MODEL 3305 pH METER
OPERATING MANUAL

544 007/REV A/03-96

SAFETY

Please read this information carefully prior to installing or using this equipment.

1. The unit described in this manual is designed to be operated only by trained personnel. Any adjustments, maintenance and repair must be carried out as defined in this manual, by a person qualified to be aware of the hazards involved.

2. It is essential that both operating and service personnel employ a safe system of work, in addition to the detailed instructions specified in this manual.

3. References should always be made to the Health & Safety data supplied with any chemicals used. Generally accepted laboratory procedures for safe handling of chemicals should be employed.

4. If it is suspected that safety protection has been impaired in any way, the unit must be made inoperative and secured against any intended operation. The fault condition should immediately be reported to the appropriate servicing authority.

MODEL 3305 pH METER
OPERATING MANUAL

CONTENTS

SECTION 1

INTRODUCTION

1.1 INSTRUMENT DESCRIPTION

The Model 3305 is a general purpose, laboratory pH/mV meter with Manual Temperature Compensation over the range of 0 to 100°C. Automatic Temperature Compensation can be achieved by use of the optional ATC probe, which will enable the user to perform temperature measurements within the range of 0 to 100°C.

The Model 3305 has a liquid crystal display and is battery operated. The use of an optional power supply permits the unit to be operated from the a.c. mains supply.

1.2 INSTRUMENT SPECIFICATIONS

	Range	**Resolution**
	0 to 14.00pH	0.01pH
	0 to ±1999mV	1mV
	0 to 100°C (with optional probe)	1°C

Accuracy:	pH:	±0.02pH
	Millivolts:	±1mV
	Temperature:	±1°C
Isopotential point:	0mV	
Temperature Compensation:	Manual:	0 to 100°C
	Automatic:	Optional ATC probe
Calibration:	Manual	
Display:	25mm LCD	
Power:	9V Battery (MN1604 or equivalent)	
Outputs:	Analogue buffered electrode potential	
Size:	275(L) x 240(W) x 150(D)mm	
Weight:	1.2 Kgs	

SECTION 2

INSTALLATION

2.1 UNPACKING

Remove the Model 3305 from the packaging and ensure the items contained within the package are as ordered.

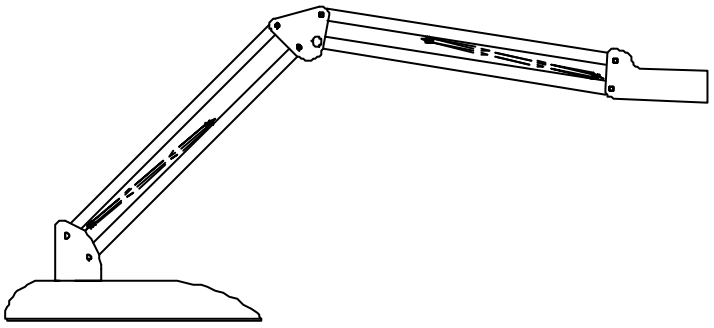
Any shortages or damage should be reported immediately to the Manufacturer or your local Distributor.

NOTE: Power Supply 021 033 is supplied with a moulded European plug. If this is not correct for your local supply it should be cut off and a suitable local connector fitted noting the colours of the internal conductors as follows:
Brown - Live Blue - Neutral

2.2 INSTALLATION

For units supplied with the swing arm electrode holder the following assembly instructions should be carried out:

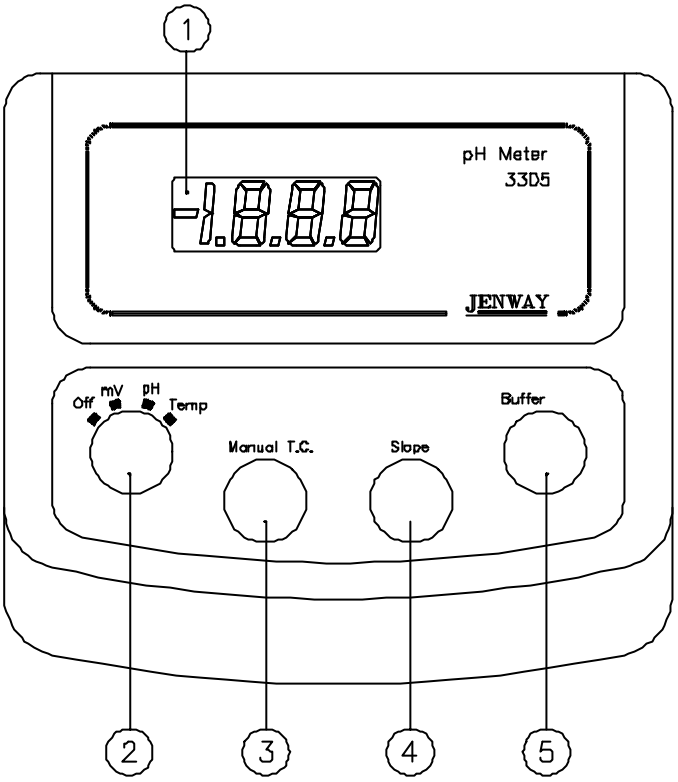
1. Unpack the assembly and ensure the following items are present:
   a) Base block and b) Swing arm. Assemble as illustrated. The moulded pivot is a tight push fit onto the pin.



2. Fit the pH electrode into the cut-out in the support block. The optional temperature probe, if supplied, should be placed into the small hole in the centre of the block. The cable(s) should be passed through the retaining clip on the holder and connected to the respective socket on the rear panel.

2.3 DISPLAYS/CONTROLS

Fig. 2.3.1 - Displays/Controls



1. **DISPLAY** — Provides direct readout of pH, millivolts and temperature of samples and standards.

2. **FUNCTION SWITCH** — Used for selection of mode of operation.
This control also disconnects the battery in the OFF position.
When using the optional battery eliminator the internal 9V supply is also disconnected.

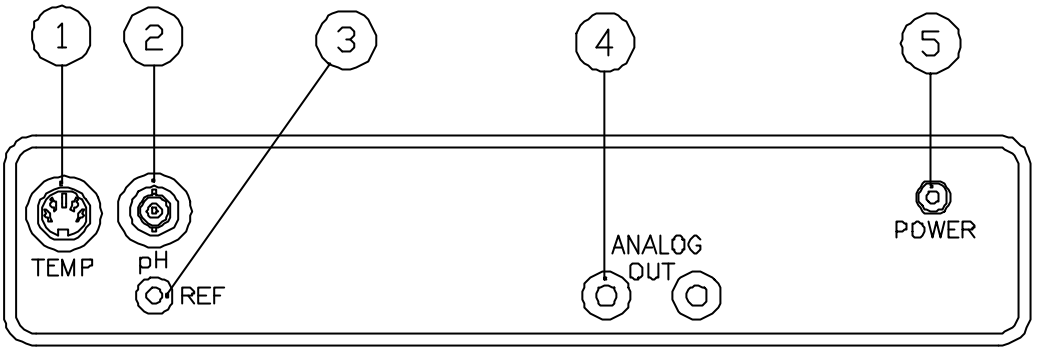
3. **MANUAL T.C. CONTROL** — When the °C mode is selected (without the optional ATC probe) this control allows the compensation temperature to be set on the display. This control becomes inoperative during use of the optional ATC probe. The display will indicate the temperature of the ATC probe.

4. **SLOPE CONTROL** — This control compensates for the variable sensitivity of pH electrodes. As the electrodes age their sensitivity decreases and this control is used to compensate for this.

5. **BUFFER CONTROL** — Used to balance out the electrode offset between the pH measurement cell and reference. This should be set with the electrode immersed in pH7 buffer.

2.4 INPUTS/OUTPUTS

Fig. 2.4.1 - Rear Panel Layout



1. **TEMP SOCKET**	6 pin socket. This allows the optional Automatic Temperature Compensation probe to be connected.
2. **pH SOCKET**	BNC type socket which allows combination pH or redox electrodes to be used.
3. **REF SOCKET**	2mm pin socket. Connection socket for a separate reference electrode. When performing measurements with some pH and Ion Selective electrodes a separate reference electrode is needed.
4. **ANALOG OUT**	2 x 4mm sockets. Buffered electrode potential.
5. **AC 9V I/P SOCKET**	2.1 x 5.5mm socket allowing the optional power supply to be connected to the unit.
BATTERY COMPARTMENT	Housing for battery (types PP3 or MN1604). Located on the base plate of the unit.

SECTION 3

OPERATION

3.1 THEORY OF pH MEASUREMENT

pH is a unit of measurement which defines the degree of acidity or alkalinity of a solution. It is measured on a scale of 0 to 14. The pH value quantifies the degree of activity of an acid or a base in terms of hydrogen ion activity.

The internationally accepted symbol, pH, is derived from "p", the mathematical symbol of the negative logarithm and "H", the chemical symbol for Hydrogen. The pH value is the negative logarithm of Hydrogen ion activity as shown in the mathematical relationship pH=log[H+1].

The pH value of a substance is directly related to the ratio of the hydrogen ion [H^+] and the hydroxyl ion [OH^-] concentrations. If the concentration of H^+ is greater than OH^-, the material is acidic and has a pH value of less than 7. Conversely, if the concentration of OH^- is greater than H^+ the material is basic, with a pH value greater than 7. If the concentrations of H^+ and OH^- are equal the material is neutral with a pH value of 7.

It can, therefore, be seen that pH is a measurement of both acidity and alkalinity, even though by definition it is a selective measurement of hydrogen ion activity. The logarithmic relationship between hydrogen ion concentration and the pH unit means that a change of one pH unit represents a ten-fold change in hydrogen ion concentration.

3.2 pH MEASUREMENT

pH can be measured by using either pH papers/indicators or a pH meter, dependent on the level of accuracy required. pH papers or indicators change colour as the pH level varies. These can be used as a guide to the pH colour level, but can be limited in accuracy and difficult to interpret correctly in murky or coloured samples.
For greater accuracy the use of a high impedance pH meter is recommended, together with a pH measuring electrode and reference electrode.

Each component part of the measurement system can be described as follows:
a) the pH meter - is a high impedance amplifier used to accurately measure the minute electrode voltages produced. The pH meter will display the results directly in pH units on either an analogue or digital display. Voltages can also be read for special applications, ORP (Oxidation-Reduction Potential) measurements or with Ion Selective Electrodes.

b) the pH electrode - is a hydrogen ion sensitive glass bulb, with a millivolt output that varies with the changes in the relative hydrogen ion concentration inside and outside of the bulb. The pH electrode has very high internal resistance, making the voltage change with pH difficult to measure. The input impedance of the pH meter and leakage resistances are therefore important factors.

c) the reference electrode - these cells consist of an internal element, usually a silver/silver chloride wire, electrolyte (KCl) and a liquid junction. The liquid junction provides a leak path for the internal electrolyte to "weep" into the sample chamber and provide an electrical contact with the liquid to be measured. If the liquid junction is inefficient then measurement will be inaccurate. It is common for the reference electrode to be incorporated into the pH electrode. It is then called a combination electrode.

The voltage developed by each individual pH electrode in the presence of a known hydrogen ion concentration is theoretically predictable, but in practise deviations from the theoretical value can be expected. These deviations will change slowly during the life of an electrode. It is therefore essential to routinely calibrate the system using solutions with a known and constant pH value. These solutions are called buffers.

3.3 PREPARATION OF BUFFER SOLUTION

Care must be taken in the preparation of all buffer solutions. The correct quantity of distilled or deionised water should be used when preparing the solutions. For accurate and repeatable results it is essential to follow the manufacturers instructions carefully.

3.4 SOLUTION TEMPERATURE VALUES

The value of all buffer solutions varies with solution temperature. For accurate calibration of electrodes using buffer solutions, it is necessary to measure the temperature of the buffer solution being used. The unit should then be calibrated to the corrected pH value. Manufacturers of buffer powders and solutions will provide a table of values at varying temperatures for their buffers.

TABLE OF BUFFER VALUES (0 - 100°C)

TEMP	pH4	pH7	pH10
0°C	4.00	7.12	10.27
10°C	4.00	7.07	10.15
20°C	4.00	7.02	10.05
25°C	4.00	7.00	10.00
30°C	4.01	6.99	9.95
40°C	4.03	6.98	9.87
50°C	4.05	6.98	9.80
60°C	4.08	6.98	9.75
70°C	4.12	6.99	9.73
80°C	4.16	7.01	9.73
90°C	4.21	7.02	9.75
100°C	4.26	7.04	9.79

The above values apply only to buffers supplied by the manufacturer. Buffers from alternative sources may differ from the above. Tolerance of the above buffers is ±0.02pH.

NOTE: Buffer solutions will contaminate with exposure to air and should be stored in airtight containers when not in use. Used solution should be discarded and not returned to the container as this will cause contamination.
For best results fresh solutions should be prepared prior to standardisation.

3.5 PERFORMING MEASUREMENTS

To perform measurements in pH, mV or temperature modes the following should be carried out:

1. **mV Measurement**
   a) Connect the electrode to the unit via the BNC socket on the rear panel. If a separate reference electrode is to be used, this should be connected to the REF socket (refer Section 2.4).
   b) Select mV mode on the FUNCTION switch. The display will show the electrode o/p directly in mV.

2. **Temperature Measurement (using ATC)**
   a) Connect the optional ATC probe to the unit via the TEMP socket on the rear panel.
   b) Select °C on the FUNCTION switch. The display will show ATC probe temperature directly in °C.

3. **pH Measurement**
   a) Connect the pH electrode to the unit via the BNC socket on the rear panel.
   Select pH mode on the FUNCTION switch.

NOTE: If Manual temperature compensation is being used, the °C range should be selected.

b) Set the display to the solution temperature using the SET TEMP control, only if the unit is in the Manual temperature compensation mode. If the ATC probe is being used, it will automatically correct for changes in solution temperature and no action will be necessary.

NOTE: Ensure the pH/Reference probe combination are compatible with the samples being measured. Non-compatibility may be indicated by drifting readings, noise or shortened electrode life. During use the electrode must be rinsed between each measurement to eliminate contamination of solutions. Excess droplets of solution may be removed by gently blotting with filter paper or tissue. For further details refer to Section 3.7-Good Practice Guidelines.

3.6 pH CALIBRATION USING BUFFERS

When performing calibrations two buffer solutions are required, a pH7 and either a pH4 or 10, dependent on the type of measurement being performed, i.e; acidic or alkaline.
Buffer solutions should be carefully prepared as per the Manufacturers instructions.

CALIBRATION - WITH MANUAL TEMPERATURE COMPENSATION

1. Select the °C range. Measure the temperature of the buffer solutions. The instrument display should then be set to the buffer solution temperature measured, using the SET TEMP control.

2. Immerse the electrode(s) in the pH7 buffer solution. Allow sufficient time for the pH reading to stabilise. Set the display to the correct value of the buffer (at the temperature measured in 1.) using the BUFFER control.

3. Rinse the electrode(s) in deionised water.

4. Immerse the electrode(s) in pH 4 or 10 buffer, depending on the type of sample to be tested. Allow sufficient time for the pH reading to stabilise. Set the display to read the correct value of the buffer (at the temperature measured in 1.) using the SLOPE control.
   Repeat steps 2-4 until no further adjustments are necessary. Care should be taken when making adjustments as the controls are slightly interdependent.

5. Rinse the electrode(s) in deionised water.

6. Immerse the electrode(s) in the unknown solution. The display will indicate the value of the solution directly in pH.

CALIBRATION - WITH AUTOMATIC TEMPERATURE COMPENSATION

1. Immerse the electrode(s) and ATC probe in the pH7 buffer solution. Allow sufficient time for the pH reading to stabilise. Set the display to read the temperature compensated value of the buffer solution using the BUFFER control.

2. Rinse the electrode(s) and ATC probe in deionised water.

3. Immerse the electrode(s) and ATC probe in the second buffer solution. Allow sufficient time for the pH reading to stabilise. Set the display to read the temperature compensated value of the buffer solution using the SLOPE control.
   Repeat until no further adjustments are necessary. Care should be taken when making adjustments as the controls are slightly interdependent.

4. Rinse the electrode(s) and ATC probe in deionised water.

5. Immerse the electrode(s) and ATC probes in the unknown solution. The display will indicate the value of the solution directly in pH.

SAMPLE MEASUREMENT

Many problems occur at the electrode to sample interface. Ensure that the pH electrode/reference combination are compatible with the samples being measured. Non compatibility may be seen as drifting readings, noise or shortened electrode life. Frequency of calibration will depend on the type of sample being measured and the particular electrode in use.

Single Samples

1. With the calibration procedure successfully carried out sample measurements are carried out by immersing the pH electrode, and ATC probe if in use, in the unknown solution.
2. Allow the reading to stabilise. Note the reading.
3. Rinse both the electrode, and ATC probe if in use, in deionised water and blot with clean tissue prior to immersing in the next sample. This will minimise carryover and contamination.

3.7 GOOD PRACTICE GUIDELINES

The types of electrodes available are many and various. For the majority of tests carried out on aqueous solutions, with a reasonable ionic strength; at ambient temperatures and with limited use in strongly acidic or alkaline solutions, the standard glass or epoxy bodied combination electrode is ideal.
For other applications a more suitable pH/reference electrode pair may be required; details or advice supplied on request.

The following general guidelines indicate the care and maintenance required for the three main groups of electrodes (Combination, Reference and pH). For more detailed advice on specific electrodes contact the electrode manufacturer.

1) **After Use** Rinse thoroughly with distilled water.

Short Term Storage Immerse in pH4 buffer

Long Term Storage Fit wetting cap filled with pH7 buffer (combination)
Fit wetting cap filled with pH4 buffer (Reference/pH)

2) Electrodes should be stored: a) away from direct sunlight
b) in a vertical position
c) within their specified temperature range

3) Always ensure the electrode is used within its specified temperature range. Degradation of electrodes used above their specified temperature is rapid and irreversible.

4) Ensure the level of the fill solution is above the internal elements in the electrode and that this level remains above the sample level in use.

5) **DO NOT** touch the sensitive glass pH membrane or reference junction during use. Excess droplets of solution may be removed by gently blotting with filter paper or tissue. **DO NOT** rub the electrode as this may induce an electrostatic charge.

6) Ensure no air bubbles are trapped at the bottom of the electrode. Removal of air bubbles is possible by holding the electrode vertically and gently tapping the electrode body. Larger bubbles may be removed by shaking the electrode in a downward direction.

7) During use ensure the electrode is rinsed between each measurement to eliminate contamination of solutions.

8) Ensure that the side port/inlet if present is uncovered, especially during a long run of tests.

SECTION 4

MAINTENANCE

4.1 GENERAL

The Model 3305 is designed to give optimum performance with minimum maintenance. It is only necessary to keep the external surfaces clean and free from dust. To give added protection when not in use the unit should be switched off and covered with the optional dust cover (544 008).

4.2 CLEANING/RE-CONDITIONING OF COMBINATION ELECTRODES

For general purpose use, combination electrodes can be cleaned with a mild detergent solution or a commercial glass cleaning solution (provided these are not strongly acidic). The electrode surface should be wiped with a clean cloth soaked in the cleaning agent, and/or allow the membrane to stand in the solution until clean. Rinse and repeat as necessary. Electrodes which have been allowed to dry out should be soaked overnight in warm distilled water.

TABLE FOR CLEANING AGENTS OF GLASS ELECTRODES

Deposit	**Cleaning Agent**
General Deposits	Genklene or mild detergent solution
Inorganic coatings	Commercial glass cleaning solution (not strongly acidic)
Metal compounds	Acid solution, not stronger than 1M
Oil/Grease	Complexing agent (EDTA) or suitable solvent
Resins/Lignins	Acetone, alcohol or detergent (not strongly alkaline)
Proteins (blood, etc)	Enzyme solutions (e.g; pepsin in 0.1M HCl)
Stubborn deposits	Hydrogen peroxide, sodium hypochlorite or domestic bleach

NOTE: Solvents such as carbon tetrachloride, trichloroethylene, petroleum, ether, etc, <u>MUST NOT</u> be used for cleaning electrodes that have a plastic body or a plastic protective skirt.

SECTION 5

OPTIONAL ACCESSORIES

5.1 OPTIONAL ACCESSORIES

The following list of items are available as optional accessories for use with the Model 3305:

903 200	Electrode stand with swing arm electrode holder
027 024	Temperature probe/ATC
021 030	Power Supply (UK Version)
021 031	Power Supply (European Version)
021 032	Power Supply (US Version)
021 033	Power Supply (230V leaded)
NOTE:	**Power Supply 021 033 is supplied with a moulded European plug. If this is not correct for your local supply it should be cut off and a suitable local connector fitted noting the colours of the internal conductors as follows:** **Brown - Live Blue - Neutral**
544 008	Dust Cover

pH Electrodes

924 001	General purpose, epoxy bodied combination, 12mm diameter. For liquids.
924 003	Redox, platinum type combination, 12mm diameter.
924 004	Micro 4.5mm diameter glass combination. For liquids.
924 005	General purpose, glass bodied combination, 12mm diameter. For liquids.
924 010	Spear type 6mm diameter stem, glass combination. For semi-solids.
924 011	Spear type 4mm diameter stem, glass combination. For semi-solids.
924 015	Glass pH electrode.
924 030	Tris Buffer. 12mm diameter. For biological fluids.
924 047	3 in 1 pH electrode

Reference Electrodes

924 016	Sealed cap calomel reference.
924 036	Double junction calomel reference.

Buffer Solutions

025 163	2.00 pH Buffer (500ml)
025 037	4.00 pH Buffer (500ml)
025 038	7.00 pH Buffer (500ml)
025 162	9.22 pH Buffer (500ml)
025 039	10.05 pH Buffer (500ml)

Redox Standards

025 157	200mV @ 25ºC (500ml)
025 158	300mV @ 25ºC (500ml)
025 159	465mV @ 25ºC (500ml)

025 160	3M KCl Electrode Fill Solution (100ml)
025 161	Electrode Cleaning Solution (500ml)

5.2 SPARES

924 001	pH combination electrode (epoxy bodied)

HEALTH & SAFETY INFORMATION

PRODUCT: Buffer Tablets

PHYSICAL DATA

Description: White tablets
Solubility in water: Soluble

HEALTH HAZARD - Harmful if ingested in quantity. May be irritating or cause physical damage in contact with eyes.

FIRST AID

Eyes	Irrigate thoroughly with water. If discomfort persists OBTAIN MEDICAL ATTENTION.
Lungs	Remove from exposure.
Skin	Wash off thoroughly with soap and water.
Mouth	Wash out mouth thoroughly with water. In severe cases OBTAIN MEDICAL ATTENTION.

EC Declaration of Conformity

Jenway Model 3305 pH Meter complies with the following European Standards:

EN 50081-1:1992 Electromagnetic compatibility - Generic emission standard

EN 50082-1:1992 Electromagnetic compatibility - Generic immunity standard (Performance criterion B)

EN 61010-1:1993 Safety requirements for electrical equipment for measurement, control and laboratory use

Following the provision of:

EMC Directive - 89/336/EEC and Low Voltage Directive - 73/23/EEC

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