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# SKW 500 Complete Soil Kit

## Operation Manual

## **Who We Are**

**“Palintest aim to be the best global provider of water and environmental analysis equipment that enable critical environmental decisions to be made with confidence.”**

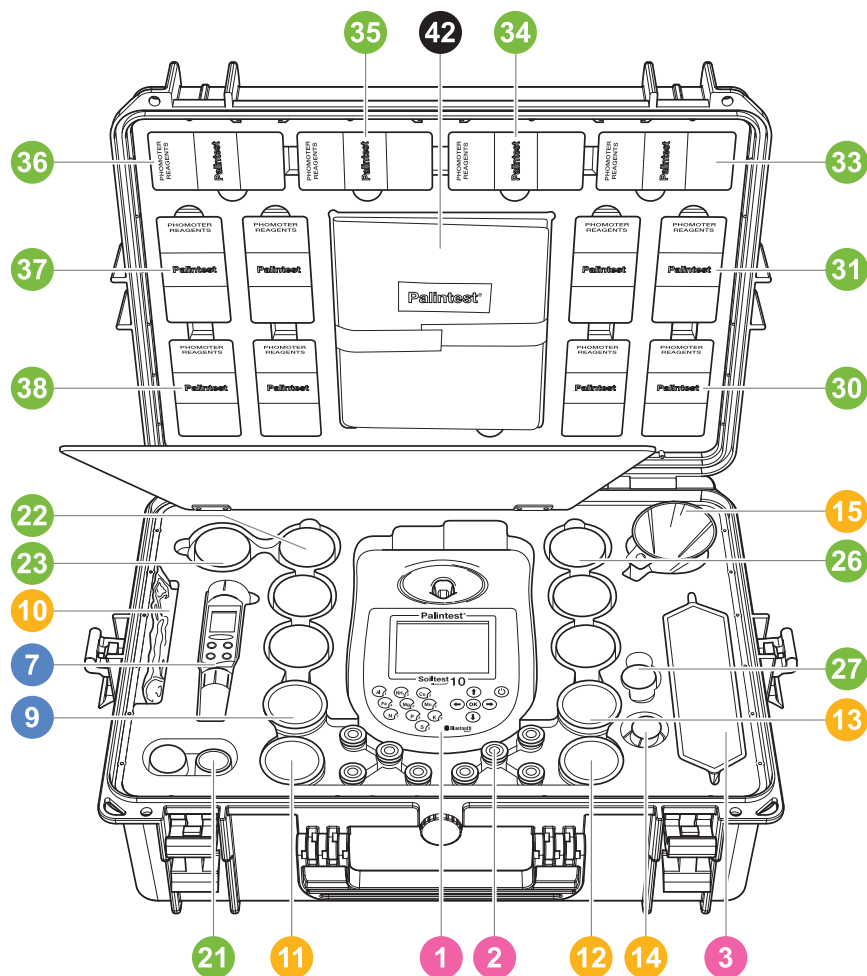
Palintest develops, manufactures and supports a comprehensive range of advanced water and environmental testing equipment. From our United Kingdom headquarters we export to over 100 countries across the globe. Our products are used in a wide variety of applications to protect the environment and safeguard public health.

The Palintest Soil Kit range benefits from 30 years of experience in developing simplified soil testing methods for field and laboratory soil nutrient analysis.

To find out more about Palintest please visit [www.palintest.com](http://www.palintest.com) or contact your local Palintest partner.






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## SKW 500 Complete Soil Kit - Layer 1

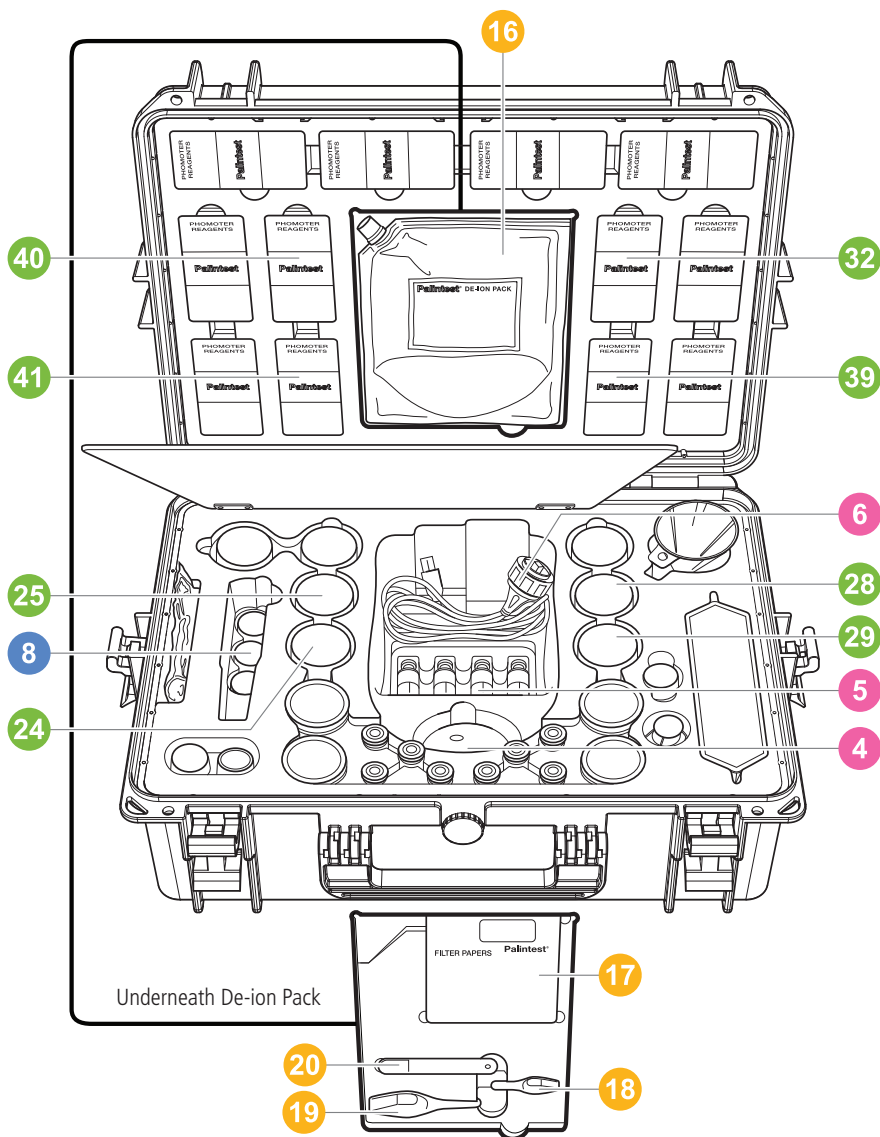


**Fig 1.** SKW 500 Complete Soil Kit opened to show contents.

Coloured circles indicate the chapter colour in which their use is explained.

Function	Equipment
 Parameter Testing Using Soiltest 10 Bluetooth	① <b>Soiltest 10 Bluetooth</b> ② <b>Cuvettes</b> ③ <b>Cuvette Rack</b>
 pH, Conductivity and Salinity Measurement	⑦ <b>Multiparameter Pocket Sensor</b> ⑨ <b>Conductivity Standard</b> (inside Dilution Tube)
 Sample Collection and Preparation Accessories	⑩ <b>Soil Sample Bags</b> ⑪ <b>Dilution Tube/Sample Container</b> ⑫ <b>1ml/2ml Syringes</b> (inside Dilution Tube) ⑬ <b>Crush/Stir Rods, Cuvette Brush</b> (inside Dilution Tube) ⑭ <b>20ml Syringe</b> ⑮ <b>Filter Funnel x 2</b>
 Soil Test Reagents	⑲ <b>Nitratetest N Powder</b> ⑳ <b>Extract A</b> ㉓ <b>Extract C</b> ㉖ <b>Extract N</b> ㉗ <b>Acidifying S</b> ㉚ <b>Lime Buffer</b> ㉛ <b>Manganese No2 S</b> ㉝ <b>Ammonia S</b> ㉞ <b>Aluminium S</b> ㉟ <b>Iron MR S</b> ㊱ <b>Coppercol S</b> ㊲ <b>Phosphate P</b> ㊳ <b>Magnecol S</b>
 Other	④② <b>Instructions/Check Standards Certificate</b>

## SKW 500 Complete Soil Kit - Layer 2



**Fig 2. SKW 500 Complete Soil Kit** opened to show contents.  
Coloured circles indicate the chapter colour in which their use is explained.

Function	Equipment
 Parameter Testing Using Soiltest 10 Bluetooth	④ <b>Light Cap</b>
	⑤ <b>Check Standards</b>
	⑥ <b>Waterproof USB Cable</b>
 pH, Conductivity and Salinity Measurement	⑧ <b>pH Calibration Buffers</b>
 Sample Collection and Preparation Accessories	⑫ <b>De-ion Pack</b>
	⑬ <b>Filter Papers</b>
	⑱ <b>2ml Soil Scoop</b>
	⑲ <b>10ml Soil Scoop</b>
	⑳ <b>2.5ml Extract Scoop</b>
 Soil Test Reagents	⑳ <b>Extract K</b>
	㉕ <b>Extract P</b>
	㉘ <b>Chloride S</b>
	㉙ <b>Calcium S</b>
	㉛ <b>Manganese No1 S</b>
	㉞ <b>Nitricol</b>
	㉟ <b>Sulphur S</b>
	㊱ <b>Potassium</b>

## 2.0 Introduction

The Palintest SKW 500 Complete Soil Kit is a professional soil management laboratory packaged within a waterproof robust case for field use.

Based on simplified and rapid soil test methods, the SKW 500 uses a number of analytical techniques to provide critical information for macronutrients and micronutrients for effective soil and agronomy management.

The key techniques used are provided by the Soiltest 10 Bluetooth photometer, Multiparameter Pocket Sensor and the Palintest Tablet Count method.

### Soiltest 10 Bluetooth

The Soiltest 10 Bluetooth is a direct-reading, waterproof photometer for determining key soil fertility parameters. Designed for both portable and laboratory use, the Soiltest 10 Bluetooth should always be used with genuine Palintest Soil Reagents for optimal performance.

The fundamental operating techniques applied to the Soiltest 10 Bluetooth are based on the principles of optical absorbance and scattering of visible light of specific wavelengths.

Optical absorbance techniques are based on creating visible colours with specific analytes upon reaction following an extraction process. The intensity of colour produced is measured with the Soiltest 10 and the data compared to the stored calibration data.

Optical scattering techniques produce small particles to scatter the source beam, the amount of scatter providing a result for the concentration of parameter under test.

For more information regarding the science behind both photometric and turbidimetric analysis technology please visit [www.palintest.com/know](http://www.palintest.com/know).

The Soiltest 10 is provided with programmed methods for a comprehensive range of soil fertility parameters. Upon choosing a test the instrument automatically selects the required parameters for accurate analysis including wavelength and reaction time. Upon completion of some tests optional follow-on tests are available and results can be converted to alternative units of expression e.g. mg/l to ppm, N or NO<sub>3</sub>.

The Soiltest 10 Bluetooth offers a choice of connectivity to download all or selected results and/or upload up to 30 User Defined Tests. Choose from

Bluetooth 4.0 wireless connectivity or USB connection. Bluetooth 4.0 (also known as Bluetooth SMART or Low Energy) connection allows seamless data exchange using the Palintest Aqua Pal app, available for iOS and Android devices. See Appendix 5 for more details. USB connection via the port located at the rear of the instrument provides a choice of either 'Hard Disk' mode or serial communication mode. See Section 4.6 for more details.

The Soiltest 10 Bluetooth offers a choice of either mains power via the USB port or using three 1.5V 'AA' batteries (supplied).

The Soiltest 10 Bluetooth is supported with a two year warranty and a full range of service, calibration and technical support. Support resources are available at [www.palintest.com](http://www.palintest.com) relating to both products and applications.

### Multiparameter Pocket Sensor

Soil pH, Conductivity and salinity are key parameters for soil fertility management and are determined using electrochemical measurement techniques with the Multiparameter Pocket Sensor included within the SKW 500 Complete Soil Kit.

The Multiparameter Pocket Sensor is a waterproof electrochemical meter designed for portable or laboratory use. The dual LCD display will show both parameter (pH, conductivity or TDS) plus the temperature of the sample under test.

Operating using electrochemical techniques, the Multiparameter Pocket Sensor does not require a filtered sample but does require a 'wet' sample. Palintest methods for soil pH and conductivity are based on a 5:1 extraction using Deionised water only.

### Palintest Tablet Count Method

Ideal for higher concentrations the Tablet Count method from Palintest provides a simple visual approach to determining the Calcium and Chloride concentration of soils following extraction.

Adding tablets one at a time until a visible colour change occurs is similar to standard laboratory titration, the tablets replacing the usual liquid format for the titrant. Count the number of tablets required to effect the colour change and calculate the result accordingly.



### 3.0 Taking a Soil Sample

The first critical step in any analysis is taking a representative sample, especially when testing soil. The effective management of soil fertility is subject to a number of factors and nutrient distribution across an area can be extremely variable.

It is good practise to test a composite of a number of individual soil samples to develop an effective soil management approach for a large area. Any areas of individual concern can be tested specifically for more detailed nutrient recommendations.

Some key points to follow when taking samples for soil testing:

- A soil sample should be collected from each plot or area to be examined. Separate samples should be collected from each area, differing in soil type, previous cropping history or type of soil management.
- Samples of soil should preferably be taken using a soil sampling auger/corer which enables 'cores' of soil to be taken from below the surface. Alternatively, a piece of narrow rigid tubing may be used. Between 10 and 25 individual cores should be taken from each area to make up the composite soil sample for analysis. The depth of penetration for soil cores should reflect the nature of the terrain and the nutrients under test.
- When sampling large areas of agricultural land take cores along the shape of an imaginary 'W' covering the area being sampled. Cores should not be taken close to hedgerows, under trees or adjacent to buildings.
- To provide the sample for analysis, individual cores should be thoroughly mixed in a bucket or similar receptacle. Stones and foreign materials should be removed by hand. The soil can be passed through a 2mm sieve or similar if available.
- The composite sample can then be transferred to a Soil Sample bag (PT 301) and labelled for reference.
- For field analysis, the tests can be conducted directly on the moist sample and in some cases this is the desired approach. Where analysis is to be carried out at a later time (more than 24 hours later), it is preferable to dry the sample by spreading it out on a tray or plastic sheet and allowing it to dry in air.
- Ensure the sample point is safe to access and follow all relevant/required local precautions.

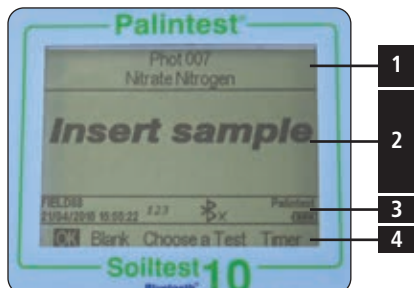
## 4.0 Soiltest 10 Bluetooth - Setup and Operation

### 4.1 Soiltest 10 Bluetooth Layout



### 4.2 Soiltest 10 Interface

The LCD screen features a selectable backlight with the screen separated into four clear, easy to read zones.



1 Mode or Test Identification.

- 2 Dialogue screen - prompts and choices will be displayed as a list. Select using up/down arrows.
- 3 Info Panel - displays status icons, date/time and Sample/Operator ID.
- 4 Action select - choices are displayed as a row. Use left/right arrows to select.

### 4.3 Info Panel Icons

Icons	Description
	Battery status
	Bluetooth connected
	Bluetooth on, not connected
	Upper/lower case text/number entry
	USB connected
	Hard Drive/COM port mode

## 4.4 Starting up the Instrument

### Power Supply

The Soiltest 10 Bluetooth is designed to be powered either from alkaline batteries or via the USB port. When operating on battery power, the battery level is indicated on the Info Panel. A minimum voltage of 3.0V is needed to operate the photometer and a flashing battery symbol indicates a critically low battery. Change batteries immediately or switch to alternative USB power. The Soiltest 10 Bluetooth will automatically power down when power is no longer capable of providing acceptable performance.

To power via the USB port, use the supplied cable connected either to the mains adaptor or a PC. The USB icon will appear when the USB connection is made and battery power will no longer be consumed. The Soiltest 10 Bluetooth has a back-up battery mounted internally to save instrument settings and data during power loss and instrument idle periods.

### Replacing Batteries

The battery compartment is located on the base of the instrument and secured by four screws. Remove the cover and install a complete set of new batteries, observing the correct polarity as indicated. Use 3 x 1.5V 'AA' alkaline batteries or equivalent. See Appendix 2 for more details. To avoid corrosion damage through leakage, remove batteries from the instrument if it is to be stored or left unused for a long period.

### Start-up Screen

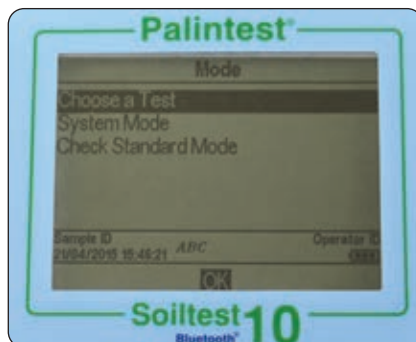


The default start-up screen on power up is the 'Choose a Test' screen.

To access the Mode menu press the left arrow key to highlight 'Menu' and OK.

To choose a test use the up/down arrows to scroll through the list and press OK on the desired parameter.

## 4.5 Mode Screen



The Soiltest 10 has three operating modes as follows:

### Choose a Test

The Choose a Test mode is the standard operating mode for taking photometer readings and is the default start-up screen on power up. See Section 4.7 for more information.

### System Mode

Personalise your Soiltest 10 Bluetooth and manage stored data within the System mode. Options include setting Operator/Sample IDs, interrogating the result log and defining the instrument operating conditions. See Section 4.6 for further information.

### Check Standard Mode

Validate performance of your Soiltest 10 Bluetooth using Palintest Check Standards. See Section 4.8 for more information.

## 4.6 System Mode

Personalise your Soiltest 10 Bluetooth and access the data log via the System Mode.



Scroll up or down using the appropriate keys to see all available options. The options and available settings are as follows:

## Log

The Soiltest 10 Bluetooth has an internal data log for up to 500 data points. The data is stored automatically upon completion of the test and automatically overwrites the oldest result when the memory is full. The data log is unaffected by power on/off.

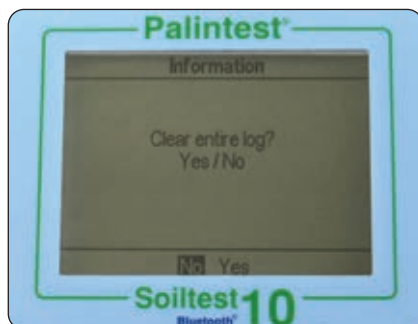
Each data point consists of the following information and is stored in a comma-separated values (CSV) format: Date, time, Operator ID, Sample ID, Test Number, Result value, Result Units, Units of Expression.



Selecting Log offers two choices:

**View** - to view individual data points use the up/down keys. Data is stored in chronological order with the most recent result shown by default. Scroll through results using the up/down arrows. Select Back to return to the previous menu.

**Clear** - the entire log can be deleted from the Soiltest 10 Bluetooth if the instrument is not locked (see **System Lock**). Selecting Clear produces the following screen:



Choose Yes to delete all data, No to return to the previous screen.

Data can be downloaded via either Bluetooth (see **Bluetooth Log Transfer**) or USB connection (see **USB Interface**).

## Operator ID

The Soiltest 10 Bluetooth offers the option to create up to 12 unique alphanumeric Operator IDs. Operator IDs are added to the result data automatically but deleting IDs does not affect the result log.



To create a new Operator ID, select Operator ID and use the up/down keys to select a blank field. Select New and press OK.

Alphanumeric characters are entered/edited using the 0-9 keys or the up/down keys. Press and hold the 1 key to toggle between upper case, lower case and numeric characters.

After entering a character, the cursor automatically moves to the next position if no key is pressed. Alternatively press the right key.

Up to 10 characters can be added for Operator IDs, including spaces.



To edit characters use the left/right keys to select the desired character. Press and hold the left key to delete the character or change the character using the entry mode.

When the Operator ID is correct press the OK key to create the ID and return to the Operator ID list. The new Operator ID will be displayed in the Operator list.



Choose the Operator ID to be used by scrolling through the list and pressing the OK key on the desired choice. The instrument will return to the System menu.

To modify or delete an existing Operator ID, highlight the ID and select Edit. Choose either Edit to modify the existing entry or Delete to remove it from the list.

## Sample ID

The Soiltest 10 Bluetooth offers the option to create up to 24 unique alphanumeric Sample IDs. Sample IDs are added to the result data automatically but deleting IDs does not affect the result log.



To create a new Sample ID, select Sample ID and use the up/down keys to select a blank field. Select New and press OK.

Alphanumeric characters are entered/edited using the 0-9 keys or the up/down keys. Press and hold the 1 key to toggle between upper and lower case characters.

After entering a character, the cursor automatically moves to the next position if no key is pressed. Alternatively press the right key.

Up to 10 characters can be added for Sample IDs, including spaces.

To edit characters use the left/right keys to select the desired character. Press and hold the left key to delete the character or change the character using the entry mode.



When the Sample ID is correct press the OK key to create the ID and return to the Sample ID list. The new Sample ID will be displayed in the Sample list. Choose the Sample ID to be used by scrolling through the list and pressing the OK key on the desired choice. The instrument will return to the System menu.

To modify or delete an existing Sample ID, highlight the ID and select Edit. Choose either Edit to modify the existing entry or Delete to remove it from the list.

### Bluetooth

The Soiltest 10 Bluetooth features the latest Bluetooth 4.0 (also known as Bluetooth Low Energy or Bluetooth SMART) for wireless communication with external devices.

The Palintest Aqua Pal app provides seamless data exchange with the Soiltest 10 Bluetooth, provides data trend analysis and user-defined action limits for key parameters.

Additional data management functionality is provided by the Palintest Portal ([www.palintestportal.com](http://www.palintestportal.com)). Uploaded data can be shared with colleagues and customers within your User Group(s) and integrated into customised reports. See Appendix 5 for more information on the Aqua Pal app and the Palintest Portal.



There are four options available in the Bluetooth menu:

- Bluetooth Communications ON - activate the Bluetooth and make the Soiltest 10 Bluetooth visible for connection/pairing
- Bluetooth Communications OFF
- Bluetooth Log Transfer - transfer historical log data to the Aqua Pal app when connected to a remote device
- Bluetooth Device ID - create a unique device name for the Soiltest 10 Bluetooth to discriminate between multiple connections

### Bluetooth Communication On

Select this option to enable Bluetooth communications allowing the instrument to be connected with a suitable Bluetooth SMART enabled device. Visit [www.palintest.com/known](http://www.palintest.com/known) for more information regarding available/suitable Bluetooth SMART devices.

The Bluetooth icon is shown in the Info Panel when Bluetooth is enabled. Connection status is shown as follows:



indicates the Bluetooth is activated and connected to an external device



indicates the Bluetooth is activated but the Soiltest 10 Bluetooth is not connected to an external device

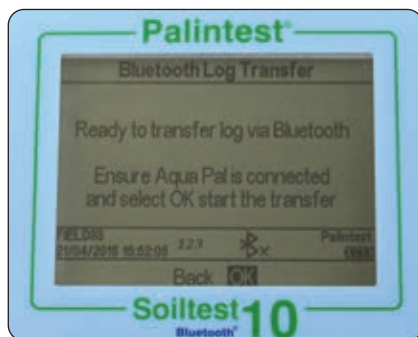
### Bluetooth Communication Off

Selecting this option disables the Bluetooth communications module. The Bluetooth icon is not visible on the Info panel.

### Bluetooth Log Transfer

Selecting this option transfers all or a selected group of results stored in the log to the connected mobile device.

The Soiltest 10 Bluetooth will validate the connected connection and confirm readiness to transfer.



Transferring selected data will require specification of the result log window e.g. from result 40 to result 100 to be transferred selectively.

Press OK to transfer the data log. The data will transfer in series. Each data point is validated by the Aqua Pal app prior to upload of the next.

If the connection is lost the Soiltest 10 Bluetooth will prompt for re-connection. If connection is not required or possible press Exit to disable Bluetooth and cancel the log transfer.

The message 'Log transfer is complete' will be shown when all data points have been uploaded successfully. Press OK to return to the previous menu.

### Bluetooth Device ID

A number of Soiltest 10 Bluetooth instruments may be available to connect to a remote device, although only one active connection is possible at any time. A user-defined Bluetooth Device ID ensures simple pairing between the desired Soiltest 10 Bluetooth and the Palintest Aqua Pal app.

Creating and/or editing Bluetooth Device ID is identical to Operator and Sample ID creation.

### USB Interface

The waterproof USB interface provides both communication between the Soiltest 10 Bluetooth and a PC and an alternative mains power source via the adaptor.

When connected the USB icon will appear, replacing the battery icon in the Info Panel, as power will be preferentially drawn from the external source.

The USB data interface has a choice of two operating modes - Hard Drive and COM Port. The current status of the USB connection is shown on the Info panel when the USB lead is connected.

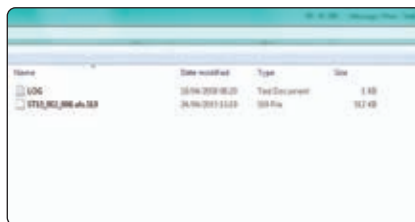
Toggle between COM Port and Hard Disk mode in the System -> USB menu by selecting the desired option.

The USB connection supports software update and data download through a simple 'drag and drop' approach when operated in Hard Disk mode.

### Hard Drive

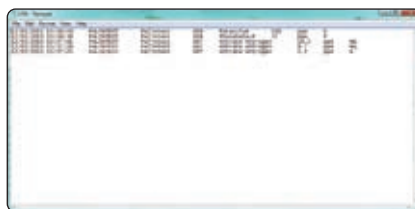
The instrument appears as a removable hard drive when connected to a PC in Hard Disk mode. Upon connection the remote drive will have the following files included:

- Soiltest10.afx.\*\*\* where \* represent version numbers of software - this is the operating software for the Soiltest 10 Bluetooth
- Log.txt - the data log file stored in a comma separated value (csv) format



Operating software or calibration library can be updated by dragging a new version to the instrument - contact support@palintest.com for new software if this option is required. Any updates to operating software will be notified via the [www.palintest.com/know](http://www.palintest.com/know) portal.

Downloading the result log is carried out by dragging the LOG.txt to the local desktop and opening with any program that can open CSV format files.



For more information regarding extracting and opening result logs using the Hard Disk mode visit [www.palintest.com/know](http://www.palintest.com/know).

### COM Port

The instrument behaves as if connected to the PC serial port via RS232 when connected in COM Port mode, allowing remote control from an external software system and data upload.

This allows backwards compatibility with software written for earlier models of Palintest instruments. In this mode, the PC requires installation of a USB virtual COM Port driver, available from [www.palintest.com/know](http://www.palintest.com/know), and the availability of software operating as a virtual com port.

A large number of third-party software systems are available to provide data upload and remote control of testing using the COM port mode. Please contact your local Palintest representative for more details.



## Units

The Soiltest 10 Bluetooth offers the choice of result expressed in mg/l, ppm, mmol/l,  $\mu$ mol/l, g/l and  $\mu$ g/l.



Changing the result units will not affect the result log.

## Dilution Factor

When samples are above the test range, indicated by >> on the result screen, a dilution procedure can be used. Setting Dilution Factor to On will prompt the Soiltest 10 Bluetooth to automatically request the dilution factor when carrying out a test. Change the dilution factor by using the up/down arrows or manually type the dilution factor. The instrument will automatically correct the result for the dilution and display the corrected result (which will also be stored in the result log).

The maximum dilution factor permitted is 99. If the calculated result exceeds the available number of permitted characters >> will be displayed.

**NOTE:** do not use sample dilution when measuring pH or alkalinity.

## System Lock

To prevent unauthorised or inadvertent changes to the System settings or log deletion a four digit code can be used to lock several options.

The default code is set to 6812. To change the System Lock code, follow the on-screen prompts to choose a memorable four digit number.

When the System Lock is applied, the items accessible within the System Mode are limited until the unlock code is entered. Access is limited to viewing the result log, adjusting the backlight, contrast and Bluetooth settings.

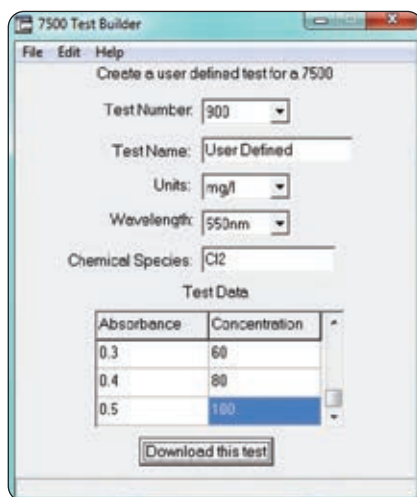
To set a unique four digit code enter the master code (7910). The Set System Lock Code screen will appear. Enter the required four digit code and press OK to set.

To reset the unique system lock code, enter the master code and select Reset.

## User Defined Tests

In addition to the many available calibrations/methods, the Soiltest 10 Bluetooth provides additional capability for up to 30 User Defined Tests. A User Defined Test is built using a table of calibration data consisting of up to 10 data pairs of absorbance and concentration.

Download or request a copy of Usertestbuilder.exe (suitable for Windows operating systems) from our websites to define the details and calibration data as shown below:



Connect the Soiltest 10 Bluetooth to the PC using the USB cable provided, ensuring the instrument is set to Hard Drive mode.

Once data is complete press "Download this test" to transfer the method details and calibration. The Soiltest 10 Bluetooth will respond with Test Data Accepted.

Alternatively save the test data as a \*.txt file and drag and drop onto the Soiltest 10 Bluetooth.

User Defined Tests are stored in Phot Numbers 900 - 929 to avoid confusion with standard Palintest soil calibrations.



Press OK once the test has been uploaded to view the test in the User Defined Test list.

A number of options are available within the Edit User Defined Test menu:

- Back** return to the previous menu
- Add** add additional User Defined Tests
- Edit** upload new data for the selected test
- Delete** remove the test from the instrument

For more information regarding creation and upload of User Defined Tests please visit [palintest.com/know](http://palintest.com/know)

Accessing User Defined Tests is carried out by scrolling through the list of tests or entering the required Phot Number.

### Language

Select the desired local language for operation, choosing from English, French, Spanish, German, Italian and Chinese (Mandarin). The selection of language will also adjust appropriate tests and units to local convention as required.

### Set Time/Set Date/Date Format

All test results are recorded automatically in the Data Log and appended with date and time (plus additional information). Date and time are stored on an internal clock, supported by a coin cell battery. To correct the time select Set Time from the System menu. Use the up/down keys to adjust the hour; press the right key to select and adjust the minutes.



Press OK when the correct time is set.

To correct the date select Set Date from the System menu. Use the up/down keys to adjust the day/month/year, using the left/right keys to select the field.



Press OK when the correct date is set.

The Date Format can be set to DD/MM/YYYY or MM/DD/YYYY as required. To select the required format highlight the desired choice and press OK.

### Time Out

When operating using battery power the Soiltest 10 Bluetooth provides automatic power-off as a power-saving measure. Three settings are provided:

- Normal** 5 minutes
- Long** 15 minutes
- Off** (disables Time Out)

The time intervals begin after the last key is pressed or activity takes place.

Time Out is automatically disabled when the instrument is powered by USB supply and during a Bluetooth data log transfer.

### Back Light

The instrument display features a high intensity backlight to support use in low light conditions. The backlight is designed to use minimal energy but activating the Backlight will naturally consume battery power more rapidly. The settings available for Backlight are:

- Backlight Auto-Dim** Backlight activates on any key press and dims after 15 seconds automatically.
- Backlight On** Backlight is on permanently
- Backlight Off** Backlight is off permanently

### LCD Contrast

In addition to the Backlight, the default contrast setting for the display can be adjusted using the up/down keys when light conditions are difficult.

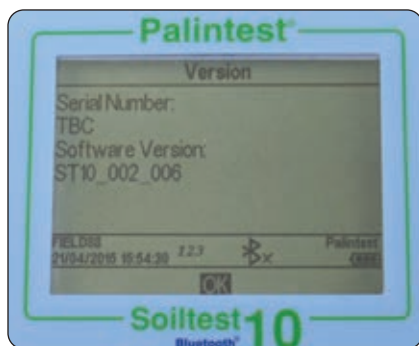
The display provides a sequence of alternating squares to give visual indication of the correct settings to apply.



When complete/acceptable press the OK key.

### Version

The serial number of the instrument and the software version are displayed. The instrument serial number will be required for technical support and servicing/warranty and can also be found on the case of the instrument.



### 4.7 Analysing Samples

The Soiltest 10 Bluetooth provides simple, accurate and reliable analysis of key soil nutrient parameters. Selecting the required parameter and performing the test are supported through on-screen prompts and comprehensive test instructions.

The principle of photometric testing is based on the absorption or scattering of a measured intensity of incident light compared to the light intensity reaching the detector array. The light intensity is determined as Transmittance (%T) or Absorbance (A) and compared to calibration tables stored within the Soiltest 10 Bluetooth. The stored calibration tables convert %T or A to results in a variety of units (mg/l, ppm etc.).

Calibration tables are defined by Palintest based on the measurement of reference standards using Palintest reagents. To achieve the best quality results there are a small number of care points:

- 1 Always use the provided light cap to prevent ambient light affecting the results.
- 2 Ensure Sample and Blank cuvettes are clean, dry and inserted correctly into the sample chamber, using the orientation mark to align.
- 3 Always blank the instrument prior to analysis.

Additional guidance is provided in **Appendix 1 Hints and Tips for Soil Testing**.

### Selecting Test Parameters

The Soiltest 10 Bluetooth offers a number of choices to select the parameter to test:

**Phot Number Entry** - use the numeric keypad to enter the unique Phot Number to directly access any programmed calibration (including User Defined Tests).

**Direct Entry** - use the numeric keypad to access the 10 most common tests with a single key push.

**Choose a Test** - available in either Phot Number Entry or Direct Entry modes, the full list of test parameters is available by selecting Choose a Test and scrolling using the up/down keys. When the desired parameter is highlighted, press the OK key to access the method. Tests are presented in Phot Number order.

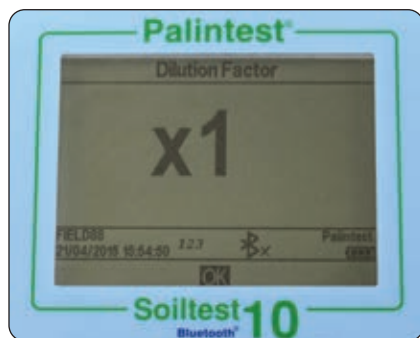
When the required test is selected the Soiltest 10 Bluetooth automatically selects the correct wavelength and sets additional method parameters as required.

Test method protocols are defined in detail in Section 6, including the reagents and accessories that may be required.

When a test is selected, the Soiltest 10 Bluetooth will display a number of screens and options to guide the user through the testing process, as described in the following pages.

### Dilution Factor

If selected in the System menu, the initial screen will request the defined Dilution Factor to apply to results.



If Dilution Factor is not active this screen will not be shown.

Results shown on the final screen have automatically been corrected for dilution prior to display. Corrected results will also be stored in the log.

### Blanking the Soiltest 10 Bluetooth

Blanking the photometer is a key first step in photometric analysis, effectively removing the potentially entrained sample colour and minor amounts of turbidity from calculation of analytical results.

To blank the photometer, prepare a Blank cuvette using untreated sample i.e. extracted sample that has not been reacted with any reagents. If the sample is to be diluted or physically treated (filtered for example) before analysis, use the same dilution/treatment for the Blank cuvette.

When accessing the test method the Soiltest 10 Bluetooth will request the user to Insert Blank.



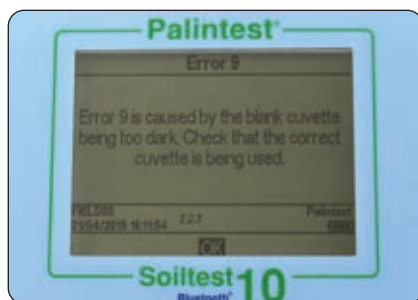
Insert the Blank cuvette and press OK.



The Soiltest 10 Bluetooth will determine the absorbance due to the sample colour at all wavelengths simultaneously and store in temporary memory for use in analysis.

Upon successful blanking the Soiltest 10 Bluetooth will automatically move to the **Insert sample** stage of the analytical method.

If the sample is too highly coloured to support effective blanking and subsequent analysis the message "Error 9 is caused by the blank cuvette being too dark. Check the correct cuvette is being used" is shown.

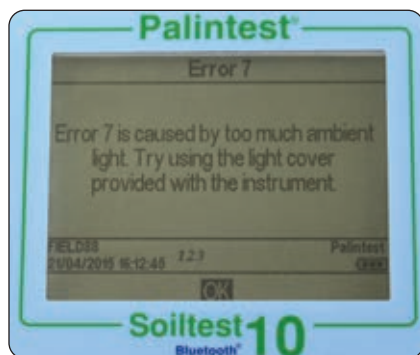


Ensure the blank cuvette is being used, not the sample plus reagent cuvette. Sample colour can be reduced by dilution with clean water; the dilution selected should take account of the expected concentration of parameter under test.

Blank results are stored in the temporary memory of the Soiltest 10 Bluetooth and will be used for all subsequent tests until:

- The instrument is powered down (temporary memory is lost/deleted)
- A new Blank reading is taken - this option is available on accessing any subsequent test at the base of the screen. Repeat the blanking process if the sample changes significantly or a new sample is under test

If the blank value generated in this step is not detectable an error message will be displayed "Error 7 is caused by too much ambient light. Try using the light cover provided with the instrument".



### Reading Results with the Soiltest 10 Bluetooth

Assuming a suitable blank has been recorded, the next step of the photometric analysis process is to carry out the reading step.

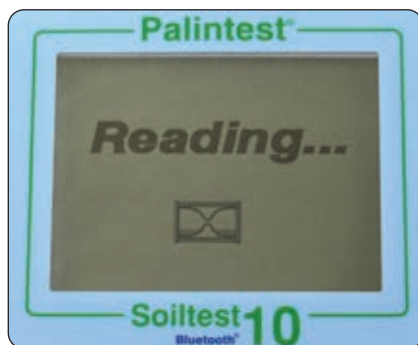
Prepare a Sample cuvette following the method instructions provided in Section 6.

Select **Read** at the base of the screen and press **OK**.

At the **Insert sample** prompt, insert the sample cuvette ensuring it is clean and dry and oriented correctly using the location mark.



Press **OK** to begin the measurement process. The screen will display **Reading...**



At the completion of the measurement process the result is displayed on screen.



## Timer

Many photometric methods require a reaction time to develop completely, the recommended time period being documented in Section 6 and included as part of the method parameters programmed into the Soiltest 10 Bluetooth.

Tests requiring a reaction time will have the option to select an automatic timer to count down the reaction time required. While in the Insert sample screen use the right key to move the cursor to highlight **Timer**.



The programmed reaction time will be displayed. Press **OK** to **Start** the countdown.

Three options will be displayed:

- Stop** cancel the countdown timer
- Exit** exits the countdown screen and returns to the Insert sample screen. The countdown will continue and the current time can be seen by selecting **Timer**. At the end of the countdown an audible alarm will sound to indicate the sample is ready to read. Select **OK** to read the sample manually.
- Exit and Read** exits the countdown screen and automatically reads the sample at the completion of the allocated time period.

## Changing Result Units of Expression

Many chemical species have a number of alternative units that can be used for reporting results e.g. Phosphate can be expressed as  $\text{PO}_4$  or P for example.



Where alternative units of expression for results are available the ▲▼ symbols will be displayed next to the current result units. Use the up/down arrows to change the units of expression as required. Values are modified automatically.

Results stored in the log will be in the units selected on screen, changing the chemical species will add an entry to the log showing the updated result and species parameter selected.

## 4.8 Calibration/Validation

Your Soiltest 10 Bluetooth is delivered with a calibration certificate validating the performance of the instrument as it leaves Palintest.

We recommend annual service and calibration of all photometric instruments in normal use.

The Soiltest 10 Bluetooth also includes an automatic routine to validate analytical performance using certified Palintest Check Standards. Accessed via the Mode menu, the **Check Standard Mode** provides a field method of ensuring your instrument is operating within defined specifications and also a troubleshooting method for unexpected results.

Every Palintest Check Standards set is supplied with certified values expressed as %T (Transmission), derived from traceable reference materials. Acceptable tolerances are defined on the certificate and are automatically specified within the Soiltest 10 Bluetooth.

### Check Standard Mode

Access Check Standard Mode from the Mode screen. Highlight Check Standard Mode and press OK.



Two choices are offered:

**Enter Check Standard Values** use the up/down keys to adjust the displayed values to match the certificate

**Check Standard Measurement** insert the Check Standards in the defined order to generate a validation report

### Enter Check Standard Values

Each standard has two values assigned, for two individual wavelengths.



Use the up/down keys to adjust the values to match the certificate, following the order defined on the display. Press OK when the correct value is shown and the prompt will forward to the next value.

Upon completion the message **Check Standard Values assigned successfully** will be displayed.

Press **OK** to return to the Check Standard Mode menu.

### Check Standard Measurement

Follow the on-screen prompts to insert the Check Standards in the defined order. The Soiltest 10 Bluetooth will automatically measure the Transmittance at the required wavelength.

Upon completion of the sequence the results are displayed on screen with pass or fail status.



If the Check Standard Mode reports a failure, see Appendix 2 Troubleshooting for guidance or contact your local Palintest supplier.

## 5.0 Multiparameter Pocket Sensor

### 5.1 Initial Use

The PT 162 Multiparameter Pocket Sensor is delivered factory calibrated and can be used immediately if required. For best results soak the sensor tip in warm tap water or pH 7 buffer for a few minutes prior to re-calibrating with supplied pH buffers and conductivity standards.



### 5.2 Taking Readings

- 1 Switch the Multiparameter Pocket Sensor on and insert into the sample to be measured.
- 2 Press **MODE/ENT** to switch between pH, conductivity, TDS and salinity parameters as required.
- 3 Readings are shown in the top part of the display for the required parameter.
- 4 To temporarily 'store' a result press **▼/HOLD** to freeze the display. Press **▼/HOLD** again to release and return to live display.

### 5.3 Set Up (General)

Specific settings within the Multiparameter Pocket Sensor are accessed by entering the Set Up mode:

- 5 Switch the sensor off.
- 6 Press and hold the **MODE/ENT** key while pressing and releasing the **ON/OFF** key. 'Setup' will appear on the screen.
- 7 Release the **MODE/ENT** key and display will show **PARa** (Parameter Set Up).
- 8 Press **▲/CAL** or **▼/HOLD** to toggle between **PARa** (Parameter) and **SYSt** (System) set up. Parameter Set Up allows definition of aspects related to the measurement parameters - pH, conductivity, TDS, salinity. System Set Up provides control for Pocket Sensor features such as units of temperature display, automatic shut-off and reset.
- 9 Press **MODE/ENT** to access the desired Set Up menu (see below for specific information regarding Parameter and System Set Up).
- 10 Once satisfied with the configuration defined in the Set Up press and hold **▼/HOLD** and **▲/CAL** until the display shows **SA** (Save).
- 11 The second line of the display will show **YES**. Press **MODE/ENT** to accept/save the changes and the Multiparameter Pocket Sensor will restart with the new settings.

#### 5.3.1 Parameter Set Up

Select **PARa** from the Set Up mode to customise the parameter measurement settings as follows:

- 1 Use **MODE/ENT** to select and/or confirm setting.
- 2 Press **▲/CAL** or **▼/HOLD** to scroll through the available parameter settings.

Options Available:

- pH** Choose either **USA** or **NIST** pH buffer settings. Choose **5-pt** or **3-pt** calibration mode.
- Conductivity** Select **A.Cal** (Automatic Calibration) or switch automatic calibration off.
- TDS** Adjust the **FAcT** (factor) used for conductivity to TDS conversion. Default is 0.71.
- Salinity** Choose **Ppt** (parts per thousand) or **Per** (% percentage) as recorded units.



### 5.3.2 System Set Up

Select **SYSt** from the Set Up mode to customise the system settings:

- 1 Use **MODE/ENT** to select and/or confirm.
- 2 Press **▲/CAL** or **▼/HOLD** to scroll through the available parameter settings.

Options Available:

- Unit rSt** Reset the Multiparameter Pocket Sensor settings. Choose **PH** or **EC** to reset either pH or Conductivity/TDS/Salinity settings. Choose **CAL** to reset the calibration to default or **Fct** to reset to factory settings.
- Set A.Off** Choose **YES** for automatic switch off after 8.5 minutes, **NO** to disable automatic switch off.
- Set t.C** Adjust the temperature coefficient from **0.0-10.0%** (2.1% is default).
- Set AtC** Choose **YES** for Automatic Temperature Compensation (ATC) or **NO** to disable.
- Set °C °F** Select **°C** for Celsius or **°F** for Fahrenheit temperature units.

### 5.4 Calibration

The Multiparameter Pocket Sensor is delivered with a factory calibration but will require regular recalibration to maintain optimal performance.

Three parameters are available for calibration as follows:

- **Temperature** - usually only required on sensor replacement as the factory calibration typically lasts for the lifetime of the instrument.
- **pH** - recommended frequently due to the drift of electrodes over time, always use accurate pH buffers provided by a reputable company.
- **Conductivity** - providing the calibration for TDS and salinity, conductivity calibration again requires the use of one or more standards.

Calibration is best performed in a controlled environment such as an office or laboratory prior to taking the SKW 500 into the field as care is required to generate best results.

### 5.4.1 Temperature Calibration

Items required: Reference thermometer

Test Sample (usually warm water)

- 1 Switch on the Multiparameter Pocket Sensor and place in the test sample with the Reference thermometer to stabilise.
- 2 Without removing from the test sample, press **MODE/ENT** until pH mode is selected.
- 3 Press **▲/CAL** to enter the pH calibration menu.
- 4 Press **▼/HOLD** for 5 seconds to begin temperature calibration mode. The dual display will show the measured temperature in the top part of the screen and the default measured temperature in the lower part.
- 5 Use **▲/CAL** or **▼/HOLD** to adjust the measured temperature to the Reference thermometer value.

**NOTE:** this must be within 5°C/9°F of the default value.

- 6 Press **MODE/ENT** to confirm and return to pH measuring mode.

### 5.4.2 pH Calibration

Items required: USA pH Buffers (1.68, 4.01, 7.00, 10.01 and 12.45)

**OR**, NIST pH Buffers (1.68, 4.01, 6.86, 9.18 and 12.45)

(Note: if 3-pt is selected only the middle three buffers are required)

Deionised water

- 1 Switch on the Multiparameter Pocket Sensor and press **MODE/ENT** to access the pH measurement mode.
- 2 Immerse the sensor end fully into the first pH buffer and press **▲/CAL**. The top part of the display will show the current reading and the lower part of the display will automatically select the correct buffer value to assign.
- 3 Allow the reading to stabilise with gentle stirring/rotating within the buffer and press **MODE/ENT** to accept the result.
- 4 Either accept a single point calibration by pressing the **▲/CAL** button to return to the measurement mode or rinse the probe end with Deionised water and repeat with additional buffers as required.



## 5.4.3 Conductivity Calibration

Items required: Conductivity calibration standard(s)  
Deionised water

### 5.4.3.1 Automatic Calibration

**NOTE:** Use Conductivity Standards with values of 84µS/cm, 1413µS/cm and/or 12.88mS/cm.

- 1 Switch on the Multiparameter Pocket Sensor and press **MODE/ENT** until Conductivity mode is selected.
- 2 Rinse the sensor end with Deionised water and insert into the first calibration standard. Press **▲/CAL** and the top part of the display will show the current value while the lower part will show the closest automatic standard value.
- 3 Allow the reading to stabilise with gentle rotation/stirring and press **MODE/ENT** to accept the value. The screen will blink briefly and return to measurement mode.
- 4 Repeat the process with further conductivity standards if required.

### 5.4.3.2 Manual Calibration

Manual calibration can be used for conductivity, TDS and salinity. For best results use one standard per range defined below:

**Conductivity** 0 - 200µS/201 - 2000µS/2.01  
- 20.00mS

**TDS** 0.0 - 99.9ppm/100 - 999  
ppm/1.00 - 10ppt

**Salinity** 1.00 - 10ppt

- 1 Switch on the Multiparameter Pocket Sensor and press **MODE/ENT** to select Conductivity, TDS or Salinity mode as required for calibration.
- 2 Rinse the sensor end with deionised water and immerse in the standard. The top part of the display will show the current value and the lower part of the display will show the factory default calibration value.
- 3 Use **▲/CAL** or **▼/HOLD** to adjust the upper part of the display to match the standard value and press **MODE/ENT** to confirm. The screen will blink briefly and return to measurement mode.
- 4 Repeat with additional standards as required.

## 5.5 Sensor Replacement

The Multiparameter Pocket Sensor contains a replaceable sensor should the tip become damaged or simply degrade over a period of time.

To remove the sensor part unscrew the lower collar of the Pocket Sensor and pull the existing sensor straight out from the housing.

Replace the entire sensor and dispose of the redundant component in accordance with local waste rules.

## 5.6 Battery Replacement

The Multiparameter Pocket Sensor is powered by four LR44 batteries located in the top cap, above the dual display.

When the battery icon on the display shows no bars and blinks it is time to replace batteries immediately.

Replace all batteries at the same time, taking care to observe the correct polarity is observed.

## 6.0 Soil Test Methods

### 6.1 Overview

Soil testing for pH, Lime Requirement, macronutrients and micronutrients is carried out using a variety of techniques and equipment within the SKW 500 Complete Soil Kit.

Parameter	Method	Test Equipment
pH	Electrochemical	Multiparameter Pocket Sensor
Lime Requirement	Electrochemical	Multiparameter Pocket Sensor
Conductivity	Electrochemical	Multiparameter Pocket Sensor
Salinity	Electrochemical	Multiparameter Pocket Sensor
Nitrate	Photometric	Soiltest 10
Phosphorous	Photometric	Soiltest 10
Potassium	Photometric	Soiltest 10
Magnesium	Photometric	Soiltest 10
Calcium	Tablet Count	Visual
Aluminium	Photometric	Soiltest 10
Ammonia	Photometric	Soiltest 10
Chloride	Tablet Count	Visual
Copper	Photometric	Soiltest 10
Iron	Photometric	Soiltest 10
Manganese	Photometric	Soiltest 10
Sulphate	Photometric	Soiltest 10

Specific sample preparation steps are required for each parameter, discussed further in the following section. The SKW 500 Complete Soil Kit features a fold-down worksurface for carrying out soil test methods conveniently regardless of environment.

### 6.2 Soil Extraction

All soil test methods require an extraction step to 'transfer' the parameters of interest into water for further measurement using the techniques identified above.

Extraction methods can be as simple as mixing a fixed volume of soil with deionised water in a known ratio with defined addition of specific Extract Reagents to promote release of nutrients from the soil sample. The extraction methods used are identical for some parameters and in these cases the same produced extract solution can be used for multiple parameter testing.

Parameter	Soil Volume	DI Water Volume	Extraction Reagent
pH*	4ml	10ml	Extract W
Lime Requirement	4ml	10ml	Extract W
Conductivity	10ml	50ml	Extract W
Salinity	10ml	50ml	Extract W
Nitrate	2ml	50ml	Extract N
Manganese	2ml	50ml	Extract N
Phosphate	2ml	50ml	Extract P
Potassium	2ml	50ml	Extract K
Calcium	10ml	50ml	Extract A
Magnesium	10ml	50ml	Extract A
Aluminium	10ml	50ml	Extract A
Ammonia	10ml	50ml	Extract A
Copper	10ml	50ml	Extract C
Iron	10ml	50ml	Extract C
Chloride	10ml	50ml	Extract W
Sulphate	10ml	50ml	Extract W

\*pH meter method

For extraction solutions to be used with either photometric or tablet count methods, filtration must be carried out.

The standard approach for filtration of extract is as follows:

- 1 Take one fresh filter paper circle, a filter funnel and a spare Sample Container/Dilution Tube.
- 2 Fold the filter paper circle in half and fold again to produce a quarter circle.
- 3 Insert a finger between the folds and open the filter paper into a cone. Place into the filter funnel.
- 4 Position the filter funnel over the Sample Container/Dilution Tube and pour the soil/water/Extract solution into the funnel.
- 5 Capture the filtrate in the second Sample Container/Dilution Tube and use for analysis as soon as sufficient volume is available.
- 6 Discard the remaining slurry once sufficient filtrate has been generated.

### 6.3 Soil Volume/Sampling

Two soil scoops are provided in the SKW 500 Complete Soil Kit:

**PT 302** Soil Scoop, 2ml

**PT 310** Soil Scoop, 10ml

Select the required scoop size defined in the specific parameter instructions.

Fill the selected scoop with a heaped scoop of soil. Discard any large particles such as stones or insects. Using a straight edge level the scoop of soil to fix the soil volume.

### 6.4 Soil Temperature

All Palintest soil test have been developed with soil samples at 20°C. For optimum results soil extraction and measurement should be carried out at this temperature.

Low temperatures may reduce the effectiveness of extraction leading to low results.

### 6.5 Drying Soil Samples

Palintest soil methods can be carried out on fresh or dried soil samples. For some parameters such as soil nitrogen, immediate testing on damp soils is recommended to prevent loss of nitrogen due to biological activity.

If samples are to be transported some distance or analysis is not possible immediately on sample collection, the soil sample should be air dried on a tray or plastic sheet. Once dried the sample can be stored in a soil sample bag for testing at a more convenient date or location.

### 6.6 Soil pH (Range pH 0.0 - 14.0)

Key to determining the availability of soil nutrients, soil pH usually lies between pH 4 and pH 8. Neutral soils have a pH value close to 7.0, soils below pH 5.0 are strongly acidic and will only support acid-loving plants.

A shortage of one or more trace elements may be related to pH as the availability of most elements is pH related. These shortages lead to the appearance of symptoms in the plant, such as chlorotic, bronzed or mottled leaves, altered habit, or death of the growing tips, or there may be no visual symptoms at all.

#### Equipment Required:

PT 162 Multiparameter Pocket Sensor

PT 302 Soil Scoop, 2ml

PT 512 Sample Container/Dilution Tube

PT 500 De-ion Pack

#### Test Procedure

- 1 Take **two** level 2ml scoops of soil and place in the sample container.
- 2 Add deionised water to the 10ml mark.
- 3 Cap container and shake gently for **one minute**.
- 4 Transfer the 10ml sample/water mixture to the Multiparameter Pocket Sensor cap
- 5 Switch on the Multiparameter Pocket Sensor and select the pH measurement mode.
- 6 Insert the pH electrode into the cap and allow the reading to stabilise. Record the reading as Soil pH.

### 6.7 Soil Lime Requirement

The Lime Requirement of a soil is the quantity of liming material required to raise the soil pH to a value defined by soil type and crop requirements. The value given by the test is the amount of Calcium Carbonate required to raise a 20cm depth of soil to the required Soil pH. Standard target values for specific soil pH types are:

Mineral soil     pH 6.5

Organic soil     pH 6.2

Peaty soil        pH 5.8

#### Equipment Required:

PT 162 Multiparameter Pocket Sensor

PT 302 Soil Scoop, 2ml

PT 512 Sample Container/Dilution Tube

PT 500 De-ion Pack

ST-2210 Palintest Lime Buffer Tablets

#### Test Procedure

**NOTE:** this test may be carried out as a continuation of Soil pH test by transferring the sample back to the Sample Container/Dilution Tube and continuing from Step 3.

- 1 Take **two** level 2ml scoops of soil and place in the sample container.
- 2 Add deionised water to the 10ml mark.
- 3 Add **one Lime Buffer** tablet to the container and shake gently for **two minutes**.
- 4 Transfer the 10ml sample/water mixture to the Multiparameter Pocket Sensor cap.
- 5 Switch on the Multiparameter Pocket Sensor and select the pH measurement mode.
- 6 Insert the pH electrode into the cap and allow the reading to stabilise. Record the modified pH reading.
- 7 Refer to the Lime Requirement tables to calculate the amount of lime required to increase Soil pH to the required value.

The Lime Requirement values given in the following tables should be regarded as maximum values. Over-liming should be avoided as this may give rise to trace element deficiencies.

### Liming Materials

The result of the Palintest Lime Requirement test is given in terms of Calcium Carbonate ( $\text{CaCO}_3$ , ground limestone or chalk).

Alternative liming materials may be used and attention must be paid to the neutralising capacity of these materials compared to Calcium Carbonate.

### Mineral Soils

Mineral soils contain less than 10% organic material.

pH Reading	Lime Requirement ( $\text{CaCO}_3$ )			
(Modified pH)	tonne/ha	gram/m <sup>2</sup>	cwt/acre	oz/sq yard
4.0	30	3000	240	90
4.5	25	2500	200	75
5.0	20	2000	160	60
5.5	15	1500	120	45
6.0	10	1000	80	30
6.5	4	400	30	12
7.0	0	0	0	0
7.5	0	0	0	0
8.0	0	0	0	0

### Organic Soils

Organic soils contain 10 - 25% organic material.

pH Reading	Lime Requirement ( $\text{CaCO}_3$ )			
(Modified pH)	tonne/ha	gram/m <sup>2</sup>	cwt/acre	oz/sq yard
4.0	32	3200	225	95
4.5	26	2600	210	78
5.0	21	2100	165	61
5.5	15	1500	120	45
6.0	10	1000	75	28
6.5	4	400	30	12
7.0	0	0	0	0
7.5	0	0	0	0
8.0	0	0	0	0

### Peaty Soils

Peaty Soils contain greater than 25% organic material.

pH Reading	Lime Requirement ( $\text{CaCO}_3$ )			
(Modified pH)	tonne/ha	gram/m <sup>2</sup>	cwt/acre	oz/sq yard
4.0	34	3400	270	100
4.5	28	2800	225	85
5.0	22	2200	180	65
5.5	17	1700	135	50
6.0	11	1100	85	32
6.5	5	500	40	15
7.0	0	0	0	0
7.5	0	0	0	0
8.0	0	0	0	0

### 6.8 Soil Conductivity

Soil conductivity provides a simple electrochemical indication of the level of soluble salts present in soil, especially where soil is potentially affected by salinisation or has been subject to prolonged irrigation. Various methods of determining soil conductivity are available. In the Palintest method the salt content of soil is extracted with deionised water. The resultant extract is measured using the Multiparameter Pocket Sensor.

#### Equipment Required:

PT 162 Multiparameter Pocket Sensor  
PT 310 Soil Scoop, 10ml  
PT 512 Sample Container/Dilution Tube  
PT 500 De-ion Pack

#### Test Procedure

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **one level** 10ml scoop of soil to the Deionised Water.
- 3 Shake the container for **two minutes**.
- 4 Allow the soil to settle and insert the Multiparameter Pocket Sensor into the liquid portion of the sample.
- 5 Switch the Multiparameter Pocket Sensor to conductivity mode and take the reading once the value has stabilised.
- 6 Report the result as Soil Conductivity in either  $\mu\text{S}/\text{cm}$  or  $\text{mS}/\text{cm}$  (the Multiparameter Pocket Sensor will select the correct units for the result).

#### Soil Salinity

To express results as parts per thousand (ppt) as NaCl switch the measurement mode from conductivity to **Salt**.

### 6.9 Soil Nitrogen (Range 0-25 mg/l N)

One of the key macronutrients, nitrogen in soil is critical for foliar growth and increased yield particularly when growing legumes. Plant growth is more limited by nitrogen than any other nutrient. Soil nitrogen is very mobile through the soil matrix and will vary considerably with location across a field and with depth of soil sample. Testing for soil nitrogen should be carried out as soon as possible on moist soil to prevent sample microbiological activity adversely affecting results.

The Palintest Soil Nitrogen test provides a combined value for soil nitrate and soil nitrite in a single test. The nitrate and nitrite are extracted from the soil matrix using 1M Ammonium Chloride (Extract N) and nitrate reduced to nitrite using Nitratetest™ powder. The resultant filtered extract is reacted with Nitricol reagent to produce a range of colours from pale pink to deep violet depending on nitrogen concentration.

#### Equipment Required:

PTB 7510 Soiltest 10 Photometer  
PT 595 Cuvette, 10ml  
PT 501 Cuvette rack  
PT 302 Soil Scoop, 2ml  
PT 512 Sample Container/Dilution Tube x 2  
PT 500 De-ion Pack  
PT 607 Filter Funnel, 7cm diameter  
PT 618 Filter Paper, 11cm diameter  
PT 311 2.5ml Extract Scoop  
ST-2106 Extract N Powder  
ST-2237 Nitratetest™ N Powder  
ST-2240 Nitricol™ Tablets

#### Test Procedure

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add one level scoop of Extract N to the deionised water using the PT 311 Long-handled Extract N Scoop.
- 3 Replace the lid and shake the container to dissolve the Extract N powder.
- 4 Add **one 2ml scoop** of soil to the deionised water/Extract N solution, replace the lid and shake for **1 minute**.
- 5 Add **one level spoonful of Nitratetest™ powder** to the soil/Extract N solution using the scoop contained within the Nitratetest™ container. Shake for **one minute**.
- 6 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 7 Pour the soil/Extract N solution into the filter paper and allow the extraction filtrate to collect in the second container.
- 8 Once 10ml of filtrate is available fill a clean cuvette to the 10ml mark and select Phot 007 Nitrogen or press key '7' and blank the Soiltest 10 photometer.

- 9 Add **one Nitricol** tablet to the filtered sample and crush to dissolve completely.
- 10 Stand the cuvette in the rack for **10 minutes** to allow full colour development.
- 11 Insert the cuvette into the photometer and take the reading in the usual manner.
- 12 The soil nitrogen result is displayed as mg/l N and comprises both nitrate and nitrite

**NOTE:**

- If the extract is cloudy following the filtration step, repeat the filtration step to ensure a completely clear filtrate is produced.
- If the result displayed is >>, dilute the filtrate with deionised water and repeat the test protocol from step 8.
- If an orange colour develops as a result of addition of the Nitricol tablet, the nitrate result is above the measurement range. Dilute the filtrate by 10x and repeat from step 8.

**6.10 Soil Phosphorus (Range 0-150 mg/l P)**

One of the key macronutrients, phosphorus in soil is critical for leaf growth, enzymatic reactions and indirectly responsible for root development. Phosphorus deficiency is widespread in many areas but difficult to diagnose, plants affected showing stunted leaves and roots. Phosphate persists in soil and over-supply can lead to algal blooms and pollution of local water sources. The Palintest Soil Phosphorus method uses 0.5M Sodium Bicarbonate solution (Extract P) to extract phosphorus from soil (also known as Olsen's Method) before reacting with ammonium molybdate in acidic conditions to form a bright blue complex. Phosphorus tests can be carried out on damp, fresh soil or on dried soil samples.

**Equipment Required:**

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 302	Soil Scoop, 2ml
PT 362	2ml syringe
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
ST-2116	Extract P Tablets
ST-2275	Acidifying S Tablets
ST-2260	Phosphate P Tablets

**Test Procedure**

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **five Extract P** tablets to the deionised water, replace the lid and shake gently to dissolve.
- 3 Add **one 2ml scoop** of soil to the deionised water/Extract P solution, replace the lid and shake for **1 minute**.

**NOTE:** with acidic soils some effervescence may be produced - release the cap frequently to prevent build-up of pressure.

- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract P solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Take exactly 2ml of the extraction filtrate using the 2ml syringe and place in a clean, dry photometer cuvette.
- 7 Make the volume in the photometer cuvette up to 10ml using deionised water.
- 8 Add **one Acidifying S tablet**, crush and mix gently to dissolve fully. The tablet will effervesce gently as it breaks down - do not cap the cuvette to prevent pressure build-up.
- 9 Select Phot 008 Phosphate-P or key '8' and blank the Soiltest 10 photometer.
- 10 Add **one Phosphate P tablet**, crush and mix to dissolve fully.
- 11 Stand the cuvette in the rack for **10 minutes** to allow full colour development.
- 12 Insert the cuvette into the Soiltest 10 photometer and take the reading in the usual manner.
- 13 The soil phosphorus result is displayed as mg/l P

**NOTE:**

- Yellow colouration seen in the extraction filtrate is common and will not affect results.
- The first few drops of filtrate may be turbid and should be discarded before proceeding with the test.
- Colour may still develop beyond the 10 minute time period but will be minor in comparison to the 'final' result.

### 6.11 Soil Potassium (Range 0-450 mg/l K)

Potassium is one of the essential elements in the nutrition of plants, and one of the three that are commonly in sufficiently short supply in soil to limit crop yield. However, it is not a constituent of the plant fabric, but is important in the synthesis of amino acids and proteins from ammonium ions. It is also important in photosynthesis.

Excess potassium in soil is deleterious. By competing, it reduces the amount of other cations that a plant can take up inducing deficiencies of other elements, for example magnesium.

The Palintest Soil Potassium test uses 0.1M Magnesium Acetate (Extract K) to extract potassium from soil; the extracted potassium is reacted with sodium tetraphenylboron to form an insoluble white complex which is measured with the Soiltest 10 photometer.

Soil Potassium can be carried out on either fresh, moist soil samples or dried soil samples.

#### Equipment Required:

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 302	Soil Scoop, 2ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
PT 311	2.5ml Extract Scoop
ST-2127	Extract K Powder
ST-2280	Potassium K Tablets

#### Test Procedure

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **one level Extract Scoop** of Extract K, replace lid and shake gently to dissolve.
- 3 Add **one 2ml scoop** of soil to the deionised water/Extract K solution, replace the lid and shake for **1 minute**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract K solution into the filter funnel and allow the extraction filtrate to collect in the second container.

6 Once 10ml of filtrate is available fill a clean cuvette to the 10ml mark and select Phot 009 Potassium or press key '9' to blank the Soiltest 10 photometer.

7 Add **one Potassium K** tablet to the filtered sample and crush to dissolve completely.

8 Stand the cuvette in the rack for **2 minutes** to allow complex development. A cloudy solution indicates the presence of potassium.

9 Insert the cuvette into the photometer and take the reading in the usual manner.

10 The soil potassium result is displayed as mg/l K.

#### NOTE:

- Ensure the light cap is fitted correctly when measuring the insoluble complex - strong light conditions can significantly interfere with the measurement.
- High levels of ammonia nitrogen will interfere with the potassium test. Avoid testing within two weeks of adding farmyard manure or slurry to soil.

### 6.12 Soil Magnesium (Range 0-500 mg/l Mg)

Magnesium is needed by all green plants, as it is a constituent of chlorophyll. It also plays an important part in the transport of phosphate within the plant. Addition of magnesium can thus increase the effectiveness of phosphate fertiliser.

Magnesium deficiency often occurs on acidic sandy soils also deficient in calcium and can be rectified by use of dolomitic instead of purely calcareous limestone.

Deficiency may be caused not only by a low concentration of magnesium, but also by ionic antagonism. High potassium levels can impede magnesium uptake by plants, high calcium: magnesium ratios impair magnesium absorption and at low pH the hydrogen ion suppresses magnesium uptake by plants.

The Palintest Soil Magnesium test uses 1M Potassium Chloride to extract soil magnesium. 1ml of the extract filtrate is then diluted to 10ml with deionised water prior to reaction with Magnecol reagent.

Soil magnesium may be determined on fresh moist soil or air-dried soil samples.

**Equipment Required:**

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
PT 361	1ml syringe
ST-2136	Extract A Tablets
ST-2440	Magnecol S Tablets

**Test Procedure**

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **five Extract A tablets**, replace lid and shake gently to dissolve.
- 3 Add **one 10ml scoop** of soil to the deionised water/Extract A solution, replace the lid and shake for **2 minutes**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract A solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Take exactly 1ml of the extraction filtrate using the 1ml syringe and place in a clean, dry photometer cuvette.
- 7 Make the volume in the photometer cuvette up to 10ml using deionised water.
- 8 Select Phot 005 Magnesium or press key '5' to blank the Soiltest 10 photometer.
- 9 Add one Magnecol S tablet and crush to dissolve fully.
- 10 Stand the cuvette in the rack for **5 minutes** to allow full colour development.
- 11 Insert the cuvette into the Soiltest 10 photometer and take the reading in the usual manner.
- 12 The soil magnesium result is displayed as mg/l Mg

**6.13 Soil Calcium (Range 0-2500 mg/l Ca)**

Calcium is essential for the proper growth of stem and root tips, and is also present in plant cell walls. Calcium deficiency causes stunting of the roots and affects the healthy growth of leaves.

A high level of calcium, as seen on calcareous soils, is not directly harmful but may depress the uptake of magnesium and potassium, requiring higher levels of fertiliser to be applied.

Soil Calcium is a key component in the determination of Cation Exchange Capacity (CEC), along with potassium, magnesium and ammonium plus other cations.

The Palintest Soil Calcium test uses 1M Potassium Chloride to extract soil calcium which is then determined using the Palintest tablet count visual titration method. Soil calcium may be determined on fresh moist soil or air-dried soil samples.

**Equipment Required:**

PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
ST-2136	Extract A Tablets
ST-2297	Calcium S Tablets

**Test Procedure**

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **five Extract A tablets**, replace lid and shake gently to dissolve.
- 3 Add **one 10ml scoop** of soil to the deionised water/Extract A solution, replace the lid and shake for **2 minutes**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract A solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Take exactly 10ml of the extraction filtrate and add deionised water to the 50ml mark on the sample container.



- 7 Add **one Calcium S** tablet and shake until the tablet dissolves/disintegrates.
- 8 Continue to add Calcium S tablets one at a time, keeping a note of how many are added, until the colour of solution changes from pink to violet.
- 9 Note the number of Calcium S tablets and calculate the result as follows:

$$\text{Calcium (mg/l Ca)} = (\text{Number of tablets} \times 250)$$

#### NOTE:

For soils with a low Calcium content use a 50ml sample of extraction filtrate made up to 100ml with deionised water. The result is then calculated:

$$\text{Calcium (mg/l Ca)} = (\text{Number of tablets} \times 50)$$

### 6.14 Soil Aluminium (Range 0-50 mg/l Al)

Excess aluminium accumulates in plant roots and considerably reduces the ability of plants to translocate phosphate upwards to the stem and leaves. Consequently plants suffer from phosphate starvation, which cannot be addressed by adding additional phosphate.

In the Palintest Aluminium test the soil is extracted using 1M potassium chloride and reacted with Eriochrome Cyanine R under acid conditions to produce a red coloured complex. In the absence of aluminium, the reagent gives a yellow coloration.

Soil aluminium is best determined on fresh moist soil samples.

#### Equipment Required:

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
PT 361	1ml syringe
ST-2136	Extract A Tablets
ST-2345	Aluminium S Tablets

#### Test Procedure

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **five Extract A tablets**, replace lid and shake gently to dissolve.
- 3 Add **one 10ml scoop** of soil to the deionised water/Extract A solution, replace the lid and shake for **2 minutes**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract A solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Take exactly 1ml of the extraction filtrate using the 1ml syringe and place in a clean, dry photometer cuvette.
- 7 Make the volume in the photometer cuvette up to 10ml using deionised water.
- 8 Select Phot 001 Aluminium or press key '1' to blank the Soiltest 10 photometer.
- 9 Add one **Aluminium S No1** tablet and crush to dissolve fully.
- 10 Add one **Aluminium S No2** tablet and crush vigorously to dissolve fully. Invert the cuvette to remove any bubbles that form.
- 11 Stand the cuvette in the rack for **5 minutes** to allow full colour development.
- 12 Insert the cuvette into the Soiltest 10 photometer and take the reading in the usual manner.
- 13 The soil magnesium result is displayed as mg/l Al

### 6.15 Soil Ammonia (Range 0-75 mg/l N)

Nitrogen is a macronutrient, needed to form proteins. It promotes lush, foliar growth and increases yield. Plant growth is limited by nitrogen more than any other element.

Plants can take up their nitrogen either as ammonium or nitrate ions and most plants use either equally easily. The main difference between these two ions is that all the nitrate is present in the soil solution, whilst if the soil contains significant clay or humus (organic matter) content the ammonium is present as an exchangeable cation, not in solution. Thus a nitrate fertiliser tends to be faster acting than ammonium fertiliser.

In most arable soils added ammonium is rapidly oxidised to nitrate, so no matter what form is used as fertiliser, nitrate is the only form available in significant concentration in the soil solution for the plant to absorb.

In the Palintest Ammonia test the soil is extracted using 1M potassium chloride and reacted with alkaline salicylate to produce a green indophenol complex.

Soil ammonia should be tested as soon as possible on fresh moist soil samples.

### Equipment Required:

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 620	Filter Paper, 11cm diameter
PT 361	1ml syringe
ST-2136	Extract A Tablets
ST-2320	Ammonia S Tablets

### Test Procedure

- 1 Fill the Sample Container to the 50ml mark with Deionised Water.
- 2 Add **five Extract A tablets**, replace lid and shake gently to dissolve.
- 3 Add **one 10ml scoop** of soil to the deionised water/Extract A solution, replace the lid and shake for **2 minutes**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract A solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Take exactly 1ml of the extraction filtrate using the 1ml syringe and place in a clean, dry photometer cuvette.
- 7 Make the volume in the photometer cuvette up to 10ml using deionised water.
- 8 Select Phot 002 Aluminium or press key '2' to blank the Soiltest 10 photometer.

- 9 Add one **Ammonia S No1** tablet and one **Ammonia S No2** tablet and crush to dissolve fully.

- 10 Stand the cuvette in the rack for **15 minutes** to allow full colour development.

- 11 Insert the cuvette into the Soiltest 10 photometer and take the reading in the usual manner.

- 12 The soil ammonia result is displayed as mg/l N

### NOTE:

Crush the Ammonia No1 and Ammonia No2 at the same time to ensure both tablets dissolve fully.

Ensure the Extract sample is 20-25°C for optimum colour development. Lower temperature will slow colour development.

To convert mg/l N to mg/l  $\text{NH}_3$  multiply the result by 1.2.

To convert mg/l N to mg/l  $\text{NH}_4$  multiply the result by 1.3.

### 6.16 Soil Chloride (Range 0-1000 mg/l Cl)

Chlorides are taken up by most plants from the soil solution principally to balance the cations in the cell sap and regulate the osmotic pressure in the plant cells. There is no evidence that it is required for crop growth.

Excessive levels of soluble salts have two types of effect on growing plants: specific effects due to the particular ion being harmful to the crop, and a general effect due to them raising the osmotic pressure of the solution around crop roots.

Crops vary in their susceptibility to damage by chloride. For example peaches and beans are less tolerant to chloride than to sulphate, while flax and grasses are more tolerant of chloride.

In the general effect, the raised osmotic pressure of the soil solution markedly reduces the plant's ability to absorb water. To combat this rise in osmotic pressure, the plant must expend greatly increased energy to take up water. This leads to stunted plants and low crop yields.

The Palintest Chloride method uses deionised water to extract soil chloride which is then determined using the Palintest tablet count visual titration method. Soil chloride may be determined on fresh moist soil or air-dried soil samples.

**Equipment Required:**

PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
ST-2367	Chloride S Tablets

**Test Procedure**

- 1 Fill the sample container to the 50ml mark with deionised water (Extract W).
- 2 Add **one 10ml scoop** of soil to the Extract W, replace the lid and shake for **2 minutes**.
- 3 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 4 Pour the soil/Extract W solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 5 Take exactly 10ml of the extraction filtrate and add deionised water to the 50ml mark on the sample container.
- 6 Add **one Chloride S** tablet and shake until the tablet dissolves/disintegrates.
- 7 Continue to add Chloride S tablets one at a time, keeping a note of how many are added, until the colour of solution changes from **yellow to brown**.
- 8 Note the number of Chloride S tablets and calculate the result as follows:

$$\text{Chloride (mg/l Cl)} = (\text{Number of tablets} - 1) \times 125$$

**NOTE:**

For soils with a low chloride content use a 50ml sample of extraction filtrate made up to 100ml with deionised water. The result is then calculated:

$$\text{Chloride (mg/l Cl)} = (\text{Number of tablets} - 1) \times 25$$

When testing suspected saline soils, Extract W should be diluted two or four times with further deionised water. Multiply the result by the dilution factor.

Alternatively use the Multiparameter Pocket Sensor to measure salinity.

**6.17 Soil Copper (Range 0-25 mg/l Cu)**

Copper is one of a group of trace elements required in very small quantities for plant nutrition, a micro-nutrient. A shortage of one or more micro-nutrients may lead to the appearance of symptoms in the plant such as chlorotic, bronzed or mottled leaves, altered habit or death of the growing tips, or there may be no visual symptoms at all. On some soils, plants suffer from a deficiency of a number of trace elements simultaneously. This can be pH related as the availability of most elements is pH controlled. Typically, most trace elements are available under acidic conditions and liming can induce deficiency. Deficiency may best be addressed by foliar spray rather than additions to soil.

Micro-nutrients are normally all very poisonous when present in an available form in more than trace amounts.

Copper has a function as a constituent of some enzymes, for example polyphenol oxidase, which can be involved in respiration or photosynthesis. It has also been suggested that copper has a role in neutralising some harmful conditions of soil, for example in precipitating or inactivating some toxins found in organic matter such as peat.

In the Palintest Copper test the soil is extracted using 0.05M disodium EDTA and reacted with Coppercol S to produce a purple complex.

Copper tests are best carried out on fresh, moist soil.

**Equipment Required:**

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
ST-2146	Extract C Tablets
ST-2455	Copper No 1S/No 2S Tablets

**Test Procedure**

- 1 Fill the sample container to the 50ml mark with deionised water (Extract W).
- 2 Add **five Extract C** tablets, cap and shake to disintegrate.
- 3 Add **one 10ml scoop** of soil, cap and shake for **two minutes**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract C solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Once 10ml of filtrate is available fill a clean cuvette to the 10ml mark and select Phot 003 Copper or press key '3' and blank the Soiltest 10 photometer.
- 7 Add **one Coppercol No 1S** tablet to the filtered sample and crush to dissolve completely.
- 8 Add **one Coppercol No 2S** tablet to the filtered sample and crush to dissolve completely.
- 9 Insert the cuvette into the photometer and take the reading in the usual manner.
- 10 The soil copper result is displayed as mg/l Cu

**6.18 Soil Iron (Range 0-25 mg/l Fe)**

Iron is one of a group of trace elements required in very small quantities for plant nutrition, a micro-nutrient. A shortage of iron typically shows up as chlorosis (yellowing) of leaves, and is most commonly found on calcareous soils, or caused by liming.

There may plenty of iron in the soil, but in an unavailable form. The problem appears to be two-fold: the plant has difficulty in extracting iron from the soil, and the iron absorbed is in a form unsuitable for plant cells to use.

On some soils, plants suffer from a deficiency of a number of trace elements simultaneously. This can be pH related as the availability of most elements is pH controlled. Typically, most trace elements are available under acidic conditions and liming can induce deficiency. Deficiency may best be addressed by foliar spray rather than additions to soil.

In the Palintest Iron test the soil is extracted using 0.05M disodium EDTA and reacted with 1,10

phenanthroline following a reduction step to produce a yellow/orange complex.

Iron tests are best carried out on fresh, moist soil.

**Equipment Required:**

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
ST-2146	Extract C Tablets
ST-2370	Iron MR No 1S/No 2S Tablets

**Test Procedure**

- 1 Fill the sample container to the 50ml mark with deionised water (Extract W).
- 2 Add **five Extract C** tablets, cap and shake to disintegrate.
- 3 Add **one 10ml scoop** of soil, cap and shake for **two minutes**.
- 4 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 5 Pour the soil/Extract C solution into the filter funnel and allow the extraction filtrate to collect in the second container.
- 6 Once 10ml of filtrate is available fill a clean cuvette to the 10ml mark and select Phot 004 Iron or press key '4' and blank the Soiltest 10 photometer.
- 7 Add **one Iron MR No 1S** tablet to the filtered sample and crush to dissolve completely.
- 8 Add **one Iron MR No 2S** tablet to the filtered sample and crush to dissolve completely.
- 9 Stand the cuvette in the rack for **10 minutes** to allow full colour development.
- 10 Insert the cuvette into the photometer and take the reading in the usual manner.
- 11 The soil iron result is displayed as mg/l Fe.

### 6.19 Soil Manganese (Range 0-25 mg/l Mn)

One of the key micro nutrients, manganese in soil is required in trace amounts for several plant health processes. It is a constituent of some respiratory enzymes, some enzymes responsible for protein synthesis and is involved in nitrogen metabolism. Manganese deficiency is common in calcareous and newly limed soils, shown as chlorotic (yellow), mottled or dying leaves. Manganese toxicity is often the first harmful effect seen when soil pH is too low, and it can accumulate in plant tissues in excessive amounts. It causes chlorosis (yellowing) and necrosis (death) of the leaves.

In the Palintest Manganese test the soil is extracted using 1M ammonium chloride under reducing conditions at a soil:water ratio of 1:25. The extracted and exchanged manganese is then oxidised to permanganate, and reacted with leuco-malachite green indicator to form a blue-green complex.

Manganese tests are best carried out on fresh, moist soil.

#### Equipment Required:

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 361	Syringe, 1ml
PT 302	Soil Scoop, 2ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
PT 311	2.5ml Extract Scoop
ST-2106	Extract N Powder
ST-2237	Nitratest™ N Powder
ST-2390	Manganese No1S Tablets
ST-2400	Manganese No2S Tablets

#### Test Procedure

- 1 Fill the sample container to the 50ml mark with deionised water (Extract W).
- 2 Add one level scoop of Extract N to the deionised water using the PT 311 Long-handled Extract N Scoop.
- 3 Replace the lid and shake the container to dissolve the Extract N powder.

- 4 Add **one 2ml scoop** of soil to the deionised water/Extract N solution, replace the lid and shake for 1 minute.
- 5 Add **one level spoonful of Nitratest™ powder** to the soil/Extract N solution using the scoop contained within the Nitratest™ container. Shake for **one minute**.
- 6 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 7 Pour the soil/Extract N solution into the filter paper and allow the extraction filtrate to collect in the second container.
- 8 Once at least 1ml of filtrate is available, use the syringe to extract 1ml and add to a clean cuvette.
- 9 Make up to the 10ml mark using deionised water and select Phot 006 Manganese or press key '6' and blank the Soiltest 10 photometer.
- 10 Add **two Manganese No1S tablets** to the cuvette and crush to dissolve completely.
- 11 Add **two Manganese No2S tablets** to the cuvette and crush to dissolve completely. **Immediately cap the cuvette.**
- 12 Stand the cuvette in the rack for **20 minutes** to allow full colour development.
- 13 Insert the cuvette into the photometer and take the reading in the usual manner.
- 14 The soil manganese result is displayed as mg/l Mn.

#### NOTE:

If the extract is cloudy following the filtration step, repeat the filtration step to ensure a completely clear filtrate is produced.

### 6.20 Soil Sulphur (Range 0-300 mg/l S)

Sulphur is an essential constituent of many proteins and occurs in the oils produced by certain plants. Lack of sulphur was one of the first deficiency diseases to be recognised. Large areas of USA and Canada are restricted by lack of sulphur, and application of gypsum (calcium sulphate) can increase yields dramatically. Areas of sulphur deficiency are also found in Australia, New Zealand and parts of Africa.

In the Palintest Sulphur test the soil is extracted using Deionised Water at a soil:water ratio of 1:5. The extracted sulphate is then reacted with barium chloride to produce an insoluble suspension. Sulphur tests can be carried out on fresh, moist soil or air-dried soil.

**NOTE:**

The extraction step can be lengthy in clay-type soils. To shorten the extraction step prepare two samples and filter in parallel.

**Equipment Required:**

PTB 7510	Soiltest 10 Photometer
PT 595	Cuvette, 10ml
PT 501	Cuvette rack
PT 310	Soil Scoop, 10ml
PT 512	Sample Container/Dilution Tube x 2
PT 500	De-ion Pack
PT 607	Filter Funnel, 7cm diameter
PT 618	Filter Paper, 11cm diameter
ST-2410	Sulphate S Tablets

**Test Procedure**

- 1 Fill the sample container to the 50ml mark with deionised water (Extract W).
- 2 Add **one 10ml scoop** of soil to the deionised water, replace the lid and shake for **2 minutes**.
- 3 Fold a filter paper into quarters and insert into the filter funnel. Place the filter funnel in a clean sample container.
- 4 Pour the soil/water solution into the filter paper and allow the extraction filtrate to collect in the second container.
- 5 Once at least 10ml of filtrate is available, add to a clean cuvette.
- 6 Select Phot 010 Sulphur or press keys '1' followed by '0' and blank the Soiltest 10 photometer.
- 7 Add **one Sulphate S tablet** to the cuvette and crush/mix. A cloudy solution indicates the presence of sulphate in the sample.
- 8 Stand the cuvette in the rack for **5 minutes** to allow full reaction to occur. Remix before measurement by stirring.
- 9 Insert the cuvette into the photometer and take the reading in the usual manner.
- 10 The soil sulphur result is displayed as mg/l S

Photometric analysis is a very powerful technique, providing accurate analysis of a wide range of critical drinking water, wastewater and environmental parameters.

A complete guide to the science behind photometric (also known as colorimetric) analysis can be found in the Know portal at [www.palintest.com/know/](http://www.palintest.com/know/)

Palintest has focused on simplifying the test methods and equipment used for this technique but there are still a number of ways to ensure the results you generate are as accurate as possible:

- 1 Always use genuine Palintest soil reagents when using the programmed test methods. Each parameter has a unique calibration which has been generated using Palintest soil reagents. Alternative reagents may follow the same general methodology but can differ substantially in formulation and performance thereby rendering the calibration and hence results inaccurate.
- 2 Always correct for the blank value - any inherent colour in the sample (which may not be visible to the naked eye) will offset the result if the blank step is omitted. If the sample colour is too intense for the photometer to blank use dilution with deionised water to reduce the intensity. Remember to dilute the sample to the same extent for analysis.
- 3 Always respect the reaction time specified within the instructions. Some methods produce instant colour whereas others require a reaction time to reach full development. Taking a reading before the reaction time has elapsed may lead to low results.
- 4 The presence of solids, either large or in the form of turbidity, can adversely affect the quality of results by preventing incident light from reaching the detector. The blanking step can reduce the impact of turbidity interference but large solid particles must be removed prior to analysis. Solids can be removed by filtration prior to analysis or, if the solids are settleable and will not lie in the optical path, allowing them to settle in the photometer cuvette can be acceptable.
- 5 Calibration curves relate transmission/ absorbance to concentration to provide result data but not all calibration ranges are linear. Frequently at higher concentrations the curve 'flattens' leading to higher potential variability in results. If greater accuracy is required than can be achieved on neat samples then dilution can be used to improve performance.
- 6 Ensure the photometer cuvette is clean, has no droplets on the outside and not excessively scratched. Good technique is to wipe the outside surface of the cuvette prior to inserting into the optical chamber to prevent contamination of the optical system.
- 7 Always use good quality, genuine Palintest cuvettes. Use the orientation mark to ensure repeatable positioning of the cuvette.
- 8 Maintain the cleanliness of the optical chamber by only inserting clean cuvettes. If the chamber becomes fouled or sample is spilled the base can be removed for cleaning access. Clean the optical chamber with a soft cloth. Do not use abrasive chemicals or scouring agents.
- 9 Always use the light cap provided to prevent ambient light affecting results. This is especially relevant when operating in strong sunlight or other light conditions.
- 10 Ensure your Soiltest 10 Bluetooth is operating effectively by using Palintest Check Standards and the Check Standard Mode (see Section 9 Calibration/Validation) and having the photometer serviced and calibrated at regular intervals. Calibration is recommended at 12 month intervals for normal usage and can be provided by your local Palintest distributor.

The Soiltest 10 Bluetooth features self-diagnostic software and hardware to optimise performance and battery life. The Info Panel indicates the status of the Soiltest 10 Bluetooth and any specific fault conditions are defined and displayed on screen.

## Optical Errors

### I have an Error 9 message

Error 9 is caused by the blank cuvette being too dark to allow the blanking step to be carried out. Check that the correct cuvette is being used i.e. ensure the sample cuvette is not being used for blanking.

If the sample is too highly coloured or contains significant solids, dilute and repeat the blanking step. If the problem persists and the blank cuvette is not the issue, clean the optical chamber by removing the access cover and cleaning with a soft cloth. Do not use corrosive or abrasive chemicals.

### I have an Error 7 message

Error 7 is caused by too much ambient light reaching the detector. Use the light cover provided with the instrument.

## Check Standard Issues

### How do I maintain my Check Standards?

Check Standards are manufactured to precise values/tolerances, certified against traceable reference materials and provided in sealed cuvettes. Do not decant or remove the sealed cap from the Check Standard.

Ensure the Check Standard cuvettes are clean and dry using lint-free cloths before inserting into the optical chamber.

Insert the Check Standard aligning the orientation arrow towards the front of the optical chamber. Values assigned to calibration standards are defined at 20-25°C. Extremely high or low ambient temperatures can affect Check Standard results so ensure standards are at the defined temperature to effectively validate.

Check Standards have a two year shelf-life, after which the colours will no longer be valid. Please dispose of the expired standards after this period according to the MSDS.

## My Check Standard validation has failed

Photometers may fail the Check Standard validation step due to the requirement for service/calibration. Contact your local Palintest partner for service and support.

Ensure the Check Standards are inserted correctly, using the orientation mark to align and inserted fully. Use the light cap to prevent any ambient light interference.

Service/calibration is recommended at annual intervals in normal operation.

## Bluetooth Issues

The Soiltest 10 Bluetooth features the latest Bluetooth SMART connectivity.

### I can't connect the Soiltest 10 Bluetooth to my device

Ensure your device is Bluetooth SMART ready and you are using the Palintest Aqua Pal app. Previous versions of Bluetooth (also known as Bluetooth Classic) will not connect to the Soiltest 10 Bluetooth. Check your device specification or visit [www.bluetooth.com](http://www.bluetooth.com) to see the latest list of SMART ready devices.

### I can't download my results to my connected device

The Info Panel will show the connected status of the Soiltest 10 Bluetooth. Ensure the connected icon is displayed.

If more than one remote device is running the Aqua Pal app, check that the correct device is connected to the Photometer.

The connected device is indicated at the base of the Aqua Pal results screen.

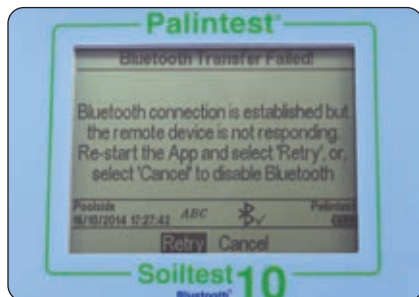
### I can't upload my data to the Palintest Portal

Ensure you have a reliable internet connection to exchange data with the Palintest Portal. Once uploaded data can be shared within your secure user group and downloaded for report generation.



## Bluetooth Error Messages

The Soiltest 10 Bluetooth communicates seamlessly with the Palintest Aqua Pal app. In the event of any errors the Soiltest 10 Bluetooth will display either of the following messages:



The Soiltest 10 Bluetooth is not receiving a response from the Palintest Aqua Pal app but the remote device is connected. This will appear 10s after a result transmission has started and no valid response has been received.

Re-start the Aqua Pal app and select Retry.

When the Bluetooth connection to the remote device is lost the following message is shown:



Check the Bluetooth has not been inadvertently deactivated in the mobile device settings.

**Note:** the Soiltest 10 will not appear as a 'paired device' in the settings of a Bluetooth SMART device.

## Battery/Power Issues

### My batteries are running out too quickly

Use good quality batteries and always replace the batteries completely when indicated on the Info Panel. The battery compartment is located underneath the Soiltest 10 Bluetooth and secured by four screws.

Remove the battery cover and replace batteries as a set.

Refit the battery cover ensuring the cover is tight enough to prevent water ingress. Do not overtighten as this will damage the screw housings.

The Soiltest 10 Bluetooth has a number of power-saving features such as auto-dim of the backlight and automatic power down after inactivity (See Section 7). Activating these features will prevent power being used unnecessarily. Bluetooth can also be de-activated if not required.

Using the USB port to provide power will automatically prevent battery power being consumed when mains or external power is available.

### My photometer will not switch on

The Info Panel provides an ongoing indication of power available from the battery supply. When the voltage available falls below 3.0V the Soiltest 10 Bluetooth will not switch on as the available power will not be sufficient to provide effective photometric testing.

Use the USB cable to provide an alternative power supply. If the photometer still fails to switch on, contact your local Palintest partner for service support.

### My USB power supply is not working

Ensure your PC is not operating in power save mode or the mains supply is not isolated.

Replace the cable with an alternative to ensure the cable is not faulty.

## USB Connection Issues

### I cannot download my data

Check the USB mode is set to Hard Disk, not COM port mode. In Hard Disk mode the data can be 'dragged and dropped' as with a conventional memory stick and is available in CSV format.

Opening CSV data files can be accomplished by a number of text editing or spreadsheet programs.

### Where do I find the COM port drivers?

The latest drivers are available at [www.palintest.com](http://www.palintest.com)

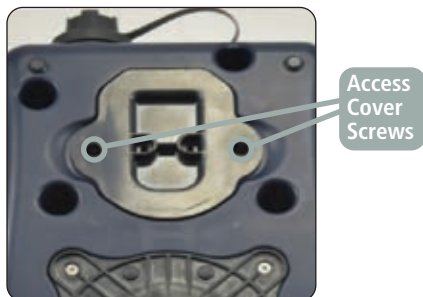
COM port drivers are provided for Windows operating systems (Windows Vista, XP and 7).

## Care and Maintenance

The Soiltest 10 Bluetooth contains no user-serviceable parts internally. User maintenance is only recommended for cleaning of the optical chamber, changing batteries and validating performance using the Check Standard Mode.

### Cleaning the Optical Chamber

The optical chamber has been designed to support removal and cleaning with a lint-free cloth as required by removal of the access cover.



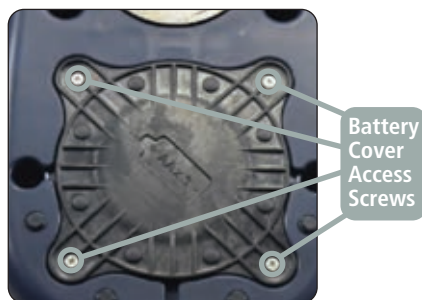
Do not use any of the following agents when cleaning this optical chamber:

- Abrasive cloths
- Corrosive chemicals
- Any organic solvents

Do not overtighten the screws on re-assembly to avoid damaging the access cover.

## Replacing the Batteries

Remove the four retaining screws from the battery cover and gently prise the cover free.



Replace all batteries at the same time.

Ensure on replacing the battery cover that the gasket is correctly located to prevent any water ingress. Tighten the screws carefully but do not overtighten.

## SKW 500 Complete Soil Kit

<b>Size (W x L x H)</b>	555 x 428 x 211mm
<b>Weight</b>	10.5kg
<b>Case IP Rating</b>	IP67

## Soiltest 10 Bluetooth

<b>Instrument Type</b>	Dual light source photometer offering direct-reading of pre-programmed test calibrations and Transmittance
<b>Optical System</b>	
Optical Source	Dual LED sources with optical filters
Optical Detectors	Silicon photodiodes
Peak Wavelengths	450nm, 500nm, 550nm, 570nm, 600nm, 650nm
Wavelength Selection	Automatic
Bandwidth	±5nm
Range	1 - 100%T (0 - 2.3 Abs)
Accuracy	± 1.0% T
<b>User Interface</b>	
Display	320 x 240 pixel LCD with contrast adjustment
Backlight	Timed, on key press with auto-dim and off
User Interface	On-screen prompts available in English, French, Spanish, German, Italian, Turkish and Mandarin (Chinese)
Keypad	Numeric keypad with direct access keys. Four navigation keys and OK key
<b>Physical</b>	
Size (W x L x H)	150 x 250 x 70mm
Weight	975g
IP Rating	IP67
<b>Power Supply</b>	
Batteries	3 x 1.5v 'AA' batteries
Lifetime	40 hours (typical use, backlight off, 'AA' alkaline cells)
Mains	5V DC, 900mA delivered via USB port
Power Management	Auto-switch off (user selectable between 5-15 minutes on battery) or continuous operation
Power Saving	User control for Backlight and Bluetooth to minimise battery consumption
<b>Test Methods</b>	
Tests Available	Pre-programmed for Palintest soil reagents. Also operates in Absorbance and Transmittance modes
User Defined Tests	Up to 30 user calibrations can be entered. Up to 10 points per calibration
Test Selection	Test number entry, direct access key or selection from a list
Test Cuvettes	12-20mm OD with automatic cuvette centering
Result Units	g/l, mg/l, ppm, mmol/l, µmol/l, µg/l, ppb
Blanking	Automatic blanking at all wavelengths. Blank value stored in memory until power off or new blank recorded
<b>Connectivity</b>	
USB	USB Type B Connector. Waterproof connector available
Wireless	Palintest Bluetooth SMART profile
<b>Data Management</b>	
Instrument Memory	Non-volatile storage
Memory Capacity	Up to 500 data sets. Each data set includes date, time, Sample ID, Operator ID, method number, method name, result, units
Sample IDs	Up to 24 at any time
Operator IDs	Up to 12 at any time
Data Download	To computer via USB using Hard Disk or COM port mode. Wireless Bluetooth SMART download, either instantly or as a data batch, using a connected device running the Palintest Aqua Pal app. Optional Palintest Portal data management available
Data Output Format	Plain text
Software Upload	Software update by 'drag and drop' in USB Hard Disk Mode

## Multiparameter Pocket Sensor

Parameter	Range	Resolution (Accuracy)
pH	0.00 - 14.00	0.01 ( $\pm 0.01$ )
Conductivity	0 - 199.9 $\mu\text{S}/\text{cm}$ 200 to 1999 $\mu\text{S}/\text{cm}$ 2.00 to 20.00 $\text{mS}/\text{cm}$	0.1 $\mu\text{S}/\text{cm}$ (1% FSD) 1 $\mu\text{S}/\text{cm}$ (1% FSD) 0.01 $\text{mS}/\text{cm}$ (1% FSD)
TDS	0.0 to 99.9 ppm 100 to 999 ppm 1.00 to 10.00 ppt	0.1 ppm (1% FSD) 1 ppm (1% FSD) 0.01 ppt (1% FSD)
Salinity	0.0 to 99.9 ppm 100 to 999 ppm 1.00 to 10.00 ppt 0.0 to 1.00%	0.1 ppm (1% FSD) 1 ppm (1% FSD) 0.01 ppt (1% FSD) 0.01% (1% FSD)
Temperature	0.0 to 50.0°C / 32.0 to 120.0 °F	0.1 °C/°F ( $\pm 0.5^\circ\text{C}$ / $\pm 0.9^\circ\text{F}$ )
Display	Dual LCD display	2.1 x 2.7cm
Power	4 x A76 batteries	>150 hours lifetime
Size/weight	18cm x 6cm x 5cm	200g

## Hardware

<b>PT 301</b>	Soil Sample Bags (100 pack)
<b>PT 302</b>	Soil Scoop, 2ml
<b>PT 310</b>	Soil Scoop, 10ml
<b>PT 311</b>	2.5ml Extract Scoop
<b>PT 361</b>	1ml syringe
<b>PT 362</b>	2ml syringe
<b>PT 370</b>	20ml syringe, Luer fitting
<b>PT 500</b>	De-ion pack
<b>PT 501</b>	Cuvette Rack
<b>PT 502</b>	Crush/stir rods (pack of 10)
<b>PT 595/5</b>	Cuvette Pack
<b>PT 512</b>	Sample Container/Dilution Tube
<b>PT 607</b>	Filter Funnel
<b>PT 618</b>	Filter Paper
<b>PT 620</b>	Filter Paper (Soil Ammonia testing)
<b>PT 663</b>	Cuvette brush
<b>SK 600</b>	Soil Accessory Pack

## Soil Combination Packs

<b>SKR 001</b>	Soil Nitrogen Pack
<b>SKR 003</b>	Soil Phosphorus Pack (P)
<b>SKR 004</b>	Soil Potassium Pack
<b>SKR 005</b>	Soil Magnesium/Calcium Pack
<b>SKR 006</b>	Soil Aluminium Pack
<b>SKR 007</b>	Soil Ammonia Pack
<b>SKR 008</b>	Soil Copper Pack
<b>SKR 009</b>	Soil Iron Pack
<b>SKR 010</b>	Soil Manganese Pack

### Individual Reagent Packs

ST-2106	Extract N Powder
ST-2116	Extract P
ST-2127	Extract K Powder
ST-2136	Extract A
ST-2146	Extract C
ST-2210	Lime Buffer
ST-2237	Nitrate N Powder
ST-2240	Nitricol N
ST-2260	Phosphate P
ST-2275	Acidifying S
ST-2280	Potassium K
ST-2297	Calcium S
ST-2320	Ammonia S
ST-2345	Aluminium S
ST-2367	Chloride S
ST-2370	Iron MR S
ST-2395	Manganese S
ST-2410	Sulphate S
ST-2440	Magnecol S
ST-2455	Coppercol S

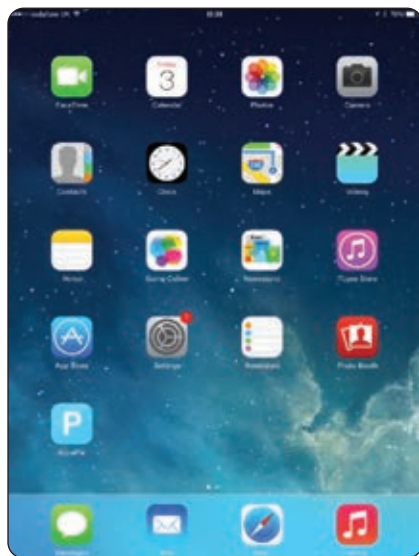
### Multiparameter Pocket Sensor Consumables

PT 105/1	pH 4 Buffer Solution, 500ml
PT 105/2	pH 10 Buffer Solution, 500ml
PT 105/3	pH 7 Buffer, 500ml
PT 142/3	Mid Range Conductivity Solution, 500ml

## What is the Aqua Pal App?

Generating reliable and accurate test data is only part of the process of managing soil nutrients and environmental impact.

Collating the data quickly and sharing with other members of the team can be the difference between effective control and failing to adhere to local regulatory standards.



The Palintest Aqua Pal app is intrinsic in the process of storing, sharing and managing data produced by the Soiltest 10 Bluetooth and also allows for additional data to be added manually for the Big Data experience.

The Aqua Pal app is available for both iOS and Android (version 4.3 or later) devices that are equipped with Bluetooth SMART connectivity.

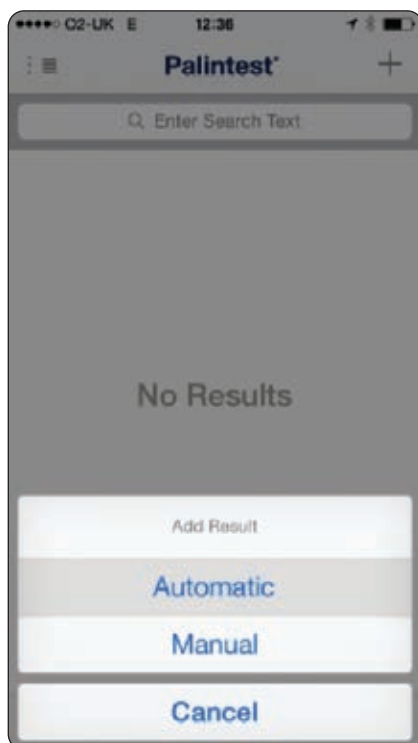
On first use the Aqua Pal app will require a registration step for both the app and the secure Palintest Portal. An internet connection is required to process the request as it will involve a second stage authentication via the provided email address.

Once the sign up process is completed the Aqua Pal app and Palintest Portal are ready to go.

## Connecting to the Aqua Pal App

Enable Bluetooth on the Soiltest 10 Bluetooth. The icon will appear on the Info Panel showing Bluetooth is on but not connected.

Open the Aqua Pal app and log in using your registration credentials. Choose whether to use automatic or manual result addition.



To connect the Soiltest 10 Bluetooth press the '+' symbol in the top right hand corner of the device screen. This will produce the list of all locally advertising Bluetooth SMART devices.



Select the Soiltest 10 Bluetooth you wish to connect (see also Section 4.6 - Adding Device Name) and Aqua Pal will link. The Info Panel will display the connected Bluetooth icon.

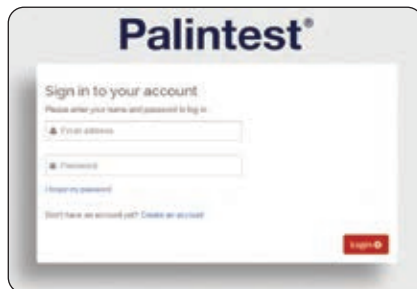
Previously connected instruments are stored in the app for future selection.

Once connected, data can either be uploaded automatically (if selected) or direct from the log (all or a selected group).

Manual data entry is also possible for results generated with non-Bluetooth instruments or external devices such as TDS meters, flow meters or level sensors.

## Connecting with the Palintest Portal

Also included with the Aqua Pal app is the secure Palintest Portal found at <https://palintestportal.com>



Data stored in the Aqua Pal app can be uploaded to the Palintest Portal when an internet connection is available.

Data stored within the portal can be shared with team members using the User Group functionality. Simply assign team members to the User Group and they can view data generated by logging in to the portal.

Results stored within the portal can be filtered by date, sample ID, Operator ID and parameter.

Data can be viewed graphically over time with the status (in spec, nearing limit, out of spec) being indicated by a simple colour key.

## Further Information

The full guide to the Aqua Pal app and the Palintest Portal are available at [www.palintest.com](http://www.palintest.com) and available for download from the Palintest Know portal.





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