**Model RT4-PH**

Loop Powered pH/Redox Transmitter

Operation and Instruction Manual

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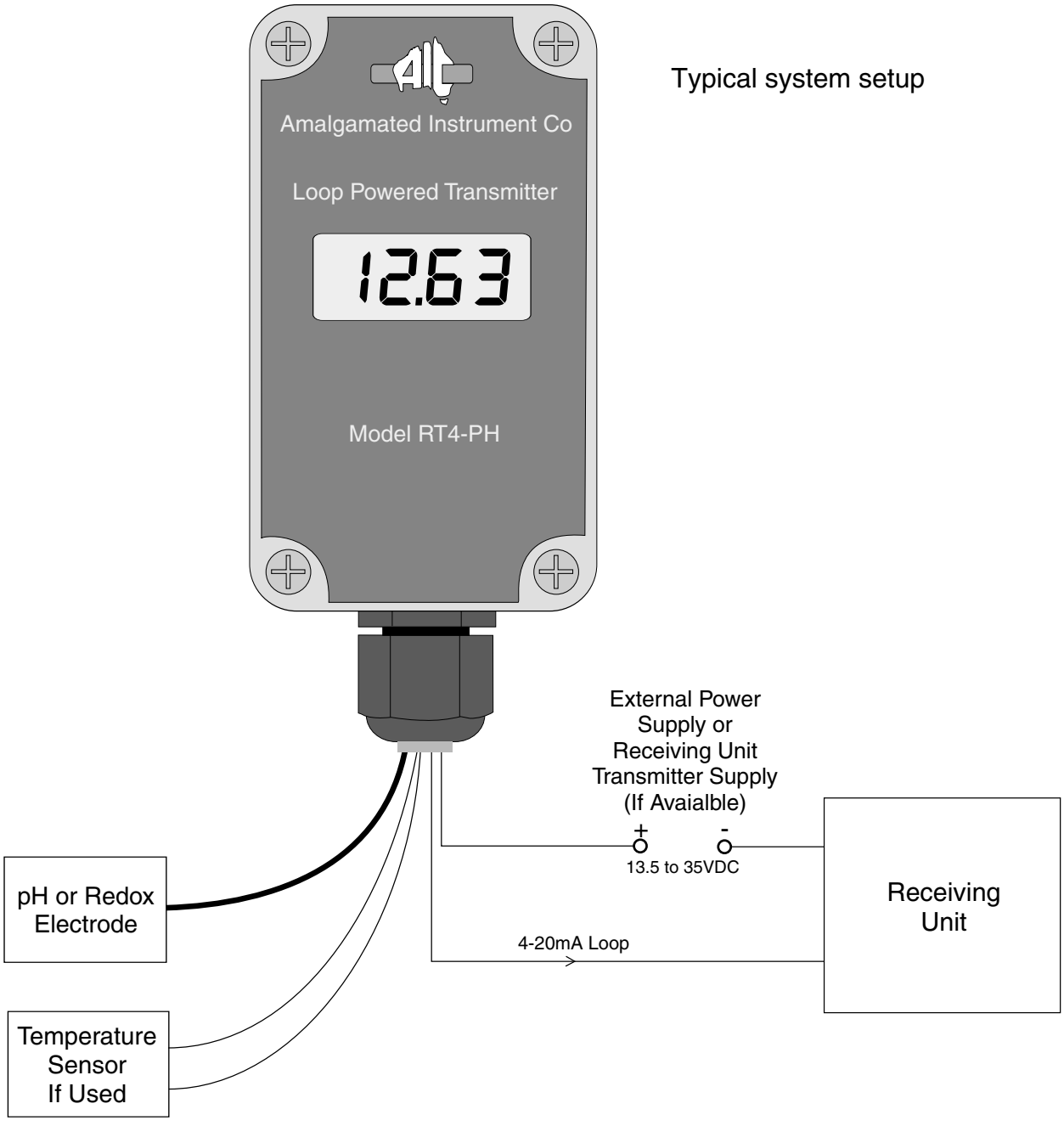
# 1 Introduction

This manual contains information on the operation of models RT4-PH and RT4-OR Intelligent Digital pH/Redox transmitters. The RT4 is a fully isolated 4-20mA loop powered pH/Redox meter which may be programmed to give a pH or Redox or temperature display. If a pH or Redox display is selected then the process temperature may be viewed by pressing the **P** push button (if a temperature sensor is connected). When the RT4 is turned on, the display will indicate various power up messages and then settle into the measurement mode.

The loop output is fully scalable and may be set to operate within any band in the measuring range.

Unless otherwise specified at the time of order, your RT4 has been factory set to a standard configuration (see “Function Table” for default settings). Like all other RT4 series instruments the configuration and calibration is easily changed by the user.

The RT4 series instruments are designed for high reliability in industrial applications. The IP65 rated enclosure makes the instrument suitable for use in many different environments. The high contrast LCD provides good visibility.

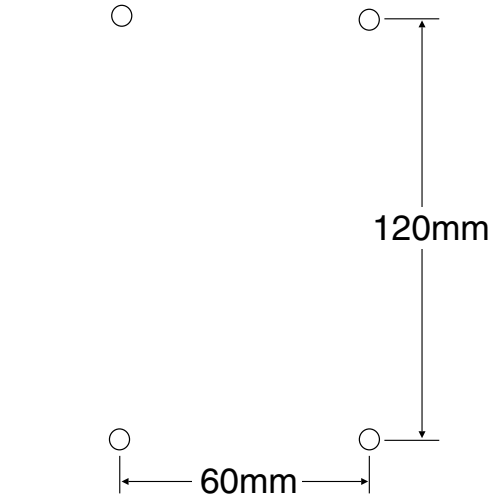


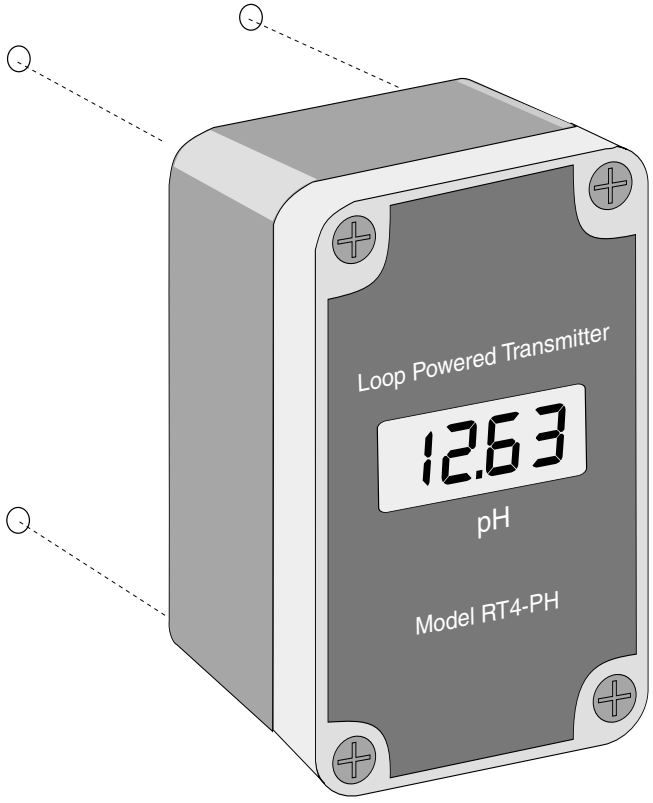
# 2 Mechanical Installation

The RT4 is designed to be wall mounted with 4 screws. Obtain screws to suit the surface on which the instrument is to be mounted. The case has holes for the mounting screws in it. They are 4.4mm in diameter. To gain access to the screw holes, the cover of the instrument must be removed.

Mounting details are as shown below.

When choosing a location to mount the instrument, try to avoid areas close to heavy electrical interference such as welders, flourescent lights, motors etc



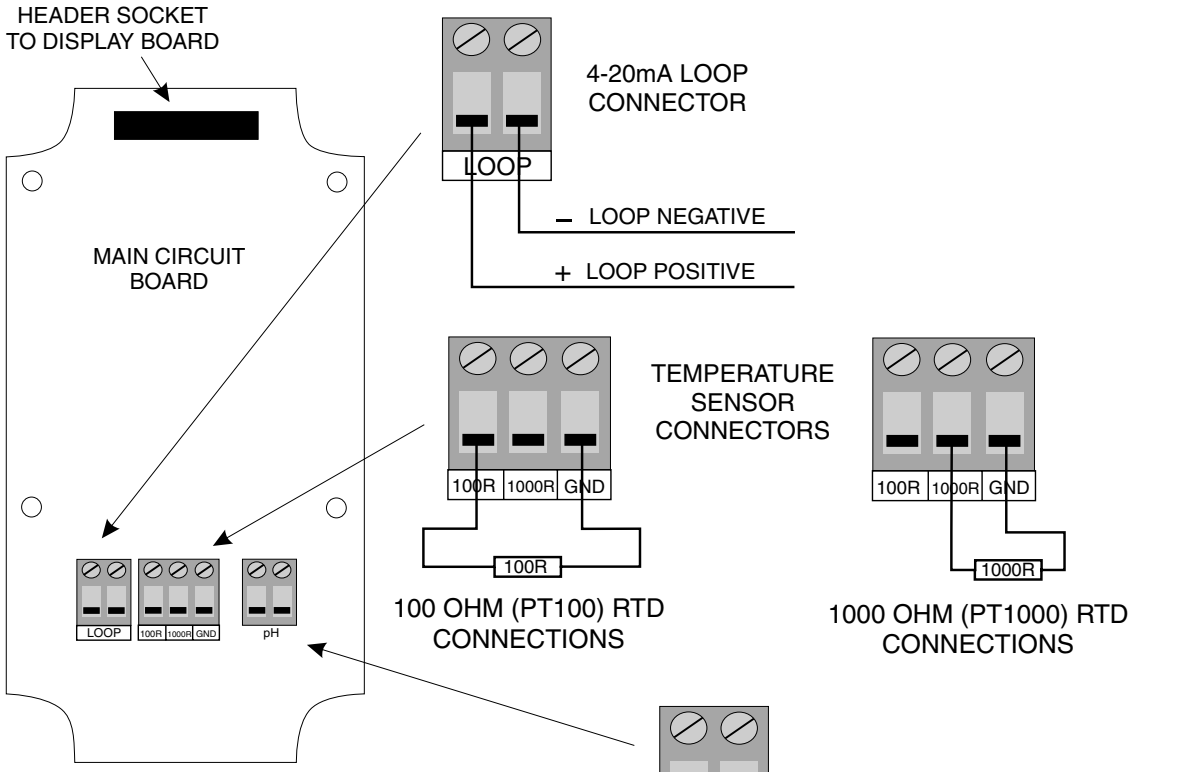



# 3 Electrical Installation

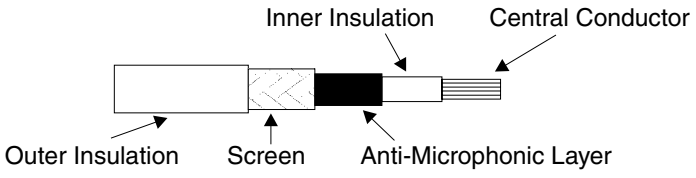
Electrical connections to the RT4-PH are made via connectors on the main circuit board as shown below. Electrode input via BNC connector (female connector on the circuit board) other connectors are screw type which accept wires up to 1.5mm$^2$ diameter. Cable entry is via housing mounted cable glands. For Redox measurement connect the Redox electrode where the pH electrode is indicated in the drawings below.

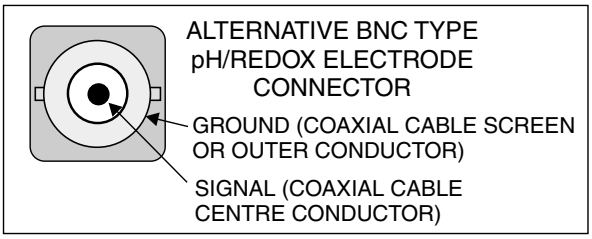
The instrument is 4-20mA loop powered and requires a voltage supply from the loop of between 13.5 and 35 VDC. The loop output is fully isolated.

pH cable lengths above 10 metres (approx) may require pH signal amplification. A long life battery powered pH amplifier which will provide adequate signal levels for transmission over 500 metres is available for these situations.




Note: If using low noise pH/Redox coaxial cable with an anti-microphonic layer ensure that this layer is removed from the exposed wiring. This layer is conductive and may cause a short circuit between the centre conductor and the cable screen resulting in an incorrect indication, usually this fault would be seen as a constant 7.00 pH or 0mV indication.



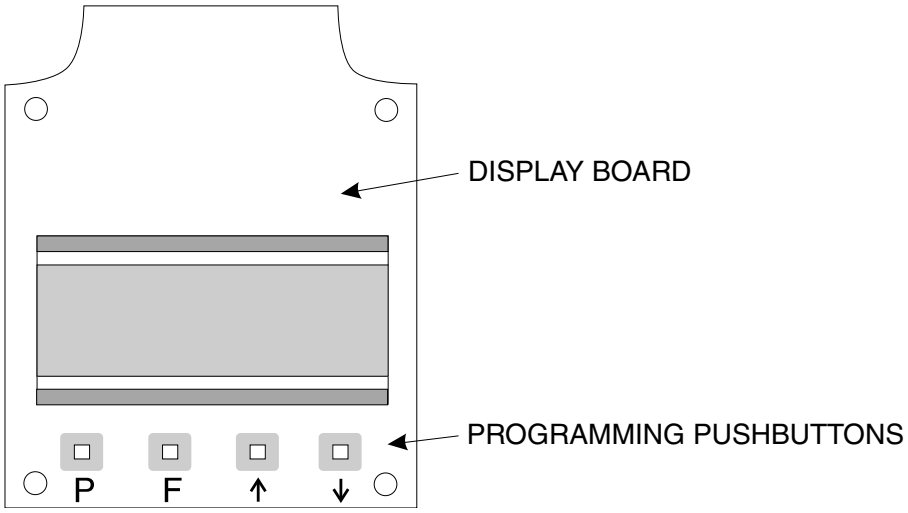
# 4 Setting up the Instrument

Setting up and calibrating the RT4 is extremely easy, since most functions are changed or viewed by pressing the pushbuttons located on the display board. The programming pushbuttons are accessed by removing the instruments front panel, take care that the front panel “O” ring is not damaged when replacing the front panel.

Calibration functions are available only through a special “power up” procedure, see the “Calibration” chapter for details.

## 4.1 Step 1, Entering the Function Setup Mode

To enter the setup mode a simple pushbutton sequence is necessary (this prevents accidental alteration of settings). First press and release the F button and then (within 2 seconds) press both the ▲ and ▼ buttons simultaneously. The display will now read FUNC indicating that you have entered the Function Setup Mode.




## 4.2 Step 2, Stepping through the settings

The display of FUNC is followed by the first setup message LP_ (loop 4mA value). As with all other messages the first display lets you know which parameter will be affected when changes are made. Each time the F button is pressed and released another setup parameter is displayed. After the last function the display returns to the normal process display.

## 4.3 Step 3, Making changes to the settings

Whilst still in the Function Setup Mode, press and release the F button until you reach the parameter you wish to change. Initially the display will indicate the particular function (e.g. dFLt), this will be followed by a display showing the current status of that setting (e.g. 30.0). The setting may now be changed by pressing the ▲ or ▼ pushbutton until the desired value is displayed. You may then proceed through the functions until you reach the next function that you wish to change or until you exit the function mode.

**Note :** Pressing the P button in the setup or calibrate mode exits the current function leaving it unchanged. This is useful for aborting a current function or a method of quickly exiting the function mode by stepping to the next function and then pressing the P button.

The P button may also be used to read the solution temperature, if a temperature probe is connected, whilst pH display is selected as the default display. When the P button is pressed during a process measurement the display will indicate Sol n followed by the solution temperature, this display will time out after 1 minute and return to pH measurement.

When a temperature display is selected as the default display, pressing and releasing the P button will show a temporary pH reading, PH will be displayed to indicate that the display has changed over to pH measurement. This reading will again time out in 1 minute and return to the temperature reading indicating Sol n as it returns.

The temperature may be read in the same manner when Redox (ORP) is selected as the default display, even though the Redox measurement is not temperature compensated.

# 5 Explanation of Functions

The RT4 setup and calibration functions are configured through a pushbutton sequence, as explained in “Setting up the instrument” and “Calibration”. Two levels of access are provided for setting up and calibrating - level 1 (simple pushbutton sequence) allows access to commonly set up functions, level 2 (power up sequence plus pushbutton sequence) allows access to calibration parameters. Note; certain functions relating to the optional retransmission output limits are only displayed when the retransmission option is fitted. Changes to the setpoints and other functions are made by pressing the ▲ and ▼ pushbuttons. Below is a brief description of each function.

**Set up functions (see also chapter titled “Setting up the instrument”)**

To enter the set up mode, a simple pushbutton sequence is necessary (this prevents accidental alteration of settings). First press the F button and then (within 2 seconds) press both the ▲ and ▼ pushbuttons simultaneously. The display will now read FUNC thereby indicating that you have entered the Setup Function Mode. Each function may be accessed by pressing the F pushbutton to step through the functions as indicated below.

**LP_ (loop 4mA value)**

Displays and sets the display value at which the 4mA loop current will be transmitted. For example to obtain a 4mA output for a pH display of 0.00 set the LP_ function to 0.00.

**LP¯ (loop 20mA value)**

Displays and sets the display value at which the 20mA loop current will be transmitted. For example to obtain a 20mA output for a pH display of 14.00 set the LP_ function to 14.00.

**drnd (display rounding)** only applicable to Redox (ORP) measurement.

Displays and sets the display rounding value. This value may be set to 0 - 5000 displayed units. Display rounding is useful for reducing the instrument resolution without loss of accuracy, in applications where it is undesirable to display to a fine tolerance. (example if set to 0.5 the instrument will display in multiples of 0.5).

**dCPt (decimal point selection)** only applicable to Redox (ORP) measurement.

Displays and sets the decimal point. By pressing the ▲ or ▼ pushbuttons the decimal point position may be set. The display will indicate as follows: 0 (no decimal point), 0.1 (1 decimal place), 0.02 (2 decimal places), 0.003 (3 decimal places). The decimal point for pH measurement is fixed at 2 decimal point places.

**dFLt (default temperature)** only applicable to pH measurement.

Displays and sets the default temperature value which will be used for temperature compensation when no temperature probe is used (i.e. tYPE set to nONE). The default temperature should be set to the process temperature of the solution being measured. This setting applies only to pH readings since Redox readings are not temperature compensated. When no temperature sensor is connected this default temperature value will be used in the temperature compensation calculations.

**FLtr (digital filter)**

Displays and sets the digital filter value. Digital filtering is used for reducing susceptibility to short term interference. The digital filter range is selectable from 0 to 8, where 0 = none and 8 = most filtering. A typical value for the digital filter would be 3.

**OFSt (offset calibration)**

Used for fast single point calibration to compensate for changes to the electrode, when exhibited as an offset error (see “Calibration” chapter).

**GAIn (gain calibration)**

Used for fast single point calibration to compensate for changes to the electrode, when exhibited as a gain error (see “Calibration” chapter).

**SLPE (electrode slope)**

This function displays the existing calibrated slope of the electrode in relation to the ideal slope of a electrode. The slope is expressed as a percentage and provides an indication of the electrode condition. When the electrode slope reduces to 80% the electrode should be discarded. The slope of an electrode is a measure of the efficiency of the electrode. Slope is calculated by measuring the mV change in electrode

output between two pH buffer solution values at a given temperature, dividing the actual change by the theoretical change value at this temperature and then multiplying by 100%. See section 5.1 for mV table.

**d, SP (set display mode)**

See “Setting up the Instrument” chapter for details on manually toggling the display.

The display modes available are:

**PH** for a pH measurement display when a pH electrode is being used.

**ORP** for a Redox (ORP) measurement display when an ORP electrode is being used.

**rtd** for a temperature display when a temperature compensation probe is used.

**toGl** When **toGl** is selected the display automatically toggles between pH and temperature displays ever 3 seconds. At the change-over from one reading to the next the display will show either **PH** to indicate a pH measurement follows or **Sol n** to indicate that a solution temperature measurement follows.

**FAIL (select failure mode)**

Displays and sets the failure mode of operation when either the pH or temperature input is out of range. When an out of range input occurs the display will show **----** and the loop output will either be forced low (4mA) or high (20mA) depending on the **FAIL** option setting.

The two options which may be selected in this function are:

**LO** - when **LO** is selected the loop current will be forced to a 4mA output if an out of range pH or temperature input occurs.

**Hi, Gh** - when **Hi, Gh** is selected the loop current will be forced to 20mA output if an out of range pH or temperature input occurs.

**CAL 1** & **CAL2 (calibration using 2 buffer solutions)**

Displays and sets the two independent calibration points. See “Calibration” chapter for full details of setting up.

Enter **CAL 1** place the electrode in buffer 1, allow to stabilise, press and release the **F** button, display will read **PH 1** (or **OF 1**) enter correct reading for buffer 1, then press **F** button to enter **CAL2** Place electrode in buffer 2, allow to stabilise, press **F** button display will read **PH2** (or **OF2**) enter correct reading for buffer 2, then press **F** display will read **Stnd** indicating the calibration is complete.

**UCAL (uncalibration)**

Used to set the instrument back to the factory calibration values. This function should only be used when calibration problems exist, and it is necessary to clear the calibration memory.

**1 nPt ( selects input slope positive or negative)**

Selects for positive or negative voltage slope. A positive slope is for a normal electrode. A negative slope caters for a reversed potential, which is a characteristic of some electronic head amplifiers.

**tYPE (selects temperature probe type)**

Select **100** for 100Ω (PT100), **1000** for 1000Ω RTD (PT1000) or **NONE** if a sensor is not used. If **NONE** is selected then the default temperature set at the **dFLt** function temperature value will be used for temperature compensation.

**CAL.t (temperature calibration)**

The temperature calibration is a single point calibration. Place the temperature probe in an accurately known temperature environment and the correct value is entered into the instrument memory. (See “Calibration” chapter).

**UC.t (temperature uncalibration)**

Used to set the instrument temperature calibration back to the factory calibration value. This function should only be used when calibration problems exist, and it is necessary to clear the calibration memory. (See “Calibration” chapter).

**Returning to the normal measure Mode**

Important; when the calibration is complete, it is advisable to return the instrument to the normal mode (where calibration functions cannot be tampered with). To return to the normal mode - turn off the instrument power by removing the loop connection - wait a few seconds and the restore power.

## 5 .1 pH values in milli Volts (mV)

The table below shows the mV output of an ideal pH electrode. The output from the electrode changes with temperature. Automatic or manual temperature compensation can be used at the pH monitor to compensate for the output change with temperature.

For temperature values not shown in the table below the theoretical change in mV output per 1pH change can be calculated by the formula:

Theoretical change in mV per 1pH = 0.198357T + 54.20 mV

Where T is the solution temperature in degrees C.

| pH | Temperature | | | |
|---|---|---|---|---|
| | 0°C | 25°C | 50°C | 100°C |
| 0 | 379.4mV | 414.1mV | 448.9mV | 518.3mV |
| 1 | 325.2mV | 355.0mV | 384.8mV | 444.3mV |
| 2 | 271.0mV | 295.8mV | 320.6mV | 370.2mV |
| 3 | 216.8mV | 236.6mV | 256.5mV | 296.2mV |
| 4 | 162.6mV | 177.5mV | 192.4mV | 222.1mV |
| 5 | 108.4mV | 118.3mV | 128.2mV | 148.1mV |
| 6 | 54.2mV | 59.2mV | 64.1mV | 74.0mV |
| 7 | 0.0mV | 0.0mV | 0.0mV | 0.0mV |
| 8 | 54.2mV | -59.2mV | -64.1mV | -74.0mV |
| 9 | -108.4mV | -118.3mV | -128.2mV | -148.1mV |
| 10 | -162.6mV | -177.5mV | -192.4mV | -222.1mV |
| 11 | -216.8mV | -236.6mV | -256.5mV | -296.2mV |
| 12 | -271.0mV | -295.8mV | -320.6mV | -370.2mV |
| 13 | -325.2mV | -355.0mV | -384.8mV | -444.3mV |
| 14 | -379.4mV | -414.1mV | -448.9mV | -518.3mV |

# 6 Function Table

| Initial display | Meaning of display | Next display | Default setting | Record Your Settings |
|---|---|---|---|---|
| LP_ | Set loop 4mA value | Value in memory | 0.00 | |
| LP^ | Set loop 20mA value | Value in memory | 14.00 | |
| drnd | Display rounding (for ORP display only) | Value in memory | 1 | |
| dCPt | Decimal point places (for ORP display only) | 0, 0.1, 0.02 or 0.003 | 0 | |
| dFlt | Default temperature set | 0.0 to 125.0 | 25.0 | |
| FLtr | Digital filter | 0 to 8 | 3 | |
| OFSt | Calibration offset | Value in memory | | |
| SAln | Calibration gain | Value in memory | | |
| SLPE | Electrode slope | Value from last calibration | | |
| d1SP | Set display mode | PH, ORP, rtd or to91 | PH | |
| FAIL | Set failure mode | LO or Hi, 9h | LO | |
| CAL1 | Calibration point 1 | See calibration chapter | | |
| CAL2 | Calibration point 2 | See calibration chapter | | |
| UCAL | Uncalibration | See calibration chapter | | |
| InPt | Select input polarity | POS or NEG | POS | |
| tYPE | Set temperature sensor type | 100, 1000 or NONE | 100 | |
| CAL.t | Temperature calibration | See calibration chapter | | |
| UC.t | Temperature uncalibration | See calibration chapter | | |

Functions shown shaded are accessible only when in the power up (Calibration) mode, see “Calibration” chapter

# 7 Calibration pH/Redox/temperature

The RT4-PH has provision for two methods of pH/Redox calibration, two single points may be used for routine calibration, whilst a two point method should be used for initial calibration, critical applications, when the electrode is replaced or for periodical maintenance etc.

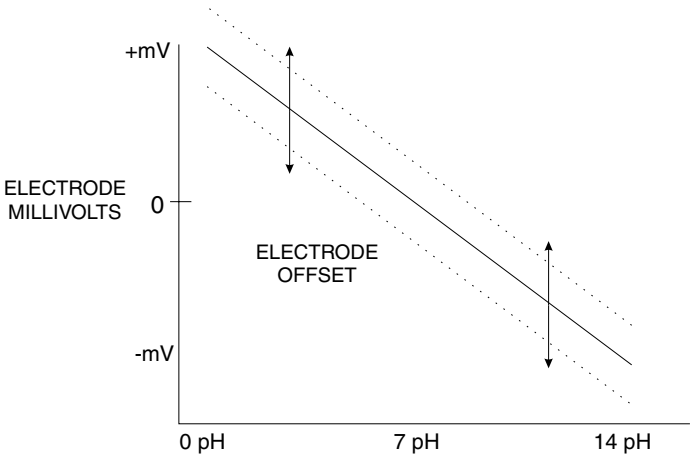
**Routine pH/Redox calibration**

The following calibration descriptions use pH as the example, these description also applies to Redox (ORP) calibration, reference to Redox in this descriptions will be made only where necessary. The two single point calibration functions are accessible by entering and stepping through the function mode (see chapter - "Setting up the Instrument"). These functions are used to compensate for changes to the offset and gain (slope) of the electrode due to normal ageing and electrode wear. Normally only one of the two points is used to carry out single point calibration - the choice is determined by evaluating the cause of the calibration shift. Ideally the difference between two pH values should be known - if the pH reading has the same error at two points, then the offset calibration **OFSt** should be used - if the pH reading is correct around 7pH (for electrodes with Eo=7pH) and increases progressively above or below 7pH, then the gain calibration (**GAIn**) should be used. As a general rule, use the offset calibration, when the type of calibration shift is unknown.

Enter the Setup Mode in the usual way by pressing the **F** button (note that the front panel must be removed to gain access to the push buttons) then pressing both the ▲ and ▼ buttons simultaneously (within 2 seconds), press and release the **F** button until the display indicates **OFSt** (Calibration offset).

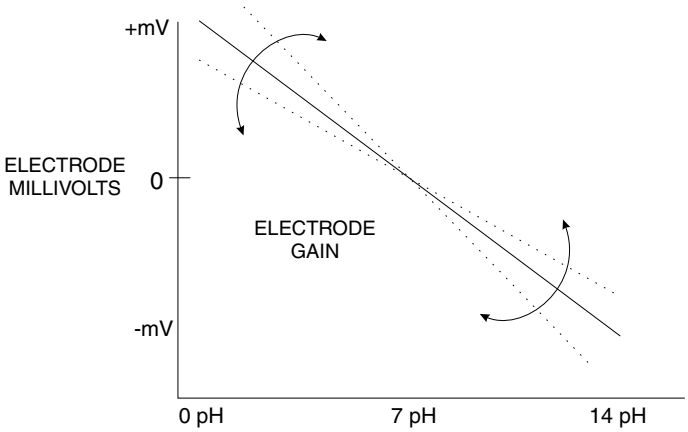
**OFSt (calibration offset)**

To enter the offset function press the ▲ and ▼ pushbuttons simultaneously - the display will indicate the current pH value at the probe. Place the probe in a known buffer solution. When the display has stabilised, press the **F** button - the display will now read **PH** (or **ORP** for Redox measurement) followed by the value in memory, the offset may now be changed using the ▲ or ▼ pushbuttons to read the correct value of the buffer solution. To enter the correct value press the **F** button. The display will show **OFSt End** and the system offset will be adjusted so that the display will match the corrected value.




**GAIn (calibration gain)**

The **GAIn** function follows the **OFSt** function. To enter the **GAIn** function press the ▲ and ▼ pushbuttons simultaneously - the display will indicate the current pH value at the probe. Either take a sample of the probe test solution (if its pH value is known) or place the probe in a known buffer solution. When the display has stabilised, press the **F** button - the display will now read **PH** (or **ORP** for Redox measurement) followed by the last value in memory, the gain may now be changed using the ▲ or ▼ pushbuttons to read the correct pH value of the probe test solution or buffer. To enter the correct value press the **F** button. The display will show **GAIn End** and the system gain will be adjusted so that the display will match the corrected value.



### Calibration Functions

To enter the calibration mode a special “power up procedure” must be followed. This procedure prevents accidental alteration of calibration and provides a degree of calibration security. The front panel of the instrument must be removed in order to gain access to the required push buttons.

### Preparing to initialise

1. Turn instrument off by removing one of the loop connections.

2. Press and hold the F button whilst applying power to the instrument. The instrument will momentarily show CAL (during the wake up messages) to let you know that the calibration level of the function mode is now accessible.

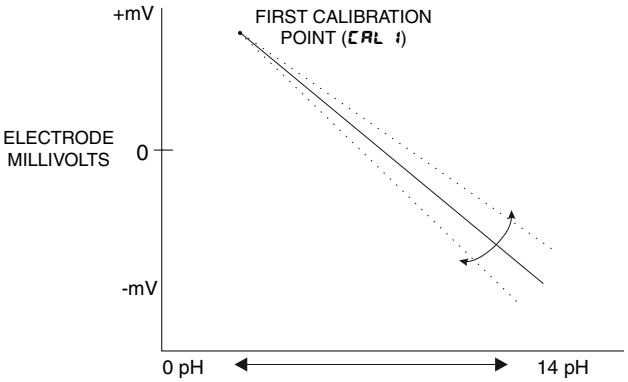
### Entering the calibration mode

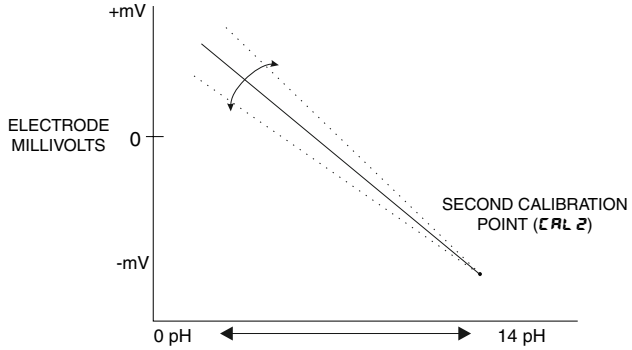
Enter the Setup Mode in the usual way by pressing the F button then simultaneously (within 2 seconds) pressing both the ▲ button and the ▼ button, then step through the functions by pressing and releasing the F button, until the display indicates CAL 1.

### pH/Redox calibration (2 points)

See also "RT4-PH two point calibration procedure example" which follows.

To enter the calibration mode press the ▲ and ▼ buttons simultaneously at the CAL 1 display. The display will now show the “live” pH or reading. Immerse the electrode in a pH buffer solution of nominally 7 pH, (or use a Redox buffer for Redox measurement) (this value is not critical and may be anywhere within the measuring range of the instrument). When the reading has stabilised press the F button. The display will now indicate PH 1 (or ORP for Redox measurement) followed by the scale value in memory. Now press the ▲ or ▼ buttons to obtain the required scale (calibration) value. Press the F button the display will now indicate Stnd followed by CAL2 press ▲ and ▼ together to enter the CAL2 programming section. Wash the electrode in distilled or pure water and immerse the electrode in a second buffer solution (again this value is not critical, for best accuracy should not be too close to the previous value). When the reading has stabilised, press the F button, the display will now read PH 2 (or ORP for Redox measurement) followed by the second scale value in memory. Press the ▲ or ▼ button to obtain the required scale value. Press F button the display will now read Stnd indicating that the calibration is complete. The display will return to the measure mode. Note: the buffer values used will remain in the instrument memory, thereby making future calibration easier, if the same value buffers are used.




### pH/Redox uncalibration

This function sets the instrument calibration back to the factory calibrated value and closely matches that of an ideal electrode. Uncalibrate is useful as a temporary measure when the electrode is replaced and on the spot recalibration is difficult or when a calibrating error exists due to incorrect calibration. To enter the uncalibrate mode follow the procedure described above and step through the functions by pressing the F button until the display shows UCAL. Press the ▲ and ▼ pushbuttons simultaneously the display will show CAL CLr indicating that the calibration is cleared. The display will return to the measure mode.

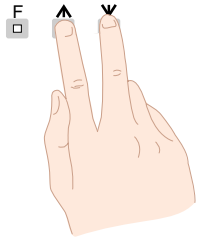
## RT4-PH two point calibration procedure example

1. Enter CAL mode as shown below.
2. Step through the functions by pressing and releasing the F button until the CAL 1 function is reached.
3. Follow the procedure in the 2 Point calibration example shown below.

### Entering CAL Mode


1. Remove power from the instrument. Hold in the F button and reapply power. The display will indicate CAL as part of the "wake up messages" when the CAL message is seen you can release the button.


2. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the F button.




3. Within 2 seconds of releasing the F button press, then release the ▲ and ▼ buttons together. The display will now indicate FUNC followed by the first function.

### 2 Point calibration example

#### First point

1. Wash and dab dry the probe then place probe in buffer 1 e.g. 7.00 pH. At the CAL 1 function press the ▲ and ▼ pushbuttons simultaneously. A live reading will be seen.
2. Allow the reading to stabilise then press the F pushbutton. The display will show PH 1 followed by a value.
3. Use the ▲ or ▼ pushbutton to make this value equal the first buffer value e.g. 7.00 for a 7.00 pH buffer.
4. Press F to accept this new scaling value. The message Stnd will be seen if the input has been accepted.

#### Second point

1. Wash and dab dry the probe then place probe in buffer 2 e.g. 4.00 pH. At the CAL 2 function press the ▲ and ▼ pushbuttons simultaneously. A live reading will be seen.
2. Allow the reading to stabilise then press the F pushbutton. The display will show PH2 followed by a value.
3. Use the ▲ or ▼ pushbutton to make this value equal the first buffer value e.g. 4.00 for a 4.00 pH buffer.
4. Press F to accept this new scaling value. The message Stnd will be seen if the input has been accepted followed by the message FUNC End. The instrument will then return to normal measurement.


Buffer solution 1


Buffer solution 2.

### Temperature calibration

Step through the calibrate functions until the display indicates CAL.t (temperature calibration). Press the ▲ and ▼ buttons simultaneously to enter the temperature calibration mode. The display will now indicate CAL 1 (calibration point) followed by the "live" reading. Place the temperature probe into an accurately known temperature environment (this value is not critical and should ideally be close to the normal measuring temperature of the instrument). When the reading has stabilised press the F button. The display will indicate °C followed by the scale value in memory. Now press the ▲ or ▼ button to obtain the required scale (calibration) value. Press the F button the display will now read CAL.t End indicating that the calibration is complete. The display will return to the measure mode.

### Temperature uncalibration

This function returns the calibration to that of an ideal temperature probe and is useful when a temperature calibration error has occurred due to miscalibration and the conditions do not allow on the spot recalibration. To enter the uncalibrate mode follow the procedure described above and step through the functions by pressing the F button until the display shows UC.t. Press the ▲ and ▼ pushbuttons simultaneously the display will show CAL.t CLr indicating that the calibration is cleared. The display will return to the measure mode.

### Returning to the normal measure mode

When the calibration procedure has been completed, it is advisable to return the instrument to the normal mode (where calibration functions cannot be tampered with). To return to the normal mode turn the instrument off by removing one of the loop wires, wait a few seconds and then turn on again by reconnecting the loop wire.

# 8 Specifications

**Technical Specifications**

| | |
|---|---|
| pH Input: | Any electrode where $E_o$= 7 (-1V to 1V nominal)<br>Resolution 0.01pH<br>Accuracy 0.03pH |
| Redox Input: | Any standard platinum electrode<br>Resolution, down to 0.001mV<br>Accuracy ±2% of full scale |
| Input Resistance: | Greater than $10^{10}\Omega$ |
| Temperature Input: | 100Ω RTD, 1000Ω RTD or manual<br>Resolution 0.1°<br>Accuracy 0.3° |
| Loop voltage drop: | 12V nominal |
| Measuring Range: | 0.00 to 14.00 pH<br>-35 to 119°C with 100Ω RTD<br>-35 to 129°C with 1000Ω RTD |
| Sample Rate: | 2 per sec (approx) |
| A/D Converter: | Dual slope integration |
| Loop Output: | Resolution 0.006mA<br>Accuracy 0.02mA |
| Microprocessor: | MC68705C8 CMOS |
| Ambient Temperature: | -10 to 50°C |
| Humidity: | 5 to 95% non condensing |
| Display: | LCD 4 digit 12.7mm |
| Power Supply: | Loop powered (4-20mA), requires 13.5 to 35 Volts DC |
| Physical Characteristics | |
| Case Size: | 140mm (h) x 80mm (w) x 65mm (d) |
| Connections: | Loop power - Plug in screw terminals (max 1.5mm$^2$ wire)<br>Temperature - Plug in screw terminals (max 1.5mm$^2$ wire)<br>pH input - Supplied with plug in screw terminals (max 1.5mm$^2$ wire) or BNC connector |
| Weight: | 500 gms unpacked |

# 9 Guarantee and Service

The product supplied with this manual is guaranteed against faulty workmanship for a period of 2 years from the date of dispatch.

Our obligation assumed under this guarantee is limited to the replacement of parts which, by our examination, are proved to be defective and have not been misused, carelessly handled, defaced or damaged due to incorrect installation. This guarantee is VOID where the unit has been opened, tampered with or if repairs have been made or attempted by anyone except an authorised representative of the manufacturing company.

Products for attention under guarantee (unless otherwise agreed) **must be returned to the manufacturer freight paid** and, if accepted for free repair, will be returned to the customers address in Australia free of charge.

When returning the product for service or repair a full description of the fault and the mode of operation used when the product failed must be given.

In any event the manufacturer has no other obligation or liability beyond replacement or repair of this product.

Modifications may be made to any existing or future models of the unit as it may deem necessary without incurring any obligation to incorporate such modifications in units previously sold or to which this guarantee may relate.