Model 3505
pH/mV/Temperature Meter
Operating Manual

350 550/REV A/03-03

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 3505
pH/mV/Temperature Meter
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Contents

Section 1

Introduction

1.1 Instrument Description

The Model 3505 is a general purpose, laboratory pH/mV meter that uses rotary controls for mode selection, pH calibration and manual temperature adjustment. Automatic Temperature Compensation can be achieved by use of the ATC probe, which will enable the user to perform temperature measurements within the range of 0 to 100°C.

The Model 3505 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
	-2.00 to 16.00pH	0.01pH
	-1999 to +1999mV	1mV
Accuracy:	pH:	±0.02pH
	Millivolts:	±1mV
	Temperature:	±0.5°C
Input Impedance:	$>10^{12}$ohms	
Temperature Compensation:	Manual: -10 to 105°C	0.1°C
	Automatic: 0 to 100°C	0.1°C
Calibration:	Manual	
Display:	25mm LCD	
Power:	9V Battery (MN1604, PP3 or equivalent)	
Outputs:	Analogue buffered electrode potential	
Size:	250(L) x 210(W) x 55(D)mm	
Weight:	850g	

Section 2

Installation

2.1 Unpacking

Remove the Model 3505 from the packaging and ensure the following items are included:

1. Model 3505 pH/mV/Temperature meter
2. Epoxy bodied combination pH electrode (924 001)
3. ATC probe (027 500)
4. Electrode holder
5. 4, 7 and 10pH buffer sachets
6. BNC shorting plug (009 146)
7. Battery (PP3)
8. Condensed operating instructions (350 551)
9. Instruction manual (350 550)

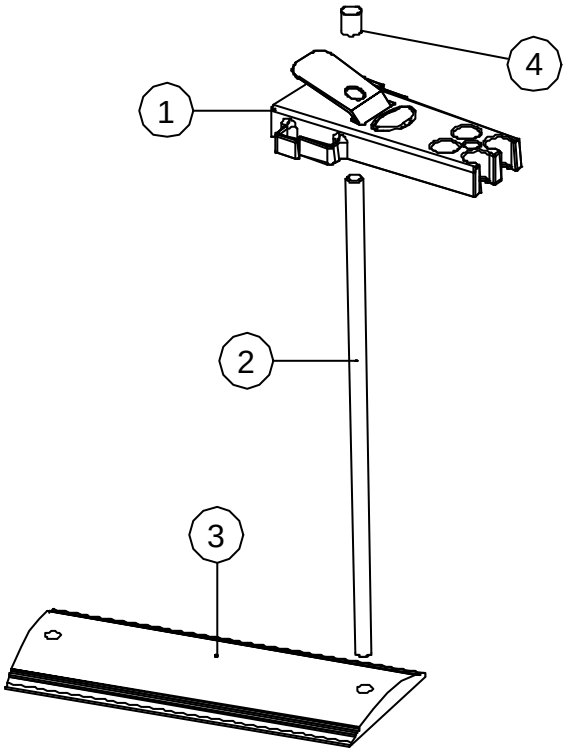
Any shortages or damage should be reported immediately to the Manufacturer or your local Distributor.

2.2 Installation

The Model 3505 is supplied ready to use. Connect the ATC (if required) and the pH electrode to the rear panel Temp and pH sockets.

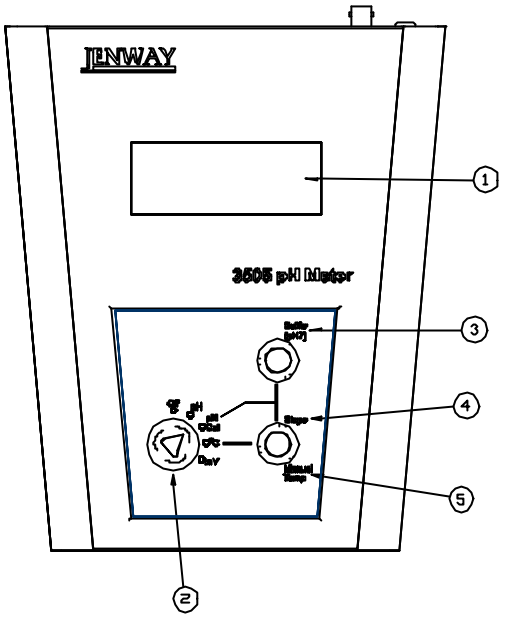
The electrode stand requires minimal assembly (refer to the diagram below).

Fig. 2.2.1 - Electrode Holder Assembly



2.3 Displays/Controls

Fig. 2.3.1 - Displays/Controls



1. **Display** — Provides direct readout of pH, millivolts, temperature of samples and standards and low battery indication.

2. **Function Switch** — Used for selection of mode of operation.
Off - power off.
pH - pH measurement based on last calibration (the adjustment controls have no function).
pH Cal - pH display based on settings of the adjustment controls for buffer and slope.
°C - displays the measured temperature if an ATC probe is connected, or the manually adjusted temperature (set by the Slope/Manual temperature control).
mV - displays the electrode potential in mV.

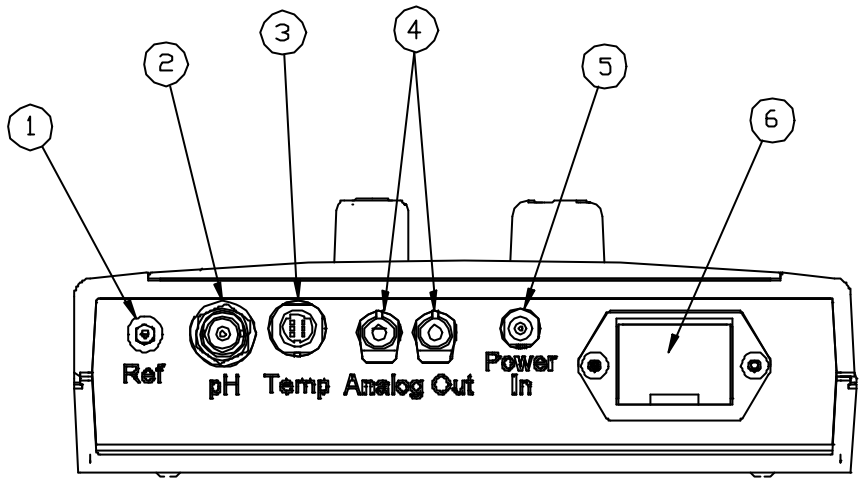
3. **Buffer** — Used to balance out the electrode offset between the pH measurement cell and reference. This should be set with the electrode immersed in pH7 buffer. This control adjusts the electrode effect between -60mV to +60mV.

4. **Slope** — Used to compensate for the variable sensitivity of pH electrodes. As the electrodes age their sensitivity decreases and this control is used to compensate for this. This control adjusts the slope between 75% and 125% of Nernst.

5. **Manual Temp** — When the °C mode is selected (without the ATC probe connected) this control allows the compensation temperature to be set on the display. This control becomes inoperative during use of the ATC probe. The display will show the measured temperature if an ATC probe is connected, or the manually adjusted temperature (set by the Slope/ Manual Temp control).

2.4 Inputs/Outputs

Fig. 2.4.1 - Rear Panel Layout



1. **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.
2. **pH Socket**	BNC type socket which allows combination pH or redox electrodes to be used.
3. **Temp Socket**	8 pin mini DIN socket. This allows the Automatic Temperature Compensation (ATC) probe (027 500) to be connected.
4. **Analog Out**	2 x 4mm sockets. Buffered electrode potential.
5. **Power In**	AC 9V I/P socket. 2.1 x 5.5mm socket allowing the optional power supply to be connected to the instrument. Refer Section 5, Optional Accessories.
6 Battery Compartment	Housing for battery (types PP3 or MN1604).

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 usually measured on a scale of 0 to 14. The pH value quantifies the degree of hydrogen ion activity of an acid or a base.

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 $pH=-\log[H^+]$.

The pH value of a solution 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 Model 3505 is supplied with 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 Solutions

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.

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 calibration.

3.5 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 3M KCl adjusted to pH 4.

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. Note: Some epoxy gel filled electrodes are not refillable.

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 in distilled/deionised water 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.

9) For samples such as blood, serum or any measurements of Tris buffer solutions the junction may become badly clogged. For these measurements it is recommended that the Tris buffer electrode is used (924 030).

10) For applications associated with the measurement of food extracts, it is recommended that the Food electrode is used (924 051). This will reduce the risk of blockage from fat and proteins, will be easy to clean and is perfect for measurements in agar media. This electrode is also recommended for measurement in any solution where deposits on the electrode are likely. The flat surface is easy to clean and robust.

11. For low ionic strength applications the Environmental electrode (924 050) is recommended.

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 (pH4) or alkaline (pH10). Buffer solutions should be carefully prepared as per the Manufacturers instructions.

Calibration - with Manual Temperature Compensation

1. Select **°C** on the **Function** switch. Measure the temperature of the buffer solutions. The instrument display should then be set to the buffer solution temperature measured, using the **Slope/Manual Temp** control.

2. Select **pH Cal** on the **Function** switch. 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/Manual Temp** control. Repeat steps 2-4 until no further adjustments are necessary. Care should be taken when making adjustments as the controls are interdependent.

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

6. Select **pH** on the **Function** switch. When this position is selected the calibration settings are locked (no further adjustment can be made to the buffer and slope values until the **pH Cal** position is re-selected on the **Function** switch).

7. If the temperature of the unknown solution differs from the buffer, the Slope/Manual Temp Control should be used to set the instrument display to the temperature of the unknown solution.

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

Calibration - with Automatic Temperature Compensation (ATC)

1. Select **pH Ca**l on the **Function** switch. 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/Manual Temp control.
   Repeat until no further adjustments are necessary. Care should be taken when making adjustments as the controls are interdependent.

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

5. Select **pH** on the **Function** switch. When this position is selected the calibration settings are locked (no further adjustment can be made to the buffer and slope values until the **pH Cal** position is re-selected on the **Function** switch).

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

3.7 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.
   b) Select **mV** mode on the **Function** switch. The display will show the electrode output 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. **Temperature Measurement (Manual)**
   a) If Manual temperature compensation is being used, the °C range should be selected on the **Function** switch.
   b) Immerse the electrode into the solution and set to the solution temperature using the **Slope/Man Temp** control.

4. **pH Measurement**
   a) Perform a calibration sequence using manual or automatic temperature compensation.
   b) Immerse the electrode(s) into the solution to be measured and note the results once the reading has stabilised. (Refer to Section 3.6 for full details).

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 3.5-Good Practice Guidelines.

Section 4

Maintenance

4.1 General

The Model 3505 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 (060 406).

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 of Cleaning Agents for 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 3505:

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**
060 406	Dust Cover

pH Electrodes

924 001	General purpose, epoxy bodied combination, 12mm diameter. For liquids.
924 005	General purpose, glass bodied combination, 12mm diameter. For liquids.

For a complete listing of all available electrodes please contact your local distributor.

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)
025 179	pH 4 buffer sachets (pack of 10)
025 180	pH 7 buffer sachets (pack of 10)
025 181	pH 10 buffer sachets (pack of 10)

Redox Standards

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

Miscellaneous

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

5.2 SPARES

924 001	pH combination electrode (epoxy bodied)
009 146	BNC shorting cap
027 500	ATC probe

Section 6

Troubleshootiing and functional checks

6.1 Troubleshooting

Fault	Possible Cause	Action
No Display	Battery failure	Replace battery Use optional Power supply (See section 5 for correct voltage)
Drifting erratic readings	Electrode fault	Use BNC cap to test 3505 (see 7.2) Replace electrode
Cannot calibrate	Electrode Fault	Use BNC cap to test 3505 (see 7.2) Replace electrode
Temperature readings fluctuating	Temp probe faulty	Check 3505 using section 7.2 Replace temperature probe
Temperature readings incorrect	Temp probe faulty	Check 3505 using section 7.2 Replace temperature probe
	Manual temp not set	Set meter to read °C and set temperature against a calibrated thermometer
Slope/Buffer controls not working	3505 incorrectly set	Set Dial to pH Cal
Battery symbol is displayed	Battery running out	Less than 8hrs lifetime left - replace battery

If the above does not answer your query try the FAQ section on the www.Jenway.com Website.

6.2 Functional check

The measurement function of the meter can be checked using the enclosed BNC shorting cap (009 146).

1) Remove the ATC probe if connected.
2) Set Manual temperature compensation to 25°C using the Dial on the 3505
3) Remove pH probe and replace with BNC shorting cap.
4) Set the meter to pH cal and adjust Buffer control to read 7.00.

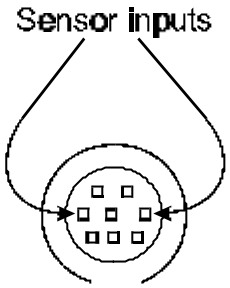
If this cannot be set to 7.00 please contact the manufacturer or you local distributor.

To make measurements from this point refit the ATC probe and pH probe and calibrate the 3505 using fresh buffer solutions (see section 3.6).

Temperature input check.

Remove the temperature probe and apply a 10Kohm resistor across the pins of the temp input as described in fig 7.2.1

Fig 6.2.1 Temperature input with connection detail



EC Declaration of Conformity

Jenway Model 3505 pH/mV/Temperature 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

Thank you for reading this data sheet.

For pricing or for further information, please contact us at our UK Office, using the details below.

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