



**PENDAR**  
TECHNOLOGIES

# Pendar X10 User Manual

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## DECLARATIONS OF CONFORMITY

### U.S.A

This device complies with FDA performance standards for laser products except for conformance with IEC 60825-1 ed. 3., as described in Laser Notice no. 56, dated May 8, 2019.

### Supplier's Declaration of Conformity

Unique Identifier: Pendar X10, Model 1.0 (100001-00) and Model 1.1 (100001-01)

Responsible Party: Pendar Technologies LLC

Address: 30 Spinelli Place, Cambridge, Massachusetts, 02138

E-mail: [info@pendar.com](mailto:info@pendar.com)

Phone: +1 617 5882128

### FCC Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### CANADA

This Class B digital apparatus complies with Canadian ICES-003.

## IMPORTANT INFORMATION ON LASER SAFETY



THIS DEVICE EMITS VISIBLE AND INVISIBLE LASER RADIATION.

AVOID DIRECT EXPOSURE TO THE BEAM

THIS DEVICE IS A **CLASS 3R** LASER PRODUCT AND COMPLIES WITH FDA PERFORMANCE STANDARDS FOR LASER PRODUCTS EXCEPT FOR CONFORMANCE WITH IEC 60825-1 ED. 3., AS DESCRIBED IN LASER NOTICE NO. 56, DATED MAY 8, 2019.

CAUTION – USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.

Per ANSI Z135.1-2014 American National Standard for Safe Use of Lasers, Laser Eye Protection is not required for Class 3R or laser systems except in conditions where intentional long-term (>0.25s) direct viewing is required.

### OUTPUT CHARACTERISTICS

#### OUTPUT 1:

Two visible beams, operated pulsed, each beam having the following characteristics:

Wavelength: 645-660nm, peak power < 2.5 mW, average output power < 0.5mW

#### OUTPUT 2:

One focused beam, operated pulsed having the following characteristics:

Wavelength: 820-835nm, Pulsed Peak Power < 87 mW, Maximum Average Output Power < 58 mW (maximum 67% duty cycle)

Pulse Width: 20 ms - 300 ms

Pulse Period: 150 ms - 900 ms (two pulses of equal width occur in each repetition period)

Beam Focal Distance from Emitting Aperture: variable, 30 cm to 90 cm

Divergence Angle: minimum 44 mrad (when focus is at 90cm); maximum 133 mrad (when focus is at 30cm)

## LASER SAFETY CALCULATED VALUES

	Per 60825-1 Ed 3
Hazard Class	3R
NOHD (unaided)	1.89 m
NOHD (aided)	6.01 m
OD (unaided)	0.7*
OD (aided)	0.7*
NSHD	0 m

\* Note: Per ANSI Z135.1-2014 American National Standard for Safe Use of Lasers, Laser Eye Protection is not required for Class 3R or laser systems except in conditions where intentional long-term (>0.25s) direct viewing is required.

### ADDITIONAL WARNINGS:

During normal operation, this device dithers the output beam, causing the focal spot to scan a small area around the focal point. Without this dithering, the hazard level of the laser would be Class 3B. Engineering controls are in place to detect a failure of the dither mechanism within 50ms of failure, and an interlock disables the laser output in such a scenario.



**IF THE APP BECOMES UNRESPONSIVE OR REMOTE CONNECTION TO THE APP IS LOST, TURN THE INSTRUMENT OFF BY PULLING OUT THE BATTERY. WAIT 3 SEC AND REINSTALL THE BATTERY (See Section II – 1). THIS IS THE SAFEST WAY TO ENSURE THE INSTRUMENT IS RESET PROPERLY.**



**NEVER LOOK DIRECTLY INTO THE LASER APERTURE WHEN THE UNIT IS ON EVEN THOUGH THE UNIT APPEARS IDLE. IF VIEWING OF THE APERTURE IS NECESSARY, PULL OUT THE BATTERY (See Section II -1). THIS IS THE SAFEST WAY TO ENSURE THAT THE UNIT IS OFF.**

## I. Introduction

The components of the hardware described below will be referenced throughout the manual.



Figure 1. Side view and panel view of the Pendar X10 instrument.

**Emitting aperture:** The laser beams are emitted from this aperture and come to a focus 30 to 90 cm away.

**Emission warning light:** For caution, this light glows red whenever the lasers are powered on. Note that although the lasers are on when the device is in the READY state, during normal operation they are not emitted from the instrument except when the trigger is half-pressed or when a measurement is in progress. Nevertheless, direct viewing of the aperture should be avoided while this light is on, in case of accidental emission due to a failure.

**Trigger:** The dual stage trigger is held down halfway (“half-press”) to enter alignment mode, which turns on the two pointer beams. A “full-press” and release initiates a measurement.

**USB Port:** This port is used to connect to a computer for software updates.

**Arm:** Pressing the Arm key puts the system into the IDLE state. To get back to the READY state, pull the trigger and wait 5-10 seconds.

**Power:** Press and hold for 3 seconds to turn instrument on.

**Speaker:** This emits audible beeps when a measurement is in progress and can be silenced in the Settings.

**Back:** used to cancel a measurement that is in progress, and to navigate between screens.

**Return:** used to navigate the screen and select items.

**Left/Right Arrows:** used to navigate the screen.

**Up/Down Arrows:** used to adjust the focus position and navigate the screen

## II. Turning on the instrument

**BATTERY INSTALLATION OR REPLACEMENT:** Partially unscrew both spring-loaded screws until the battery cover opens. Remove the installed battery by pulling gently on the tab. Insert a charged battery into the compartment. Replace the cover and secure it by screwing the spring-loaded screws.



Figure 2. (left) Pull gently on the tab to remove the battery. (right) Slide the new battery into the compartment with terminals facing up.

**TURNING THE INSTRUMENT ON:** Press and hold the power button for 3 seconds, then release. After 3 seconds, the instrument will beep twice, confirming that the instrument has powered on, and a blue bootup screen with a progress bar appears.

After  $\approx 30$  seconds, the Scan mode screen appears. An hourglass icon at the top right of the screen, next to the battery indicator, indicates that the instrument is not yet in the READY state. After another  $\approx 20-30$  seconds, the hourglass icon disappears, and the instrument is in the READY state.

In the READY state, the emission indicator and the ARM button will illuminate to indicate that the lasers are energized. This is to inform the user that the laser emission is imminent upon trigger press and viewing of the aperture should be avoided. To exit from READY state and turn off the lasers for safety, press the illuminated ARM button. This will turn off the lasers, and accordingly also turn off the emission and arm lights (Figure 3).



Figure 3- The ARM key (left) and laser emission indicator are illuminated when the system is in READY state.

### III. Display and Status Indicators

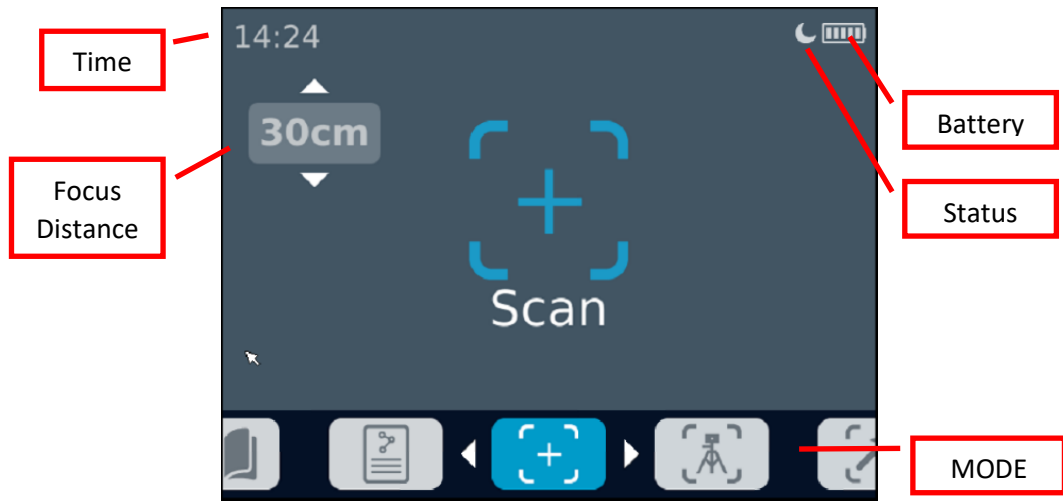




Figure 4- Pendar X10 starts up in Scan Mode

The bottom sliding bar indicates which mode the instrument is in. You can navigate from one mode to the another by using the LEFT and RIGHT arrow keys. By default, Pendar X10 starts up in SCAN mode ready to make measurements.


You can adjust the focus distance of the instrument using the UP and DOWN keys.

The following icons may appear at the top right of the screen, to the left of the battery indicator, to indicate the instrument status.

 The hourglass icon indicates that the hardware is being prepared for the READY state. Measurements cannot be taken while this icon is displayed.

 The thermometer icon indicates that the temperature of the hardware is outside of the desired range. If this icon is displayed for longer than 10 seconds, it is recommended to power off the instrument.



 The moon icon indicates that the instrument is in the IDLE state. The ARM button toggles between READY and IDLE states. In rare cases, the moon icon may appear immediately after booting up which indicates an error in hardware initialization, which will prevent the user from taking measurements.

## IV. Measurement Modes and Results

A Pendar X10 measurement comprises one Quick scan followed by zero or more Detailed scans.

Quick scan: the first scan of a sample is a Quick scan, designed to give the user useful information as quickly as possible. The sample is interrogated until a sufficient signal-to-noise ratio is reached, or until 30s elapse, whichever comes first. The instrument then compares the sample to the library using a proprietary algorithm. When the analysis is finished, the display will show up to 5 materials that were identified in the sample. The displayed spectrum will be the Raman spectrum, overlaid with the fit obtained from regression analysis of the algorithm.

Detailed scan: any scan that follows the Quick scan is a Detailed scan, and the purpose of these scans is to improve the quality of the measured spectrum in order to increase confidence, to detect lower-concentration components in a mixture or to look for the presence of materials that *are* in the library mixed with unknown items that are not in the library. Each Detailed scan runs for a fixed time interval, after which the analysis is run and the results are displayed.

Pendar X10 has three modes of operation to guide the user from Quick scan to Detailed scans, and from one sample to the next sample. These modes can be quickly selected using the Left/Right buttons of the keypad.

Scan mode: This is the primary mode of the X10, optimized for handheld use. When the trigger is pulled, a Quick scan is initiated. After the quick scan is completed and the user has reviewed the results, the user then has the choice to follow up with a Detailed scan to improve the signal, which can be used to improve confidence and/or identify lower-concentration components. There is no limit to the number of additional detailed scans that can be performed; it is up to the user's discretion. (However, if a long measurement time is expected, we recommend to use a tripod to eliminate the need to hold the instrument steady for extended periods of time.) When the user is satisfied, the measurement should be terminated before moving on to a new sample.

Tripod mode: This mode is optimized for a stationary operation of the X10, such as when using the tripod provided in the X10 kit. In this configuration, the X10 should first be aimed at the sample using the trigger half-press while adjusting the tripod or sample position. When the sample is in focus, a measurement is initiated by a full-press and release of the trigger. The measurement sequence is similar to Scan mode, i.e., a Quick scan followed by Detailed scans, except that the instrument automatically continues to take Detailed scans without requiring user intervention, and updates the results after each scan. The user can terminate the measurement at any time; without any intervention, the measurement pauses after Tripod Max Duration is reached, at which point the user must choose to continue or end the measurement.

Build mode: This mode is intended for the acquisition of spectra of known materials. For example, this mode would be used to measure a material to add to the library. The duration of the measurement is set by the Build Mode Duration setting. At the end of the measurement, the spectrum is processed and the resulting Raman spectrum is displayed. (The Quick scan and Detailed scan concepts are irrelevant in Build Mode.)

## Understanding Results

The decision to extend a Quick scan to a Detailed scan is left to the user, as is the total number of Detailed scans. This decision will depend on the context of the scenario, such as available time to make the measurement, and the level of detail/confidence required in the result. This decision will also be guided by the results presented to the user, which take the following form.

a) Each component of the sample that is identified will be accompanied by a confidence indicator.



The checkmark symbol next to a component indicates identification with high confidence.



The question mark symbol next to a component indicates identification with low confidence.

A low-confidence result is presented to the user as an indication that a small signal is present which may be improved by increasing the measurement time. By extending the measurement time through the use of Detailed scans, a low-confidence result can:

1. become a confident result, or
2. disappear from the Results list, or
3. remain a low-confidence result

At the end of the measurement (determined by the amount of time the user is willing to spend on the sample), any remaining low-confidence result should NOT be used as a reliable identification of the measured sample.

- b) The result “Unknown Item” indicates the presence of a material that is not included in the library. It can appear by itself, or as one component in a mixture of identified materials. Possible actions:
1. If “Unknown Item” appears after the Quick scan, use a Detailed scan to look for the presence of materials that *are* in the library mixed with unknown items that are not in the library.
  2. Sometimes this result occurs due to poor aiming. Do another Quick scan but hold the unit more steadily. Use a tripod if situation permits.
  3. Optional: you may send the results of your scans to Pendar Technologies for further examination. In that case, connect to your device via PendarLink and create a reach-back file as described in the related section below.
- c) The result “Poor Data Quality” indicates very low Raman signal. Possible reasons and actions:
1. The X10 was not aimed properly on the sample. Re-aim and take a new Quick scan.
  2. If the unit was properly aimed, then Poor Data Quality indicates that the sample does not generate a strong Raman signal. This can occur with some black powders. Use a Detailed scan to continue to look for the small signal.
  3. If after a few minutes of measuring the result remains Poor Data Quality, then it is likely that the material does not generate any Raman signal within the X10’s measurement range. This can occur with certain samples, such as table salt.

## V. Taking a Measurement

We will walk through an example of taking a measurement in each of the two modes.

Scan mode:

1. Navigate to the Scan mode screen using the LEFT and RIGHT arrows.

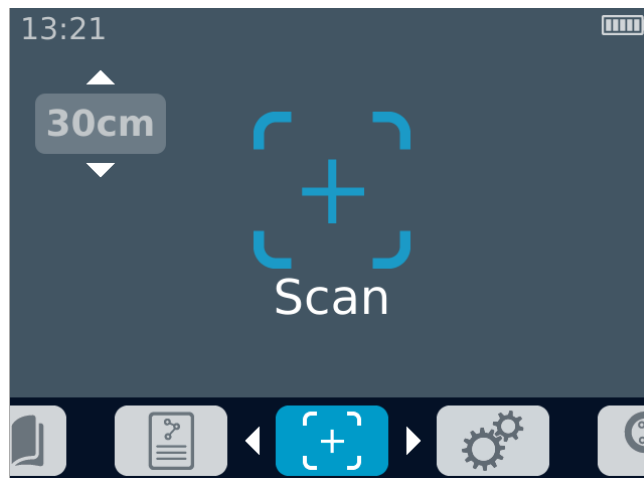


Figure 5. The Scan mode screen. The indicator in the upper left shows the focus distance setting.

2. Pull the trigger half-way down to turn on the two pointing laser beams. The two red beams cross at the focal point of the IR pump beam. Move the instrument or adjust the focus position so that the red beams cross and form one single spot on the sample of interest.
3. When ready, press the trigger fully all the way down and release. This initiates the measurement.
4. The instrument will begin to beep and the progress bar will advance. Samples with weak Raman signatures require longer integration time, and the progress bar will advance more slowly. Samples with strong Raman signatures (e.g. acetaminophen, sulfur) can often be recognized in less than five seconds if the sample is in focus. The progress bar is an indicator of the signal-to-noise ratio of the measurement. For best results, keep the instrument as steadily as possible on the target.
5. When needed, adjust the focus distance using the UP and DOWN arrow keys, or by moving the instrument closer to or farther from the sample.

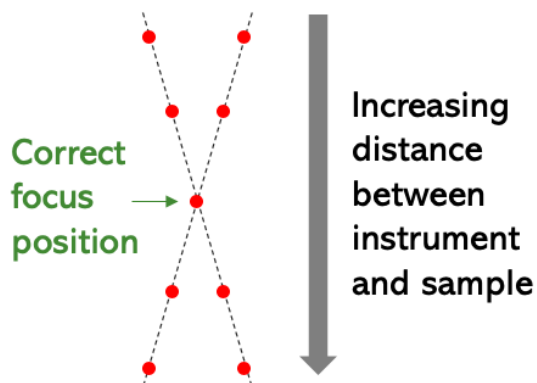


Figure 6- The target sample should be located where the red dots meet. If you see two spots on the sample, the focus is incorrect.

- The first measurement is a Quick scan. Press ESC button any time during the measurement to abort it.

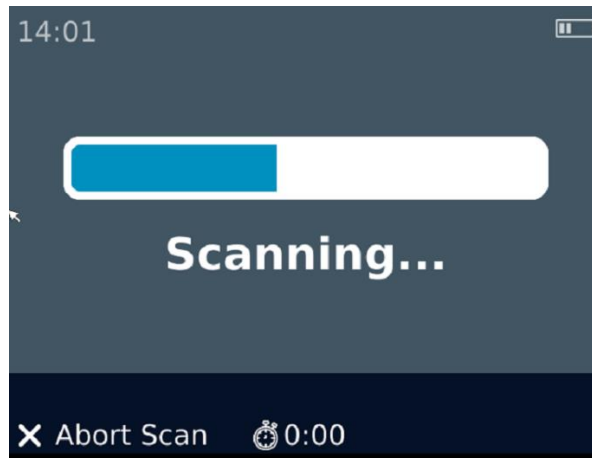


Figure 7 - Scan progress screen

- The instrument processes the measurement, compares it to the library, and displays the chemicals that were identified. Each chemical is accompanied by a confidence indicator, either a checkmark (for a confident result) or a question mark (for an unconfident result).

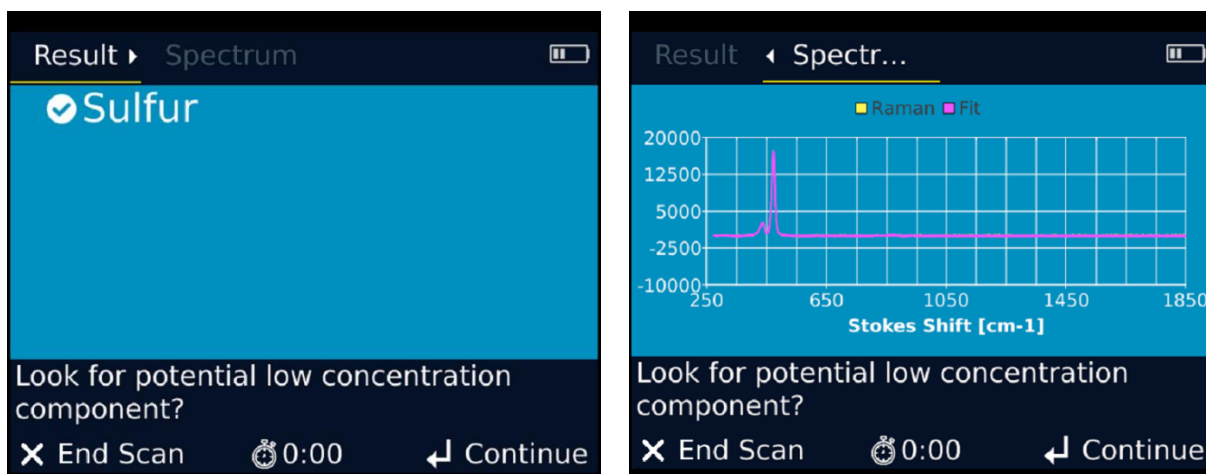


Figure 8. The results screen appears after a Scan mode measurement. In this example, sulfur was identified.

- Press RIGHT button to see the measured Raman spectrum, overlaid with the fitted curve that was found by regressing against the chemical library.
- At this point, you can either
  - end the measurement by half-pressing the trigger or pressing ESC, which takes you back to the Scan Mode screen, where you can begin scanning a new sample, or
  - press ENTER to begin a Detailed scan. This is recommended in samples where secondary components in low concentrations are expected.

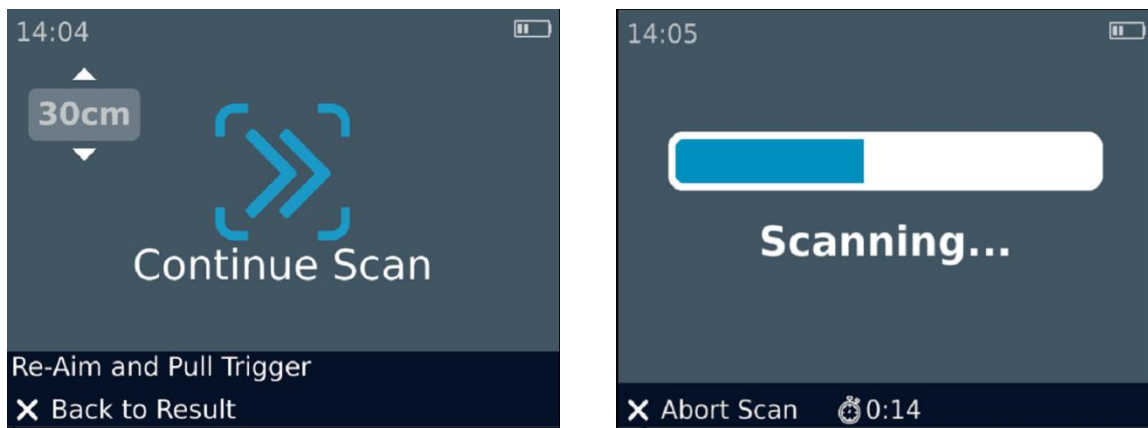


Figure 9 - Choosing Continue after a quick scan allows you to re-aim and take a detailed scan

10. If you pressed ENTER, the Continue Scan screen appears, allowing you to re-aim on the sample and do a full-press and release of the trigger to begin the Detailed scan.
11. After the Detailed scan, the instrument will analyze again, and report the updated results in a similar manner as above. During a detailed scan, you can press ESC any time to return to the previous result.
12. When the new result is displayed, you can press ENTER or half-press the trigger to re-aim and start another detailed scan to further refine your result. You can repeat this as many times as you want.

In Figure 10, Goody's Powder (a mixture of aspirin, acetaminophen, and low-concentration caffeine) is measured and the results screens from the Quick scan and two Detailed scans are shown, showing how the Detailed scans can be used to increase confidence and detect low-concentration components.

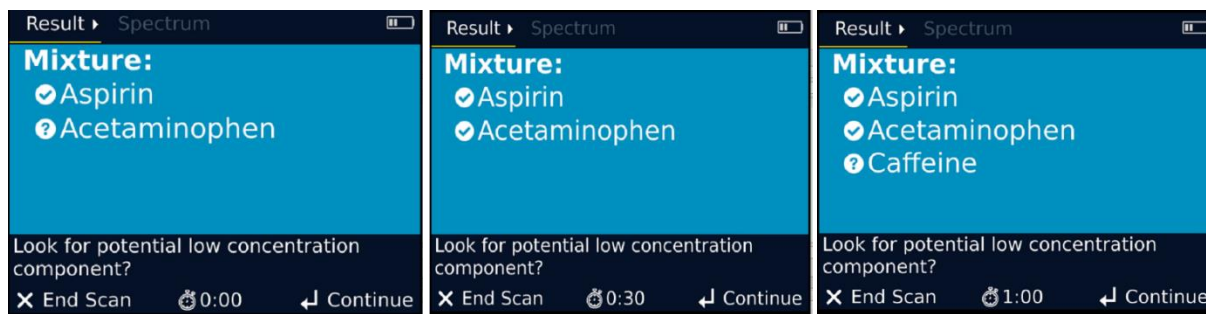


Figure 10 – An example of a results progression from a quick scan (left), first detailed scan (middle), and second detailed scan (right). The sample had roughly equal concentrations of aspirin and acetaminophen, and a low concentration of caffeine. The quick scan detected the aspirin and acetaminophen; the first detailed scan increased the confidence in acetaminophen, and the second detailed scan picked up the presence of caffeine, though the result is unconfident.

Tripod Mode:

Use LEFT and RIGHT arrows to navigate to Tripod Mode screen.

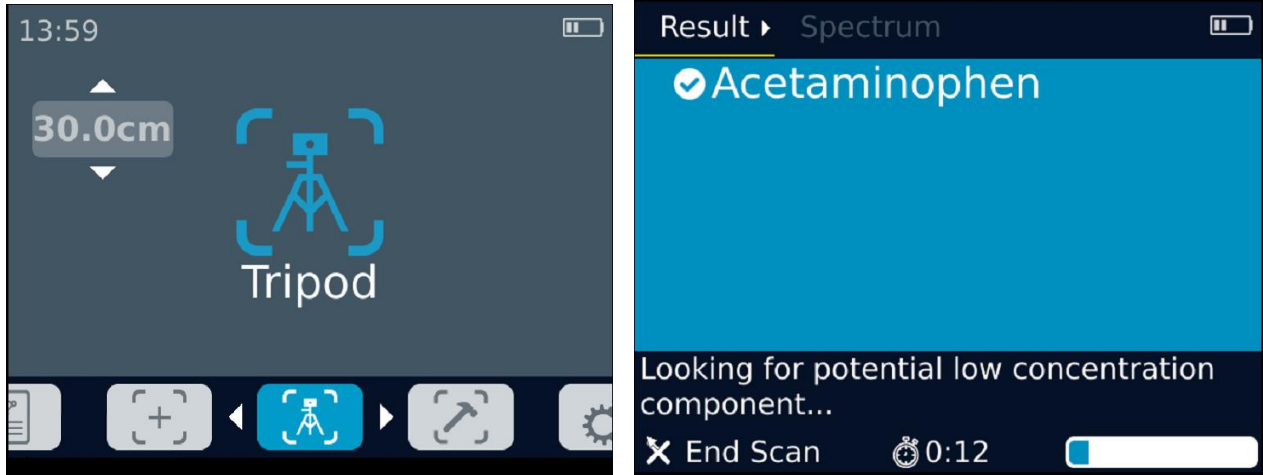


Figure 11- In Tripod mode, the unit continues to take repeated detailed scans updating the result screen at regular preset intervals.

Aim and start scan as in Scan mode. The instrument will take a Quick scan and report the results. Without waiting for any user action, it will automatically proceed to take repeated Detailed scans, updating the results after each additional Detailed scan. The user can terminate the measurement at any time and all data up through the previous analysis is saved; without any intervention, the measurement pauses after Tripod Max Duration has elapsed, at which point the user must choose to continue or end the measurement.

At any time during the Detailed scans, you can press the RIGHT button to view the spectrum obtained from the most recent analysis.

#### Build Mode:

1. (Optional) To collect the highest-quality spectrum, the instrument should be stationary. Screw the included mini-tripod into the Pendar X10 and position the tripod on a level surface.
2. Navigate to the Build mode screen, using the RIGHT and LEFT arrows.

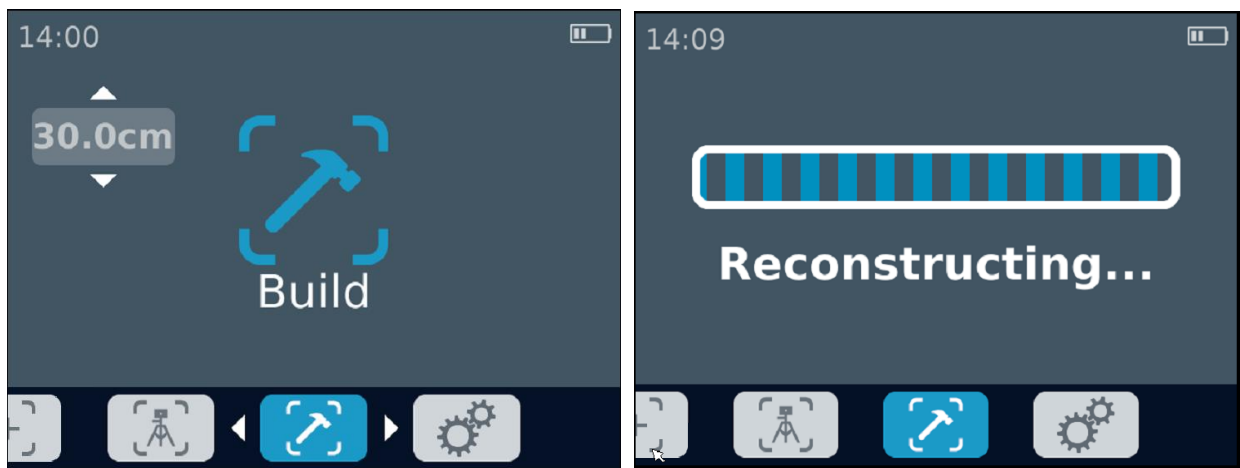


Figure 12. Build mode screens.

3. Pull the trigger half-way down to turn on the two pointing laser beams. The two red beams cross at the focal point of the IR pump beam. Move the instrument or adjust the focus position so that the red beams cross and form one single spot on the sample of interest.
4. When ready, press the trigger fully all the way down and release. This initiates the measurement.
5. The instrument will begin to beep, and the progress bar will increase. For best results, keep the instrument as steadily as possible on target.
6. You can end the scan at any time by pressing ESC after the scan has started. If more than 5 seconds have elapsed since the start of the measurement, the accumulated data will be saved, otherwise it will be discarded.
7. When the measurement is complete, the instrument processes and displays the measurement (Figure 13).
8. To return to the Build mode screen, press the ESC button.

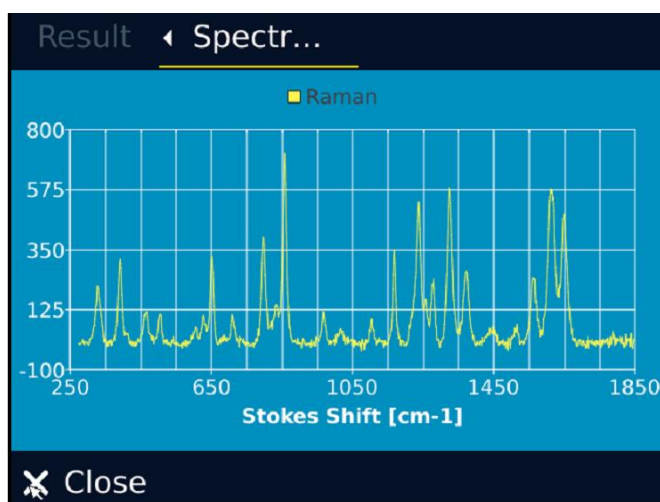


Figure 13. The display screen after a Build mode measurement of acetaminophen

## VI. Review Mode

The entire measurement history, of both Build mode and Scan mode scans, is stored on the instrument. Navigate to the Review screen using the LEFT arrow.



Figure 14. The Review screen shows all measurements taken since the most recent power-on.

Use the keypad arrows to navigate to the desired scan, and press ENTER to see the results screen and spectrum that were obtained during the selected measurement.

## VII. Settings/Information

To view or adjust the settings and get information about the device, navigate to the Settings screen using the keypad arrows.

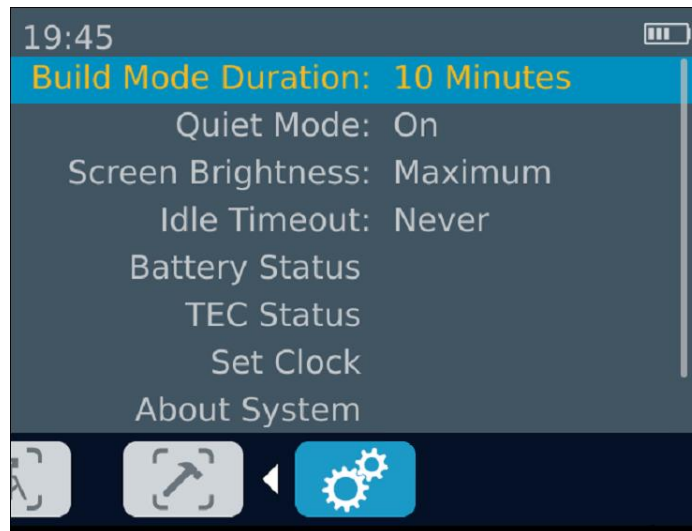


Figure 15. The Settings screen.

Settings can be adjusted by navigating to the desired setting using the UP and DOWN keys and pressing ENTER. The adjustable settings are described below:

- a. **Tripod Max Duration:** the amount of time the unit spends measuring a sample in tripod mode without user intervention. When this time elapses the measurement pauses, and the user can choose whether to extend or end the measurement.



- b. Build Mode Duration: the amount of time that the unit will spend measuring the sample in Build mode.
- c. Quiet Mode: the instrument is designed to beep to alert the user that an acquisition is taking place, and to provide an audible indicator of whether a chemical was identified in the measurement or not. By turning Quiet mode on this feature is silenced.
- d. Screen Brightness: Minimum, Low, Medium, High, Maximum
- e. Idle Timeout: if no buttons are pressed for a period equal to the Idle Timeout time, the instrument goes into IDLE mode, and the crescent moon icon appears at the top right. If no buttons are pressed for an additional Idle Timeout time after the unit has gone IDLE, the instrument will power off. To exit out of IDLE mode, pull and release the trigger and wait for the instrument to return to the READY state.
- f. Battery Status: detailed information on the status of the battery.
- g. TEC Status: detailed information about the thermal status of the instrument.
- h. Set Clock: a dialog to let you set the clock of the device.
- i. About System: information about the system, and firmware/software versions.
- j. Legal: legal information related to the device.

## VIII. Browsing the Library

In this screen below, you can browse the items in the instrument library using the UP and DOWN arrow keys to scroll.

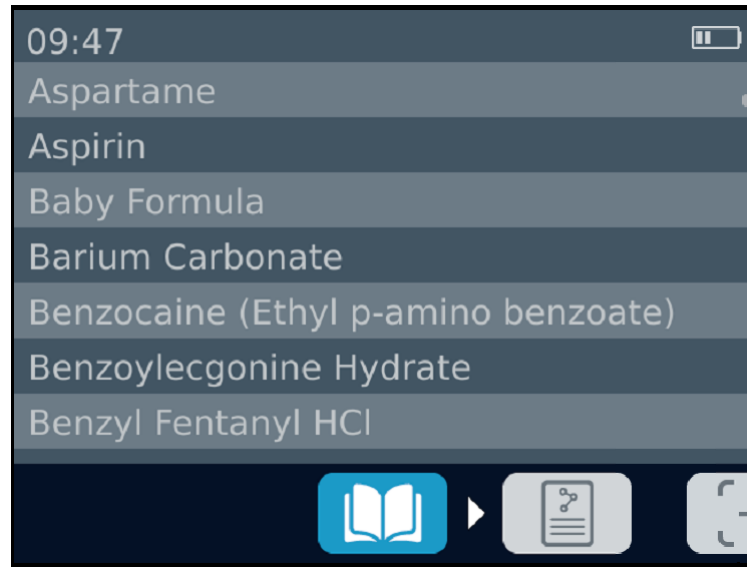


Figure 16 - Library List screen

## IX. Turning off the instrument

To properly turn off the instrument, be sure to follow the following instructions:

1. Press the POWER button on the instrument. A dialog will appear asking you to confirm.
2. Press enter to turn off the instrument.
3. After a few seconds, the instrument will make three audible beeps.
4. After a few more seconds, the instrument will fully power down.



**IF APP BECOMES UNRESPONSIVE, TURN THE INSTRUMENT OFF BY PULLING OUT THE BATTERY. WAIT 3 SEC AND REINSTALL BATTERY. THIS IS THE SAFEST WAY TO ENSURE THE INSTRUMENT IS TURNED OFF.**

## X. Software Update Procedure using PendarLink™

The following procedure requires PendarLink™ to be installed on a Windows PC computer connected to the Internet.

1. Click on your PendarLink shortcut or launch PendarLink via Start Menu. Initially you will see no unit connected.
2. Connect the instrument to the computer with the USB cable and turn on the instrument.
3. Once the unit boots up, press Connect button. PendarLink will detect your system and display it.

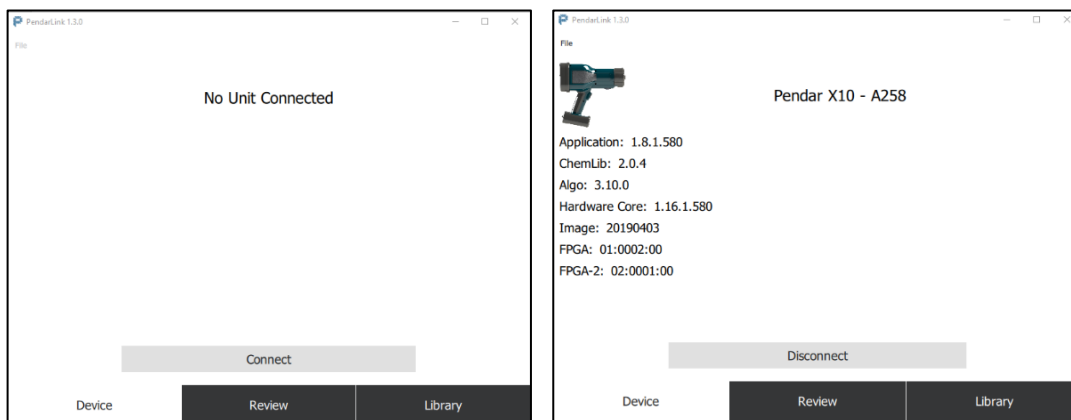


Figure 17. PendarLink screen before and after a unit is connected.

4. If an update is available to download for your system, Update System button will appear. You can click this button to update your system.

## XI. Reviewing and exporting scans using PendarLink™

While your system is connected, Press the Review button on the bottom of PendarLink window. This will bring up a list of your previous scans as shown below.

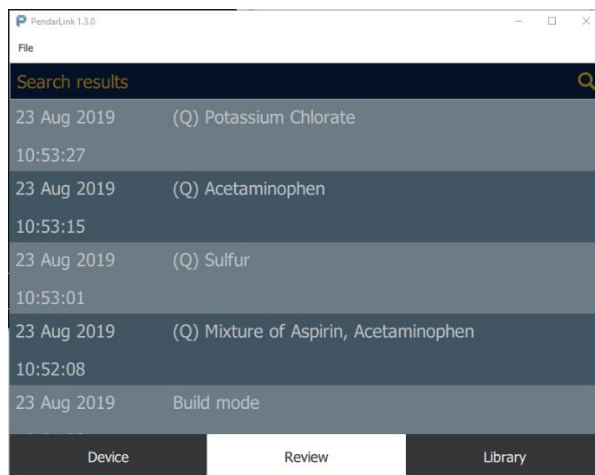


Figure 18. PendarLink review screen (The scans marked Build mode are scans where only data was collected but no analyzed).

Double-click the desired scan to display its results or choose File/Review Selected Scans in the menu.

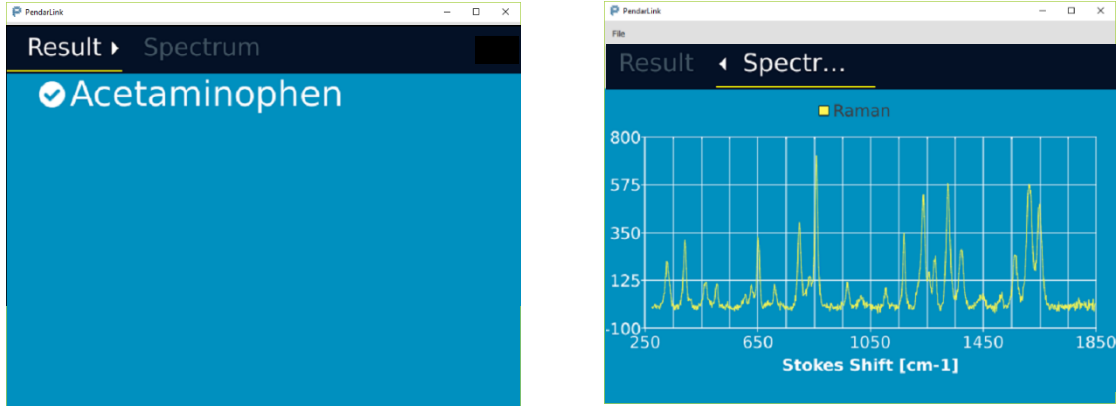


Figure 19. Reviewing a selected scan in PendarLink.

To export data, select the scans of interest, go to File/Save Selected Scans in the top menu. You can choose multiple scans by SHIFT/CTRL clicking items.

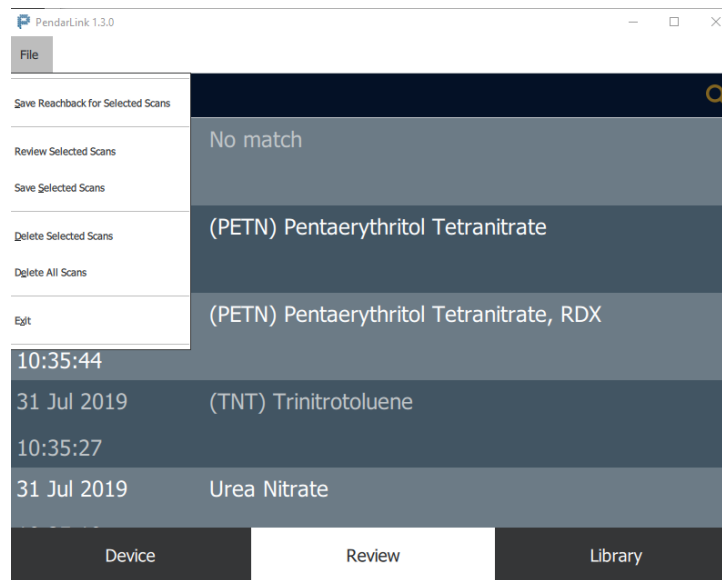


Figure 20. Export data in PendarLink.AS shown, multiple scans can be selected and highlighted.

## XII. Creating a Reach-back file

As part of customer support, you may choose or be asked to send a reach-back file to Pendar Technologies for detailed analysis of your case. To create this file, connect to your device on PendarLink. Go to Review Tab and select the scans of interest by holding down SHIFT or CTRL keys and clicking on the scans as needed. Go to Save Reach-back for Selected Scans under File menu. Follow the instructions to create and save the file. This file will be encrypted. You can email this file to Pendar Customer Support.

### XIII. Troubleshooting

*Issue: Pendar X10™ works well indoors, but not in bright environments.*

Try shadowing the sample of interest by positioning your body between the sample and the sun.

*Issue: I am pressing the trigger, but I do not see the red aiming dots.*

Check that the lens cap is removed.

The unit may have been in sleep mode. Pressing trigger will wake it up. Wait for the unit to become ready.

If you see the “Thermometer” symbol in the status bar, the unit is unable to maintain temperature stability. This may occur after extended operation in hot ambient conditions or extended storage in hot conditions. Turn off the instrument and allow it to cool.

*Issue: I just have taken a measurement, but I see no identification results.*

You may be in Build mode. Make sure you perform the measurement in Scan mode.

*Issue: While taking a measurement, “Error in data acquisition” dialog appears.*

The instrument detected a problem in the collected signal frames. Exit the dialog and try the measurement again. If the error appears again, try on a known good sample. If the error persists, contact Pendar Technologies.

*Issue: After taking a measurement, the instrument reports “Poor Data Quality”*

1. Some measurement conditions such as high levels of ambient sunlight or other bright light sources require very steady aiming. Aim and measure again with a steadier hold. In these situations, the use of a tripod is highly recommended.
2. You may be measuring a sample with no Raman signature.

*Issue: The instrument displays “Dither Failure. Contact manufacturer”.*

The instrument has detected a problem in the dither monitoring system and shut down the laser system to ensure eye safety. Try restarting the system once. If the problem persists, discontinue using the system and contact Pendar Technologies.

### XIV. Contact Pendar Technologies

You can send your questions, support requests and reach-back files to [support@pendar.com](mailto:support@pendar.com)

You can also reach support at +1 617 5882128 extension 722.