

Handheld 2 Spectroradiometer



Online Resources:
<https://www.malvernpanalytical.com/en/products/product-range/asd-range/fieldspec-range/handheld-2-hand-held-vnir-spectroradiometer>

Ref: FieldSpec HandHeld 2™ Spectroradiometer
User's Manual by ASD Document 600860 Rev. A
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Helpful videos

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Use of Handheld Spectroradiometer

- https://www.youtube.com/watch?v=fAF0_x2sBdE
- Field Spectroradiometry
- <https://www.youtube.com/watch?v=IE47dBxVXjI>

How does spectrophotometer works

- <https://www.youtube.com/watch?v=pxC6F7bK8CU>

Parts of Handheld 2 Spectroradiometer

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Figure 2: HandHeld 2 and Standard Accessories

Know your Spectroradiometer

1.3 FieldSpec® HandHeld 2 Instrument Components

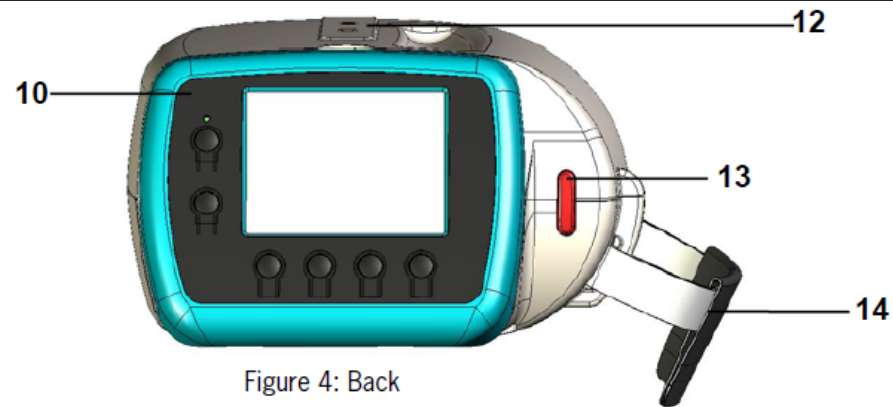
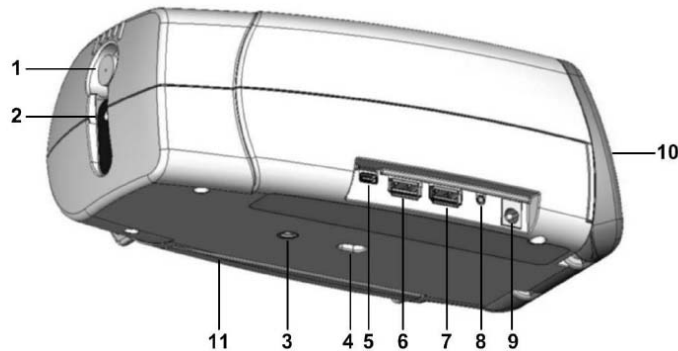
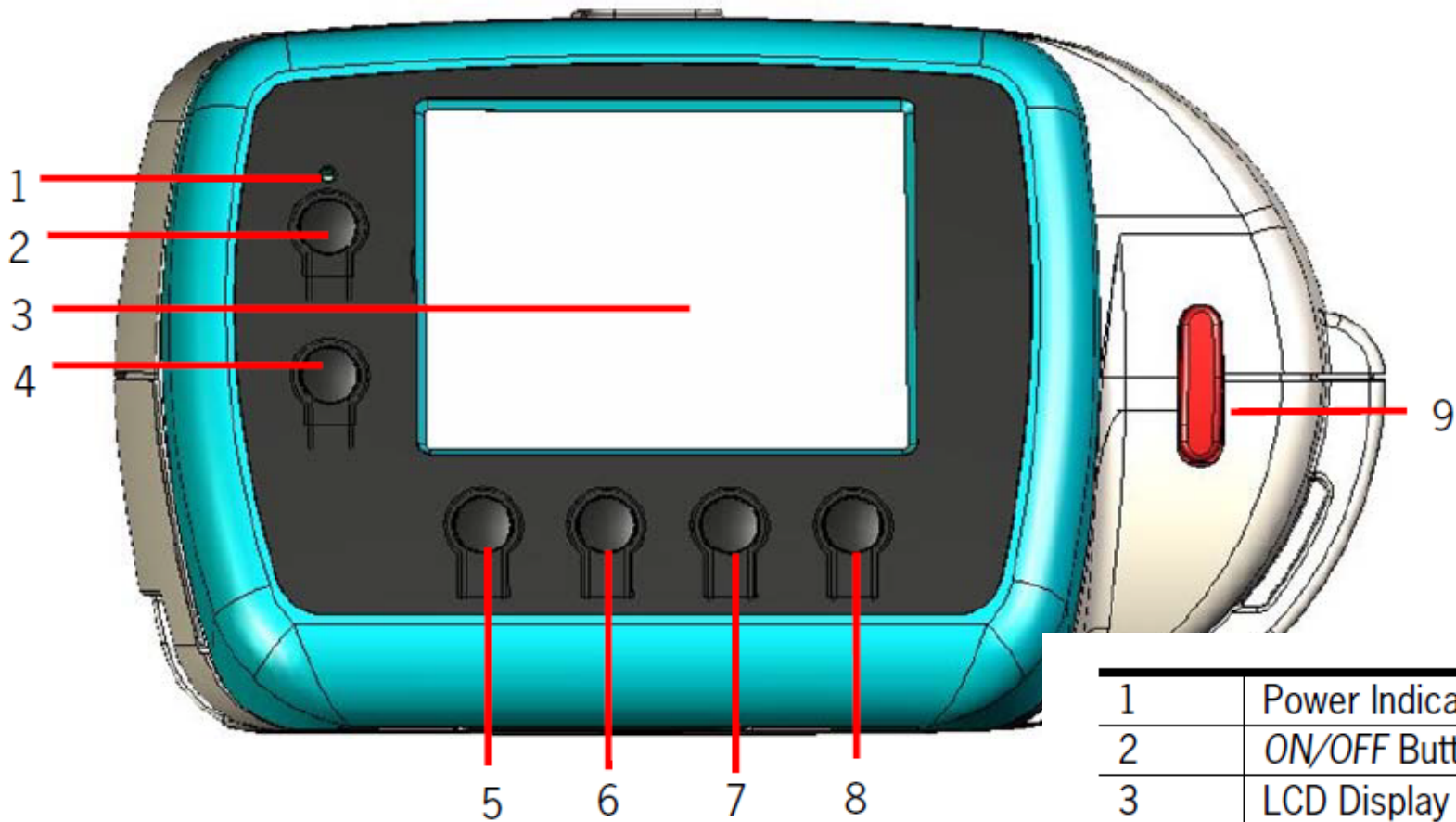


Figure 4: Back

1	Optical input	8	Jack for optional remote trigger
2	Laser pointer	9	5 Volt DC Power Input*
3	Threads for handle or optional tripod	10	Display Panel (Swivel Hinged)
4	Trigger connection (for the Handle)	11	Battery compartment for 4 AA Rechargeable Batteries
5	USB Mini-B for tethered mode only, controlled by optional computer	12	Mounting threads for optional spotting scope
6	USB A (female)	13	Thumb trigger button (red)
7	USB A (female)	14	Hand strap

2.1 Control and Display Panel



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1	Power Indicator LED
2	ON/OFF Button
3	LCD Display
4	Laser Pointer ON/OFF
5-8	Menu Buttons
9	Thumb Trigger Button (red)

Working with Handheld 2

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- Batteries / Adopter for power supply
- Power On
- Point towards target object
- Wait for updating the spectrum
- Press Red button for Saving the spectrum (Keep a record of each object for future reference)
- Better is to work outside in sunshine
- For indoor working use appropriate illumination source (Tungsten Quartz Halogen Lamp)

Digital Number and Reflectance

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- Two kinds of Spectrum
 - Wave Lengths on x-axis vs Raw Digital Number (DN) on Y axis
- Or
- Wave length of x-axis vs Reflectance on Y Axis

View White Reference Panel

Choose a suitable white reference panel, such as the three inch round white reference panel which comes standard with the HandHeld 2 instrument or the five inch square panel (sold separately). Hold or mount the panel so that it is level and fully illuminated.

Aim the HandHeld 2 instrument so that optical input is viewing—but not shading—the white reference panel and is still close enough to ensure the field-of-view is filled by the panel (Figure 16). For a five inch square panel, keep the distance within nine inches. For a three inch round panel, keep the distance within four inches. Dark clothing helps minimize light reflected from the operator. (See section 6.10 for more information on white reference.)

Note: The diameter of the spot size is approximately half of the height.



How to View White Reference Panel

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- White reference is special material (Spectralon) having characteristics that it reflects more than 99% of incident energy
- Its reflectance is used to:
 - Optimize the time of capturing the sample data, and to
 - Compute Reflectance = E_r / E_i , considering that E_r from white reference = E_i
- *While viewing the White Reference, it should be at height of 4" above the 3" dia white surface*

Wavelength (nm)	SRM-990 Spectralon® Uncalibrated Reflectance (plus/minus 0.5 percent)
300	0.985
400	0.990
500	0.991
600	0.992
700	0.992
800	0.991
900	0.991
1000	0.993
	0.993

Spectralon Average Reflectance data



With the HandHeld 2 instrument viewing the white reference panel, a curve—called a raw DN spectrum—is displayed, signified by D on the Y axis (Figure 17). Raw DN is the raw output of the detector converted to digital numbers.

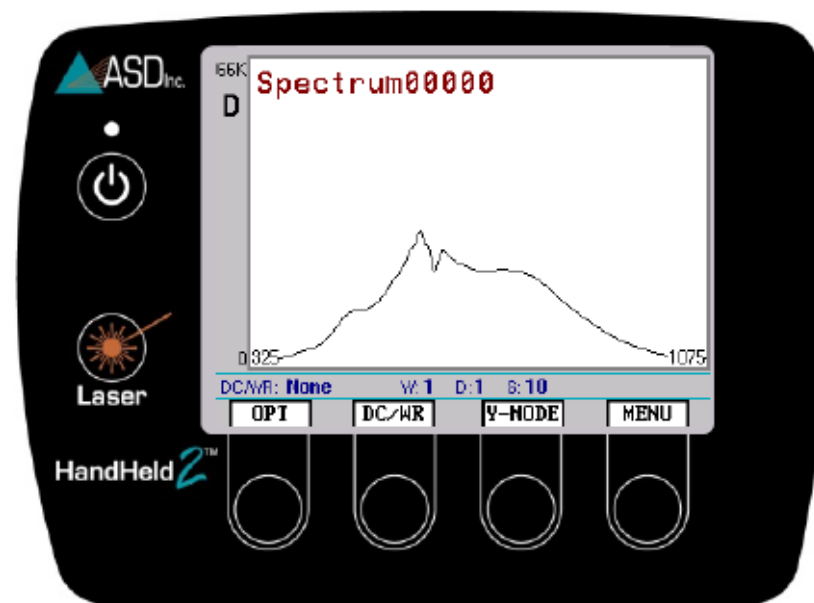


Figure 17: Raw DN spectrum

This display updates in real-time. As the HandHeld 2 instrument views different illumination levels or different surfaces, the curve on the display will change.

Saturation Alert

If the light is too bright for the present settings, the curve will go above the display scale and SATURATION ALERT will be displayed (Figure 18). If this warning appears, the model must be optimized as discussed in Section **2.7 Optimization**.

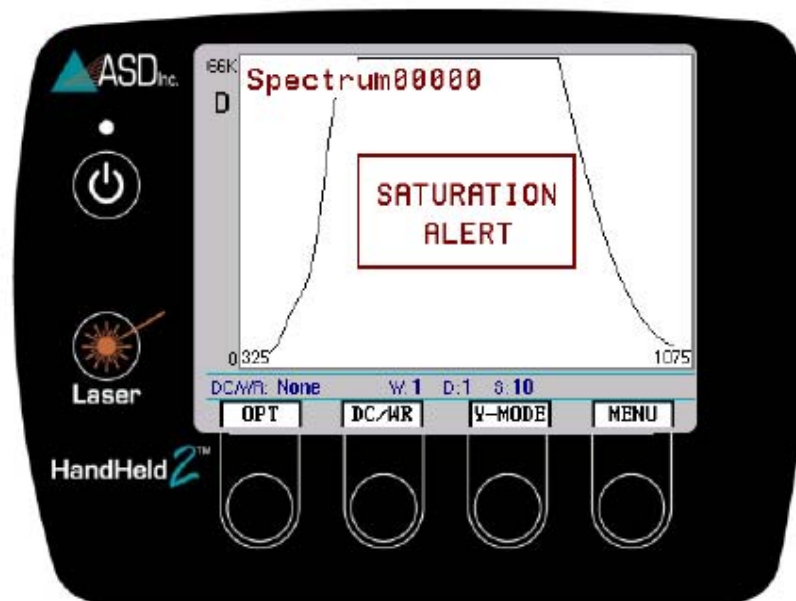


Figure 18: Saturation alert

Optimization

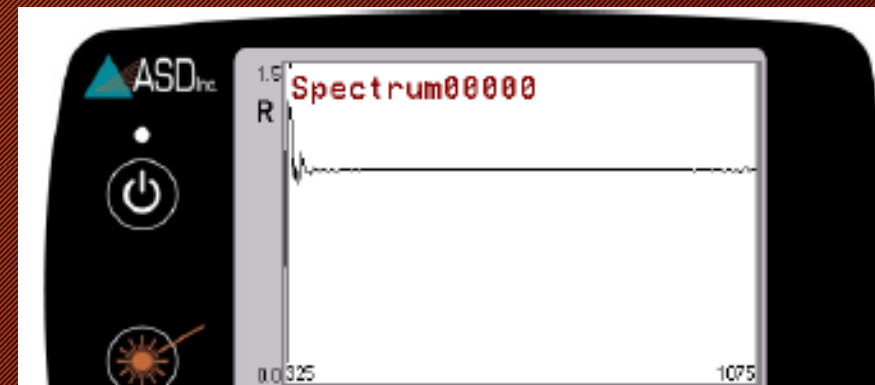
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- Optimization, optimizes the time of integration to improve signal to noise ratio.
- Optimization should be done when:
 - Illumination change Significantly
 - On Saturation Alert
- A well optimized instrument will display between 20,000 - 35,000 raw digital number
- Raw DN should be ideally three quarters of full scale while we are viewing the White Reference.
- NOTE: Integration time can be set manually too, using Menu options

Collection of Reflectance Spectrum

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- In order to collect Reflectance Spectrum, the instrument need base line measurement of DARK surface and WHITE Surface (using DC/WR button)
- Press DC/WR Button, then press the red button once asked to PUSH Trigger, Keep the instrument pointed towards the white reference surface. You will hear shutter closing and opening sounds.
- After Base line data is collected, if you continue seeing White reference data, you will get a straight line with reflectance equal to 1.



Viewing and Saving Reflectance Spectrum of SAMPLE

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- Aim the Handheld towards the Sample surface, without making a shadow on surface
- It should be close enough so that the sample surface fill the field of view
- Screen will start showing the Reflectance Spectrum of the Target Surface
- Save the spectrum by pressing the RED button.
- May use Laser pointer to see the view direction (don't save spectrum, while laser pointer is on)



Figure 28: View of sample

Main Menu

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- To access the Main Menu screen, press the *MENU* button (Figure 31).

The main menu contains five icons:



System Presets – Allows selection of a system preset group.



Foreoptics – Allows selection of a foreoptic.



File Save – Enables access to the File Save menu.



Integration Time – Allows selection of system integration time.



Spectrum Counts – Allows user to select white reference, dark current and spectrum sample counts.

2.14.3 Integration Time Menu

Integration time is the set time interval for detector build-up of electric signal converted from the incoming light. After each build-up, the electric signal is read and cleared-out for the next build-up.

The optimization function automatically selects the integration time. However, the integration time can be set manually. In some instances, this may improve the signal-to-noise ratio.

Step 1 Press the left and right arrow buttons to move the selection box to the *Integration Time* menu icon (Figure 41).



Figure 41: Integration Time menu icon

Step 2 Press the *SEL* button. The file save menu is shown with its submenu icons (Figure 42).

Note: The peak of the raw DN curve should be three quarters of full scale while the HandHeld 2 instrument is viewing the white reference panel. If the peak DN is too low, adjust the integration time for a slower setting. If the peak DN is too high (saturated), adjust the integration time for a faster setting.



Figure 43: Choose an integration time

Spectrum Counts Averaging Menu

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- The signal-to-noise ratio improves with the square root of the number of scans used in the averaging.
- When outside, it is usually sufficient to use 30 scans in the spectrum averaging for the sample and 60 scans for the white reference and dark current.
- When inside using artificial illumination, one can use lower averaging to achieve similar signal-to-noise results.

It is recommended to take multiple spectra with spectrum averaging set to 10-25, then further average those spectra in postprocessing using the ViewSpec program. ViewSpec also permits viewing large groups of files.

Spectrum Averaging Counts and Equations

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Figure 45: Move selection box to Spectrum Counts menu icon

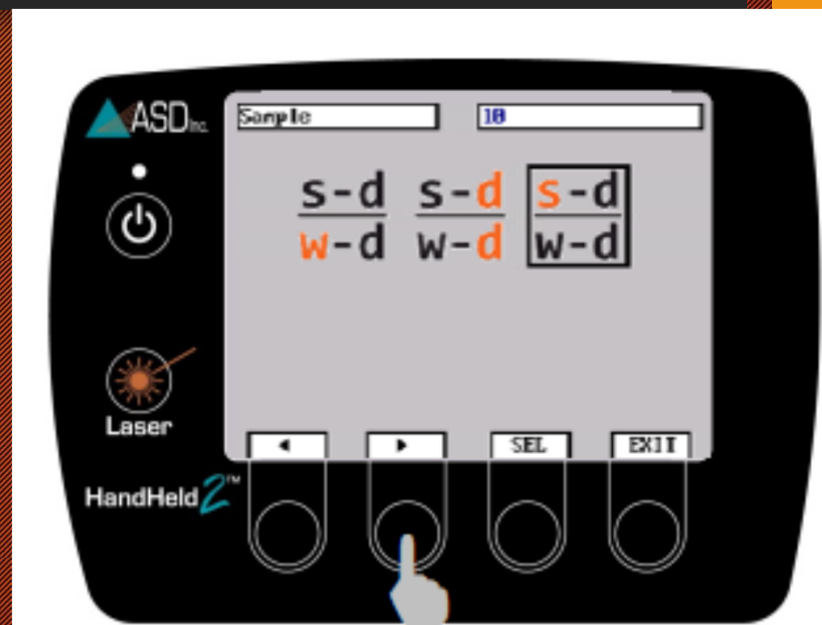


Figure 47: Move selection box to White, Dark, or Sample

After selecting the averaging equation, number of counts are selected

Data Export

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- A computer is used to import and process the stored data files from the HandHeld 2 instrument.



Figure 89: Mini USB plug connects to the instrument



Figure 90: Standard USB plug connects to a computer

Software installation from USB

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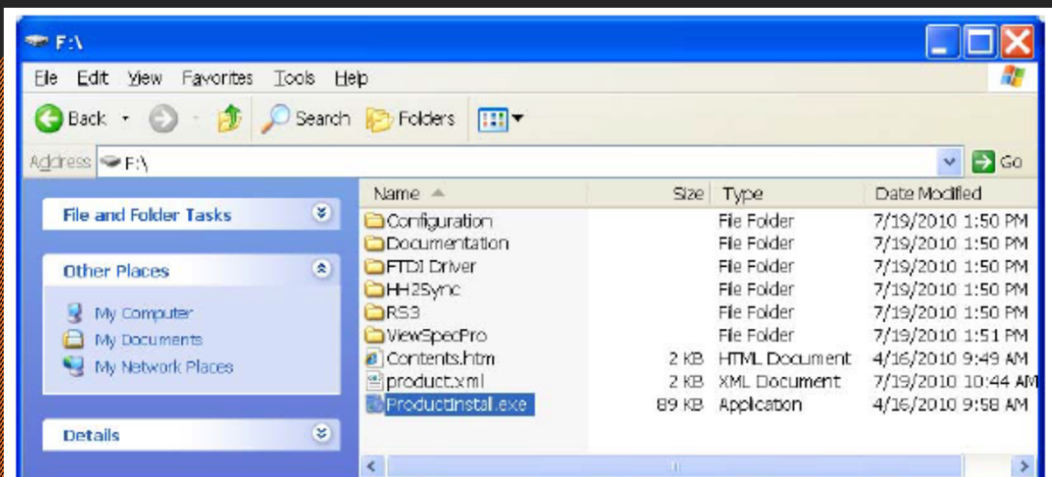


Figure 91: Files on USB drive

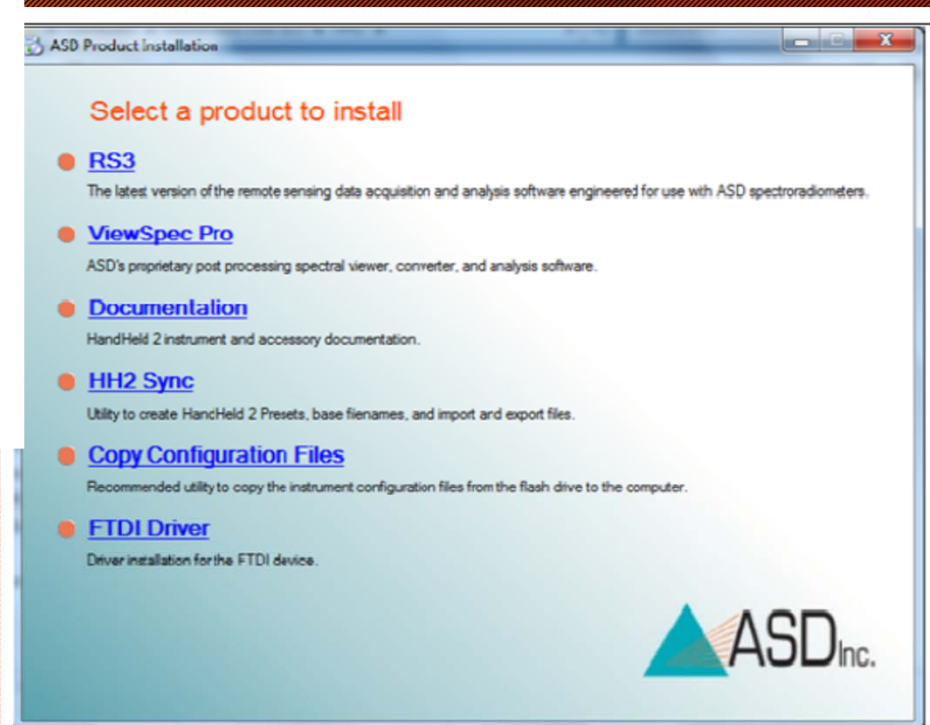






Figure 92: ASD software introduction screen

When all of the installations are finished, the following shortcuts will be on the desktop:

 RS³	RS³ for controlling the HandHeld 2 instrument from an external controller computer.
 RS³ High Contrast	RS³ with high contrast black and white screen for outdoor use.
 HH2 Sync	HH2 Sync for importing data files from the HandHeld 2 instrument, managing the system presets and base file names, and exporting calibration files to the HandHeld 2 instrument.
 ViewSpecPro	ViewSpec™ Pro for post-processing spectra files saved using the HandHeld 2 instrument.

HH2 Sync Application Software

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- Turn on the computer and completely boot up first then turn on the HandHeld 2 instrument. When the HandHeld 2 instrument is ready, the Tethered Mode message will appear on the display.
- On laptop, Click on the HH2 Sync shortcut on the computer desktop

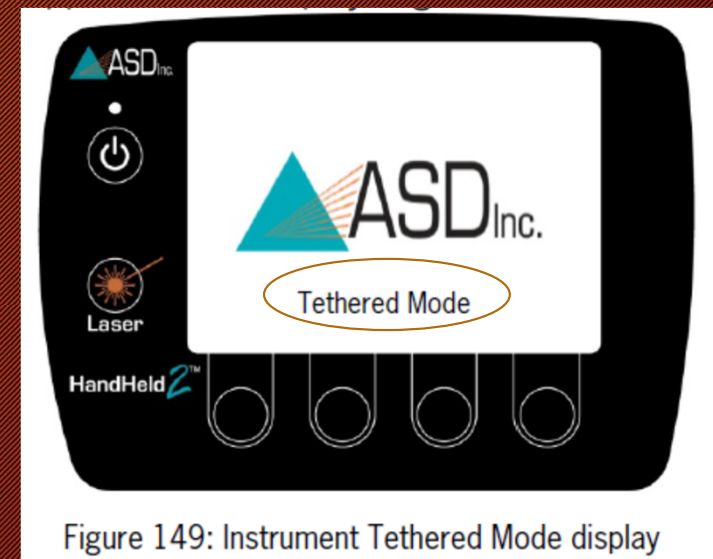


Figure 149: Instrument Tethered Mode display

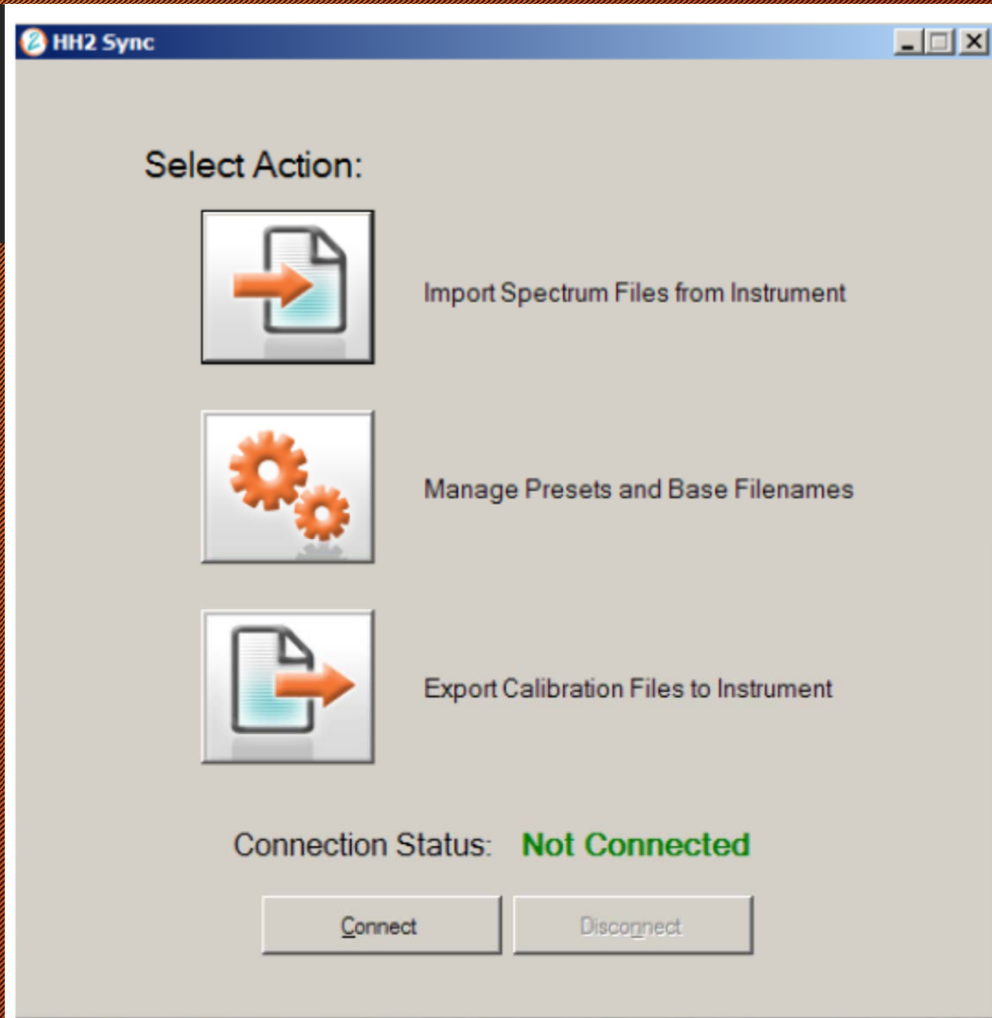


Figure 152: HH2 Sync Select Action screen

USING RS³ Software

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- You can use all control functions of Spectroradiometer Through RS³ software, rather using control button on instrument
- You can view saved spectrum, in groups.

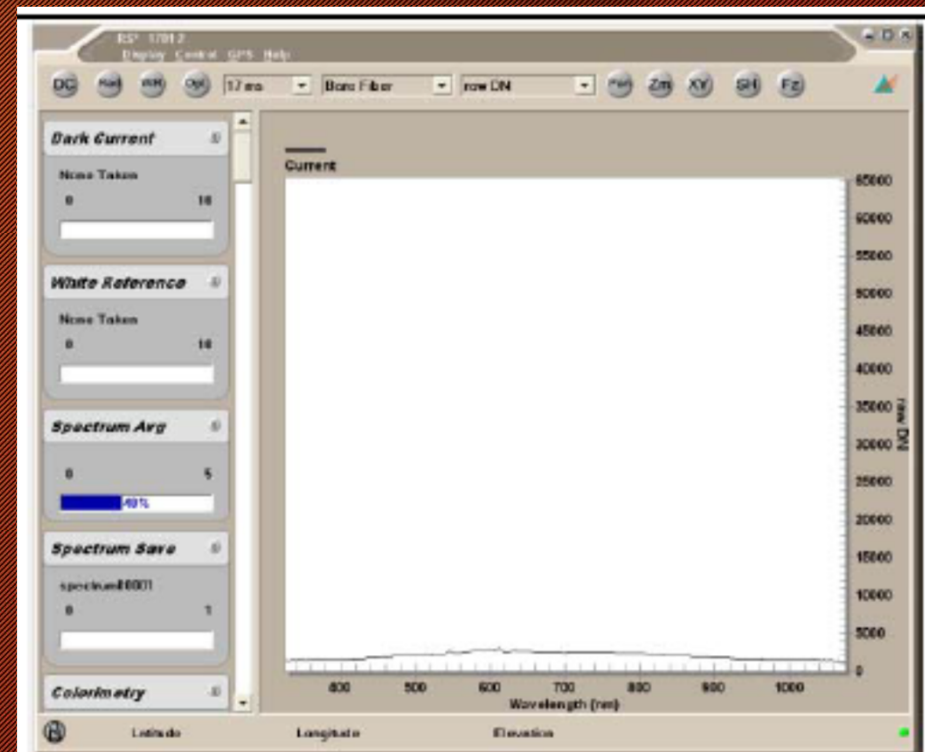


Figure 99: RS³ spectrum display

View File

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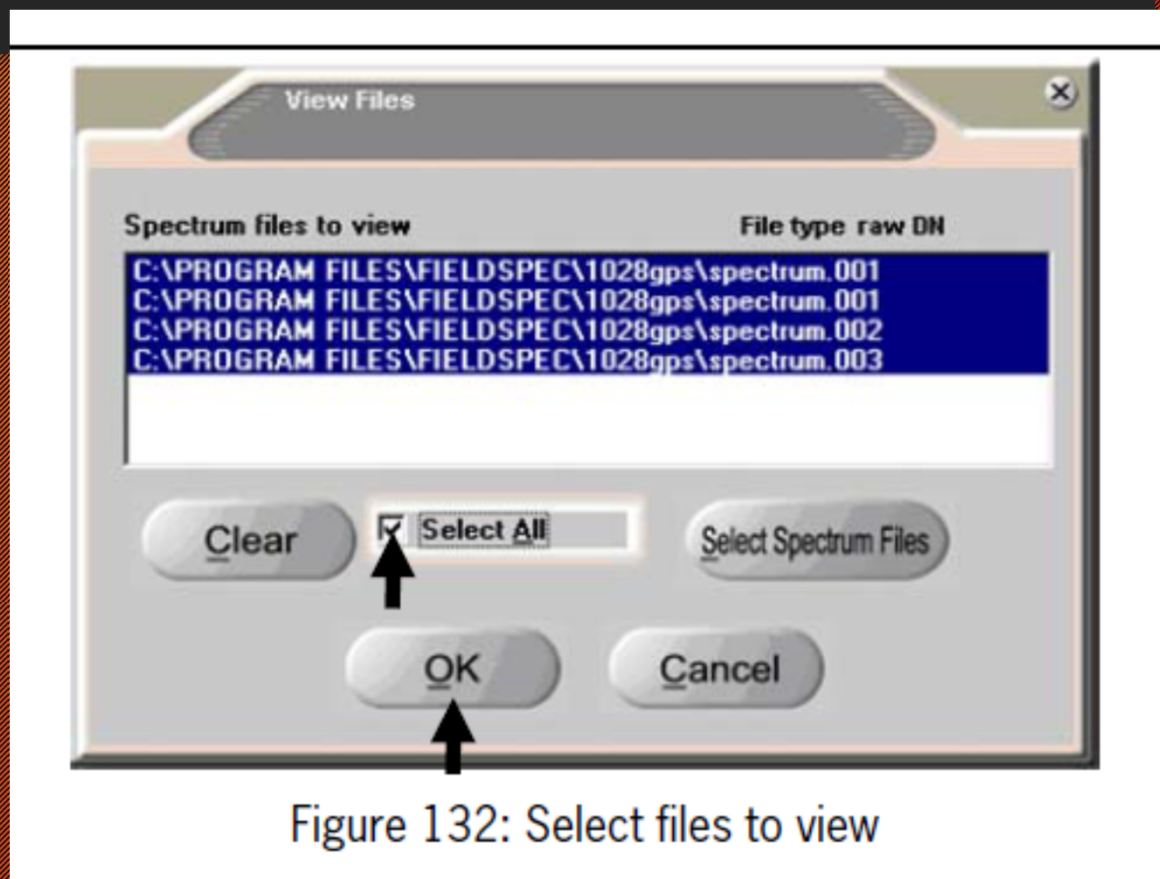


Figure 132: Select files to view

ViewSpecPro

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- ViewSpecPro can be used to carry out indepth analysis on each of the spectrum or group of spectrum saved.
- It can be used to find ratio , and differences between two bands (NDVI)
- It can used to export the .asd files to .txt file (ASCI format) so that it may be used in Excel or other software.

Sample use of Spectrum

2.2.1 NDVI

Normalized Difference Vegetation Index is one of the most popular indices to get the information about the vegetation cover on ground. It shows the difference of reflectance in infra red band and in red band (i.e.) Band 7 & Band 5 of Landsat MSS.

It can be calculated as;

$$NDVI = \frac{NIR - red}{NIR + red} \dots\dots\dots Eq. 1$$