Congratulations !

You have purchased the latest in Handheld Conductivity-Salinity-pH-Temperature instrumentation. We trust that your new **MC-81** will give you many years of reliable service.

The **MC-81** 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 **MC-81**. It also contains a full listing of all of the items that you should have received with your **MC-81**. 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 **MC-81**, 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 MC-81
Conductivity-Salinity-pH-Temp. Meter

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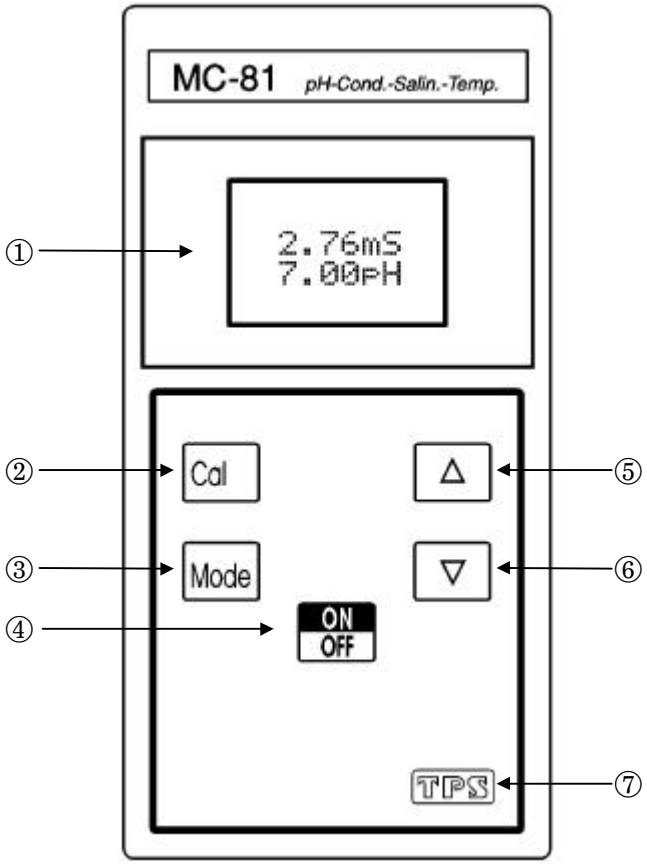
Contents

1. Introduction

1.1 MC-81 Display and Controls



① **Display**

16 character alpha-numeric display. “Dual Display” Mode shows your choice of Conductivity + pH, Salinity + pH, Conductivity + Temperature, Salinity + Temperature, or pH + Temperature simultaneously. A unique “Large Digit” mode nearly doubles the size of the digits. See section 2.1. User-friendly prompts and error messages are also provided.

② Cal

Press to calibrate conductivity, salinity, pH and temperature modes. Also used to set manual temperature compensation value for pH when the conductivity sensor is unplugged. See sections 3.1, 4.1, 5.1, 6.1 and 6.4.

Also used to select pH6.88 or pH7.00 as the primary buffer. See section 8.

③ Mode

Press to change modes between Conductivity/Salinity, pH, and Temperature.

Press and hold down this key for 2 seconds to toggle between Conductivity and Salinity modes. See section 2.2.

④ ON OFF

Press to switch the **MC-81** on and off.

Press and hold down this key for 3 seconds to invoke the Battery Saver mode. See section 7.

⑤ ▲ and ⑥ ▼

Press to toggle the **MC-81** between Large Display mode and Dual Display mode. See section 2.1.

The ▲ and ▼ keys are also used to set the manual temperature compensation value if the temperature probe is unplugged. See section 6.4, Manual Temperature Setting.

NOTE: To initialise the unit and reset the memory, press and hold down the ▲ key while switching the **MC-81** on. See section 9.

⑦ TPS

The TPS logo. Your guarantee of **T**echnology, **P**recision and **S**ervice, in electrochemistry.

1.2 Unpacking Information

Before using your new **MC-81**, please check that the following accessories have been included:

	Part No
1. **MC-81** pH-mV-Temperature Instrument	121131
2. Combination pH Electrode	121207
3. K=1/ATC/Temperature Electrode, plastic body	122201
4. pH6.88 Buffer, 200mL	121306
5. pH4.00 Buffer, 200mL	121381
6. 2.76mS/cm Conductivity Standard, 200mL	122306
7. 2ppK TDS Standard, 200mL	122307
8. 9V Battery	130026
9. **MC-81** Handbook	130050

Options that may have been ordered with your **MC-81**:

1. k=10/ATC/Temperature Electrode, plastic body	122220
2. 36ppK Salinity Standard, 1L	122304
3. Low volume, k=1/ATC/Temp sensor, glass body	122216
4. NiCad Rechargeable battery and charger	130007
5. Hard Plastic Carry Case	130057

1.3 Specifications

	Ranges	Resolution	Accuracy
pH	0 to 14.00 pH	0.01 pH	±0.01 pH
Conductivity	k=1 cell 0 to 20.00 mS/cm k=10 cell 0 to 200.0 mS/cm	0.01 mS/cm 0.1 mS/cm	±0.2%
Salinity	k=1 cell 0 to 10.00 ppK k=10 cell 0 to 100.0 ppK	0.01 ppK 0.1 ppK	±0.3%
Temperature	-10.0 to 120.0 °C (Sensor limit 60 °C)	0.1 °C	±0.2 °C

pH Input Impedance : >3 x 10^{12} Ω
pH Asymmetry Range : -1.00 to 1.00 pH
pH Slope Range : 85.0 to 105.0%
Conductivity Sensor Span Range : 75 to 133 %
Temperature Sensor Offset Range : -10.0°C to +10.0°C
Temperature Compensation : pH : 0 to 120.0 °C, automatic or manual
Cond. : 0 to 50.0 °C, automatic only
Auto Standard Recognition : pH : pH4.00, pH6.88 or 7.00, pH9.23
Cond. : k=1 cell : 2.76mS/cm,
k=10 cell : 2.8mS/cm, 58.0mS/cm
Salinity : k=1 cell : 2.00ppK
k=10 cell : 2.0 ppK, 36.0ppK
Display : 16 Character alphanumeric LCD, with full text prompts and error messages.
Power : 9V Alkaline Battery for 70 hours operation. Optional NiCad battery/charger pack available.
Battery Saver : On : Auto switch-off after 5 minutes
Off : Continuous use
Dimensions : 158 x 80 x 31 mm
Mass : Instrument only : Approx 200g
Full Kit : Approx 2.0 kg
Environment : Temperature : 0 to 45 °C
Humidity : 0 to 90 % R.H.

2. Display Formats and Readout Modes

2.1 Display Formats

The **MC-81** has two display formats:
1. Dual Display format
2. Large Display format

Press the ▲ or ▼ keys to toggle between these two formats.

NOTE: The digits in Large Display format are made by combining the two rows of the display. The result is a small gap approximately half way up the digits.

2.2 Readout Modes for Dual Display format

Press the Mode key to roll through the readout modes.
In Dual Display format, the readout modes are:

1. **Conductivity/Salinity & pH**
   Displays Conductivity or Salinity and pH readings simultaneously.
   eg : **2.76mS** or : **2.00 ppK**
   7.00 pH **7.00 pH**

   Press and HOLD the Mode key for 3 seconds to alternate between Conductivity and Salinity readout in this mode.

   The Large Display format is not available from this mode.

   Calibration is not available from this mode.

2. **Conductivity/Salinity & Temperature**
   Displays Conductivity or Salinity and Temperature readings simultaneously.
   eg : **2.76mS** or : **2.00 ppK**
   25.0°C **25.0°C**

   Press and HOLD the Mode key for 3 seconds to alternate between Conductivity and Salinity readout in this mode.

   NOTE: If the temperature of the solution exceeds 120.0 °C, or the temperature sensor inside the conductivity electrode is faulty, the temperature reading on the bottom line is replaced by "**OVR°C**", to signify the over-range condition.

3. **pH & Temperature**
   Displays pH and Temperature readings simultaneously.
   eg : **7.00 pH**
   25.0°C
   If the temperature probe is unplugged, the manual temperature setting is displayed with 1°C resolution.
   eg : **7.00 pH**
   Man 25°C

4. **Temperature only**
   Displays just the temperature reading.
   eg: **25.0°c**
   If the temperature probe is unplugged, the manual temperature setting is displayed with 1°C resolution.
   eg: **Man 25°c**

2.3 Readout Modes for Large Display format

In Large Display format, the readout modes are:

1. **Conductivity/Salinity**
   Displays just the Conductivity or Salinity reading in large digits.

   Press and HOLD the Mode key for 3 seconds to alternate between Conductivity and Salinity readout in this mode.

2. **pH**
   Displays just the pH reading in large digits.

3. **Temperature**
   Displays just the temperature reading in large digits. If the temperature probe is unplugged, the manual temperature setting is displayed with 1°C resolution,
   eg : **Man 25 °C**

Note: The decimal point is replaced by a ∗ if calibration has failed for that parameter. (see sections 3.1, 4.1, 5.1, and 6.1), if the unit is initialised (see section 9), or if the unit has lost its factory calibration. (see section 10.1).

3. Conductivity Calibration

3.1 Calibration Procedure

1. *NOTE 1*: A ∗ in place of a decimal point indicates the mode is not calibrated.
2. *NOTE 2*: For correct calibration and measurement, the white plastic cover must be in place covering the cell. It sets the volume of liquid to be measured.
3. Press the ON/OFF key if the meter is not already switched on.
4. Press the Mode key until the meter is in Conductivity mode (see section 2.2).
5. Plug the Conductivity electrode into the **Cond** socket.
6. Rinse the Conductivity electrode in distilled water.
   Shake off as much water as possible. Blot the outside of the electrode dry.
   DO NOT BLOT THE ELECTRODE WIRES.
7. **Zero Calibration**
   Let the electrode dry in air.
   When the reading has stabilised at or near zero, press and hold the Cal key for 2 seconds.
   The ∗ will not be removed after a zero calibration.
8. **Standard Calibration**
   Allowable Conductivity standards are 2.76mS/cm for the standard k=1 electrode and 2.8mS/cm & 58.0mS/cm for the optional k=10 electrode. The standard should be selected according to your range of interest.
   Place the electrode into a sample of Conductivity standard, so that it is immersed at least to the vent hole in the white plastic cover. The white plastic cover MUST be in place for correct readings.
   DO NOT place the electrode directly into the bottle of standard. Discard the used sample of standard after use. It is advisable to use a narrow sample vessel to minimise the use of standard solution.
   When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate.
   The ∗ will now be replaced by a decimal point, if calibration was successful.
9. The **MC-81** is now calibrated for Conductivity and is ready for use. When taking sample measurements, the white plastic cover MUST be in place for correct readings. The electrode must be immersed at least to the level of the vent hole in the cover.

3.2 Conductivity Calibration Notes

1. A Zero calibration should be performed at least monthly. In low conductivity applications (where a zero error is particularly significant) a zero calibration may have to be done weekly.
2. A Standard calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
3. Conductivity and Salinity calibration data is stored separately in memory. Ensure that the **MC-81** has been correctly calibrated for the mode in which it will be used. The **MC-81** does not require Recalibration when alternating between Conductivity and Salinity modes, providing the instrument has been correctly calibrated for both.
4. All calibration information is retained in memory when the **MC-81** is switched off, even when the battery is removed.

3.3 Conductivity Calibration Messages

1. If a Zero calibration has been successfully performed, the **MC-81** will display the following message.

   Zero
   Cal. OK

2. If a Standard calibration has been successfully performed, the **MC-81** will display the following message, and then the span of the electrode.

   eg: **Span** then: **Span**
   Cal. OK **100.0%**

3. If a Standard calibration has failed, the **MC-81** will display the following message, and then the failed span value of the electrode.

   eg: **Span** then: **Span** or: **Unknown**
   Cal.Fail **60.0%** **Standard**

   Note that the decimal point is replaced by a ∗ when a Standard calibration fails.

4. Salinity Calibration

4.1 Calibration Procedure

1. *NOTE 1*: A ∗ in place of a decimal point indicates the mode is not calibrated.
2. *NOTE 2*: For correct calibration and measurement, the white plastic cover must be in place covering the cell. It sets the volume of liquid to be measured.
3. Press the On/Off key if the meter is not already switched on.
4. Press the Mode key until the meter is in Salinity mode (see section 2.2).
5. Plug the Conductivity electrode into the **Cond** socket.
6. Rinse the Conductivity electrode in distilled water. Shake off as much water as possible. Blot the outside of the electrode dry. DO NOT BLOT THE ELECTRODE WIRES.
7. **Zero Calibration**
   Let the electrode dry in air.
   When the reading has stabilised at or near zero, press and hold the Cal key for 2 seconds.
   The ∗ will not be removed after a successful zero calibration.
8. **Standard Calibration**
   Allowable Salinity standards are 2.00 ppK for the standard k=1 electrode and 2.0 ppK & 36.0 ppK for the optional k=10 electrode. The standard should be selected according to your range of interest.
   Place the electrode into a sample of Salinity standard, so that it is immersed at least to the vent hole in the white plastic cover. The white plastic cover MUST be in place for correct readings.
   DO NOT place the electrode directly into the bottle of standard. Discard the used sample of standard after use. It is advisable to use a narrow sample vessel to minimise the use of standard solution.
   When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate.
   The ∗ will now be replaced by a decimal point, if calibration was successful.
9. The **MC-81** is now calibrated for Salinity and is ready for use. When taking sample measurements, the white plastic cover MUST be in place for correct readings. The electrode must be immersed at least to the level of the vent hole in the cover.

4.2 Salinity Calibration Notes

1. A Zero calibration should be performed at least monthly. In low Salinity applications (where a zero error is particularly significant) a zero calibration may have to be done weekly.
2. A Standard calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
3. Salinity and Conductivity calibration data is stored separately in memory. Ensure that the **MC-81** has been correctly calibrated for the mode in which it will be used. The **MC-81** does not require Recalibration when alternating between Salinity and Conductivity modes, providing the instrument has been correctly calibrated for both.
4. All calibration information is retained in memory when the **MC-81** is switched off, even when the battery is removed.

4.3 Salinity Calibration Messages

1. If a Zero calibration has been successfully performed, the **MC-81** will display the following message.

   Zero
   Cal. OK

2. If a Standard calibration has been successfully performed, the **MC-81** will display the following message, and then the span of the electrode.

   eg: **Span** then: **Span**
   Cal. OK **100.0%**

3. If a Standard calibration has failed, the **MC-81** will display the following message, and then the failed span value of the electrode.

   eg: **Span** then: **Span** or: **Unknown**
   Cal.Fail **60.0%** **Standard**

   Note that the decimal point is replaced by a ∗ when a Standard calibration fails.

5. pH Calibration

5.1 Calibration Procedure

1. Press the On/Off key if the meter is not already switched on.
2. Press the Mode key until the meter is in pH mode. (See section 2.2)
3. Plug the pH electrode into the **pH** socket. For automatic temperature compensation, plug the Conductivity sensor into the **Cond** socket. If the Conductivity sensor is not connected, then the **MC-81** will use manual temperature compensation.
4. Ensure that temperature has already been calibrated, or manually set (see sections 6.1 and 6.4). NOTE: If the decimal point in the temperature reading is replaced by a ∗, then the temperature readout is not calibrated.
5. Remove the wetting cap from the pH electrode.
6. Rinse the pH and Conductivity electrodes in distilled water and blot them dry.
7. Ensure that you are using the primary buffer for which the **MC-81** has been set (See section 8, Selecting pH6.88 or pH7.00 as the Primary Buffer). Place both electrodes into a small sample of pH6.88 (or pH7.00) buffer, so that the bulb and reference junction are both covered. **DO NOT** place the electrodes directly into the buffer bottle. Discard the used buffer after use.
8. When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate. If a 1 point calibration has been performed, the ∗ will not be removed until a full 2 point calibration has been performed.
9. Rinse the pH and Conductivity electrodes in distilled water and blot them dry.
10. Place both electrodes into a small sample of pH4.00 or pH9.23 Buffer, so that the bulb and reference junction are both covered. **DO NOT** place the electrodes directly into the buffer bottle. Discard the used buffer after use.
    NOTE: pH9.23 buffer is highly unstable. Avoid using this buffer if possible. Discard immediately after use.
    When the reading has stabilised, press and hold the Cal key for 2 seconds to calibrate. The ∗ will now be replaced by a decimal point, if calibration was successful.
11. The **MC-81** is calibrated for pH and is ready for use.

5.2 pH Calibration Notes

1. A 1-point calibration should be performed at least weekly. In applications where the electrode junction can become blocked, such as 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.
3. All calibration information is retained in memory when the **MC-81** is switched off, even when the battery is removed.
4. The **MC-81** displays the value of the pH buffer that it has attempted to recognise at calibration. Ensure that the buffer value displayed corresponds to the buffer that you are using.

5.3 pH Calibration Messages

1. If a 1-point calibration has been successfully performed, the **MC-81** will display the following message, and then display the asymmetry of the electrode.

   eg: **1 Point** then: **Asy**
   6.88 OK **0.10 pH**

2. If a 1-point calibration has failed, the **MC-81** will display the following message, then the failed asymmetry value of the electrode.

   eg: **1 Point** then: **Asy Hi** or: **Asy Lo**
   6.88Fail **1.50 pH** **-1.50 pH**

3. If a 2-point calibration has been successfully performed, the **MC-81** will display the following message, and then the asymmetry and slope of the electrode.

   eg: **2 Point** then: **Asy** then: **Slope**
   4.00 OK **0.10 pH** **95.0%**

4. If a 2-point calibration has failed, the **MC-81** will display the following message, and then the failed slope value of the electrode.

   eg: **2 Point** then: **Slope Hi** or: **Slope Lo** then: **Check**
   4.00Fail **130.0%** **70.0%** **Buffers**

6. Temperature Calibration

The temperature readout must be calibrated or manually set before attempting pH calibration. The decimal point is replaced by a ∗ if the reading is not calibrated.

6.1 Temperature Calibration

1. Press the On/Off key if the meter is not already switched on.
2. Press the Mode key until the meter is in Temperature mode.
3. Plug the Conductivity sensor into the **Cond** socket.
4. Place the probe into a beaker of room temperature water, alongside a good quality mercury thermometer. Stir the sensor and the thermometer gently to ensure an even temperature throughout the beaker. The temperature sensor is inside the stainless tip of the sensor, but better temperature response is achieved by immersing the sensor to at least the level of the vent hole in the white plastic cover.
5. When the reading has stabilised, press and hold the Cal key for 2 seconds.
6. The reading from the probe is now displayed on the top line, and the value you are going to set is on the bottom line.
   eg: **25∗0 °C**
   ↑26.0↓
7. Press the ▲ and ▼ keys until the bottom line shows the same temperature as the mercury thermometer.
8. Press the Cal key to calibrate the temperature readout.
   Alternatively, press the Mode key to abort temperature calibration.

6.2 Calibration Notes

1. Temperature calibration information is stored in memory when the meter is switched off, even if the battery is removed.
2. Temperature does not need to be recalibrated unless the Conductivity sensor is replaced or the meter is initialised.

6.3 Calibration Messages

1. If a temperature calibration has been successfully performed, the **MC-81** will display the following message and then the offset value of the probe.
   eg: **Temp** then: **Offset**
   Cal. OK **1.0°C**
2. If a temperature calibration has failed, the **MC-81** will display the following message, and then the failed offset value of the probe.
   eg: **Temp** then: **Offset**
   Cal.Fail **10.5°C**

6.4 Manual Temperature Setting

1. Press the ON/OFF key if the meter is not already switched on.
2. Press the Mode key until the meter is in Temperature mode.
3. Manual temperature setting is only available if the Conductivity sensor is not connected.
4. Press and hold the Cal key for 2 seconds.
5. The display should now look like this:

   Man.Temp
   ↑25.0↓
6. Press the ▲ and ▼ keys until the bottom line shows the temperature which you wish to set. This value should be the same as the temperature of the solution you are measuring.

Press the Cal key to set the temperature.

7. Battery Saver Function

The **MC-81** is equipped with a battery saver function. If no button has been pressed for five minutes, the unit beeps and flashes the display for 20 seconds, and then shuts off. This function can be disabled for continuous use.

To enable or disable the battery saver function:

1. Press the ON/OFF key if the meter is not already switched on.
2. With the meter already switched on, press and HOLD the ON/OFF key for 3 seconds.
3. The display should now look like this:

   Either: **:ON↑↓** / **9.00V** or: **:OFF↑↓** / **9.00V**
4. In this mode, use the ▲ or ▼ keys to toggle the battery saver function on or off.

   NOTE: The display also shows the battery volts. This gives the operator an idea of how much battery life is remaining. The symbol flashes when the battery volts drops below 7.50 volts. At 6.00 volts the meter turns itself off.
5. When you have set the battery saver function to the desired position, press the Mode key to return to normal measurement mode. The setting is kept in memory when the meter is switched off, even if the battery is removed.

8. Selecting pH6.88 or pH7.00 as the Primary Buffer

The **MC-81** is factory set to automatically recognise pH6.88 as the primary buffer. However, some users may prefer to use pH7.00. The following procedure describes how to alternate between pH6.88 and pH7.00 as the primary buffer.

1. Switch the meter **OFF** with the ON/OFF key.

2. Press and HOLD the Cal key while switching the meter back on.
3. Release the Cal key when the message, **"Select Buffer**" is displayed.
4. The display will now show the currently selected primary buffer. Use the ▲ or ▼ keys to alternate between pH6.88 and pH7.00 buffers.
5. Press the Mode key to exit when the desired buffer has been selected. The setting is kept in memory when the meter is switched off, even if the battery is removed. The primary buffer is re-set to pH6.88 during initialisation.

   Note: pH6.88 buffer is a DIN 19266 and NBS Primary-standard pH solution. Its use is highly recommended for the most accurate possible results. If pH7.00 buffer is used, ensure that it is manufactured to 0.01pH accuracy. pH7.00 buffer has a buffer capacity less than half that of pH6.88 buffer and is therefore much less stable.

9. Initialising the MC-81

If the calibration settings of the **MC-81** exceed the allowable limits, the unit may need to be initialised to factory default values. This action may be required if one or both of the sensors are replaced.

To initialise the **MC-81**:

1. Switch the **MC-81** off, by pressing the ON/OFF key.
2. Press and hold the ▲ key while switching the **MC-81** the on with the ON/OFF key.
3. The following messages should be displayed:

Memory	then:	**You MUST**	then:	**TPS MC81**
Reset !		**Re-Cal.**		**Con Sal pH**

4. The meter then displays Conductivity and pH. Note that the decimal points have been replaced with a ∗, to indicate that the unit requires Recalibration.

   Note: When the **MC-81** is initialised, the primary buffer value is re-set to pH6.88. See section 8 if you wish to select pH7.00 buffer.

10. Troubleshooting

10.1 General Error Messages

Error Message	Possible Causes	Remedy
Factory Cal. Fail See Handbook	The EEPROM chip which contains the factory calibration information has failed.	The unit must be returned to TPS for service. • Conductivity and Salinity readings will be accurate after a full two point calibration. • pH readings will be accurate after a 2-point calibration (use manual temperature compensation). • Temperature readings may be up to ±5°C incorrect.
Memory Failed Calib. Lost Memory Reset ! You MUST Re-Cal.	User calibration settings have been lost or corrupted.	Re-calibrate the instrument. Both a Zero and a Standard calibration will be required for Conductivity and Salinity (see sections 3.1 and 4.1). A full 2 point calibration will be required for pH (see section 5.1) and a 1 point calibration for temperature (see section 6.1).
Meter displays the word **OFF**, and switches off.	Battery is below 6.00 volts.	Replace the battery.
Meter will not turn on.	Battery is exhausted.	Replace the battery.
Flashing  symbol.	Battery is below 7.50 volts.	Replace the battery soon. Note that the unit will switch itself off when the battery falls below 6.00 volts.

10.2 Conductivity and Salinity Troubleshooting

Symptom	Possible Causes	Remedy
Unit attempts Span calibration instead of Zero calibration.	Electrode has Zero error.	Thoroughly rinse electrode in distilled water and allow to completely dry in air before attempting zero calibration. If instrument does not calibrate at Zero with electrode disconnected, then the instrument is faulty.
Standard calibration fails, and span is less than 75%.	1. Electrode is not immersed deeply enough. 2. Electrode may have a build-up of dirt or oily material on electrode wires. 3. Platinum-black coating has worn off. 4. Standard solution is inaccurate. 5. Electrode is faulty.	Immerse electrode at least to the vent hole in the white plastic cover. Clean electrode, as per the instructions detailed in section 12.4. Electrode requires replatinisation. Return to the factory, or see details in section 12.5. Replace standard solution. Return electrode to factory for repair or replacement.
Standard calibration fails, and span is greater than 133%.	1. White protective cover is not fitted. 2. Standard solution is inaccurate. 3. Electrode may have a build-up of conductive material, such as salt. 4. Electrode is faulty.	The white protective cover MUST be fitted for correct readings. Replace standard solution. Clean electrode, as per the instructions detailed in section 12.4. Return electrode to factory for repair or replacement.

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Conductivity and Salinity Troubleshooting, continued...

Inaccurate readings, even when calibration is successful.	1. Electrode may have a build-up of dirt or oily material on electrode wires. 2. Platinum-black coating has worn off.	Clean electrode, as per the instructions detailed in section 12.4. Electrode requires replatinisation. Return to the factory, or see details in section 12.5.
Readings drift.	1. Electrode may have a build-up of dirt or oily material on electrode wires.	Clean electrode, as per the instructions detailed in section 12.4.
Readings are low or near zero.	1. Electrode may have a build-up of dirt or oily material on electrode wires. 2. Electrode is not immersed deeply enough. 3. Electrode is faulty.	Clean electrode, as per the instructions detailed in section 12.4. Immerse electrode at least to the vent hole in the white plastic cover. Return electrode to factory for repair or replacement.

10.3 pH and mV Troubleshooting

Symptom	Possible Causes	Remedy
Unit fails to calibrate, even with new probe.	Calibration settings outside of allowable limits due to previous failed calibration.	Initialise the unit. See section 9.
1 Point calibration fails (Asymmetry is greater than +/-1.00 pH).	1. Reference junction blocked.	Clean reference junction, as per instructions supplied with the electrode.
	2. Reference electrolyte contaminated.	Flush with distilled water and replace electrolyte.
2 Point calibration fails (Slope is less than 85.0%).	1. Incorrect primary buffer.	Ensure that you are using the primary buffer which the **MC-81** has been set (See section 8, Selecting pH6.88 or pH7.00 as the Primary Buffer)
	2. Glass bulb not clean.	Clean glass bulb as per instructions supplied with the electrode.
	3. Electrode is aged.	Attempt rejuvenation, as per instructions supplied with the electrode. If not successful, replace electrode.
	4. Connector is damp.	Dry in a warm place.
	5. Buffers are inaccurate.	Replace buffers.
Unstable readings.	1. Reference junction blocked.	Clean reference junction, as per instructions supplied with the electrode.
	2. Glass bulb not clean.	Clean glass bulb as per instructions supplied with the electrode.
	3. Bubble in glass bulb.	Flick the electrode 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. Replace electrolyte.

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pH and mV Troubleshooting, continued...

Inaccurate readings, even when calibration is successful.	Reference junction blocked.	Clean reference junction, as per instructions supplied with the electrode.
Displays 7.00 for all solutions.	Electrical short in connector.	1. Check connector. Replace if necessary. 2. Replace electrode.
Displays 4-5 pH for all solutions.	Glass bulb or internal stem cracked.	Replace electrode.

10.4 Temperature Troubleshooting

Symptom	Possible Causes	Remedy
Displays "**Man**" in pH/Temperature mode and Temperature mode when conductivity sensor is connected.	1. Faulty temperature sensor in conductivity sensor.	Fit new conductivity sensor. NOTE: Conductivity readout may still be accurate.
Displays "**OVR°C**" in Conductivity/ Temp. and Salinity/ Temp. modes when conductivity sensor is connected.	1. Faulty temperature sensor in conductivity sensor. 2. Faulty instrument.	Fit new conductivity sensor. NOTE: Conductivity readout may still be accurate. Return instrument to factory for repair.
Temperature inaccurate and cannot be calibrated.	1. Faulty connector. 2. Faulty temperature sensor in conductivity sensor. 3. Faulty instrument.	Check the connector and replace if necessary. Fit new conductivity sensor. NOTE: Conductivity readout may still be accurate. Return instrument to factory for repair.

11. 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 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 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 $13.50 for return freight for units under warranty,**
  or $24 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 by air express where possible.

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.**

12. Appendices

12.1 Soil Salinity Information

Soil salinity problems can occur naturally or can be induced in nurseries due to the management practices in that nursery. In nature, the two most common situations where salting is likely to occur are:

1. In soils of areas of low rainfall.
2. In soils situated close to the sea (coastal areas).

The types of salts prevalent in these two areas are different. In low rainfall areas, the salts are commonly sulphates, chlorides, and carbonates or bicarbonates of calcium, magnesium or sodium. In coastal areas, the salt problems are generally caused by sodium chloride (common salt).

In nurseries, salting problems can occur where the plants are container grown, or where the plants are rowed out in the field, if...

1. Saline water is used in watering from either bores or salty creeks.
2. Excess fertiliser is used in mixes.
3. Excessive amounts of soluble fertiliser is used in liquid feed programs.
4. Soil containing fertiliser is subject to prolonged over-sterilising or sterilising at the wrong temperature.
5. Soils are poorly drained.
6. Unwashed sand is used in propagation mixes.
7. Salt accumulates in porous pots, e.g. clay pots.

All salts added as fertilisers are potential hazards in these nursery situations, and particularly the soluble chlorides, sulphates and nitrates of potassium, ammonium, calcium and sodium.

Visual symptoms of salting damage or where latent problems occur include:

1. Dead, brown margins and tips of older leaves.
2. Sudden dropping of apparently healthy older leaves and excessive soft tip growth.
3. Salt crusting on the surface of pots.
4. Plants dying from the root upwards.
5. Bare patches of soil or uneven growth of plants in patches of the field, with patches of salt showing on the surface where the drainage is poor.
6. Reduced root growth and little evidence of fine feeder roots.

Unfortunately, by the time these symptoms are obvious, extensive damage to the crop has already occurred, causing in some cases considerable loss to the grower. On the other hand, where insufficient fertiliser is present, plants do not grow at the optimum growth rates. This requires the grower to hold stock longer before it reaches marketable sizes.
The best method for monitoring soil salt levels is by the use of a conductivity meter.

Collection of samples.
An important part of correct soil testing is to obtain a sample which is representative.

A: Field samples.
Take samples from areas of poor growth.

1. Using a spade, clear the growth from the top of the soil, being careful not to remove any soil.
2. Dig a small hole with straight sides.
3. Take a 1 cm thick slice from the side of the hole to a depth of 15 cm (or 5 cm for turf.)
   If the subsoil occurs before 15 cm, take the sample from the top soil only.
4. Repeat this process 10 times over the area to be checked.
5. Mix all the sample together, and take about 1/2 kg as the test sample. Spread the sample out on a piece of clean paper, and allow it to dry.

B: Samples from Potted Plants.

1. Select 10 plants showing evidence of salt injury.
2. Knock out the plants, and remove the soil from each pot.
3. Mix the samples together well, then take 1/2 kg sample, and spread it out to dry on clean paper.

12.2 pH, Conductivity & Salinity Measurement of Soil & Potting Mix.

The Department of Primary Industries Soils Testing Section recommend the following methods for pH and Salinity/Conductivity measurements in particular soils. Listed below are two methods of measurement.

Soils Method - A

1:5 (Weight/Volume)

This has been the standard method used in Australia for measuring the pH and Salinity/Conductivity of soils. This method is suitable only for soils, and then mainly when you want to compare the results with earlier results obtained with this method, or when the sample of soil is too small to make a saturated paste.

1. Weigh 40g of air-dry soil into a clean screw-topped glass or plastic jar with a capacity of about 250ml.
2. Add 200ml of distilled or deionised water.
3. Shake thoroughly every 5 minutes for 1 hour,
   OR: Shake thoroughly after adding water, leave stand overnight, and shake thoroughly again the next morning.
4. Allow the suspension to settle for 15 minutes or longer.
5. Measure the Conductivity, Salinity, or pH by dipping the electrodes just into the liquid or suspension.

NOTE: pH readings taken with this method are slightly higher in pH than those taken with other methods. The hydrogen ions in the soil are diluted by the larger volume of water used.

For the Conductivity and Salinity measurements, make sure the vent-hole in the side of the electrode cover is submerged under the surface of the solution. It may be necessary to pour off the liquid from the sample into a smaller container to do this correctly.

Potting Mix Method - B

1:1.5 (Volume Extract)

This method is now commonly used in Holland, France and New Zealand for the analysis of container growing media. This method has been developed for soil-less media. It should NOT be used for soils.

1. Take several handfuls of medium (potting mix). Add distilled or deionised water while mixing by hand.
2. The final moisture content should be such that firmly squeezing the mix just expresses water from it between the fingers. The amount of squeeze is like a firm handshake. It is neither a limp nor a crushing squeeze. The mix will be just a little drier than if it had just stopped draining while in a fairly tall pot.
3. Select a straight-sided, screw-top jar of about 400ml capacity.
4. Pour into it 100ml of water. Mark where this comes to. Pour the water out.
5. Fill about 120ml of moist, loose mix into the jar. Firm it gently with the fingers and by light dumping. Add more mix if the volume is below 100ml, or take some out if it is above.
6. Add 150ml of distilled or deionised water.
7. Shake 50 times, leave stand for 15 minutes, than shake 50 times again.
8. Measure the Conductivity, Salinity, or pH by dipping the electrodes into the water.

For the Conductivity and Salinity measurements, make sure the vent-hole in the side of the electrode cover is submerged under the surface of the solution. It may be necessary to pour off the liquid from the sample into a smaller container to do this correctly.

12.3 Water Classification Types

Class 1: 0 to 175 ppM
Low Salinity Water - can be used for most crops and soils, with all methods of water application, with little likelihood that a salinity problem will develop. Some leaching may be required, but this should occur under normal irrigation practices, except in soils with extremely low permeability.

Class 2: 175 to 500 ppM
Medium Salinity Water - can be used if a moderate amount of leaching occurs. Plants with medium salt tolerance can be grown, usually without special practices for salinity control. Sprinkler irrigation with the more saline waters in this group may cause leaf scorch on salt sensitive crops, especially at high temperatures in the daytime, and with low water application rates.

Class 3: 500 to 1500 ppM
High Salinity Water - cannot be used on soils with restricted drainage. Even with adequate drainage, special management techniques for salinity control may be required, and the salt tolerance of the crops to be irrigated must be considered.

Class 4: 1500 to 3500 ppM
Very High Salinity Water - not suitable for irrigation under ordinary conditions. For use, soils must be permeable, drainage adequate, water must be applied in excess to provide considerable leaching, and salt tolerant crops must be selected.

Class 5: Above 3500 ppM
Extremely High Salinity Water - may be used only on permeable well- drained soils under good management, especially in relation to leaching. Also can be used for salt-tolerant crops, or for occasional emergency use.

12.4 Care, Cleaning and Maintenance of Conductivity Electrodes

12.4.1 Care of Conductivity electrodes

The conductivity section of the electrode supplied with your **MC-81** consists of two platinum wires that are plated with a layer of "platinum-black". This is quite a soft layer and is required for stable, accurate measurements. In time, the platinum-black layer may wear off in some applications, at which time the electrode will require Replatinising (see section 12.5). You can help to maintain the platinum-black layer by following these simple rules:

1. **NEVER** touch or rub the electrode wires with your fingers, cloth etc.
2. Avoid using the electrode in solutions that contain a high concentration of suspended solids, such as sand or soil, which can abrade the electrode wires. Filter these types of solutions first, if possible.
3. Avoid concentrated acids. If you must measure acids, remove the electrode immediately after taking the measurement and rinse well with distilled water.

Conductivity electrodes can be stored dry. Ensure that the electrode is stored in a covered container, to avoid dust and dirt build-up.

12.4.2 Cleaning of Conductivity of Electrodes.

Platinised platinum Conductivity electrodes can only be cleaned by rinsing in a suitable solvent. **DO NOT wipe the electrode wires**, as this will remove the platinum-black layer.

1. Rinsing in distilled water will remove most build-ups of material on the electrode wires.
2. Films of oils or fats on the electrode wires can usually be removed by rinsing the electrode in methylated spirits.
3. Stubborn contamination can be removed by soaking the electrode in a solution of 1 part Concentrated HCl and 10 parts distilled water. The electrode should not be soaked for more than approximately 5 minutes, otherwise the platinum-black layer may start to dissolve.
4. If all of these methods fail, then the last resort is to physically scrub the electrode wires, which will remove the contaminant and the layer of platinum-black. Use only a cloth or nylon scouring pad. DO NOT USE STEEL WOOL. The electrode will then need to be cleaned in HCl, as per step 3 and replatinised, as per section 12.5.
5. Re-calibrate conductivity and salinity after cleaning the electrode. See sections **Error! Reference source not found.** and 4.1.

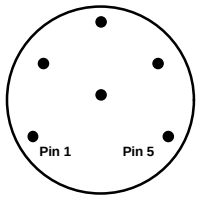
12.5 Replatinising Conductivity Electrodes

There are several ways to replatinise Conductivity electrodes.

1. The simplest way is to return the electrode to the TPS factory. We can fully clean the electrode, replatinise it and test all aspects of its performance.
2. An automatic replatiniser is available from TPS, along with replatinising solution. This will plate the electrodes for the right amount of time at the correct current. Ordering details are as follows:
   Automatic Conductivity Electrode Replatiniser Part No 122160
   20mL Platinising Solution (suitable for approx 30 uses) Part No 122300
1. Conductivity electrodes can be manually replatinised, according to the following procedure:
   1) Soak the electrode in a solution of 1 part Concentrated HCl and 10 parts distilled water for approximately 5 minutes.
   2) Rinse the electrode well in distilled water.
   3) Immerse the electrode in platinising solution at least to the vent hole in the white plastic cover. Platinising solution is available from TPS (part no 122300). Alternatively, platinising solution can be prepared by dissolving 1g of Hydrogen Chloroplatinate (H_2PtCl_{16}) in 30mL of distilled water, and including about 0.01g of Lead Acetate ($(CH_3COO)_2Pb$) and a drop or two of concentrated HCl.
   4) Apply a direct current of 10mA between pins 1 and 5 of the electrode plug, as per the diagram below. Reverse the polarity every 30 seconds. After approximately 8 minutes (4 minutes per electrode wire), they should have an even “soot” like appearance. Avoid excess current, as this will cause incorrect platinising.
   5) After platinising, rinse the electrode well in distilled water.
   6) Re-calibrate conductivity and salinity before use. See sections 3.1 and 4.1.
   7) If you have any doubts about any of these steps, then you should consider returning the electrode to the factory. The cost of replatinising is quite low, and you will be guaranteed of the best possible result.

12.6 pH Electrode Fundamentals

A combination pH Electrode is two electrodes in one. The sensing membrane is



Electrode Connector

the round or spear shaped bulb at the tip of the electrode. This produces a voltage that changes with the pH of the Solution. This voltage is measured with respect to the second part of the electrode, 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.

12.6.1 Asymmetry of a pH Electrode

An “ideal” pH electrode produces 0 mV output at 7.00 pH. In practise, pH electrodes, 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 12-1 illustrates how asymmetry is expressed.

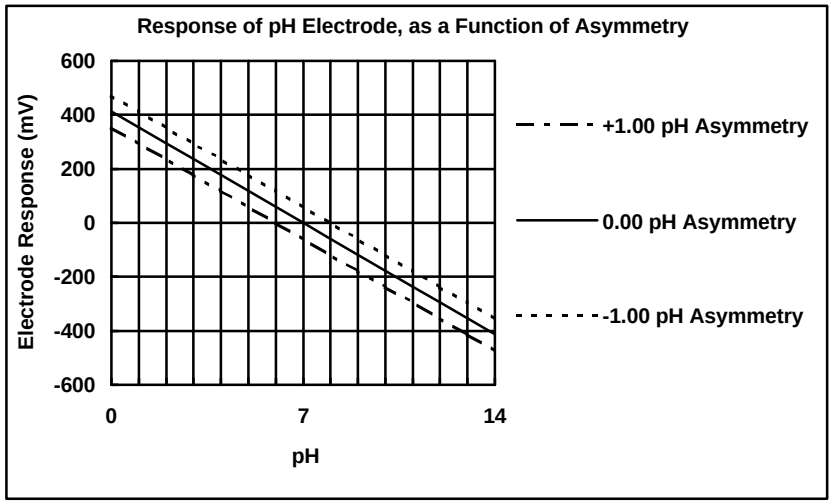


Figure 12-1

12.6.2 The Slope of a pH Electrode

As mentioned above, a pH electrode produces 0 mV output at around 7.00 pH. As the pH goes up, an “ideal” pH electrode produces -59mV/pH unit at 25 ^{o}C As the pH goes down, an ideal pH electrode produces +59mV/pH unit. In practice, pH electrodes usually produce slightly less than this. The output of a pH electrode is expressed as a percentage of an ideal electrode. For example, an ideal electrode that produces 59mV/pH unit has “100% Slope”. An electrode that produces 50.15mV/pH unit has “85% Slope” (see Figure 12-2).

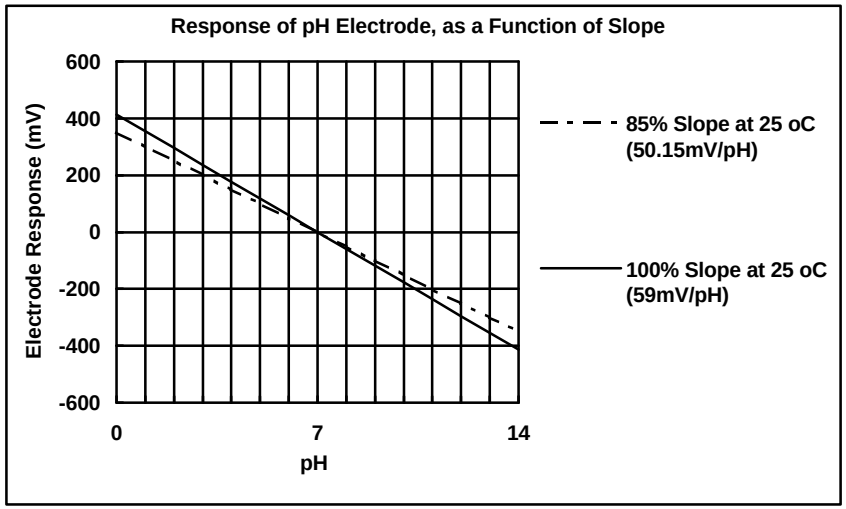


Figure 12-2

12.6.3 Temperature Compensation

The slope of a pH electrode (section 12.6.2) is affected by temperature. This effect is compensated for either by using an Automatic Temperature Compensation (ATC) probe or by entering the sample temperature manually. Figure 12-3 shows the slope of a pH electrode at various temperatures.

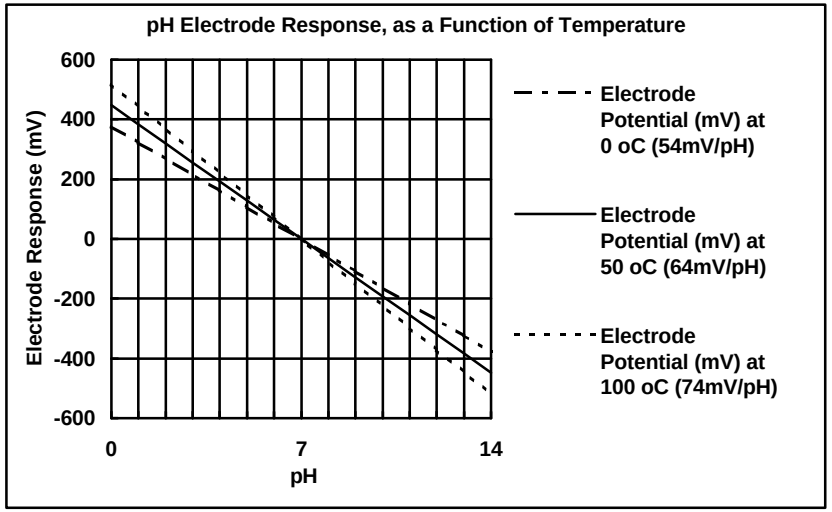


Figure 12-3

12.7 Checking the reference junction of a pH electrode.

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

1. Calibrate the **MC-81**, as per section 5.1.
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 +/-0.02 pH.
4. If the value obtained is outside of these limits, then clean the reference junction, as per the instructions supplied with the pH electrode.
5. Re-calibrate the **MC-81** and repeat the test.
6. If the value obtained is still outside 7.06 +/-0.02 pH, then the electrode should be replaced.

12.8 Determining if an instrument or pH electrode is faulty

The following test can be performed to help determine if the **MC-81** or the pH electrode is faulty.

1. Initialise the **MC-81** (see section 9).
2. Disconnect the pH electrode.
3. Connect the centre pin of the **pH** connector with the outside frame of the connector, using a short piece of wire or a paper clip etc.
4. The meter should read approximately 7.00. If you press the Cal key, the **MC-81** will calibrate to around 6.88 pH, depending upon the temperature readout.
5. If the **MC-81** is operating correctly, the reading should be totally stable with the wire firmly in place. If not, the meter requires servicing.
6. 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).
7. After and initial small jump, 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 **MC-81** is faulty and requires servicing.

12.9 Instrument software version number.

If you need to phone or fax TPS for any further technical assistance, the version number of your **MC-81** firmware may of benefit to us. Please obtain the version number as follows, before phoning or faxing:

1. Switch the **MC-81** on by pressing the ON/OFF key.
2. While the model is being displayed, press the Mode key.
3. The unit will now display the model and version number,
   eg: **TPS MC81**
   Ver 1.0