



STS Developer's Kit

Installation and Operation Manual



For Products: STS Developer's Kit
Document: DEV-RASPI-KIT-02-201512b

A HALMA COMPANY

AMERICAS & WORLD HEADQUARTERS

Phone: +1 727-733-2447
Fax: +1 727-733-3962

Sales: info@oceanoptics.com
Orders: orders@oceanoptics.com
Support: techsupport@oceanoptics.com

Ocean Optics, Inc.
830 Douglas Ave.
Dunedin, FL 34698
USA

Manufacturing & Logistics
4301 Metric Dr.
Winter Park, FL 32792
USA

EUROPE, MIDDLE EAST & AFRICA

Phone: +31 26-319-0500
Fax: +31 26-319-0505
Email: info@oceanoptics.eu

Germany : +49 711-341696-0
UK : +44 1865-811118
France : +33 442-386-588

Sales & Support
Geograaf 24
6921 EW Duiven
The Netherlands

Manufacturing & Logistics
Maybachstrasse 11
73760 Ostfildern
Germany

ASIA

Phone: +86 21-6295-6600
Fax: +86 21-6295-6708
Email: asiasales@oceanoptics.com

Japan & Korea: +82 10-8514-3797

Ocean Optics Asia
666 Gubei Road
Kirin Tower Suite 601B
Changning District
Shanghai
PRC, 200336

www.oceanoptics.com

Copyright © 2014 Ocean Optics, Inc.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, by any means, electronic, mechanical, photocopying, recording, or otherwise, without written permission from Ocean Optics, Inc.

Trademarks

All products and services herein are the trademarks, service marks, registered trademarks or registered service marks of their respective owners.

Limit of Liability

Every effort has been made to make this manual as complete and as accurate as possible, but no warranty or fitness is implied. The information provided is on an "as is" basis. Ocean Optics, Inc. shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this manual.

Table of Contents

About This Manual.....	iii
Document Purpose and Intended Audience.....	iii
What's New in this Document	iii
Document Summary.....	iii
Product-Related Documentation	iii
Upgrades.....	iv
Warranty.....	iv
ISO Certification	iv
<u>Chapter 1: Introduction</u>	1
Product Overview	1
Out of the Box Wi-Fi Over the Web.....	1
Easy-to-Use Development Platform.....	2
Features.....	2
<u>Chapter 2: Start-up and Shut Down</u>.....	3
Connecting the Components	3
Power Up	4
Connecting to the Device.....	4
Shut Down the System	4
Setting the Default Passwords	5
<u>Chapter 3: User Interface</u>	7
Controlling the Spectrometer with a Browser	7
Spectrometer Settings	7
Set Spectrometer Parameters.....	8
Set Up a Timed Sequence of Measurements	9
Select a Location to Save Results	10
Scope Mode	12
Taking Dark, Reference and Single Spectra	12

Manage Results (Download and Delete)	14
Configure Default Values.....	15
Set a Password	17
Change the Wireless Access Point Name and Password	18
Upgrade the Software.....	19
<u>Appendix A: Results File Format</u>.....	21
<u>Appendix B: Advanced Functionality</u>.....	23
Overview	23
System Description.....	23
The Wired Network.....	23
Logging in Using SSH	24
Logging in to the Linux Console.....	25
Changing Passwords.....	25
Changing the Access Point Name (SSID) and Password	25
Reconfiguring the Device as a Wireless Network Client or Access Point	26
Selecting Client Mode.....	29
Selecting Host Mode	29
The Web Server	29
PHP Scripts.....	29
Worked Example – Connect Two Kits as a Host/Client Pair	30
Configure the Host.....	30
Configure the Client.....	31
<u>Appendix C: Specifications</u>.....	33
Index	35

About This Manual

Document Purpose and Intended Audience

This document describes the STS Spectrometer Development Kit. It is for users of a single development kit who have no need to make any alterations to the network capabilities of the device. More complex cases of multiple devices operating in a variety of network environments are described in Appendix B: [Advanced Functionality](#).

What's New in this Document

This version of the *STS Developer's Kit Installation and Operation Manual* clarifies the warranty information.

Document Summary

Chapter	Description
Chapter 1: Introduction	Provides an overview of the Wireless Spectrometer Development Kit product.
Chapter 2: Start-up and Shut Down	Contains instructions for installing and configuring the product, as well as shutting it down properly.
Chapter 3: User Interface	Describes how to operate the product.
Appendix A: Results File Format	Provides information on the Results file.
Appendix B: Advanced Functionality	Contains information on advanced system functionality and administration.
Appendix C: Specifications	Lists specifications of the product.

Product-Related Documentation

- [STS Developer's Kit Programming Guide](#) – Examples and information on how to make custom PHP scripts for the Developer's Kit
- [STS Developer's Kit Quick Start](#) – Information needed to get the Developer's Kit up and running
- [SeaBreeze](#) – Detailed instructions for the SeaBreeze software
- [STS Data Sheet](#) – Engineering-level information for the STS Spectrometer

You can access documentation for Ocean Optics products by visiting our website at <http://www.oceanoptics.com>. Select *Support*→*Technical Documents*, then choose the appropriate document from the available drop-down lists.

Upgrades

Occasionally, you may find that you need Ocean Optics to make a change or an upgrade to your system. To facilitate these changes, you must first contact Customer Support and obtain a Return Merchandise Authorization (RMA) number. Please contact Ocean Optics for specific instructions when returning a product.

Warranty

Our **1-Year Warranty** covers Ocean Optics OEM equipment from manufacturing defects:

<http://www.oceanoptics.com/warranty.asp>

This comprehensive warranty ensures you of the highest level of craftsmanship and reliability.

The warranty covers parts and labor needed to repair manufacturing defects that occur during the warranty period. We also will cover the costs of shipping warranty-related repairs from our customers to Ocean Optics and from us to our customers.

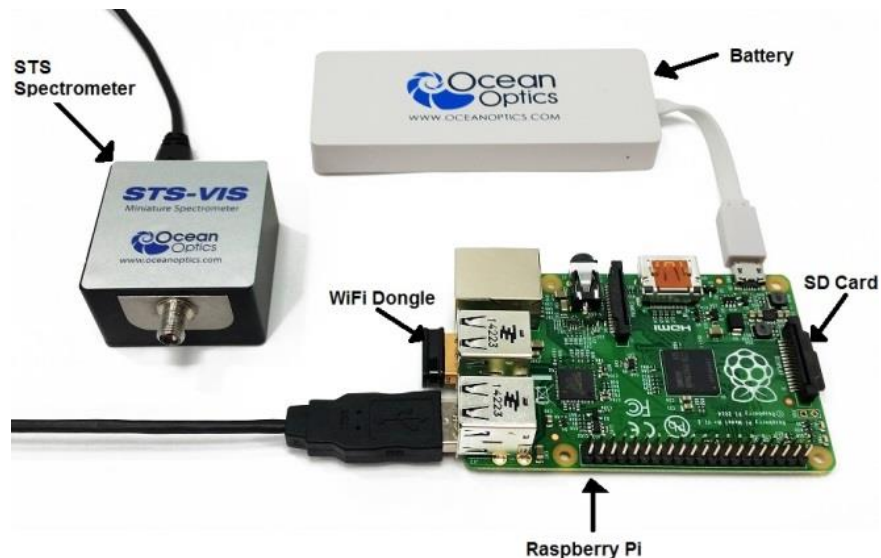
ISO Certification

Ocean Optics, the industry leader in miniature photonics, has been certified for ISO 9001:2008 certification applicable to the design and manufacture of electro-optical equipment since 2009.

Introduction

Product Overview

The STS Developer's Kit is the easiest way to develop and integrate spectral sensing into your application. Leveraging the STS micro-spectrometer, a Linux powered Raspberry Pi microcomputer, a Li-Ion battery and an easily customizable software platform it is built for out of the box Wi-Fi™ and much more. Put it on a UAV, create a remote monitoring station, develop a handheld device – this is spectral sensing made quick, easy and flexible.



Out of the Box Wi-Fi Over the Web

The Developer Kit comes loaded with a simple interface that makes it simple to control your spectrometer out of the box through your web browser on phone, tablet or computer. Simply connect to the developer kit Wi-Fi network and off you go. Set up the measurement, take references and manage data all through simple clear interfaces. Collecting data on a UAV and you fly out of Wi-Fi range? No problem. All data is saved directly to the SD card. Web scripting API makes it easy to script your own custom applications.

Note

The default password for the Wi-Fi network is **oceanwifi**.

Easy-to-Use Development Platform

The STS Developers kit comes complete with a copy of our SeaBreeze drivers that lets you talk directly to the spectrometer via a USB interface. The next layer of software is a Daemon Service that can be extended to coordinate behavior with other hardware or supply more autonomous functionality. Finally, the web API allows for quick development of custom scripts and applications that allow the STS and Raspberry Pi to perform even more complex tasks.

All of the source code used in creating this product is contained on the SD card included in your STS Development Kit. The source for the daemon and SeaBreeze library is located under the directory `/home/pi/dev-kit`.

Features

- Out of the box Wi-Fi over Web interface
- Write custom scripts through web API or access drivers directly
- Easily transferable software on SD card
- SMA connection for fibers and sampling accessories

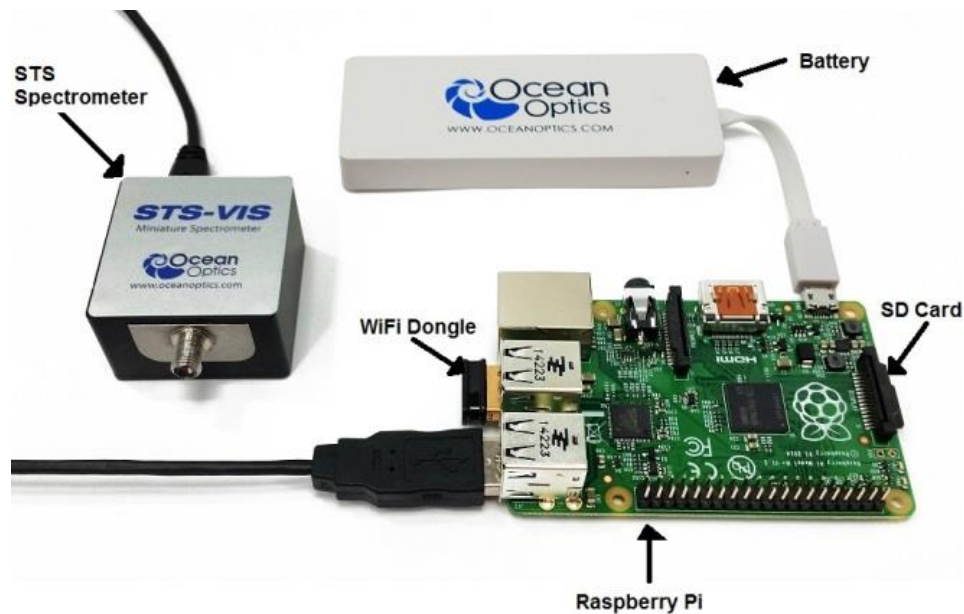
Start-up and Shut Down

Connecting the Components

Before beginning, ensure that the battery supplied with the kit is fully charged, or provide an alternative power supply for the kit that is capable of providing 5 Volts and at least 1000mA through a micro-USB connection. You can connect up to two spectrometers to the Raspberry pi USB ports (depending on other devices that may be connected). It is possible to connect more spectrometers if a powered USB hub is used.

► Procedure

1. Insert the dongle into one of the USB ports on the Raspberry Pi B+ computer.
2. Plug the spectrometer into one of the remaining USB ports on the Raspberry Pi B+ computer.
3. Insert the SD card before plugging in the power supply.



Device Connection

Power Up

When the battery (or alternative power supply) is plugged into the micro-USB port, the Raspberry Pi automatically boots and starts the software to control the spectrometer. Allow at least 30 seconds for operating system and services to start before attempting to use any of the software to control the device. See [Shut Down the System](#) for information on powering off.

Connecting to the Device

When the Raspberry Pi has completed starting up it will appear as a secure wireless access point that you can connect to in order to control the spectrometer:

- The default name (SSID) of the access point is **ocean-spectrometer**.
- You can connect to this with the default password **oceanwifi**.

These settings can be changed.

► Procedure

1. Ensure that the Raspberry Pi has power and has booted up. This takes approximately 30 seconds. The Wi-Fi dongle flashes blue when it is transmitting.
2. From your wireless device, look for the network named **ocean-spectrometer**.
3. Enter the password **oceanwifi**.
4. Open your browser and load the interface at address <http://192.168.42.1/cgi-bin/settings.php>.

The Raspberry Pi can be reconfigured to connect as a DHCP client to another wireless network. These changes may be necessary for more complex networks or if you have more than one development kit operating within wireless range of each other. Setting up the device for more complex networks is described in *Appendix B: Advanced Functionality*).

The Raspberry Pi assigns your computer or smartphone an IP address on the network in the range 192.168.42.x where x is a number between 10 and 50. This address can also be reconfigured for more complex cases. The Raspberry Pi is configured to have a fixed IP address on the wireless network of 192.168.42.1.

Shut Down the System

Shut down the Raspberry Pi with the **Shutdown** button on the **Spectrometer Settings** web page. Or, expert users can log in to the operating system and shut down the Raspberry Pi directly as described in *Appendix B: [Advanced](#)*).

Caution

It is important to shut down the device correctly before removing the power supply. If you fail to do this you risk corrupting the SD card, potentially losing software and any measurements stored on the card.

► **Procedure**

To shut down the system safely,

1. Enter the administrator password for the *ocean* account.

The default password is **ocean**.

2. Click Shutdown.
3. Allow sufficient time for the shutdown to complete (around 60 seconds) before removing the power supply.

Setting the Default Passwords

There are two user accounts set up on the Raspberry Pi, the superuser “root” and an administrative account, “ocean.” The default password for both of these accounts is **ocean**. This is not secure so it is recommended that you change the password for these accounts at the earliest opportunity. A simple web interface for changing the passwords for these accounts is provided (see [Set a Password](#)).

User Interface

Controlling the Spectrometer with a Browser

Version 2 of the STS Development Kit allows you to control up to two spectrometers connected directly to the Raspberry Pi USB ports. The spectrometers are associated with a channel number (either 0 or 1) assigned when the software starts up. If only one spectrometer is connected, it will always be Channel 0. If more than one spectrometer is connected, it is not guaranteed that they will be assigned the same channel number each time the software is started. If a powered USB hub is used to connect more than two spectrometers the channel numbers are assigned in the range 0..{number of spectrometers – 1}.

The Raspberry Pi runs a web server that offers the simplest mechanism for controlling the spectrometers. Once you have connected to the device you can begin controlling the spectrometers by directing your browser to the URL <http://192.168.42.1/cgi-bin/settings.php> which will take you to the **Settings** page.

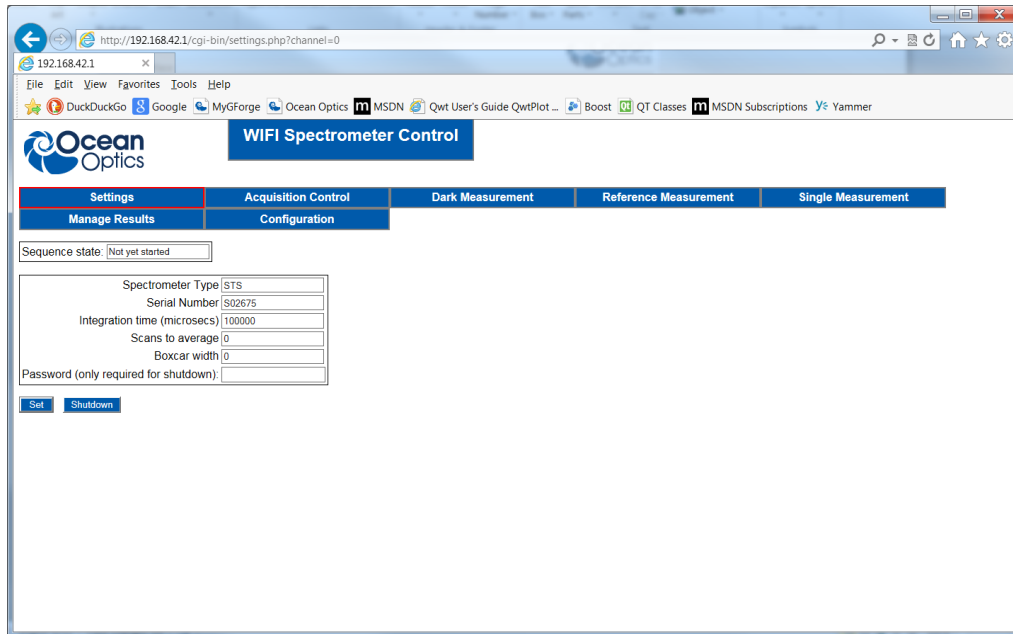
Note

Be sure that at least one spectrometer is connected to the Raspberry Pi before starting the software or the software will not detect it. Spectrometers connected after start-up after startup, or disconnected and reconnected, will not be detected by the software.

Spectrometer Settings

The **Settings** page allows you to set the basic spectrometer parameters (integration time, scans to average and boxcar smoothing width). This page also displays the spectrometer type and serial number, along with the current status of any ongoing sequence of measurements initiated on the **Acquisition Control** page.

Unless you specify otherwise, this web page assumes the spectrometer assigned to channel 0 is being set up. You can specify the channel you are setting up by adding the channel number to the URL (for example, “<http://192.168.42.1/cgi-bin/settings.php?channel=1>”) to set up the spectrometer assigned to channel 1. You can identify the spectrometer by the type and serial number displayed on the web page.



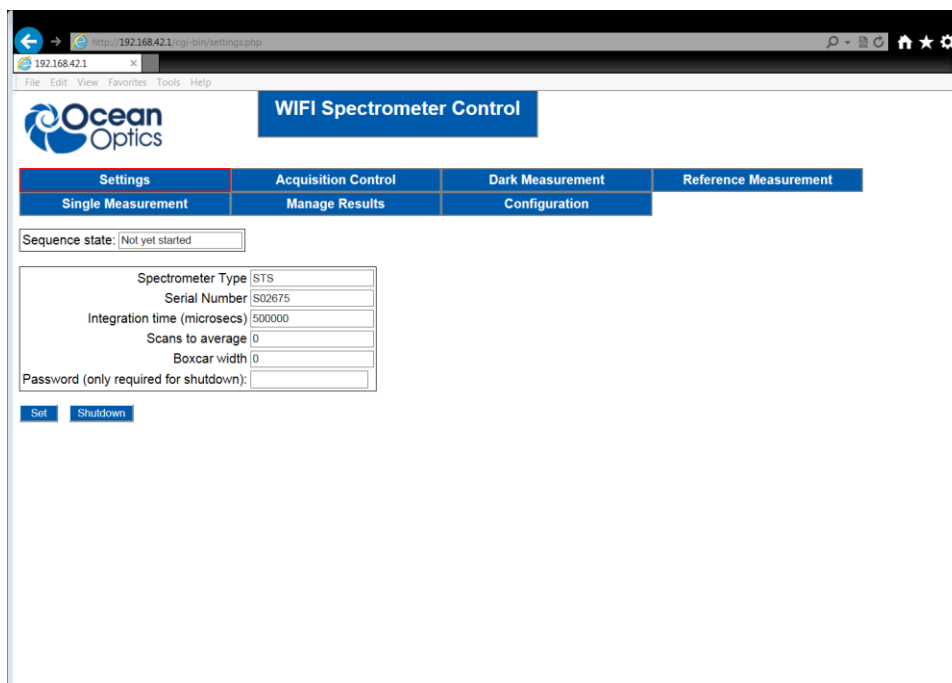
Set Spectrometer Parameters

► Procedure

To set spectrometer parameter values,

1. Enter the values in correct fields on the web page.
2. Click **Set**.

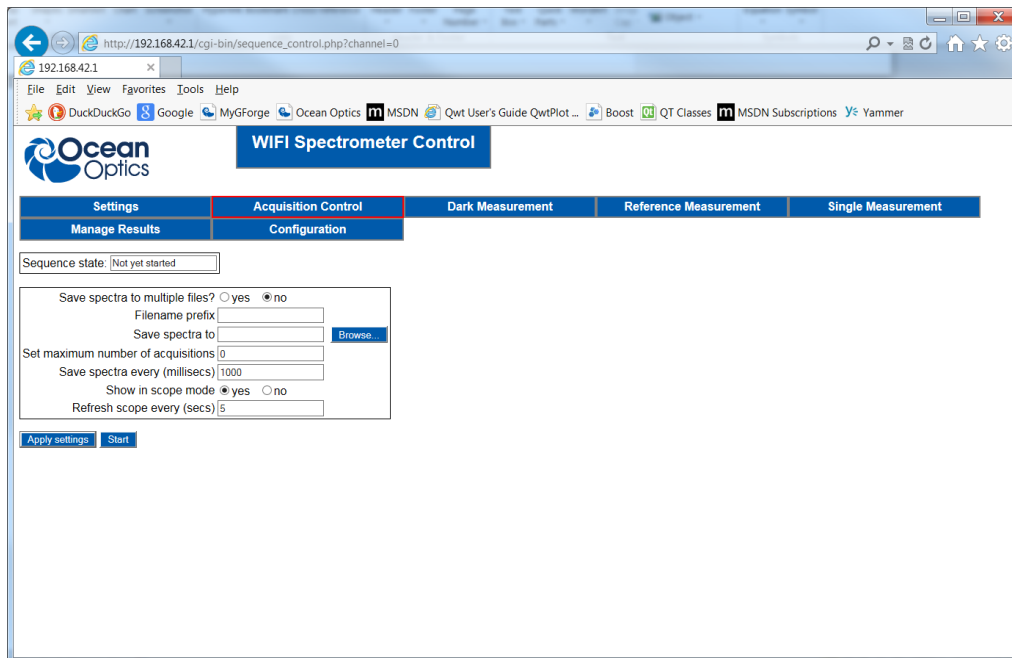
The values will persist until they are either changed with the web page or the device is powered off.



Set Up a Timed Sequence of Measurements

The **Acquisition Control** web page allows you to set up a sequence of measurements to take place at regular timed intervals. Specify the spectrometer to acquire the sequence by adding the channel parameter to the URL (for example, http://192.168.42.1/cgi-bin/sequence_control.php?channel=0). This channel number is automatically added to the URL as you move from page to page so you don't have to enter it manually unless you want to change the channel you are working with.

If you have more than one spectrometer connected it's possible to have two sequences of acquisitions running concurrently. This can be initiated by starting a sequence on one channel, and then moving to the next channel and starting the next sequence. Each sequence will continue until they reach the specified maximum number of acquisitions, or they are stopped manually.



Field	Function
Save spectra to multiple files?	Saves spectra to single or multiple files. Select either of the following: Yes – Each spectrum is saved into its own file. The files are given filenames that include a number indicating their position in the sequence of acquisitions. No – Each spectrum is appended onto a single file
Filename prefix	This prefix is prepended to the name of any files where spectra are saved.
Save spectra to	The location of the saved spectra. This is the directory where the sequence will be saved. A Browse button allows a directory to be selected and new directories to be created (see Select a Location to Save Results). This must be a valid directory on the Raspberry Pi.

Field	Function
Set maximum number of acquisitions	This is a safety feature to prevent the SD card from being filled up if the acquisition sequence is not stopped deliberately with the Stop button. If you set this value to zero, the maximum will not be enforced and the sequence can only be stopped with the Stop button.
Save spectra every (milliseconds)	The time interval (in milliseconds) between each acquisition. This value must be greater than zero. This time interval must also be greater than the time taken for each acquisition (the integration time multiplied by the number of scans to average).
Show in scope mode	A simple Scope mode can be started showing the current acquired spectrum at regular intervals.
Refresh scope every (secs)	The period between updates to the Scope mode (in seconds). This value must be greater than zero.

Notes

If any of the values entered on this page do not meet the restrictions described an error message is displayed and the sequence will not be started.

If you start an acquisition sequence with the same prefix and location as an earlier sequence, the older files will be overwritten.

The **Apply settings** button allows you to apply the values you have entered before starting a sequence. If you make any changes and leave this page before clicking the either **Apply settings** or **Start**, your changes will be lost.

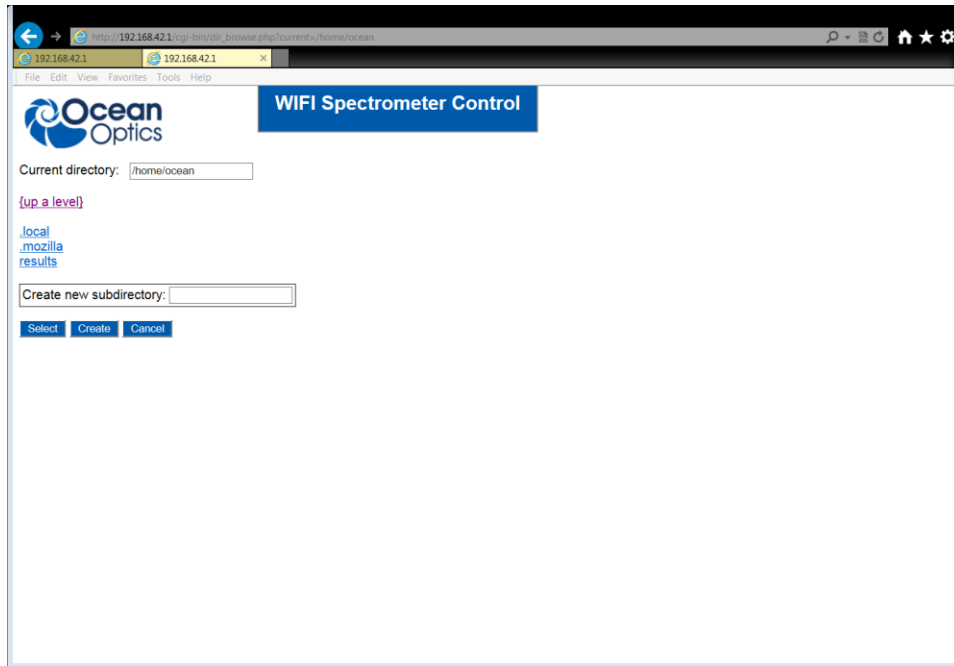
When you click **Start**, the acquisition sequence begins, the **Apply settings** button disappears, the **Start** button changes to a **Pause** button, and a **Stop** button appears.

The **Pause** button suspends the acquisition sequence allowing ad-hoc measurements (for example, reference measurements) to be taken. The sequence can be resumed by clicking the **Resume** button that replaces the **Pause** button.

When a sequence of acquisitions is active, some buttons on the web pages that could interfere with the sequence are disabled (for example, the **Set** button on the **Settings** page. These buttons are re-activated by either pausing or stopping the sequence.

Select a Location to Save Results

The web pages for acquisition control and the pages for taking reference, dark or single measurements all allow a location on the SD card to be selected for saving the spectra. Each of these pages has a **Browse** button that opens another window in the browser that allows you to navigate the directories in the Raspberry Pi.



Field	Function
Current directory	The currently selected directory. A list of subdirectory names (if there are any) in the currently selected directory are shown. These are hyperlinks that navigate the web page into the named subdirectory.
{up a level}	This link takes you into the directory above the current selection.
Create new subdirectory	Enter a valid name in this box and click Create . The subdirectory list is refreshed and shows the newly created subdirectory.

When you click **Select**, the browse page closes and the current selected directory is automatically entered in the text box on the page you started from (for example, Acquisition Control). The browse page also allows you to create a subdirectory in the current directory.

Notes

The Raspberry Pi is running a Linux operating system so the directories will appear as “/home/ocean/” for example.

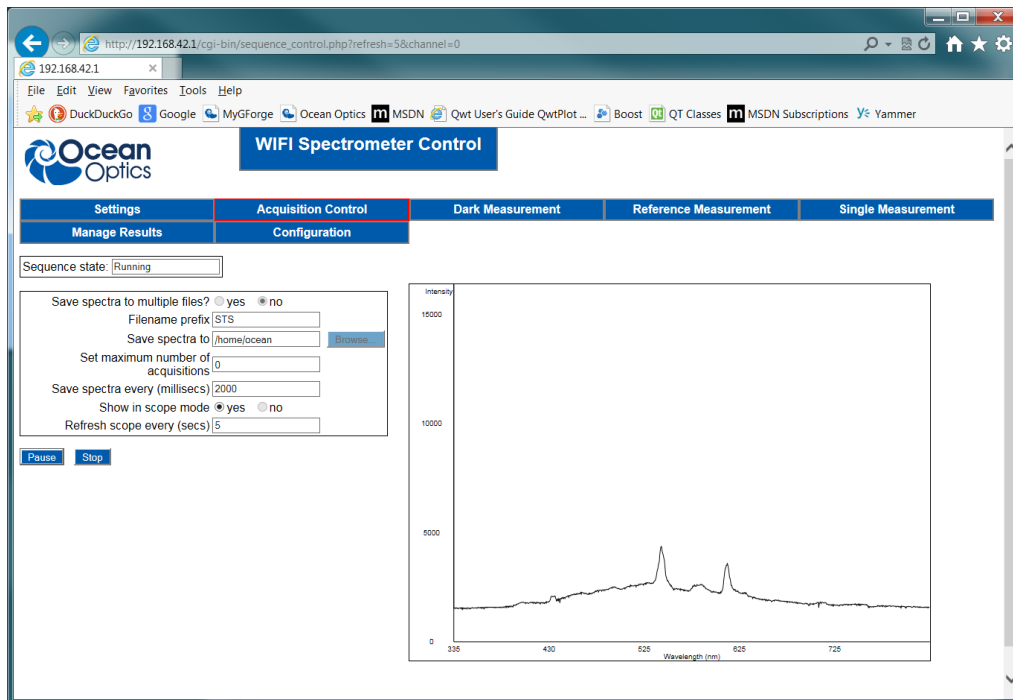
There is no restriction on where you can navigate to – this includes locations containing important operating system files.

The directory browser should appear as a popup web page. If you are blocking popups in your web browser then this will not appear. Javascript must also be enabled in your browser.

Scope Mode

When a sequence of acquisitions is running and Scope mode is selected (see [Set Up a Timed Sequence of Measurements](#)), a web page automatically opens to display the most current spectrum. This page is refreshed periodically. The interval between each page refresh is the time in seconds entered in the **Refresh scope every** text box in the **Acquisition Control** page (see [Set Up a Timed Sequence of Measurements](#)).

If a maximum has been set for the number of acquisitions, then the scope display will automatically stop when the limit has been reached.

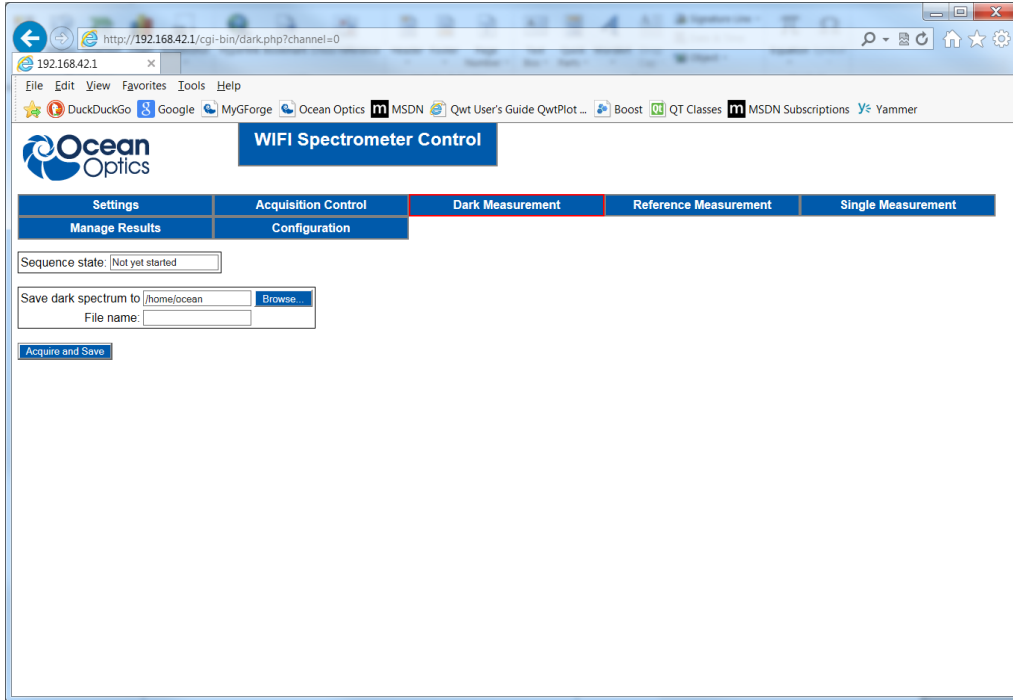


Note

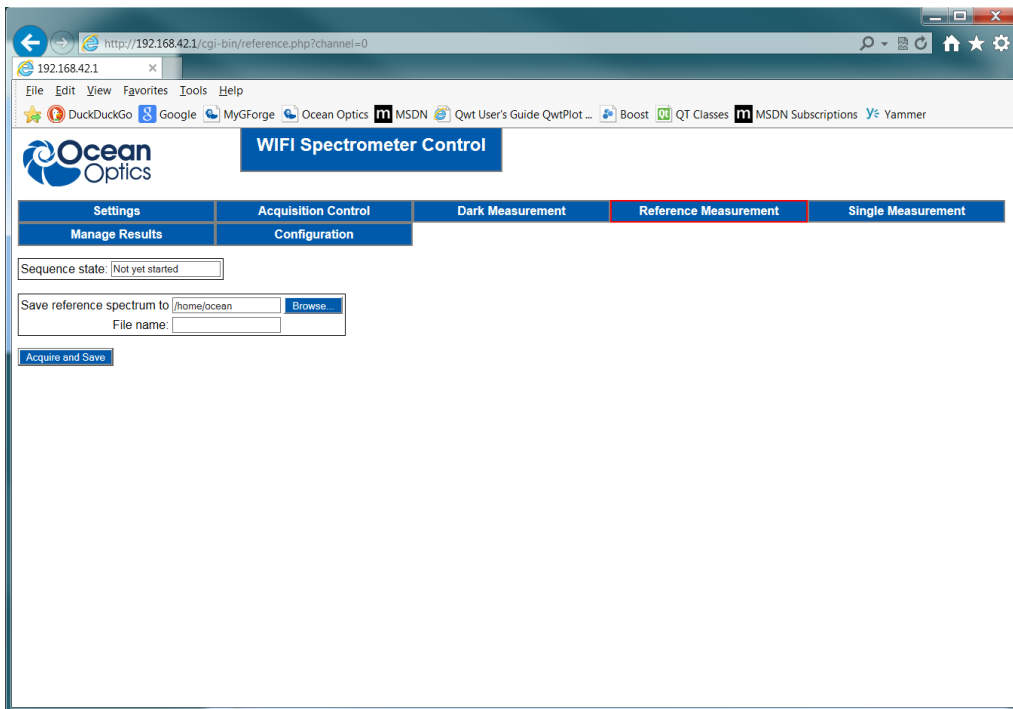
In this version of the software there is no way of making the spectrometer force an update of the graph on the browser so the spectra displayed are not synchronized with each acquisition – the display is of the last spectrum acquired when the refresh occurs.

Taking Dark, Reference and Single Spectra

A single spectrum can be taken on demand for the purpose of measuring a dark or reference spectrum or taking an ad-hoc measurement. There are three pages, one for each of these purposes but all with the same functionality: Dark Measurement, Reference Measurement and Single Measurement. The channel is specified in the URL (it is added by default and only needs to be changed if you want to change channels).



Dark Measurement Page



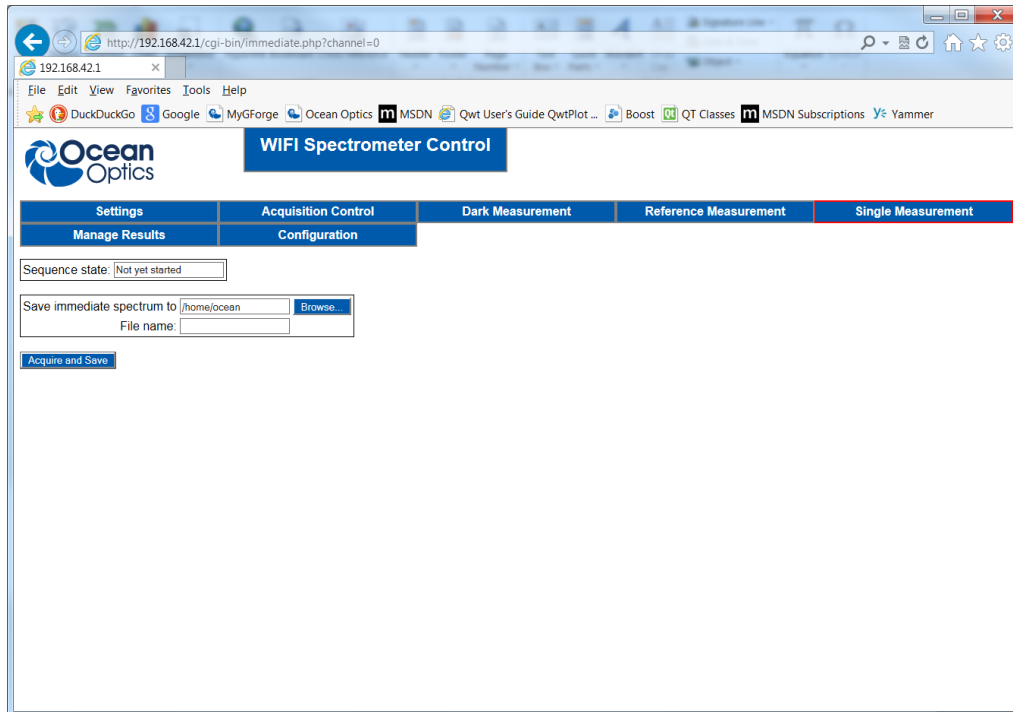
Reference Measurements Page

Before taking any of these measurements you must first select a location where the result file will be saved and the name of the result file. The same criteria apply for the file location as a sequence of measurements – it must be a valid directory on the Raspberry Pi. A valid file name must also be supplied.

3: User Interface

The default file extension is added to the file name if you omit it – this is normally a “.txt” extension but you can change this default value (see [Configure Default Values](#)).

If you enter an invalid directory or filename, an error is reported and the acquisition does not start. The acquisition is started by clicking **Acquire and Save**. The values set for the integration time, scans to average and boxcar smoothing in the [Spectrometer Settings](#) page will be used for this acquisition.



Immediate Acquisition Page

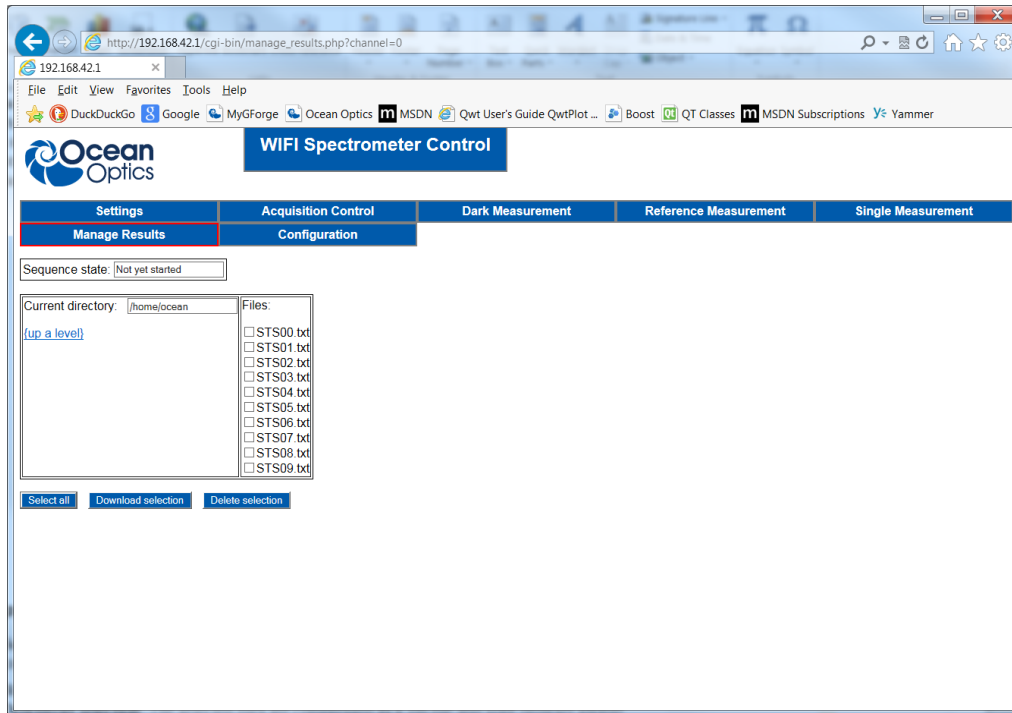
Notes

The web page will not respond until the acquisition is complete so if you have a long integration time and/or a large number of scans to average then this may take some time.

You can only take a dark, reference or single measurement if there is no sequence of acquisitions running or the sequence is paused.

Manage Results (Download and Delete)

The **Manage Results** page allows you to download results you have taken and to delete results from the SD card to free space on the card for further results. You can navigate the directory structure on the SD card in a similar way to the browse page by using the **{up a level}** and subdirectory hyperlinks. The main difference is that you now see the files contained in the current directory (if any exist) as a list on the right side of the page, with check boxes beside each file name.



► **Procedure**

1. Select the files for downloading or deletion with the check boxes. There is a **Select all** button for convenience that automatically selects all of the check boxes.
2. When you are satisfied with the selection, the checked files can be downloaded by clicking **Download selection**. The selected files are compressed as a zip file and your browser should prompt you to download or open this zip file.
3. When you have downloaded the results, the files can be checked once more and deleted with the **Delete selection** button.

Note

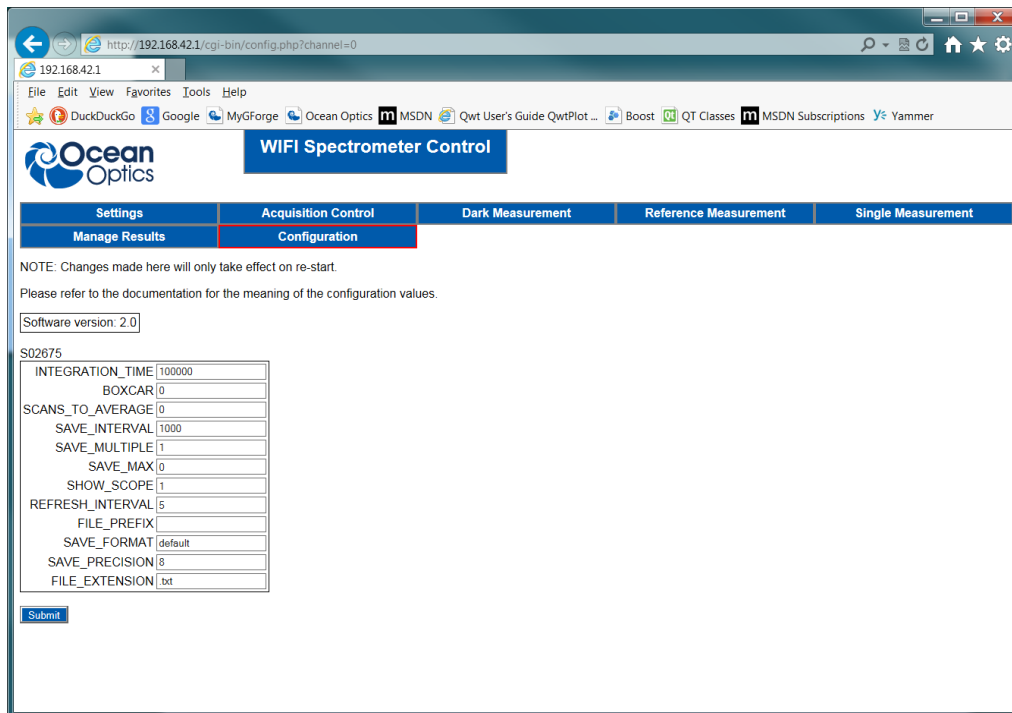
There is no restriction on where you can navigate to. This means it is also possible to delete important files required by the operating system, potentially making the device unusable.

Configure Default Values

The **Configuration** page allows some common default values to be set by the user to avoid re-entering them each time you start the device. You will see the default values for each of the spectrometers that have been connected to the Raspberry Pi. This information is retained even if a spectrometer is removed. It will be reloaded if the spectrometer is subsequently re-connected. This feature uses the spectrometer serial number to identify spectrometers it “knows” about.

When you click **Submit**, the configuration file containing these default values is overwritten.

3: User Interface



Field	Function
INTEGRATION_TIME	The default integration time (in microseconds). This number must be an integer greater than zero
BOXCAR	The default boxcar width. Set this to 0 to turn off boxcar smoothing. This number must be an integer greater or equal to zero.
SCANS_TO_AVERAGE	The default scans to average. Set this to 0 to turn off scans to average. This number must be an integer greater or equal to zero.
SAVE_INTERVAL	The interval in milliseconds between acquisitions in a timed sequence. This number must be an integer greater than zero.
SAVE_MULTIPLE	The default selection for saving to multiple or single files on the Acquisition Control page. Set this value to 0 if you want to save to a single file by default or nonzero integer if you want to save to multiple files.
SAVE_MAX	The default limit on the maximum number of files in the acquisition sequence. Set this to 0 to turn the limit off. This number must be an integer greater or equal to zero.
SHOW_SCOPE	The default selection for showing the scope mode. Set this to 0 to turn this off by default or nonzero integer to turn it on.
REFRESH_INTERVAL	The refresh interval for scope mode (in seconds). This must be an integer greater than zero.
FILE_PREFIX	The default file prefix for saved spectra.

Field	Function
SAVE_FORMAT	Set this to default to save spectra in the default file format. Set this to ov-plain to save spectra in a format that is compatible with OceanView.
SAVE_PRECISION	Specifies the precision for saving spectral values. Note, this only determines the number of digits stored in the results file and does not affect the accuracy of the measured spectrum in any way.
FILE_EXTENSION	The default file extension for saved spectra is .txt and can be changed to .dat, for example, with this page.

Notes

Setting these values does not have an immediate effect – they will take effect when the device is restarted.

If you enter an invalid value for any of these parameters it will be ignored and set to a “sensible” value by the software.

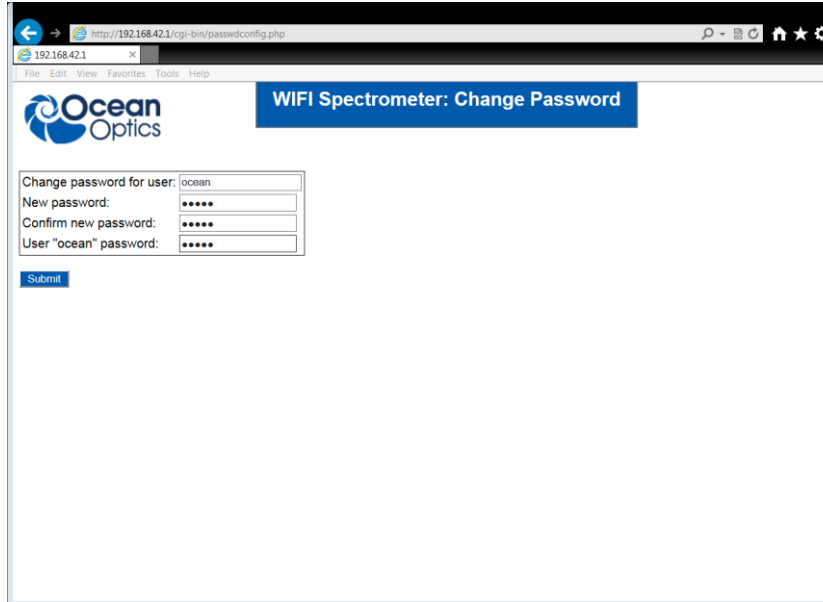
Set a Password

The default passwords for the two accounts (“root” and “ocean”) set up on the Raspberry Pi are not secure. Both of the accounts have administration privileges so it is important to change these passwords as soon as possible. A web page is provided for changing the password for these accounts (<http://192.168.42.1/cgi-bin/passwdconfig.php>).

► Procedure

1. Enter the name of the account you are changing in the **Change password for user** field.
2. Type the new password into the **New password** field and again into the **Confirm new password** field. The passwords entered in the **New password** and **Confirm password** fields must match, otherwise no change will be made.
3. Type the password for the *ocean* account in the **User “ocean” password** field. This must be the current password for the *ocean* user even if you are changing the password for that account. The password for the *ocean* account must be correct, otherwise no change will be made.
4. Click **Submit**. The password should be changed with immediate effect.

The operating system on the Raspberry Pi may enforce some complexity criteria on the password but this has been minimized for user convenience.



The screenshot shows a web browser window with the address bar displaying `http://192.168.42.1/cgi-bin/passwordconfig.php`. The page title is "WIFI Spectrometer: Change Password". The Ocean Optics logo is in the top left. The form contains the following fields:

- Change password for user: ocean
- New password: [masked with dots]
- Confirm new password: [masked with dots]
- User "ocean" password: [masked with dots]

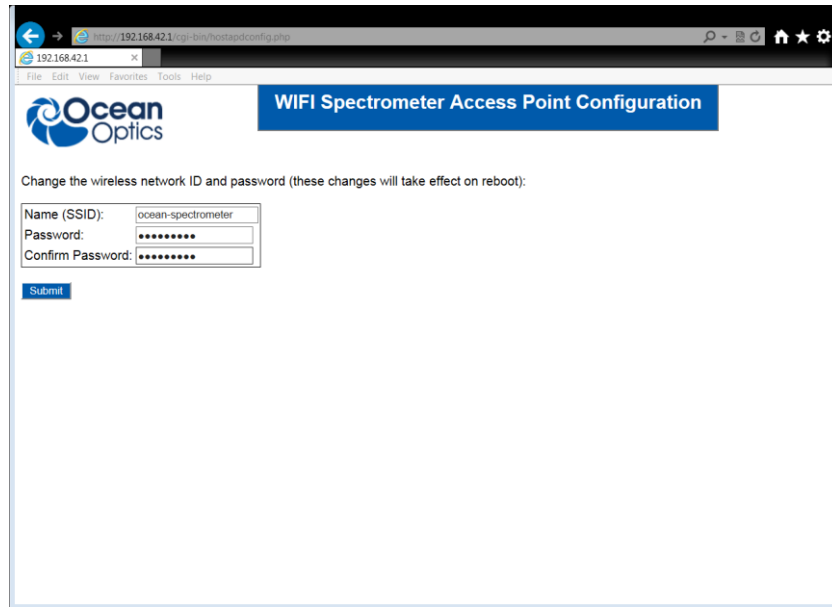
A blue "Submit" button is located below the form.

Change the Wireless Access Point Name and Password

You can change the name (SSID) broadcast by the Raspberry Pi that makes it visible as a wireless access point, as well as the password. This is a necessary step if you have more than one kit operating within wireless range of each other to prevent a clash of SSID names. A web page has been provided to do this at <http://192.168.42.1/cgi-bin/hostapdconfig.php>.

► Procedure

1. Enter the new name of the SSID in the **Name (SSID)** field.
2. Enter the new password in the **Password** field.
3. Enter the new password again in the **Confirm Password** field.
4. Click **Submit**. The changes will be made. The changes will not take effect until the Raspberry Pi has been restarted.



Upgrade the Software

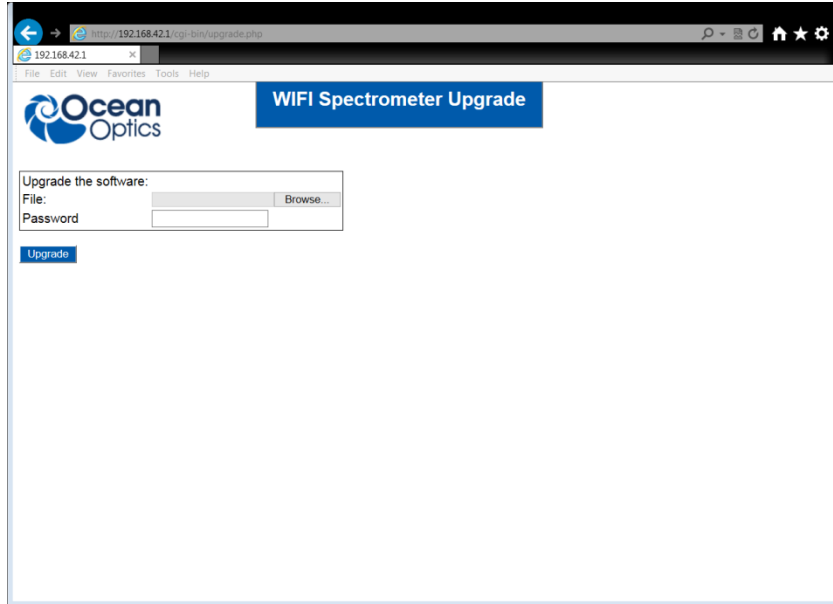
Ocean Optics will provide software updates for the kit as new features are added. A web page for installing the updates has been provided at <http://192.168.42.1/cgi-bin/upgrade.php>. A file containing the upgrade contents will be supplied by Ocean Optics. This file is a zip archive and the contents should not be modified in any way, otherwise the upgrade may fail with the risk of corrupting the software.

► **Procedure**

1. Click **Browse** to select the location of the zip archive provided by Ocean Optics.
2. Enter the password for the *ocean* account in the **Password** box. The default is **ocean**.
3. Click **Submit**.

The upgrade can take up to several minutes.

3: User Interface



Appendix A

Results File Format

Each spectrum in a sequence is stored in a file (either one file per result or appended into a single file depending on the selection made in Acquisition Control). The default result begins with the position in the sequence followed by the timestamp indicating when the acquisition started. This is followed by a list of wavelength/intensity pairs (the wavelengths are in nanometers and the intensities are in counts). It is also possible to save the results in a format that is compatible with OceanView. This is specified in the Configuration web page. To save in the default format enter “default”. To save in an OceanView compatible format enter “ov-plain”. An example of the first few lines from a default format file are shown below:

```
Spectrum sequence number 0
Saved at time: 235168 milliseconds
Integration time: 500000
Scans to average: 0
Boxcar smoothing: 0
Wavelengths      Intensities
336.22659302     1501.00000000
336.68054362     1540.00000000
337.13454419     1493.00000000
337.58859472     1495.00000000
338.04269517     1554.00000000
338.49684552     1547.00000000
338.95104576     1521.00000000
```

Notes

The Raspberry Pi has no way of storing the current time when it is powered off and the system does not assume the clock is set correctly after it is powered on. This means that all timestamps are given in milliseconds relative to the time the device is powered on.

If the system clock is updated (by time synchronization via the Internet or manually), the time calculated relative to the device being powered on may produce invalid results.

Advanced Functionality

Overview

The operating system on the Raspberry Pi is Raspbian Wheezy (2015-05-05 release). You can log in to the device and administer it to optimize it for your specific requirements or use the web pages described in this document. Some of the essential administration tasks are described here but the supplied Raspberry Pi is a Linux computer so there are many more tasks that must be left to other sources to describe. A basic level of familiarity in administering a Linux computer is assumed for some of the operations described in this manual.

System Description

The STS Development Kit is based around a Raspberry Pi Model B+ board with an ARM11 processor, 512Mb of RAM, four USB 2.0 ports and a 100Mbit/s Ethernet port. Ocean Optics supplies a preconfigured 8Gb SD card with the Raspbian operating system installed and all of the software described in this document and the [STS Developer's Kit Programming Guide](#) (see [Product-Related Documentation](#)). One of the USB ports is used for the supplied Edimax wireless adapter and the other is used for the Ocean Optics STS spectrometer supplied in the kit.

A set of web pages hosted on the Raspberry Pi provide a simple means of controlling the basic spectrometer functionality. Some of the functionality is implemented by PHP scripts running on the web server and these scripts can be reused, modified or added to if custom functionality is desired.

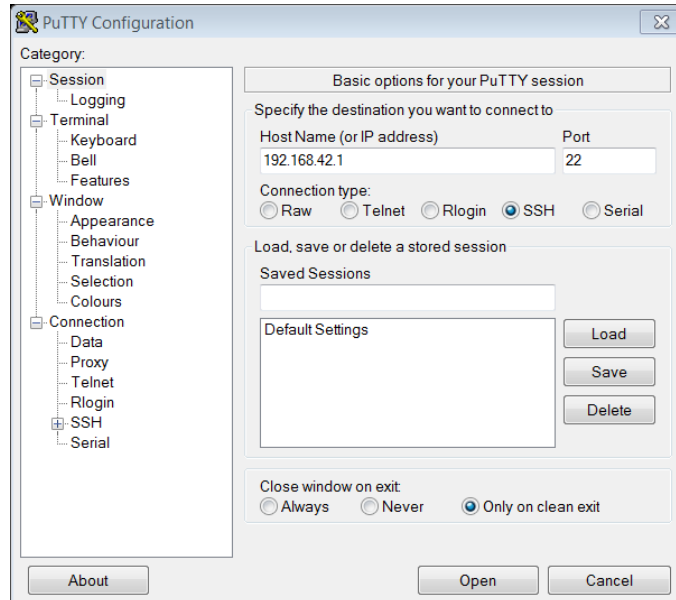
The Wired Network

The Model B+ version of the Raspberry Pi used in the kit has a 100Mbs Ethernet port. The device is configured to behave as a DHCP client on this port so it is possible to connect it into an existing network infrastructure. This feature is useful when making changes to the wireless network configuration where a connection via wireless can be dropped as a result of some of the operations described in this manual such as reconfiguring the device to become a wireless network client.

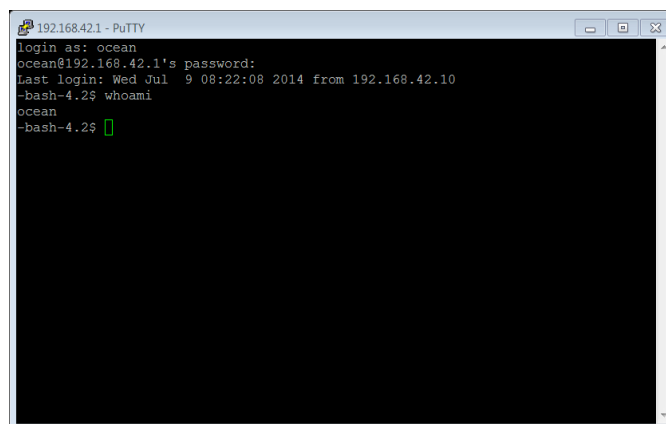
The wired network can also be used to control the spectrometer using the supplied web pages simply by changing the IP address in the URLs to the address of the device on the wired network.

Logging in Using SSH

The Raspberry Pi is configured to provide a Secure Shell (SSH) service that will allow you to log in to the device from another computer to administer it directly through the command line on a terminal. This is especially useful if there is any configuration that is needed that goes beyond the capabilities of the simple administration web pages provided. You can log in using ssh on a Unix computer or PuTTY from a Windows computer. There are two accounts with administrator privileges, the super user account (root) and another account (ocean). The default password for both of these accounts is **ocean**.



Logging in using PuTTY from a Windows Computer on the Default Wireless IP Address



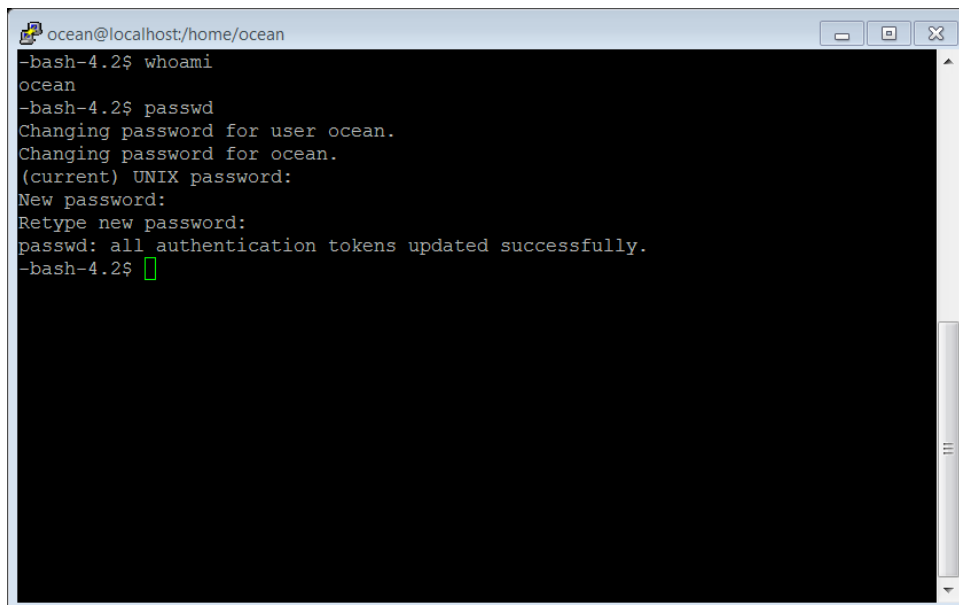
Command line after logging in as user "ocean"

Logging in to the Linux Console

The Raspberry Pi is configured to boot as a multi-user system. It is possible to connect a keyboard and monitor directly to the Raspberry Pi and to log in to the console to administer the device. This method can be especially useful if any errors are made in the network configuration that prevents logging in over a network connection.

Changing Passwords

The default passwords are not secure, so it is recommended that you change them as soon as possible. There is a simple web interface described in Chapter 3: [User Interface](#), but this can also be done from the command line with the “passwd” command. The superuser account (root) can change any user’s password with this command or alternatively other users can change their own password. For a full description of the command see the main page.



```
ocean@localhost:/home/ocean
-bash-4.2$ whoami
ocean
-bash-4.2$ passwd
Changing password for user ocean.
Changing password for ocean.
(current) UNIX password:
New password:
Retype new password:
passwd: all authentication tokens updated successfully.
-bash-4.2$
```

Changing the password for user ocean with "passwd"

Changing the Access Point Name (SSID) and Password

The Raspberry Pi is configured to behave as a wireless access point by default. This functionality is provided by a package called “hostapd” (<http://w1.fi/hostapd/>). The default identifier (SSID) for the access point is **ocean-spectrometer** but it may be desirable to change this if, for example, you have more than one kit operating within wireless range of each other. A simple web page is provided to change this name and the password, but this can also be done directly, and more of the wireless parameters can be changed by editing the configuration file located at `/etc/hostapd/hostapd.conf`.

The default configuration supplied is a minimal working example; the description of the full configuration is beyond the scope of this manual and is best left to the provider's web page and other online resources.

Reconfiguring the Device as a Wireless Network Client or Access Point

It is possible to configure the Raspberry Pi as:

- A wireless access point and DHCP server. Other computers connect to the Raspberry Pi and receive IP addresses from it.
- A wireless/DHCP client. The Raspberry Pi connects to a wireless access point (potentially another Raspberry Pi) and receives an IP address from it.

The wireless access point service has already been described in [Changing the Access Point Name \(SSID\) and Password](#).

The wireless client functionality is provided by a package called “wpa_supplicant” (http://w1.fi/wpa_supplicant/) which is installed on the device by default but not enabled. The configuration file for this service is located at `/etc/wpa_supplicant/wpa_supplicant.conf`. Make sure the correct values for the SSID of the access point you intend to connect to and the password are correctly entered in this configuration file (the relevant fields are called “ssid” and “psk”).

Note

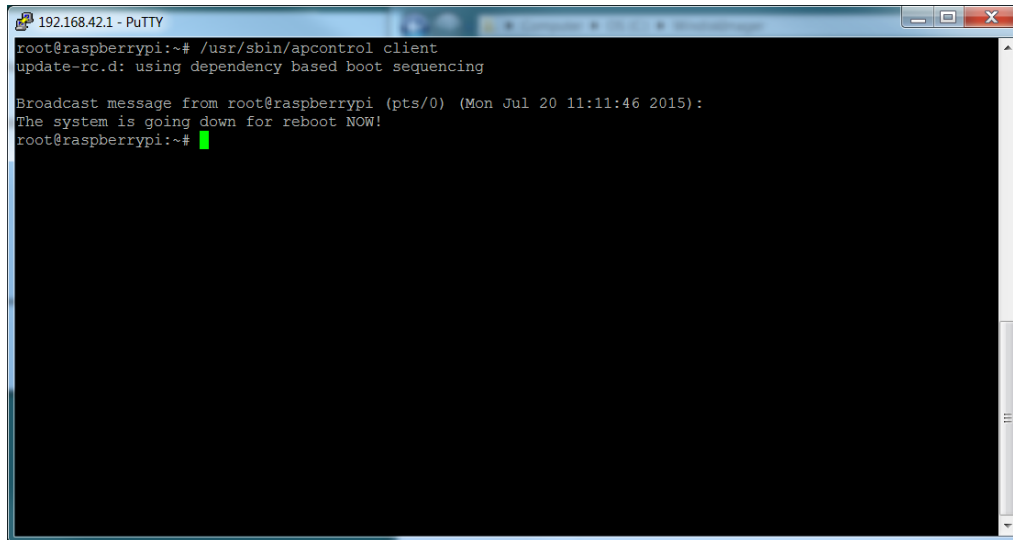
If you choose to configure the Raspberry Pi as a wireless client you must configure the name of the network you intend to connect to and the password before switching modes otherwise the Raspberry Pi will attempt to connect to an un-named network with no password. This configuration can be easily done with the web page described [Configure the Client](#) which also automatically invokes the `apcontrol` script. Subsequent switches between host and client will re-use this client information. The client will only need to be configured again if you are switching networks or the network password has changed.

Switching configuration to either a host or client involves several steps in which a number of network-related services are started and some stopped to support either “`hostapd`” or “`wpa_supplicant`” as required. A script to automate this process is provided “`/usr/sbin/apcontrol`” that can be run from the command line as the root user. The desired configuration is chosen by supplying an argument to the script: “`client`” to switch to the client configuration or “`host`” to switch to the host configuration (“`/usr/sbin/apcontrol host`” or “`/usr/sbin/apcontrol client`”). The steps involved to start and stop the necessary services can be examined by opening the `apcontrol` script with a text editor. A full explanation of these steps is beyond the scope of this manual.


```
root@localhost:~#  
ctrl_interface=/var/run/wpa_supplicant  
ctrl_interface_group=wheel  
network={  
    scan_ssid=0  
    proto=WPA RSN  
    key_mgmt=WPA-PSK  
    pairwise=CCMP TKIP  
    ssid="the SSID of the access point you want to connect to here"  
    psk="the password for connecting to the acces point here"  
}
```

Configuration File for wpa_supplicant

```
PuTTY (inactive)  
[root@localhost ~]# /root/apcontrol client  
Stopping AP mode on wlan0
```



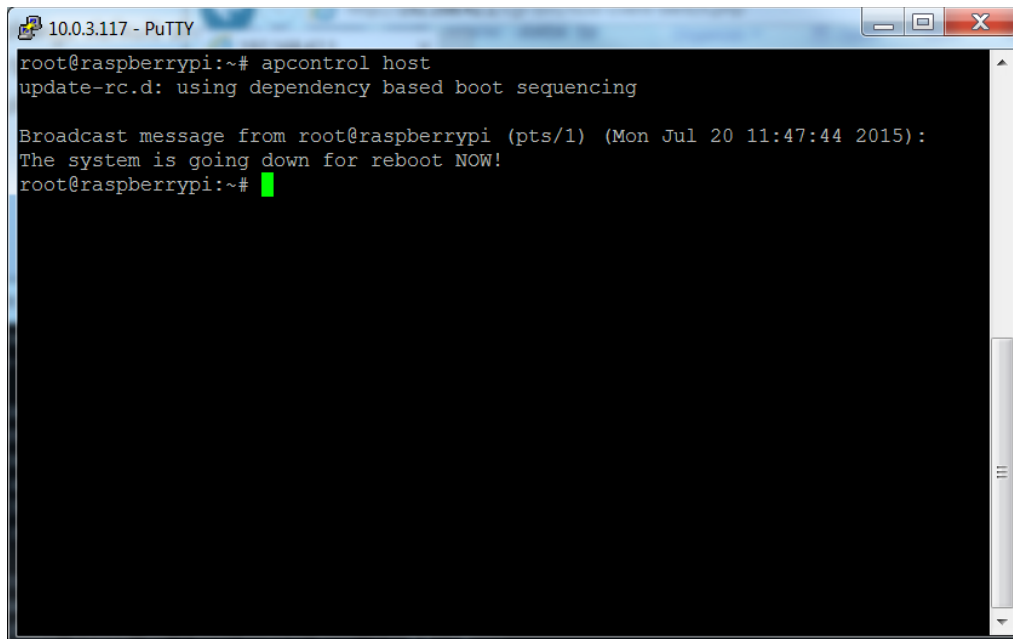
```

192.168.42.1 - PuTTY
root@raspberrypi:~# /usr/sbin/apcontrol client
update-rc.d: using dependency based boot sequencing

Broadcast message from root@raspberrypi (pts/0) (Mon Jul 20 11:11:46 2015):
The system is going down for reboot NOW!
root@raspberrypi:~#

```

Running the apcontrol Script to Switch to Client Mode



```

10.0.3.117 - PuTTY
root@raspberrypi:~# apcontrol host
update-rc.d: using dependency based boot sequencing

Broadcast message from root@raspberrypi (pts/1) (Mon Jul 20 11:47:44 2015):
The system is going down for reboot NOW!
root@raspberrypi:~#

```

Running the apcontrol Script to Switch to Host Mode

A simple web page is also provided to make the switch from host to client (or vice versa) easier where IP is the current IP address of the Raspberry Pi. This page has a radio button to select the host or client mode.

Selecting Client Mode

If the client mode is chosen a pull down list of visible wireless networks allows a network to be chosen and a password entered. Pressing the **Set** button reconfigures the Raspberry Pi, starting and stopping network services as required, and then reboots the device.

Note

There is no mechanism provided for testing the connection to a wireless network. If you have entered an incorrect password, at this point the Raspberry Pi will fail to connect and you must use either the wired network connection or a direct keyboard/monitor connection to the device to reconfigure the device.

Selecting Host Mode

If the host mode is chosen pressing “Set” reconfigures the Raspberry Pi as a wireless access point with the SSID and password configured in the file `/etc/hostapd/hostapd.conf`. The device is automatically rebooted and should appear as the configured access point when it restarts.

The Web Server

The Raspberry Pi is configured to run a web server (Apache 2.4.9, <http://httpd.apache.org/docs/2.4>) that is used to provide the web API and to run the scripts described in this manual. You can create your own web pages and scripts to control the spectrometer or provide some other useful functionality.

The directory containing the web pages is `/var/www/html` and the directory containing the scripts is `/var/www/cgi-bin`.

Note

The document root is set to `/var/www/cgi-bin` and the directory index is set to `settings.php` so that the spectrometer Settings page is the default page. The scripts supplied are written in PHP (see <http://www.php.net/>) but other scripting languages could be used equally well.

The configuration for the web server is located at `/etc/httpd/conf/httpd.conf`. A description of the configuration is beyond the scope of this manual and is best left to the originator (<http://httpd.apache.org/docs/2.4/configuring.html>).

PHP Scripts

The scripts supplied with the kit are written in PHP (<http://www.php.net/>). For those already familiar with PHP, it will allow some powerful functionality to be added to the kit and at the same time it is easy to grasp the basics so that even novices can add useful scripts very quickly.

All of the supplied scripts are located in /var/www/cgi-bin and can be freely modified to suit your own purposes.

Note

Modified scripts are not supported by Ocean Optics. A set of scripts that provide the web API as well as the web interface described are in this manual. A full description of these API scripts and some worked examples of additional scripts can be found in the [STS Developer's Kit Programming Guide](#) (see [Product-Related Documentation](#)).

Worked Example – Connect Two Kits as a Host/Client Pair

An example is shown of setting up one kit as a wireless access point and a second kit as a client to the first kit as one illustration of the flexibility of network configuration. Other configurations are possible but this shows the essential steps used for all.

Configure the Host

The first device is configured as a wireless access point with the name **pi-host** and password **connect-to-me**. The SSID and password could be left with their default values, in which case this step could be omitted.

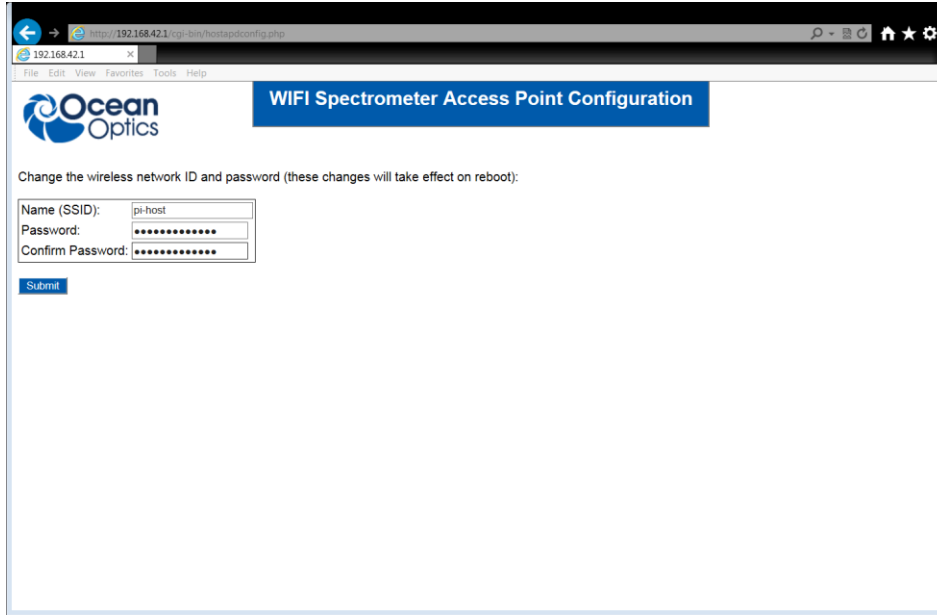
Note

If the SSID was left with the default value of **ocean-spectrometer**, then it would be necessary to configure the client with the host device switched off until the client configuration was complete to prevent a clash of (default) SSID names.

► Procedure

1. Go to the web page <http://192.168.42.1/cgi-bin/hostapdconfig.php> and enter the name **pi-host** into the Name (SSID) text box.
2. Type the new password **connect-to-me** into the **Password** text box and then once again into the **Confirm Password** text box.
3. Click the **Submit** button.
4. Shut down the device, unplug the power supply, and re-insert the power supply.

On rebooting, the device should appear with the new SSID and password. Leave it powered on but do not connect to the access point until the client configuration step is complete.



Changing the SSID and Password of the Host Device

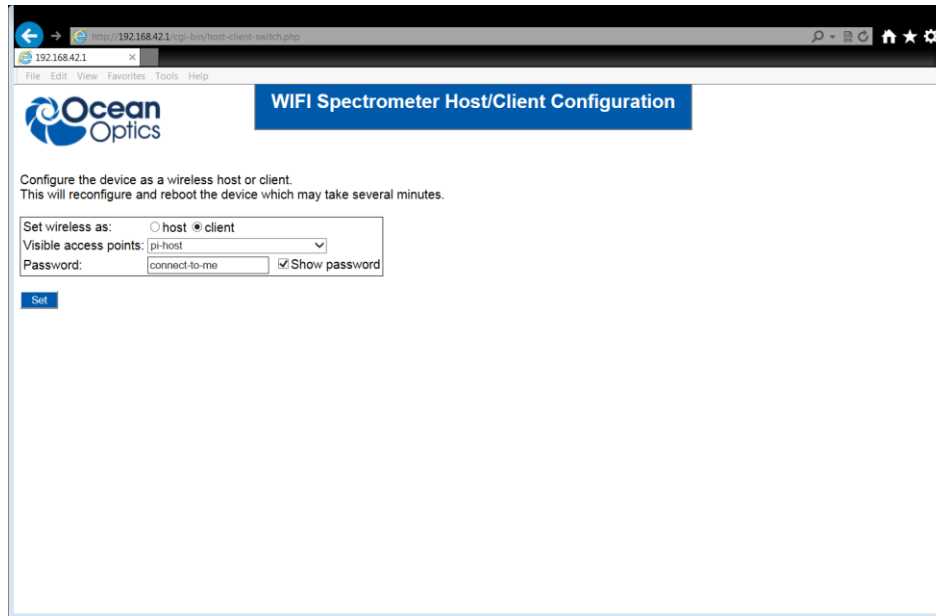
Configure the Client

The next step is to reconfigure the second device as a wireless network client that will connect to the host device configured in [Configure the Host](#).

► Procedure

1. Start the device. It will initially appear as the default access point **ocean-spectrometer** and connect to it.
2. Go to the web page <http://192.168.42.1/cgi-bin/host-client-switch.php> and check the **client** radio button. The pulldown list of visible access points should include the newly created **pi-host**.
3. Select **pi-host** from the list and type the password **connect-to-me** into the **Password** text box.
4. Click the **Set** button.

The Raspberry Pi should now reconfigure itself as a wireless client to **pi-host** and then it will reboot – this may take several minutes. When it has restarted, it should connect to the host Raspberry Pi and obtain an IP address in the range 192.168.42.10 to 192.168.42.50.



Configure the SSID and Password on the Client

If you now connect to the access point “pi-host” with your computer, tablet or smartphone, both Raspberry Pis should be visible and it will be possible to control each spectrometer using the web pages described in this manual. If the client has been given the address 192.168.42.15, then its settings page can be found at <http://192.168.42.15> and the host can be found at <http://192.168.42.1> as before. Both spectrometers can now be controlled and run sequences of acquisitions simultaneously through a single browser or multiple browsers, or even from different computers.

Appendix C

Specifications

Specification	Value
Total weight (including cables)	190 g (0.42 pounds)
Wi-Fi range	up to 150m (2.4GHz frequencies)
Power draw	~1A with Wi-Fi
Battery	3000mAh (~3 hours endurance)
Interfaces	Wi-Fi, USB, Ethernet

A

advanced functionality, 23

B

browser
controlling spectrometer, 7

C

Client
configuring, 31
Client mode
selecting, 29
configure default values, 15
configuring
client, 31
host, 30
connect two kits, 30
connection
components, 3
device, 4
controlling spectrometer with browser, 7

D

dark spectra, 12
default passwords, 5
default values
configure, 15
development platform, 2
document
audience, iv
purpose, iv
summary, iv
documentation, iv

F

features, 2

H

Host
configuring, 30
Host mode
selecting, 29

I

ISO certification, v

L

Linux console
logging in, 25
logging in
Linux console, 25
logging in
SSH, 24

M

measurements
set timed sequence, 9

N

name change
Wireless Access Point, 18

P

parameters
set, 8
password, 17
changing, 25
changing default, 17
ocean account, 5
WI-FI, 4
passwords
changing Wireless Access Point, 18
setting, 5
PHP scripts, 29

power-up, 4
product description, 1

R

reconfiguring the device, 26
reference spectra, 12
results
 delete, 14
 download, 14
 file format, 21
 location, 10

S

Scope mode, 12
SeaBreeze, iv, 2
shut down, 4
software
 upgrade, 19
specifications, 33
spectra, 12
spectrometer
 control, 7
 parameters, 8
 settings, 7
SSH
 logging in, 24
SSID
 changing, 25
system description, 23

U

upgrade software, 19
upgrades, v

W

warranty, v
web server, 29
what's new, iv
wired network, 23
Wireless Access Point
 name change, 18
 password change, 18