration process.

AUTO Select this mode when the HP2 has been calibrated, and the limits have been set. In **AUTO** mode, the HP2 automatically switches on the dosing pumps when the limits have been exceeded.

:**LIMIT** Select this mode to display and set the Conductivity and pH control limits. The A and B nutrient pumps are activated when the Conductivity gets too low. Using the **Add Acid/Add Base** switch, the pH channel can be set up to add acid when the pH gets too high, or to add base when the pH gets to low.

When the limit is exceeded, and the output to the pump is activated a colon ("**:**") lights up in the relevant display.

1.2 Addition Timer

In ideal installations, the point where nutrient and acid or base are added will be next to the take-off point for the sample chamber. This will cause the sensors to immediately detect any chemical addition and shut the pump(s) off. When the chemicals have mixed further more will be added, if necessary. This starting-and-stopping process means that the chemicals will not be over dosed.

The addition timer is supplied for use in installations where the nutrient cannot be injected close to the sample chamber take-off point. The addition timer inhibits the addition of further chemicals until an adequate amount of time has been allowed for mixing.

1.3 Conductivity Limit

Used to set the limit below which the A and B nutrient pumps are activated.

1.4 Conductivity Zero

Used to calibrate the conductivity sensor to zero, with the probe dry and in air.

1.5 Conductivity Span

Used to calibrate the conductivity sensor in a known conductivity standard, e.g. 2.76mS/cm.

1.6 pH Limit

Used to set the limit above or below which the pH pump is activated. See 1.14 for a description of the Add Acid/Add Base switch.

1.7 pH Zero

Used to calibrate the pH sensor in a pH6.88 or pH7.00 buffer.

1.8 pH Span

Used to calibrate the pH sensor in a pH4.00 buffer.

1.9 Low Flow Light

The Low Flow light provides a visual indication if the sample flow in the sample chamber is has stopped, or is too low.

1.10 pH Sensor Connector

A BNC socket is provided to connect the pH sensor. BNC sockets are inherently waterproof.

1.11 Conductivity Sensor Connector

A waterproof socket is provided for the Conductivity sensor.

1.12 Flow Sensor Connector

The red socket is for the flow sensor, which sits in the top of the sample chamber.

1.13 Solution Guard Connector

For accurate and stable readings, a solution earth wire is attached to a stainless steel bolt in the sample chamber.

1.14 Add Acid / Add Base Switch

Set this switch to **Add Acid** if the pH of your system drifts up, and you add acid to correct it. Set this switch to **Add Base** if the pH of your system drifts down, and you add base to correct it.

1.15 Mains Power Plug

A single power plug is pre-wired into the ***HP2-DS*** to provide power for the whole system, including the dosing pumps. A normal 220-240V AC power outlet is suitable, as the system consumes less than 300W (less than 2 amps) of power.

NOTE: If you are in a country with 110-120 V AC mains power, your ***HP2-DS*** will have been set up for this voltage in the factory.

2 Sample Chamber

The sample chamber makes mounting the sensors easy, by simply inserting the sensors into the correct fitting. An overflow pipe is provided to keep the sensors moist when the flow stops.

2.1 Conductivity Sensor

The TPS GK1 is an industrial conductivity sensor, and is designed for continuous use. It is a k=1.0 sensor, which is ideal for hydroponics.

2.2 pH Sensor

An industrial sensor is also supplied for monitoring the pH. The gel filled reference system requires minimum maintenance, and never needs to be refilled.

2.3 Flow Sensor

The flow sensor detects a drop in the level of nutrient in the sample chamber, due to low flow or no flow. It measures the flow by allowing the nutrient to make electrical contact between the flow sensor and the Solution Guard wire (2.14) when the flow rate is adequate. When the flow rate drops off or stops, this contact is broken and the Low Flow light is switched on and the outputs to the pumps is inhibited.

2.4 Solution Guard

In any system where a number of devices are attached to a body of liquid, stray earth current can interfere with the pH measurements. The ***HP2-DS*** is supplied with a solution guard, which is a stainless steel bolt in the sample chamber. The Solution Guard eliminates the electrical interference and results in more stable, accurate measurements.

2.5 Overflow Pipe

The overflow pipe ensures that level of the nutrient in the sample chamber is high enough for the Conductivity, pH and Flow sensors with an adequate flow rate. When the flow rate becomes too low or stops, the level drops to the vent hole only. This ensures that the sensors are always kept moist, to give them the longest possible life.

2.6 Input Fitting

The 13mm fitting on the base of the sample chamber is for the sample input. It is smaller than the output fitting to ensure that the sample chamber does not become pressurised.

2.7 Output Fitting

The 25mm fitting on the base of the sample chamber is for the sample output. This should drain back to the main tank.

3 Output Power Sockets

To keep installation as simple as possible, waterproof power points have been provided for the dosing pumps. This means that the pumps can be connected and disconnected as required, or swapped for different pumps. The outputs are 240V AC, and are rated to 2 Amps maximum.

3.1 Nutrient Power Output

The nutrient power output socket is activated when more A and B nutrient are required. One of the three pumps supplied with the ***HP2-DS*** is fitted with a piggy-back plug, so that both the A and B pumps can be connected simultaneously.

3.2 pH Power Output

The pH output socket is activated when more acid or base is required, depending on the setting of the **Add Acid/Add Base** switch.

NOTE

Always switch the power switch OFF before connecting or disconnecting any device to the power output sockets. Even when the controller switches the pumps off, there may be some residual voltage on the output.

4 Peristaltic Dosing Pumps

For accurate and reliable dosing, the ***HP2-DS*** is supplied with peristaltic dosing pumps. The only part of these pumps that makes contact with the solution being dosed is the tubing. This eliminates the problem of pump failure due to failed seals. Dosing pumps also eliminate the problem of solenoid valves jamming and dumping entire nutrient and acid or base drums into the main tank.

4.1 Dosing Pump Input

Connect the required length of 3/8” clear tubing from the concentrate drums to the pump inputs. Please note that the pump can only lift up to 2 metres on the suction side. Peristaltic pumps are self-priming, but a non-return valve may be used to ensure that the liquid level in the tubing does not fall between doses.

4.2 Dosing Pump Output

Connect the required length of 3/8" clear tubing from the pump output to the main mixing tank. The dosing pumps supplied can pump up to 6 metres of head, so you don't need to mount your concentrate drums above your main tank. This is especially useful where the main tank is not mounted in the ground, and is another reason why dosing pumps are superior to solenoid valves.

4.3 Piggy-Back Plug

One of the pumps supplied with the ***HP2-DS*** is supplied with a piggy-back power plug. This is so that two pumps can be plugged into the Nutrient power output socket for dosing A and B nutrient.

2. Unpacking Information

Before using your new ***HP2-DS*** Dosing System, please check that the following accessories have been included:

		Part No	Qu/Unit
1.	HP2 Conductivity and pH Controller (modified for HP2-DS system)	111107	1 ea
2.	Peristaltic Dosing Pumps (3L/Hour standard)	116318	3 ea
3.	GK1 Conductivity Sensor with waterproof plug for HP2-DS	112208	1 ea
4.	Gel-filled pH sensor with BNC plug	121226	1 ea
5.	pH4.00 Buffer, 200mL	121381	1 Bottle
6.	pH6.88 Buffer, 200mL	121306	1 Bottle
7.	2.76mS/cm Conductivity Standard, 200mL	122306	1 Bottle
8.	Flow sensor for HP2-DS	HP2DSF	1 ea
9.	½" Ball valve for sample flow rate adjustment	NBV12	1 ea
10.	Adaptor from ½" ball valve to ½" clear tubing	NPH12M12	1 ea
11.	12mm Hose Clamp, for output of ball valve and input to sample chamber	MC12	2 ea
12.	25mm Hose Clamp, for output of sample chamber	MC25	1 ea
13.	1/2" Clear tubing for sample chamber input	NPH.5	5 mtr
14.	1" Clear tubing for sample chamber output	NPH1	5 mtr
15.	3/8" Clear tubing for input and output of peristaltic dosing pumps	NPH3.8H	24 mtr
16.	HP2-DS Handbook	130050	1 ea

3. Installation

3.1 Mounting the panel

The ***HP2-DS*** panel is designed for wall mounting near the main nutrient mixing tank. Although the entire system is weatherproof, TPS still recommends that the ***HP2-DS*** is mounted under cover, away from direct sunlight. This will offer the longest possible service life.

- For mounting directly into solid wood, such as wall studs, use the 10 gauge self tapping wood screws supplied. Pre-drill with a 1/8" or 3.5mm drill bit.
- For wall sheeting, such as fibre board, use suitable wall anchors. Note that they should be capable of holding the total weight of the dosing system, which is 15kg.

The illustration of the **HP2-DS** system in section 1.1 shows the distance between the centres of the four mounting holes.

3.2 Power and Sensor Connections

The ***HP2-DS*** is supplied with all power connections pre-wired. Sensor connections are pre-wired to the internal terminal strip, with weatherproof sockets provided underneath the unit.

All connections are clearly labeled, and are described in section 1.

Note that one of the dosing pumps supplied is fitted with a piggy back style power plug. This is to enable both the A and the B nutrient pumps to be connected simultaneously.

When mounting the sensors into the lid of the sample chamber, the Conductivity sensor fits into the largest hole, the pH and flow sensors fit into each of the smaller holes. Note that the fitting for the flow sensor has an internal flange to stop it falling into the sample chamber. All three sensors should be mounted squarely, in a vertical position, as per the diagram in section 1.

3.3 Connecting the tubing

Once the panel is mounted and the sensors are connected, it is time to connect the various lengths of clear tubing.

The 3/8" tubing is for the peristaltic pumps. The pumps rotate clockwise, so the input is on the left and the output is on the right (see the illustration in section 1). Peristaltic pumps have limited suction capability, so the input tubing should be as short as possible. The height of the pumps must be less than 2 metres above the empty level of the drum. The output, however, can be quite some distance from the pump. The pumps are capable of pushing liquid to a height of 6 metres or more, making them ideal for above-ground mixing tanks.

The 1/2" tubing is for the input to the sample chamber. Take a sample line of the output side of the main crop feeding pump, or the mixing tank stirring pump. Run this sample through the ball valve supplied and then into the 1/2" input to the sample chamber (see the illustration in section 1). The ball valve allows adjustment to an ideal sample flow rate (see section 3.4). The diagram over the page indicates an ideal flow rate.

NOTE: In applications where the growing tables are above the sample chamber, a non-return valve should be fitted after the sample chamber take-off point. This will prevent a back-flow of nutrient while the main pump is switched off, and avoid potential overdosing problems. See the diagram the next page.

The 1" tubing is for the output of the sample chamber. The larger diameter is provided to ensure that the sample chamber does not become pressurised. This tubing should be run back to the main mixing tank in as close to a direct line as possible. Do not have any loops in this drain line, as it may cause the output flow of the sample chamber to back up, and cause the sample chamber to overflow.

3.4 Flow Rate Adjustment

The flow rate of the nutrient solution running through the sample chamber is adjustable with the ball valve supplied with the ***HP2-DS*** system. The flow rate should be adjusted so that the nutrient runs out of the top of the overflow pipe in the sample chamber.

If the flow rate is too low, the nutrient falls to the level of the vent hole in the overflow pipe. This will cause the flow sensor to inhibit the addition of nutrient and acid (or base). The vent hole in the overflow pipe is provided so ensure that the pH sensor is kept moist at all times, even when there is little or no flow.

If the flow rate is too high, the sample chamber may become pressurised, causing nutrient to spill out of the top and onto other components of the **HP2-DS** system. The diagram below indicates the optimum flow rate.

4. Conductivity Calibration

1. Plug the Conductivity sensor into the **Conductivity** socket.
2. Switch the function switch to **CALIB**.
3. Rinse the Conductivity sensor in distilled water. Shake off as much water as possible. Blot the outside and cover of the sensor dry. **DO NOT BLOT THE SENSOR WIRES INSIDE THE COVER**.
4. Adjust the Conductivity **Zero** control until the display reads **0.00**.

   This calibration only needs to be performed occasionally. If a zero calibration cannot be achieved, the most likely cause will be a build-up of contamination between the sensor wires. This should be rinsed off with distilled water or a 1:10 solution of Hydrochloric acid. If a zero calibration can still not be achieved, then the sensor may need to be returned to the factory for a thorough clean and re-platinising.
5. Place the Conductivity sensor into a sample of Conductivity standard (TPS supplies 2.76mS/cm).

   DO NOT place the sensor directly into the bottle of standard. It is advisable to use a narrow sample vessel to minimise the use of standard solution.

   Immerse the Conductivity sensor at least to the vent hole in the white plastic cover (see diagram below). The white plastic cover **MUST** be in place at all times for correct readings.

1. Adjust the Conductivity **SPAN** control until the display reads the value of the Conductivity standard (e.g. 2.76 mS/cm).

   This span calibration should be performed weekly, as it is critical to the accuracy of the readout. Regular calibration checks can often show up problems before they become serious enough to affect the success of an entire crop.
2. Take the Conductivity sensor out of the standard and rinse. Place it into the large hole in the lid of the sample chamber. For accurate, consistent results, ensure that it is sitting squarely .
3. Discard the used sample of Conductivity standard after use.

See section 12.9 if there are any problems with either the zero or the span calibrations.

5. pH Calibration

1. Plug the pH sensor into the **pH** socket.
2. Switch the function switch to **CALIB**.
3. Remove the clear wetting cap from the tip of the pH sensor.
4. Rinse the pH sensor in distilled water and blot dry.
5. Place the pH sensor into a small sample of pH6.88 (or pH7.00) buffer, so that the bulb and reference junction are both covered (see diagram below).

   IMPORTANT : Also place a solution guard wire into the buffer, alongside the pH sensor. This wire should be run back to the **Guard** socket on the controller.

   HINT : The flow sensor can be used as a solution guard for calibration. Simply connect it to the **Guard** socket and place it into the buffer alongside of the pH sensor during calibration. Be sure to re-connect it to the **Flow** socket after calibration, otherwise the flow sensing will not work.
6. Adjust the pH **Zero** control until the display reads **6.88** (or **7.00**).

   This calibration should be performed weekly, as it is critical to the accuracy of the readout. Regular calibration checks can often show up problems before they become serious enough to affect the success of an entire crop.
7. Rinse the pH sensor in distilled water and blot dry.
8. Place the pH sensor into a small sample of pH4.00 buffer, so that the bulb and reference junction are both covered (see diagram below).

   IMPORTANT : Also place a solution guard wire into the buffer, as per step 5, above.
9. Adjust the pH **SPAN** control until the display reads **4.00**.

   This calibration should be performed monthly, as the slope of the pH sensor is quite stable over several weeks.

1. Take the pH sensor out of the buffer and rinse in distilled water. Also remove the flow sensor, if this was used as a solution earth for calibration, and rinse with distilled water.

   Place the pH and flow sensors into the smaller holes in the lid of the sample chamber. The hole for the flow sensor has a flange to stop it falling into the sample chamber. For accurate, consistent results, ensure that both sensors are sitting squarely.
2. Re-connect the solution guard wire to the **Guard** socket and the flow sensor to the **Flow** socket. These connectors are colour coded to ensure that they are connected correctly.
3. Discard the used samples of pH buffer after use.

See section 12.8 if there are any problems with either the pH4.00 or the pH6.88 calibrations.

6. Setting the Control Limits

6.1 Conductivity Limit

The Conductivity Control Limit is set to switch the Nutrient pumps ON when the Conductivity gets TOO LOW.

To set the control limit…

1. Switch the function switch to **LIMIT**.

   The Conductivity and pH limits are now displayed on their respective displays.

2. Adjust the Conductivity **LIMIT** control until the Conductivity display shows the value at which you wish to control the Conductivity.

3. When the ***HP2-DS*** is in normal automatic operation, the A and B nutrient pumps will be switched ON as soon as the Conductivity falls below the control limit.

   The A and B nutrient pumps will be switched OFF when the Conductivity has risen to approximately 0.10 mS/cm above the control limit.

   The Conductivity display will show the " **:** " symbol above the decimal point while the output to the A and B nutrient pumps is switched ON.

6.2 pH Limit

Switch the ***Add Acid / Add Base*** switch to **Add Acid** to turn the pH pump ON when the pH gets TOO HIGH.

Switch the ***Add Acid / Add Base*** switch to **Add Base** to turn the pH pump ON when the pH gets TOO LOW.

To set the control limit…

1. Switch the function switch to **LIMIT**.

   The Conductivity and pH limits are now displayed on their respective displays.

2. Adjust the pH **LIMIT** control until the Conductivity display shows the value at which you wish to control the pH.

3. When the ***HP2-DS*** is in normal automatic operation, the pH pump will be switched ON as soon as the pH limit is exceeded.

   If the unit is set to **Add Acid**, the pH pump will be switched OFF when the pH has fallen to approximately 0.10 pH below the control limit.

   If the unit is set to **Add Base**, the pH pump will be switched OFF when the pH has risen to approximately 0.10 pH above the control limit.

   The pH display will show the " **:** " symbol above the decimal point while the output to the pH pump is switched ON.

7. Addition Timer

To avoid overdosing chemicals, the ***HP2-DS*** is fitted with an Addition Timer. This controls a timer cycle that can be used to inhibit the addition of chemicals, even if the control limits have been exceeded. This feature allows time for A and B nutrient and acid/base to mix thoroughly before more is added.

The Addition Timer adjustment can be set from approximately 20 seconds minimum to approximately 10 minutes maximum. This timer sets the maximum length of time the output relays operate in each 15 minute cycle.

> ***FOR EXAMPLE…***
> If the timer is set to 5 minutes, then addition can take place for 5 minutes (if the Control Limit is exceeded), and then the controller will turn off for 10 minutes (ie: 15 minute cycle less 5 minutes ON = 10 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.

8. Automatic Control

Once your ***HP2-DS*** has been installed and calibrated and the limits have been set, it is ready for automatic control.

To begin automatically controlling the Conductivity and pH of the nutrient solution, simply switch the function switch to **AUTO**.

Whenever the ***HP2-DS*** is automatically adding nutrient or acid/base, the " **:** " lights up above the decimal point in the relevant display.

9. Manual Pump Operation

If nutrient or acid/base is required, even when the readings are within the Control Limits, the pumps can be operated manually.

To operate the pumps manually, simply unplug them from the ***HP2-DS*** system board and plug them directly into a mains power outlet. This is one of the benefits of having all components pre-wired into standard sockets.

If your ***HP2-DS*** system requires factory servicing, the three pumps can be taken off the panel and operated manually while the ***HP2-DS*** is being serviced.

10. Maintenance

Regular maintenance will help ensure that your ***HP2-DS*** system gives you many years of reliable service. Please take the time to review these simple maintanence procedures, as this may save a time-consuming repair in the future.

10.1 Conductivity Sensor Maintenance

1. Do a span calibration in Conductivity standard every week.
2. Do a zero calibration with the Conductivity sensor dry and in air every month.
3. Thoroughly rinse the Conductivity sensor in distilled water every month. If build-ups of algae or chemical deposits persist, dip the sensor in a 1:10 solution of Hydrochloric acid for several seconds. This should remove any contaminants. Re-calibrate after cleaning the sensor.

10.2 pH Sensor Maintenance

1. Do a zero calibration in pH6.88 buffer every week.
2. Do a span calibration in pH4.00 buffer every month.
3. Thoroughly rinse the pH sensor in distilled water every month. If build-ups of algae or chemical deposits persist, dip the sensor in a 1:10 solution of Hydrochloric acid for several seconds. This should remove any contaminants. Re-calibrate after cleaning the sensor.
4. ***ALWAYS keep the pH sensor moist.***

10.3 Flow Sensor Maintenance

Thoroughly rinse the Flow sensor in distilled water every month. If build-ups of algae or chemical deposits persist, dip the sensor in a 1:10 solution of Hydrochloric acid for several seconds. This should remove any contaminants.

10.4 Sample Chamber Maintenance

Because the sample chamber has an overflow pipe to ensure that the sensors are always immersed, it is prone to dirt and algae build-up. TPS recommends that the chamber is visually checked every month, and cleaned out if necessary. The lid of the sample chamber can be easily removed for this purpose.

10.5 Peristaltic Pump Maintenance

The peristaltic dosing pumps are inherently very reliable and require little maintenance. There are no seals or diaphragms that come into contact with nutrient or acid/base.

For regular preventative maintenance, re-grease the tube every year with silicon grease. Do not use petroleum based grease, as this will cause the tubing and other plastic parts to perish.

11. Specifications

Ranges

Conductivity	: 0 to 19.99 mS/cm
pH	: 0 to 14.00 pH

Resolution

Conductivity	: 0.01 mS/cm
pH	: 0.01 pH

Accuracy

Conductivity	: ±0.02 mS/cm
pH	: ±0.02 pH

HP2 Controller Outputs

Recorder	: 0 to -2.5 V DC
Relays	: 1 x clean contact, changeover relay per channel, each rated to 2Amps at 240V AC. For the HP2-DS dosing system, these relays have been pre-wired to 240V AC weatherproof power sockets. Note that the current rating is still 2 Amps maximum.

Pumps

Type	: Peristaltic, two roller
Power	: 240V AC, 0.25 Amps
Output rate	: 3 Litres/Hour at 20RPM
General	: Fan cooled Thermal overload protection Needle bearings Long life, hardened gears & output shaft Large, high oil capacity rear bearing Replaceable tubing.

12. Appendices

12.1 Overview of Hydroponic Solution Control

The ***HP2-DS*** 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. The addition of A and B nutrient and Acid or Base is by use of Peristaltic pumps, which are supplied with the ***HP2-DS*** system. Peristaltic pumps are extremely reliable and accurate. They are far superior to systems with solenoid valves, which are prone to clogging and which can potentially dump entire drums of nutrient and acid or base into your system.

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 Concentration 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.

12.1.1 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-DS*** controller. As the plants consume nutrients, the conductivity of the nutrient solution decreases. The ***HP2-DS*** 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-DS*** 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.

12.1.2 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 by the addition of only one type of chemical, generally Phosphoric Acid. The ***HP2-DS*** is therefore only supplied with one pump for pH correction, with an ***Add Acid / Add Base*** switch on the front panel.

12.1.3 Control Method:

The ***HP2-DS*** 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 power output socket 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.

12.1.4 Addition Timer

The ***HP2-DS*** also has an “ADDITION TIMER". This is a variable timer with a front-panel control setting.

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

12.2 Planning The Installation

12.3 Power Requirements

The ***HP2-DS*** controller requires a standard 240 Volt AC power supply. For Australian installations, a standard 240V AC mains power plug is provided. This can be connected to any standard power socket, which 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).

12.4 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.

12.4.1 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:

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

12.4.2 Volume

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

12.4.3 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 main tank from a small height above the level of the nutrient to provide stirring, and also re-oxygenation of the nutrient.

12.4.4 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.

12.5 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 (or base) solution.

The peristaltic pumps supplied with the ***HP2-DS*** should be mounted no more than about 2 metres above the level of the A, B or acid/base solution. However, they are capable of pushing the solution up a considerable head (more than 6 metres). This must be taken into consideration when mounting the ***HP2-DS*** panel. The pumps can be removed from the panel and mounted separately, if required.

12.5.1 Location

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

12.5.2 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, with a large air stone.

12.5.3 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.

12.6 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.

12.7 Injection of Nutrient and Acid/Base

The correct placement of sensors with respect to the nutrient delivery point 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, with the ***HP2-DS***, the injection points of the Nutrients and Acid should be as close as possible to the take-off point for the sample chamber.

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 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.

A flow sensor is therefore provided with the ***HP2-DS***, which is mounted in the top of the sample chamber. When the flow stops, this flow sensors causes the “**Low Flow**” light to come on, and the output to the dosing pumps will be inhibited. Incorrect addition of nutrient and acid or base is therefore avoided when the flow in the system stops. Whether the main pump is on a timer cycle, or it fails, your hydroponics system is safeguarded against overdosing.

12.8 pH Electrode Appendix

12.8.1 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 a pH6.88 calibration 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-DS*** 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 display will go off scale or become unstable. Great care must be taken not to wet the electrode plug or the meter socket. Clean with pure alcohol and cotton wool. Blow dry with a heat gun set at a moderate temperature.

12.8.2 pH Troubleshooting

1. pH reading unstable:

a) Electronics fault ?
   Check controller by disconnecting the pH electrode. Replace with a wire linking the outside frame of the socket with the centre pin. 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) Solution earth wire not in solution
   A solution earth wire should be immersed in the solution and connected to the **Guard** socket. The ***HP2-DS*** has a stainless steel solution earth point installed in the wall of the sample chamber.

c) Clogged pH electrode Reference Junction.
   Check reading stability in pH Buffer solutions. Remember to put a solution guard into the buffer solution alongside the pH electrode.
   Clean or replace electrode. If an Intermediate Junction (IJ) style sensor has been supplied, try re-filling it.

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

2. Low or Excessive response to pH change:

a) Check pH sensor in buffers. Clean or replace electrode. If an Intermediate Junction (IJ) style sensor has been supplied, try re-filling it.

12.9 Conductivity Electrode Appendix

12.9.1 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.

12.10 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.)

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.**