

# NeoSpectra - Scanner Quick Start Guide

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## About NeoSpectra-Scanner

NeoSpectra-Scanner is a portable and handheld spectral sensing device that can be used in a wide variety of material sensing applications. It shines light that interacts with the sample to be measured, collects its diffuse reflectance, and generates NIR spectra that corresponds to the spectral response of the material in the spectral range (1,350 - 2,500 nm). The scanner enables the development of in-field material analysis applications in various industries.

## About this guide

If you are using NeoSpectra-Scanner for the first time, this guide is your reference on what the different parts of NeoSpectra-Scanner are, what they are used for, and how to use them.

## 1 Box Components

- A. **NeoSpectra - Scanner:** The main spectra collection device with NeoSpectra sensor inside (Figure 1).
- B. **Scanner Cover:** It is a protection for the optical window that should be placed on top of the scanner when it is not being used. To do this, just place the cover on top of the scanner, and it will be magnetically fixed. The cover also includes the white reference material for background measurements. To avoid losing the cover, make sure to use the lanyard to attach the cover to the scanner.
- C. **Scanner Sample Holder:** It is provided to facilitate the measurement of some types of samples like soil, feed, powders,...etc, however the scanner can be used without it. It is magnetically attached to the scanner cover and needs to be detached from it when used (Figure 2). The sample holder can be magnetically attached and aligned on the scanner top surface to hold the sample during scanning.
- D. **Scanner power adapter:** An AC / DC adapter dedicated to NeoSpectra - Scanner with a USB connection. The adapter shouldn't be used with other USB devices due to its high DC voltage output. It also comes with a power plug converter for users located in the USA. Refer to section 3 for more details about the adapter usage.

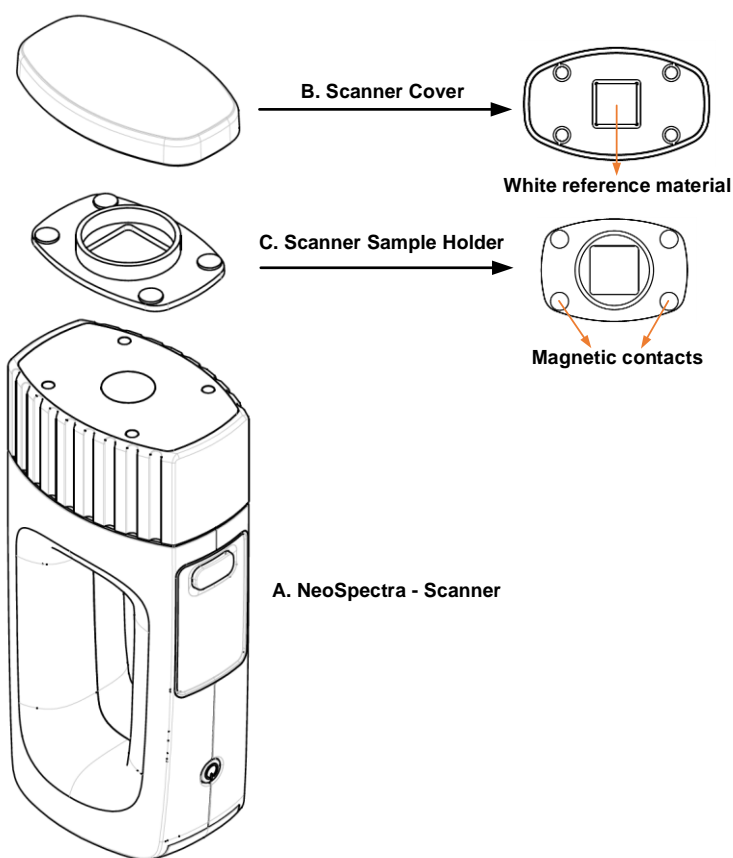


Figure 1 NeoSpectra – Scanner Box Components

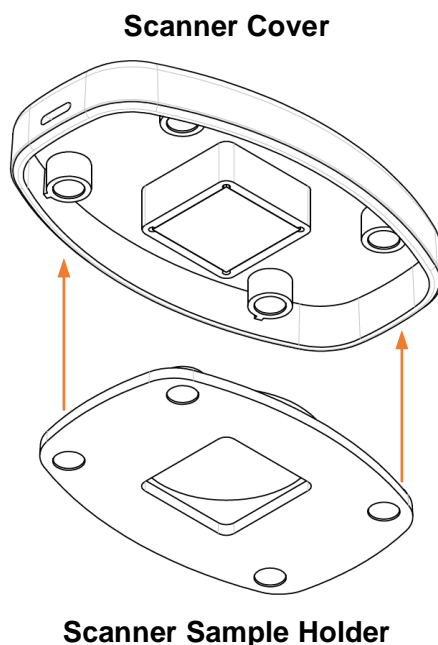


Figure 2 Attaching the sample holder to the scanner cover

## 2 Scanner User Interface

### 2.1 Scan and Power Buttons

The scanner main functionality is controlled by the scan and power buttons as summarized in the table below.

Power Button Functionality	Scan Button Functionality
<ol style="list-style-type: none"> <li>1. A short press turns on the scanner, if it's powered off.</li> <li>2. A long press turns the scanner off.</li> <li>3. With the scanner powered on, a short press on the power button will re-initiate the Bluetooth advertising (refer to section 5.3 for more details)</li> </ol>	<ol style="list-style-type: none"> <li>1. A short press is used to take material scans.</li> <li>2. A long press identifies the scan as a background reference scan.</li> </ol> <p>Note that taking a scan with the scan button will always store the measured data on the scanner even if it is connected to a mobile device over Bluetooth.</p> <p>Refer to section 5.1 and 5.4 for more details about the usage of the Scan button.</p>

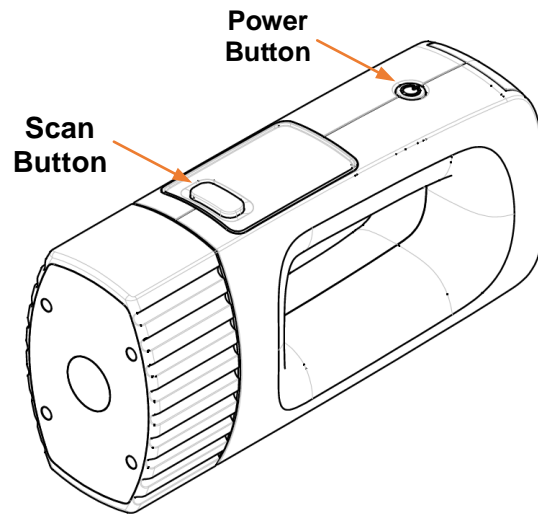


Figure 3 Scanner power and scan buttons

## 2.2 Scanner USB port

The scanner USB port is used for battery charging only. It is shown in Figure 4. To start the battery charging, plug in the adapter in the USB port and power on the scanner. Note that charging will not start if the scanner is powered off. **USB user data transfer is not supported in the Alpha samples.**

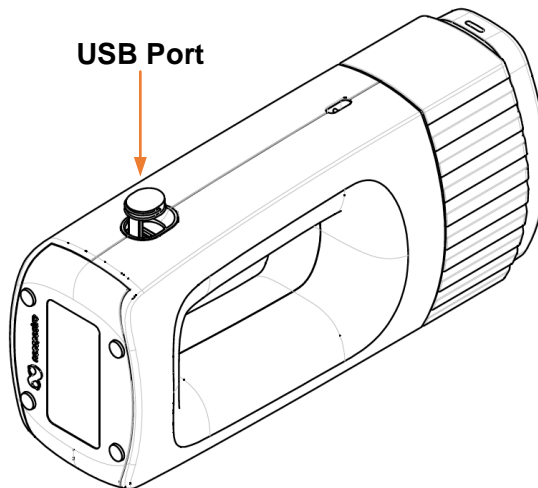


Figure 4 Scanner USB charging port

## 2.3 Scanner Screen Panel

The scanner screen panel is shown in Figure 5. It has 4 main areas: the messages area, the BLE status area, the stored scans area and the battery status area.

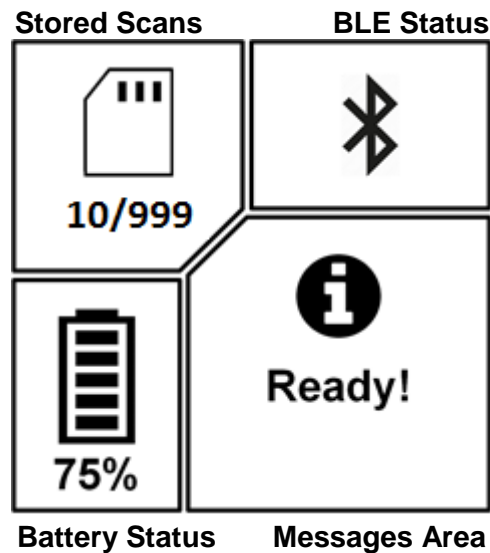


Figure 5 Scanner screen panel overview

### 2.3.1 Stored scans area

The number shown indicates the number of stored scans on the scanner local storage out of 999 scans.

### 2.3.2 Battery status area

The battery status area shows the remaining battery capacity and indicates whether the charger is connected or not as illustrated in Figure 6 a & b.

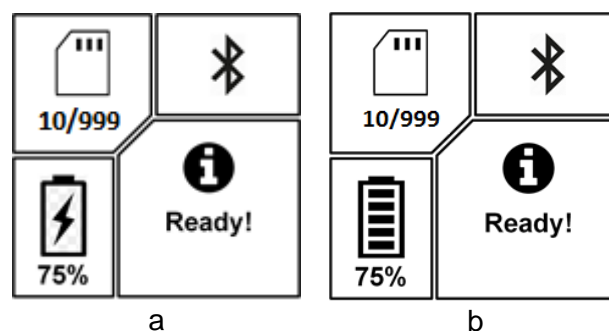


Figure 6 Battery status area with and without the charger connected

### 2.3.3 Bluetooth status area

The Bluetooth status area shows the state of the BLE connectivity of the device. It is either advertising, connected or disconnected (Figure 7 a, b, c). The details of the 3 states are described in section 5.3.

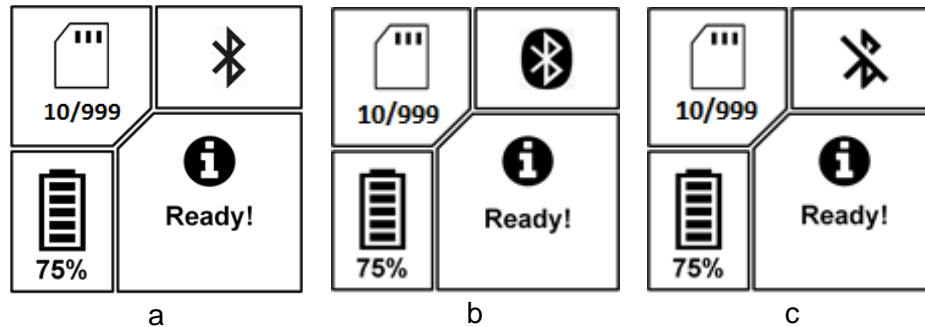


Figure 7 BLE status area during different connection states

### 2.3.4 Messages area

The messages area displays all the user interface data about the current scan. It shows whether the scan being taken is a white reference scan or a material scan and it also shows a progress bar for the scanning process Figure 8 (a) and (b). It indicates when the scan is completed successfully Figure 8 (c) or if there was an error with the last scan Figure 8 (d). A detailed list of error messages is shown in section 7.

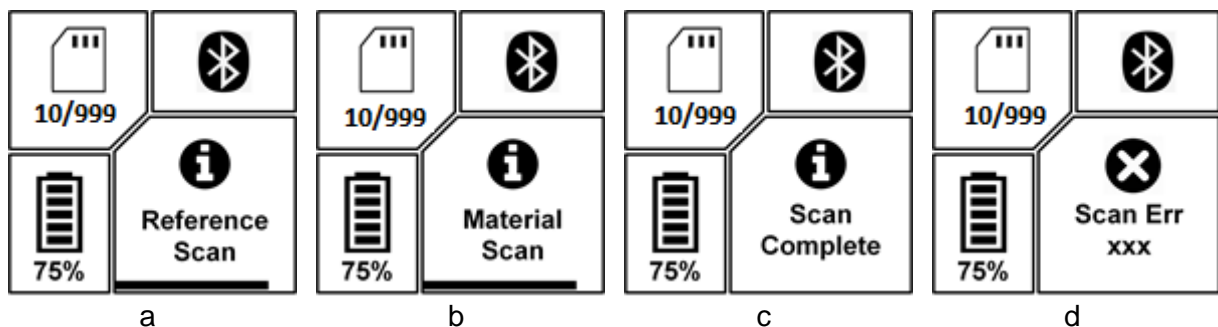


Figure 8 Messages area during reference and material scans

## 3 Powering Up the Scanner

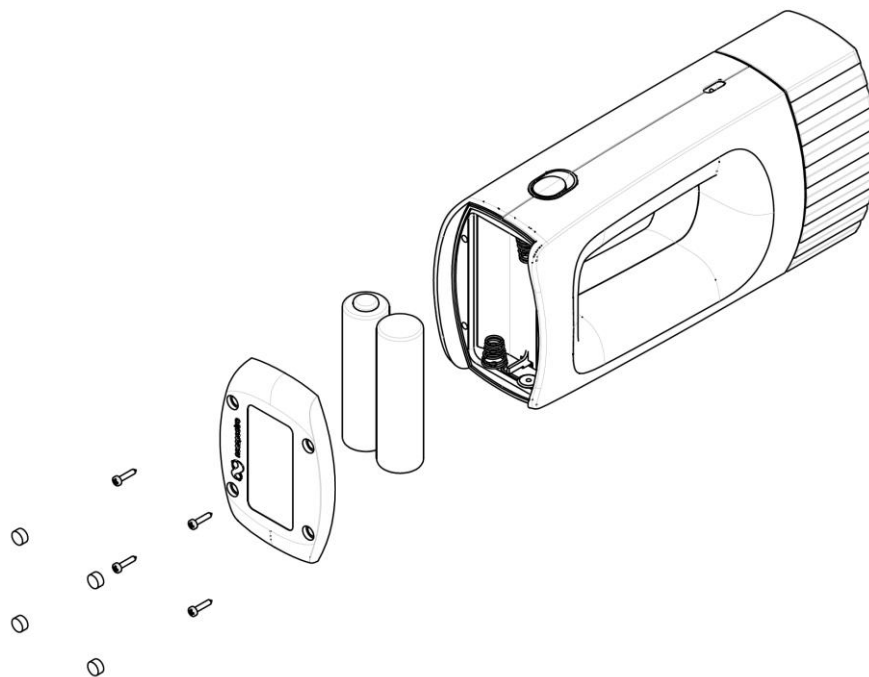
### 3.1 Charger / Battery Powered Operation

NeoSpectra - Scanner is powered by two user replaceable 18650 batteries with 3400 mAh nominal capacity. The batteries are readily installed in the device for out-of-the-box operation. The scanner also comes with a dedicated **15 V / 2.4 A** AC / DC adapter capable of powering the scanner to charge and scan simultaneously irrespective of the battery status.

The scanner can still be charged using a standard 5 V USB charger, however in that case scanning during charging will only be available if the battery is sufficiently charged. It's important to note that the power adapter provided with the scanner must not be used with other standard USB devices due to its high voltage output, otherwise these devices will be damaged.

### 3.2 Battery Replacement

The scanner batteries can be replaced by unscrewing the 4 screws in the battery cover at the bottom of the scanner below the rubber pads to remove the battery cover. The process is illustrated in Figure 9. It's important to note that when the battery is replaced or removed from the device the charger must be connected to the scanner before powering it up again for the first time after the batteries are placed back.





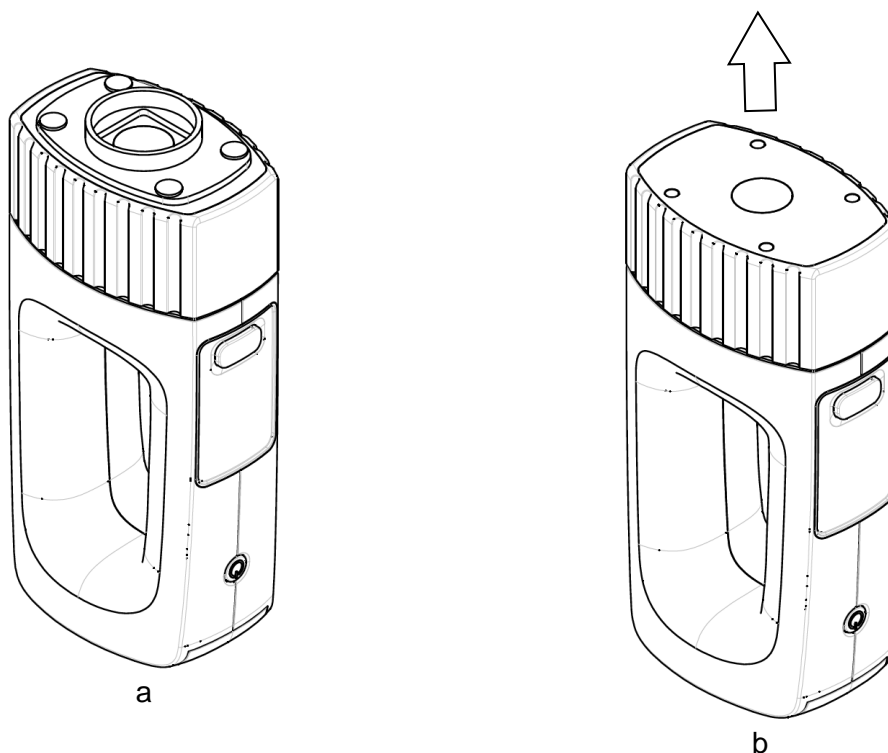
*Figure 9 Battery replacement process*

## 4 Sample Interfacing

The scanner industrial design allows for multiple usage models in terms of sample interfacing. The sample can be placed on top of the scanner or the scanner can be placed on top of the sample or it can be used in a point and shoot mode. The different sample interfacing schemes are illustrated in the following sections. **In all cases, the user must ensure that the sample is in contact with the scanner window.**

### 4.1 Sample above the Scanner

- Set the scanner on a flat surface.
- Place the sample on top of the scanner with the provided sample holder (Figure 10 a) or directly without it using any NIR-transparent container (Figure 10 b).

*Figure 10 Sample on top of scanner mode*

## 4.2 Point & Shoot

- Hold scanner in hand.
- Point and shoot at the sample while ensuring that the scanner window is pressed against the sample.

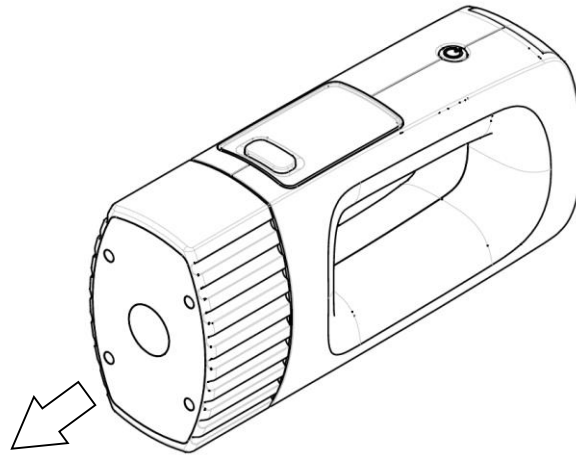
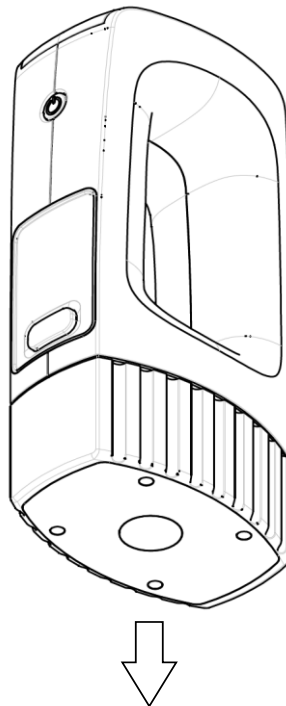


Figure 11 Scanner used in point-and-shoot mode

## 4.3 Sample below the Scanner

- Place the sample on a flat surface.
- Set the scanner on top of the sample.



*Figure 12 Scanner on top of sample mode*

## 5 Scanner Modes of Operation

The scanner has 2 main modes of operation; the Standalone operation mode and the Bluetooth connected operation mode. The standalone mode can be useful for users with a large number of consecutive scans to be captured with the same settings either in the field or in the lab. The Bluetooth connected mode allows for more flexibility in configuring the scanner parameters and visualizing the captured spectra as they are recorded. The two modes of operation are detailed in the following sections.

### 5.1 Standalone Operation Mode

In this mode, the scanner is operated without being connected to a mobile phone. The user can take scans normally, either background or material scans based on pre-configured scan parameters that are set earlier using the mobile application. The scans will be stored on the scanner internal storage and can be transferred to the mobile application when connected using Bluetooth.

### 5.2 Bluetooth Connected Operation Mode

In this mode, the scanner is fully controlled from the mobile application, which enables the user to capture spectra and view the results immediately. It also allows the user to configure all the sensor settings and scan time and to store it on the scanner memory to be used later. Moreover, it allows the user to retrieve and visualize the stored scans taken by the scanner in standalone mode.

### 5.3 Scanner Power States in Different Operating Modes

The scanner has four main power states related to the operating mode and establishing a connection with a Bluetooth device: Power Off, Standby - Advertising, Standby - Connected, Standby - Disconnected. The power and scan buttons controls the scanner transitions between these states as detailed below.

1. **Power Off:** A long press on the power button powers off the scanner. This is a low power sleep state in which the scanner is turned off to save the battery. It's recommended to keep the device in this state as long as it's not being used to avoid draining the battery.
2. **Standby - Advertising:** This is a transitional state between the Bluetooth connected and standalone modes. A short press on the power button turns the scanner on and it starts advertising for nearby Bluetooth devices ready to connect. The scanner keeps advertising for 2 minutes and turns off the advertising afterwards to save power, if no devices attempt to establish a connection within this period. A short press on the power button will initiate the advertising again.

3. **Standby - Connected:** This is the main state during the **Bluetooth connected operation mode**. In this state, the scanner is powered on and connected to a mobile device via Bluetooth ready to take scans either from the mobile application or the scan button.
4. **Standby - Disconnected:** This is the main state during the **standalone operation mode**. In this state, the scanner is powered on but not connected to a mobile device and also the advertising is turned off. This state is entered after advertising for 2 minutes with no connection or if the user presses the scan button before the scanner is connected to a Bluetooth device right after power up.

## 5.4 Taking Measurements in Different Operating Modes

Standalone Mode	Bluetooth Connected Mode
<ol style="list-style-type: none"> <li>1. In this mode the scanner will use the stored device configuration (either the defaults or those pre-configured using the mobile application).</li> <li>2. With the scanner powered on and without a previously stored reference scan, start with a background reference scan before doing a material scan.</li> <li>3. To run a reference scan, attach the white background reference cover to the scanner.</li> <li>4. Long press the scan button to identify the reading as a background reference scan. The stored scans counter on the display will be incremented by one scan.</li> <li>5. To run a material scan, place the material to be scanned in contact with the scanner window as detailed in section "Sample Interfacing".</li> <li>6. Short press the scan button to take the reading. Again the stored scans counter will be incremented by one scan.</li> <li>7. The stored scans can be retrieved on the mobile application either for viewing or transferring to a PC for</li> </ol>	<ol style="list-style-type: none"> <li>1. Start the NeoSpectra - Scanner application and power on the scanner.</li> <li>2. Press the "Connect" button on the screen to connect the scanner to a mobile device.</li> <li>3. With a connected scanner to the mobile device, press the "Take Measurements" button in the application.</li> <li>4. If no background reading has been previously taken, start with a background reference scan before doing a material scan.</li> <li>5. To run a reference scan, attach the white background reference cover to the scanner.</li> <li>6. On the measurements screen, set the scan time and press the "Background" button in the application.</li> <li>7. To run a material scan, place the material to be scanned in contact with the scanner window as detailed in section "Sample Interfacing".</li> <li>8. On the measurements screen, choose the scan time (must be the same as the reference scan or lower), number of runs and press the "Scan" button in the application.</li> </ol>

<p>further processing.</p> <p>Refer to section “Mobile Application Overview” for more details about how to set the scan parameters from the mobile application and how to retrieve the stored scans from the scanner.</p>	<p>9. To view the results, press the “View” button in the application.</p> <p>10. The results are stored on the mobile device and can be either viewed in the application or transferred to a PC for further processing.</p> <p>Refer to section 6 for detailed illustrations of the application usage.</p>
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## 6 Mobile Application Overview

The mobile application allows the user to easily exercise the different functionalities of the scanner. This includes monitoring the scanner status indicators, configuring the measurements parameters, capturing spectra, accessing the spectra stored on the scanner and visualizing the measured spectra. The different functions are described in the following sections.

### 6.1 Connecting to the Scanner

The home screen of the application is shown in Figure 13 (a). The first step is to connect to a nearby scanner. This is done by pressing on the “Connect” button on the home screen. The application displays the list of available devices identified by their serial numbers as shown in Figure 13 (b). To connect to a specific scanner, press the “Connect” button beside the corresponding serial number. Once connected the application retrieves the scanner status indicators. This includes the device serial number, battery status, number of stored scans and the firmware version of the scanner as shown in Figure 13 (c). From this screen the user can configure the device, take measurements or access the stored scans on the scan during previous standalone operation sessions as will be shown in the following sections.

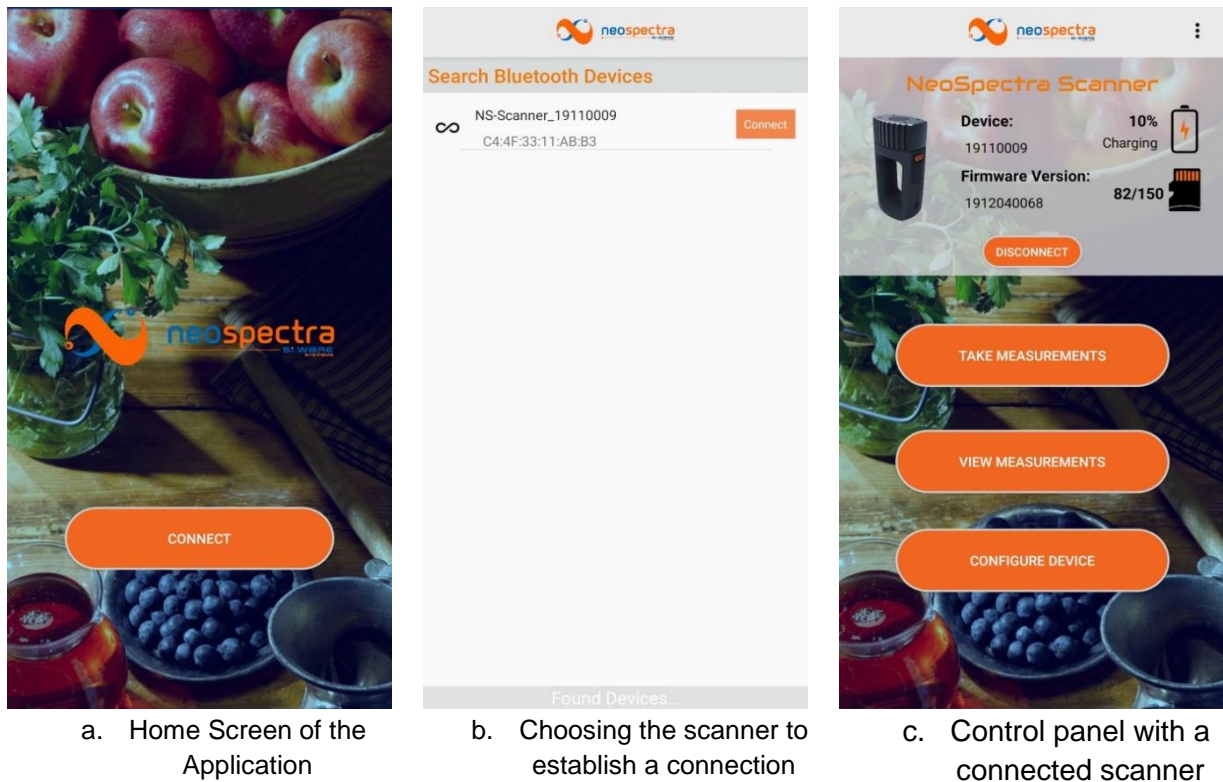


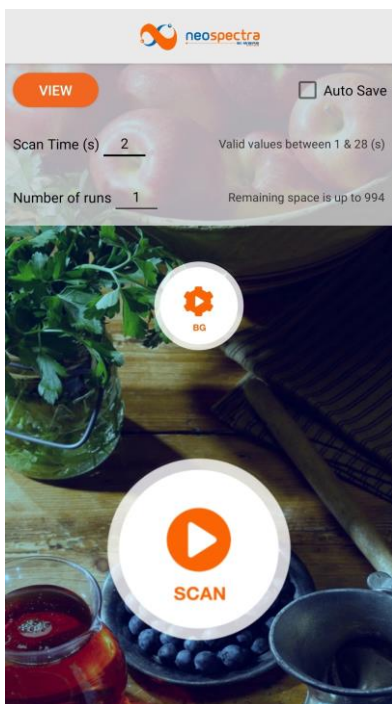
Figure 13 Connecting to the scanner from the mobile application

## 6.2 Taking Measurements

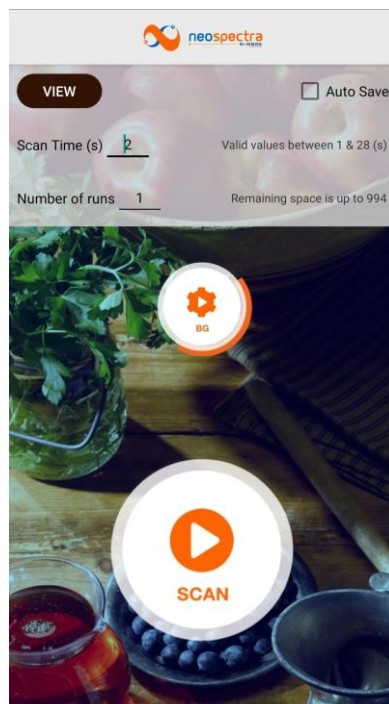
To start capturing spectra, press on the “Take Measurements” button of the connected scanner screen. The measurements screen is shown in Figure 14 (a). From this screen the user can execute different functions:

1. Perform a certain number of scans, by setting the required number of scans in the text box.
2. Set the scan time. Note that it must be the same scan time for both the material scans and the corresponding reference scan.
3. Perform background (reference) scan by pressing on “Background” button.
4. Perform sample scans by press on “Scan” button.
5. Visualize the captured spectra by pressing the “VIEW” button at the top left of the screen.
6. On-going scans can be stopped by pressing on “Stop” button while taking multiple sample scans.
7. Additionally, on the results viewing screen shown in Figure 14 (d), the user can load previously measured spectra or save the current displayed ones to the mobile device storage.

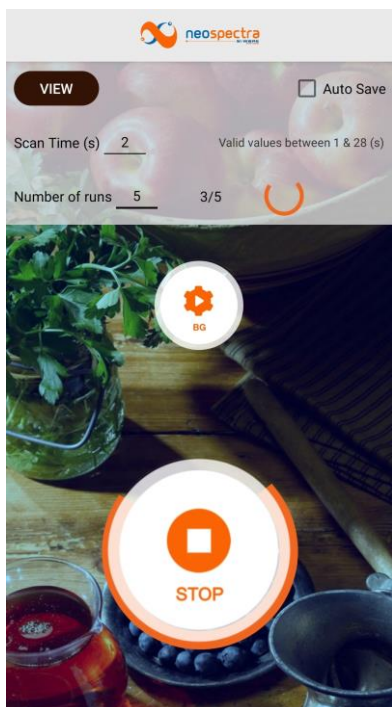




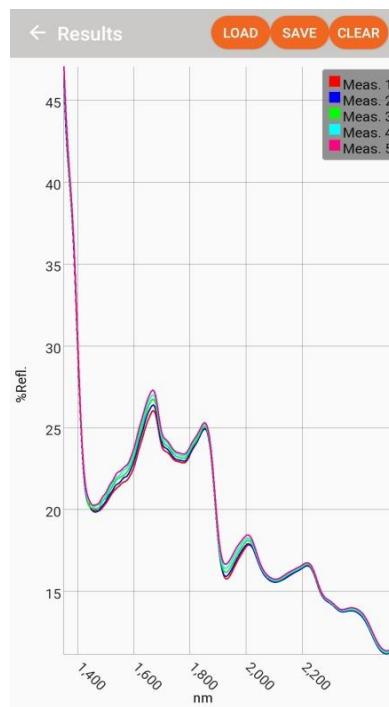
a. The main measurements screen



b. Taking a reference scan



c. Taking a material scan



d. Visualizing the measured spectra

Figure 14 Taking measurements screen in the application

## Accessing the Scans Saved on the Scanner

In order to retrieve the scans history saved on the scanner's internal memory, press on the dotted menu in the control panel screen. Then press on "Retrieve Scans" item as shown in Figure 15. A progress indicator will show up stating how many measurements are being retrieved and the live progress of getting them. The retrieved scans are saved in "**DCIM/NeoSpectra**" folder.

A total of 999 scans can be saved on the scanner's internal memory. In order to measure / save more, clearing history must be done to free up space. Clearing history can be done by pressing on the dotted menu in the control panel screen then pressing on "Clear History" item as shown in Figure 15.



Figure 15 Retrieving/Clearing the stored scans on the device

The clearing and retrieval actions are executed on all the scans stored on the device together i.e. no individual scans can be selected for clearing or retrieval. This feature will be implemented in future versions of the applications.

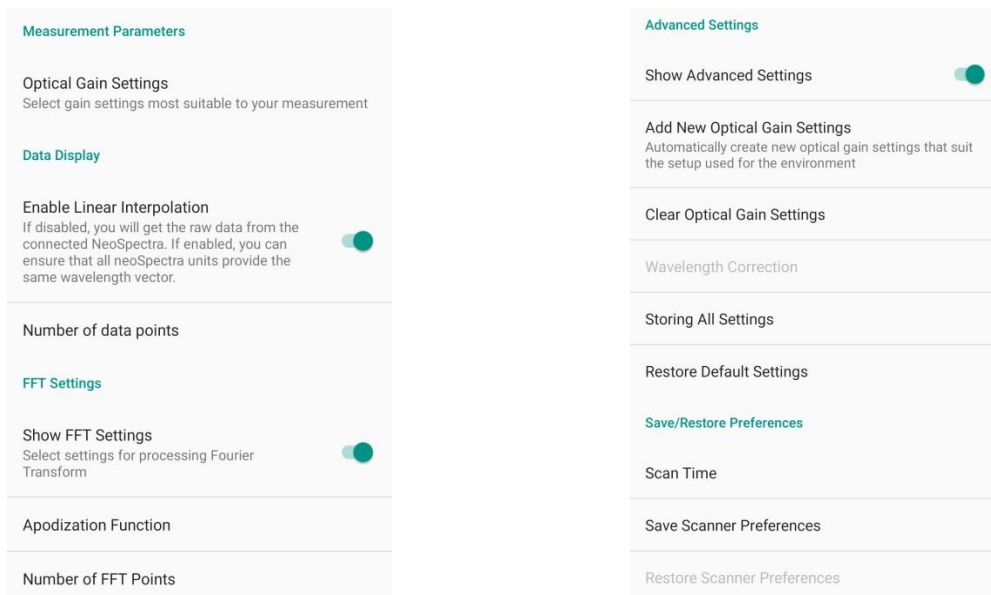
The scans are stored on the scanner with an incremental naming convention function of the scan order. This will lead to overwriting the previously retrieved scans on the mobile storage folder "**DCIM/NeoSpectra**". To avoid this, it's recommended to rename the retrieved scans as soon as they are copied to the mobile phone storage.



## 6.3 Configuring the Scanner

Detailed configuration and settings of the scanner can be accessed from the configuration screen shown in Figure 16. These configurations are described below in details.

Group	Item	Description
Measurement Parameters	Optical Gain Settings	This field is selected to choose between various optical gain setups that was previously measured and adjusted
Data Display	Enable Linear Interpolation	Enables the linear interpolation feature to get a constant wavenumber vector across all scanners
	Number of data points	The number of wavenumber vector points (valid only in case linear interpolation feature is enabled)
FFT Settings	Apodization Function	Selects the used window for apodization (boxcar, Gaussian, Happ-Genzel, Lorenz)
	Number of FFT Points	Select the number of points used during FFT function (8K, 16K and 32K points)
Advanced Settings	Add New Optical Gain Settings	Add new optical gain setup to be used during scanning
	Clear Optical Gain Settings	Clear all the saved optical gain setups done by user
	Wavelength Correction	Perform wavelength correction routine.
	Storing All Settings	Save all the wavelength correction parameters on flash.
	Restore Default Settings	Restore the factory settings for wavelength correction parameters.
Save/Restore Preferences	Scan Time	View the value of scan time to be saved with the configuration preferences when pressing "Save Scanner Preferences".
	Save Scanner Preferences	Save all the configuration preferences selected by user on the scanner. This makes it the default settings on scanner in standby mode.
	Restore Scanner Preferences	Restore the factory preferences saved on scanner



a. Part1 of scanner configuration parameters

b. Part2 of scanner configuration parameters

Figure 16 Configuring the scanner parameters

## 6.4 Firmware Update

Updating the firmware of the scanner can be done through the mobile app. The firmware itself is supplied by Si-Ware Systems.

Here is the procedure that needs to be done in order to perform FW update:

1. Download the new firmware bin file named "image.bin" and place it inside "Download" folder.
2. Press on the dotted menu in the control panel screen. Then press on "Firmware Update" item as shown in Figure 17.
3. A message will be shown asking to pair with your scanner but with a new ID that starts with "OTA\_...", please press "Pair".
4. A progress window will be shown to indicate the progress of writing the new firmware to the scanner.
5. Once the firmware update is complete, the scanner will be turned off automatically. And the mobile app is disconnected. Please close the app and re-open it.
6. Press on the power button of the scanner to power it on.
7. Sometimes the OS caches the ID for each device with specific MAC address, so sometimes it will show the ID that starts with "OTA\_..." for a couple of times before the OS refreshes the ID and it will be shown normally "NS-Scanner\_..." again.
8. But even during these couple of times, the scanner will be completely operational and can be used with the mobile app perfectly.
9. If any error occurred during the FW update process, please restart the scanner by powering it off then powering it back on.

## 6.5 Restore Default Firmware

Restoring the default firmware of the scanner can be done through the mobile app. This action brings the scanner FW back to the one originally was flashed by Si-Ware Systems during the production of this unit.

Here is the procedure than needs to be done in order to perform Restore Default FW:

1. Press on the dotted menu in the control panel screen. Then press on “Restore Default FW” item as shown in Figure 17.
2. A progress window will be shown to indicate the progress of restoring the default firmware to the scanner.
3. Once the firmware update is complete, the scanner will be turned off automatically. And the mobile app is disconnected. Please close the app and re-open it.
4. Press on the power button of the scanner to power it on.



Figure 17 Performing FW update or Restore default FW

## 7 Scanner Error Codes

Scanner error codes ranges from 1 to 255. The detailed description of these error codes is shown in the table below.

Error code	Description
0	No error
1 ~ 127	Reserved
128	Core sensor timeout
129	Last background scan settings differ from the current material scan settings
130	No background scan found.
148	Error in opening scan file for reading
149	Error in opening scan file for writing
150	Error in reading scan file
151	Error in writing scan file
152	Scan numbers file does not exist
153	Scan file is out of range of the stored scan files
154	Maximum number of scan files is exceeded
155	Failed to open configuration file
156	Mismatch in configuration file length
157	Error in parameter extraction from configuration file
158	Incorrect location is being accessed in internal memory
159	Internal memory is full
168	BT classic controller initialization failed
169	BT classic controller enable failed
170	BT classic initialization failed
171	BT classic enable failed
172	BT classic GAP register failed
173	BT classic SPP register failed
174	BT classic SPP initialization failed
178	BLE packet failed
181	Scan failure due to low battery

## 8 Disclaimers

- Si-Ware Systems offers Alpha samples of NeoSpectra-Scanner to customers as a tool to evaluate the performance of the device. Production version can differ from Alpha samples.
- The Alpha samples are not yet IP65 or drop tested.
- The scanner body paint may be scratched in these Alpha samples.
- The high voltage USB charger is customized for NeoSpectra scanner. It must not be used with any other USB device. Its 15V DC output will damage normal USB devices.

## 9 Precautions

- Avoid long periods of exposure to infrared light coming out of the light source as heating may occur. Heating may affect the sample's surface.
- Avoid having direct eye contact with the light emitted from the light source.