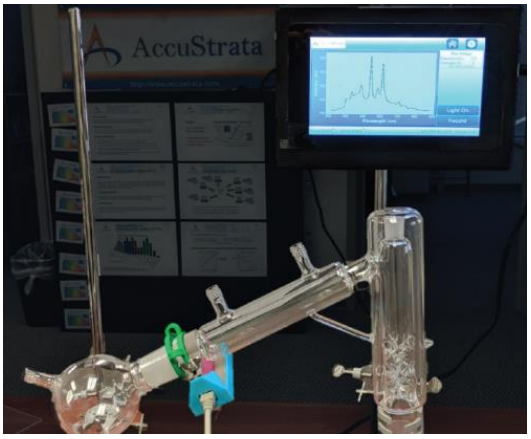
AROMETRIX

Fraction Finder

Operation Manual



YOU MUST READ THIS MANUAL BEFORE USE

Manual for Firmware Version 1.1.2

NEVER LOOK DIRECTLY INTO THE LIGHT SOURCE

Table of Contents

Section 1: Description and Principles of Operation

The Fraction Finder is a system used to identify the contents of a flow through a glass tube in-situ, in real time. It is composed of two key components: The optical transducer, or the "eyes" of the system, and the "brains" or the display and compute module. The optical transducer is currently mountable on size 29 glass, and soon, size 24 glass. The compute module has a pole clamp, so it can be pole mounted on a laboratory stand. The ability to directly track molecules of interest during distillation comes with a few key benefits:

1. The data to improve purity
2. The information to improve process techniques and enhance process repeatability
3. Reduce Contamination and by-products

The initial system was designed specifically for plant oils specific to Cannabis. This spectroscopic technique was borrowed from other industries and empirically applied to Cannabis through pure research. Our research was conducted in labs that were doing first and second pass short path distillations for the purpose of creating the purest cannabis oil. The result is the Fraction Finder, a simple system that allows the user to see:

- **The relative concentration of Cannabinoids**
- **The flow of Cannabinoids**

The Fraction Finder optical transducer is mounted on the condenser just before the cow when installed in a short path distillation configuration. Knowing the flow and the relative concentration of cannabinoids, and whether that purity is increasing, or decreasing can help make the decision of when to transition from Heads to Bodies, and Bodies to Tails. In our work, we found processors were most proud when they could get the most pure, least contaminated distillate for their clients. It is with this goal in mind that the Fraction Finder was developed.

What Fraction Finder is not:

The Fraction Finder is not a quantitative measure. It cannot replace good laboratory practice and experience. It is a qualitative means that directly tracks relative concentration of cannabinoids. Fraction Finder's data in combination with temperature, vacuum, good laboratory practice an experience will help the experienced distillation scientist further perfect their craft for the purist distillate.

How it works

The Fraction Finder uses a light source and a full wavelength spectrometer along with signal conditioning circuitry in the optical transducer. This information is digitally transmitted to the compute module, where the spectra is cataloged, analyzed, graphed and displayed as a function of time.

The Fraction Finder does additional math on this multi-wavelength spectral temporal data and creates a visualization for the user where both flow and relative potency are deduced. It is Arometrix's goal to amass enough spectral data from the fraction finder to eventually be able to determine *quantitative potency in the **future***.

Section 2: Construction

Each Fraction Finder system consists of a compute module housed in an ABS case with a 7" display with a pole mount clamp, an optical transducer for size 29 or 24 glass (depending on options ordered), Transducer cable and international power supply.

This unit is intended for laboratory use, and care should be taken not to spill anything on it, as it is not water proof.

Section 3: Unpacking and Inspecting

After the instrument is received, it should be carefully unpacked and inspected for damage during shipment and to confirm that all components are present. The Compute module and optical transducer unit warranty pertains only to the instrument, and does not cover losses in shipping.

Each Fraction Finder should come with:

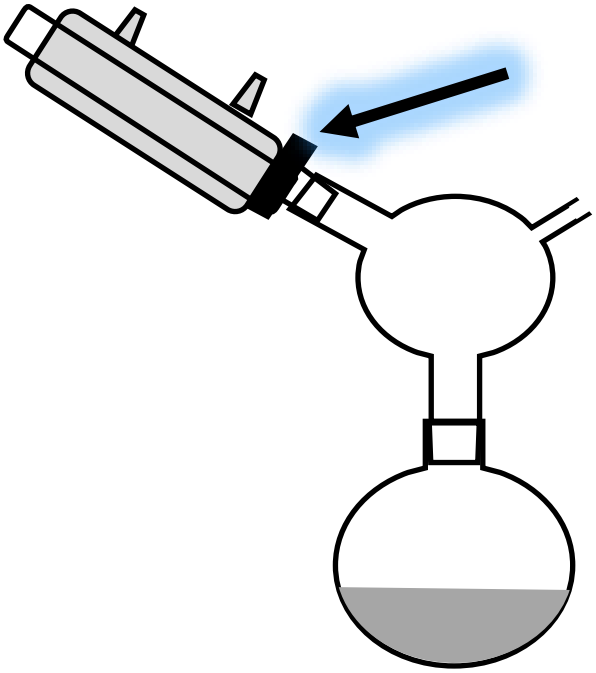
- Compute Module (black box with display) with pole mounting bracket
- 3' Sensor cable, USB
- International Power Supply
- Quick Start Guide

Section 4: Installation

The instrument should be in a clean, dry environment for best results. The unit can be pole mounted with the hardware provided. Alternatively, the Compute module can be placed on a desktop by placing the unit in separately procured tablet stand. Care should be taken to avoid any spillage

The optical transducer should be installed on the condenser just before the cow as shown, with the thicker part of the sensor down.

This optical transducer fits on most condensers, but in some cases may require a slight extension. Having the glass be of high quality will help increase the signal to noise ratio – which will yield better information.



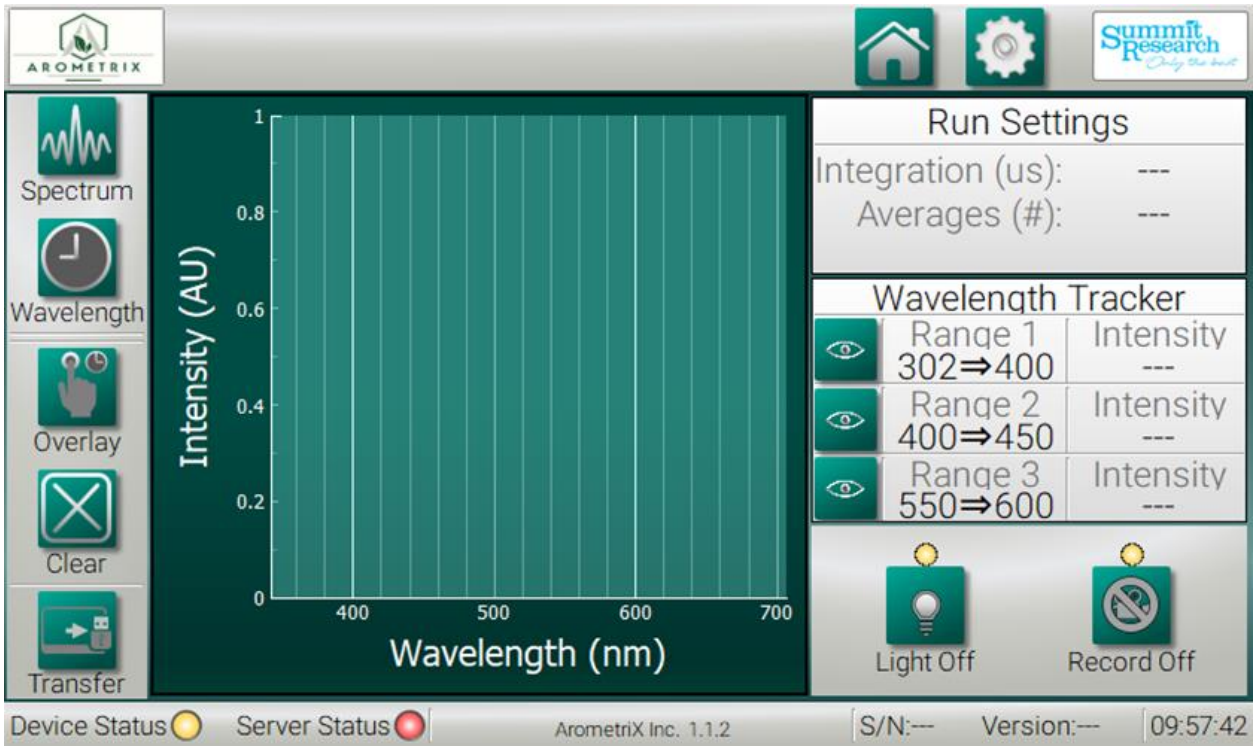
Please use the supplied AC adapter with your Instrument. This adapter provides clean short protected power to protect and insure accuracy of the internal circuitry.

Section 5: Operation

After installation, the Display Unit is ready for immediate operation. Note that the Fraction Finder give qualitative information. Our intensity measure of Arbitrary units (AU) is indicative of this qualitative information. The Fraction Finder is meant to be an additional reference to existing methods for determining the current part of the distillation fraction. The system supports hot-swapping of the sensor

to the display unit, even so, it is advised to have the sensor plugged into the system when the system is powered on. **NEVER LOOK DIRECTLY INTO THE LIGHT SOURCE**

Layout of Software and Purpose of "Tabs"



Spectrum Tab (Top Left)

What it does: Displays current background subtract, uninterpreted measurement

How it should be used: It should be used for the following purposes:

1) Analyze current Exposure time and assist in "tuning" of exposure time parameter
2) Give a broad indication of whether the system is detecting heads or main body/tails
    a. This tab is difficult to evaluate and identify the transition between main body and tails

Wavelength Tab (Top Left under Spectrum)

What is does: Displays and tracks the interpreted values from your measurement

How it should be used: This plot reduces the raw data and shows you the "highlights" of the run. Due to this it has the following purpose:

1) Analyze noise in your measurement over time, and assist in “tuning” of scans to average
2) Used to identify when the distillation is transferring from heads to main body or main body to tails
    a. Due to the massive amount of data reduction, this plot is hard to analyze when trying to assess issues with individual measurements from the fraction finder

General Procedure to Operate the Fraction Finder

Overview:

1) Setting Up Distillation System
2) Tune Exposure Time and Scans to Average for Heads
3) Identify Transition from Heads to Main Body
4) Perform Flask Transfer & Let Distillation System Equilibrate
5) Tune Exposure Time and Scans to Average for Main Body and Tails
6) Identify Transition from Main Body to Tails
7) Perform Flask Transfer

Step 1) Setting Up Distillation System

1) Setup your short path system as you usually would initially
2) Install the Fraction Finder at the end of the condenser tube
3) Let system reach desired vacuum temperature and pressure
4) Initial setup for Fraction Finder
    a. Plug Fraction Finder in
    b. Give sensor ~2-5 minutes to boot
    c. Ensure that the Device Status and Server Status indicator light on the bottom left hand side of screen are green – If not contact customer support

Step 2) Tune Exposure Time and Scans to Average for Heads

The tuning of the sensor Integration time can be done in 2 different ways; either using the Auto-Integration Determination (AID) Algorithm or by tuning the integration time manually. It is recommended that all users use the AID algorithm as it will automatically determine an optimal integration time for the sensor throughout the entire distillation process.

1) Preliminary Operations
    a. Ensure that the light is on and the indicator light above the button is Green

i. If the light it not on, turn it on and wait for the indictor light above the button to turn green

b. With the light on, click the spectrum tab

c. On the spectrum tab, you should see one single peak at ~365 nm (x-axis)

i. If you see multiple peaks, this means that either:

1. You have bad light contamination from lighting in the workspace

a. Solution: turn off light in workspace or cover the sensor with a black cloth

2. If peak is at 400-450 nm (x-axis value) the column is probably not clean, and contains a contaminate from a previous distillation

a. Solution: either stop the distillation and clean inside of glassware or just make a note of it – it may be cleaned when the vaporized heads flow through the column

2) OPTION 1 – Recommended: Tuning Integration Time with AID

a. Set the scans to average to 1 (if it is not already set to 1)

b. Go to the set the Set Integration Menu

c. Click the check box next the AID (Auto), this will enable auto-integration determination

2) OPTION 2 – Not Recommended: Tuning Integration Time Manually

a. Tune the exposure time so that the maximum intensity value (y-axis) is between 500-800 AU

i. The exposure time is pseudo-linear to the intensity (i.e. if the exposure time is doubled, the intensity will approximately double; if the exposure time is halved, the intensity will also approximately be halved)

ii. The exposure time for the heads typically is very small – the exposure time probably will not be above 2 ms (2000 µs on exposure time setting panel), and may be lower than 0.1 ms (100 µs on exposure time setting panel)

iii. WARNING: The update time for the plot will increase with increased exposure time and decrease with decreased exposure time. Distillation is a slow process, so this will not be an issue

1. It is more important that you there is a good signal than to have a fast update speed, so tuning to higher exposure times (as long as the intensity does NOT go above 800 AU – y-axis value), will ensure that the fraction finder will work as intended

3) Tune Scans to average

a. Open the Wavelength tab

b. If the signal seems to be varying widely:

i. Increase scans to average setting

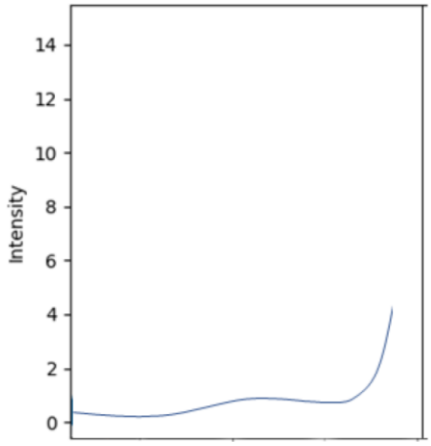
1. A typical value is 5 – It is strongly suggested that the scans to average is not set significantly smaller or larger than this value

ii. WARNING: The update time for the plot will increase with increased scans to average (good estimate is 2 * exposure time * scans to average) and decrease with decreased scans to average. Distillation is a slow process, so this will not be an issue
    1. It is more important that the signal is less noisy than to have a fast update speed, so tune the scans to average to 5

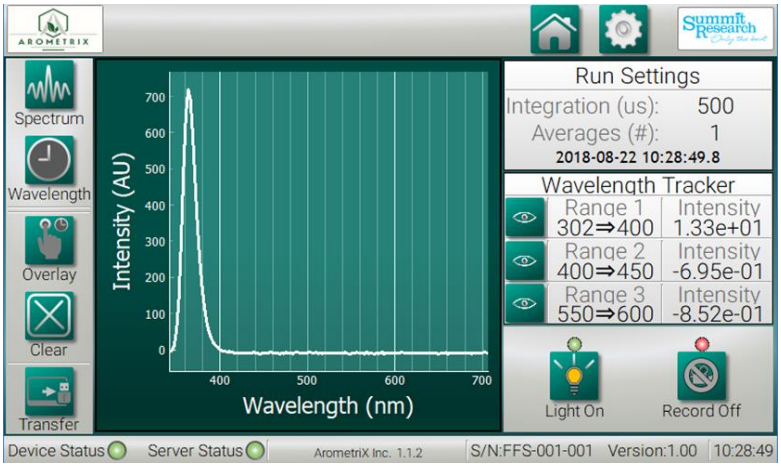
Step 3) Identify Transition from Heads to Main Body

There are two separate methods for identifying when the distillation is transferring to the main body.

1) The 1st indicator is that there is a sharp "uptick" in the value of the wavelength plot (example plot shown below)



2) The 2nd indictor is that a 2nd peak show up in the Spectra plot between 400-450 nm (example plot shown below, keep in mind peak location and intensity may vary)



a. A piece of advice: Use the Wavelength plot to see when to start checking the Spectrum plot. Use the Spectrum plot for an absolute indicator of the heads to main-body transition

3) Once you've entered main body, proceed as you typically would with a flask transfer, there is no need to turn off or clear the fraction finder, unless you want to
    a. It is advised that the heads be allowed to distill for ~10 minutes before performing a flask to ensure that no solvents contaminate the main body

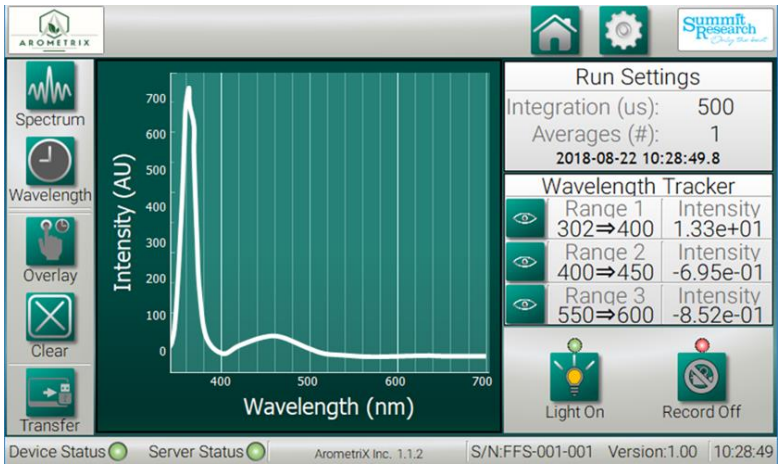
Step 4) Perform Flask Transfer & Let Distillation System Equilibrate

1) Perform flask transfer
2) After flask transfer, let the system come to its equilibrated point (let pressure and temperature become relatively constant) before using the Fraction Finder

Step 5) Tune Exposure Time and Scans to Average for Main Body

If you are using the AID algorithm Step 5.1 and all further adjustment to the integration time can be skipped, the AID algorithm will do all the adjustment autonomously.

1) Go back to the Spectrum tab
    a. If a 2nd peak is appearing up between 400-450 nm (x-axis value), main body is being distilled (example picture below is just for illustration purposes, secondary peak position and intensity can vary widely):



    b. If the maximum signal value is lower than 500 AU or above 850 AU
        i. Turn the light off
        ii. Wait for a new scan of the background light in the room
        iii. If the maximum value of this spectra is above 700 AU:

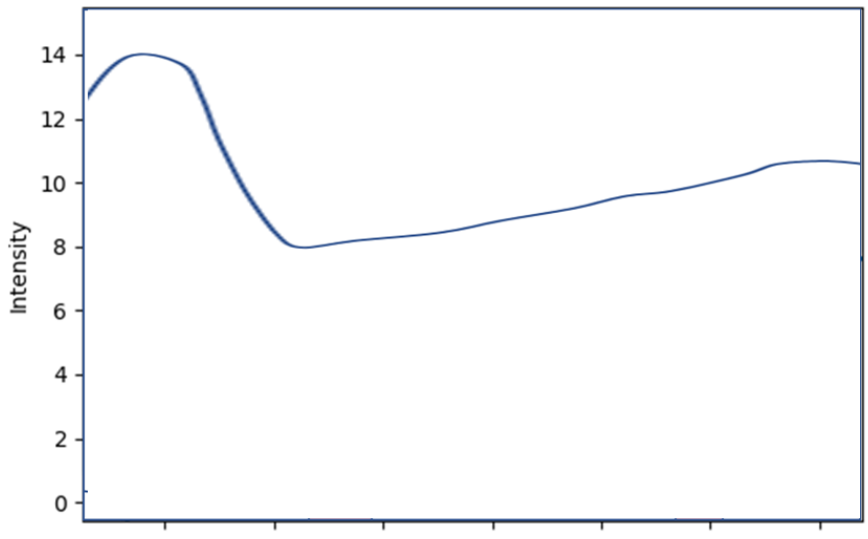
1. Adjust the exposure time so that this value is less than 700 au by decreasing it
2. The exposure time is pseudo-linear to the intensity

iv. Turn the light on

2) For the next ~20 minutes the exposure time will need to be adjusted as the signal changes, by following the steps outlined in 5.1.b.
    a. Factors that increase how often it will need to be adjusted are:
        i. The darkness of the distillate (darker increase frequency of exposure time adjustment)
        ii. Turbulent flow rate (increases the of frequency exposure time adjustment up to a point, then will not have an effect)
            1. This is more of an issue for tails than main body
        iii. Background light (More ambient/background light will increase frequency of adjustment)
            1. NOTE: Higher ambient/background light will also reduce the overall signal

Step 6) Identify Transition from Main Body to Tails

1) After 20 minutes, the signal will likely stabilize
2) Check the wavelength tracking tab
3) A sharp increase of the signal at the beginning will likely be shown followed by a sharp drop-off of the signal to a stable moderate level
    a. This initial increase is very concreted main body initially coming through the system as well as any oxidized/degraded fluid that may been generated during the vacuum release while performing a flask transfer
4) This signal will likely stay constant for the next 1 – 1.5 hours, then will slowly start to fall (an example plot is shown below)



   a. NOTE: Intensity and trends may vary, the only important thing is the signal starts decreasing
5) The exposure time will need to be adjusted slightly
   a. This adjustment should follow the steps outlined in 5.1.b
6) The constant loss or significant loss of signal at this point indicates that the distillation may be entering tails, but the signal also will vary slightly with:
   a. Significant changes in vacuum pressure - can lower this signal
   b. Significant changes in flow rate - can lower this signal
   c. Background light gets brighter
7) If a drop is observed that does not seem to track with the three outlined changes above, the distillation has likely entering tails

Step 7) Perform Flask Transfer

1) Once the tails are identified, perform a flask transfer as per usual
2) If the fraction finder used during tails, follow the same procedure for main body, starting with step 5
   a. Keep in mind that the signal will be very low and all ambient lighting effects will greatly increase

WARNINGs AND GOTCHAs

1) If the signal is abnormally low signal, a few things should be checked:
   a. Ensure that the alignment of the Fraction Finder sensor is correct. This can be done by trying to align the screw in the light shield and the top of the light shield with the cooling water port of the condenser, if they are aligned, the alignment is good
   b. Ensure that the integration time is set high enough following the procedure outlined in step 5
2) If the signal looks sporadic and very abnormal, a few things should be checked:
   a. If it is right after a flask transfer, wait a few minutes – this is normal behavior
   b. If the vacuum pressure is still changing quickly, wait for the pressure to become more constant
   c. If the boiling flask is still heating by more than 30 deg. C from the current thermocouple reading, wait for the boiling flask temperature to become more constant
   d. The issue could be attributed to background light
      i. Either cover the sensor with a thick black cloth or turn off the overhead lights in the room

   e. Ensure that the integration time is set high enough following the procedure outlined in step 5
   f. Increase the scans to average
      i. This should not be set significantly higher than 5
   g. If none of the above are the problem – ensure that liquid is still flowing
   h. If none of the above seem to be the origin of the problem, please take a photo of both your spectrum plot and your wavelength plot and contact customer service
3) If the system is not detecting the sensor (bottom left light on panel is red or yellow)
   a. If the system was turned on, give the system up to 5 minutes, it may detect
   b. Ensure that all cables are connected securely – especially the cable connecting the display unit to the sensor
      i. It may be easier just to disconnect and reconnect the cables from the display unit and the sensor unit
   c. Contact customer service if above problems persist
4) Warnings about safe operating conditions for the Fraction Finder:
   a. Currently the fraction finder is specified to work up to slightly above 80 deg. C, please do not raise your condenser fluid temperature above this
   b. The fraction finder housing (both the sensor and the display unit) are sensitive to distillate and extract, to increase sensor lifetime and reduce likelihood of damage:
      i. Wipe down the outside of the glass that the fraction finder will clamp onto before installing the sensor with isopropanol or acetone.
         1. WARNING: ENSURE THAT GLASSWARE IS NOT HOT!!!
      ii. If an accidental spill occurs, try to wipe it off the sensor/display unit with a damp, not soaked, cloth/towel as quickly as possible. Dry off the area immediately afterwards

Other issues and suggestions:

1) We are constantly working to fix any issues with the system, and appreciate you reporting any abnormal behavior, we will not leave you hanging and will address any issue you have ASAP
2) If find anything in this manual confusing or unclear, please customer support, we are more than happy to assist you, and do our best to do so in a timely manner
3) If you want to see something new in the software please let us know and give your suggestion, we strive to make the fraction finder the tool that works for you!

Section 6: Firmware Update Instructions

At Arometrix, we strive to tailor-make all our products to our customers desired needs and wants. As we've advanced our algorithms, add features, fix bugs, etc., we thought it would be great if we could give Fraction Finder users more than what we sold. Now, if you own a Fraction Finder, you can download our latest, free Firmware update to your software in the field: Version 1.1.2.

This Firmware update will make Fraction Finder systems more cohesive and user-friendly. Read below for important instructions on how to go about this download.

Warning*: You should do these steps far in advance before using the Fraction Finder (~10 minutes)*

1) Find the .fff file by contacting **sales@arometrix.com** (will be posted soon to our website). Copy the Fraction Finder Firmware (.fff) file to a USB flash drive. (It is preferred the USB flash drive not have other data on it, but it truly doesn't matter if it does.)
2) Turn off the Fraction Finder.
3) Plug the flash drive into the USB port on the bottom of the Fraction Finder.
4) Turn the Fraction Finder on.
5) After the initial boot screen, you should see a Firmware updater screen appear on it. You will see text pop up saying things like authenticating, and extracting firmware.
    a. You will notice that it will relatively quickly hit 41%, then it won't update at all for about 10 minutes. This is normal and should not be considered bad.
    b. DO NOT UNPLUG THE FLASH DRIVE UNTIL STEP 6. This can cause your system to become corrupted and unrecoverable unless it is shipped to Arometrix.
6) After the firmware update, you should see the software boot up as normal.
7) Unplug the flash drive from the Fraction Finder.
8) Delete the .fff file from the flash drive. If you don't, and you plug it in, on boot up, it will try to update the firmware again, causing you to have to go through this entire procedure.

There is a new transfer function on the most recent updates that is the beginnings of getting your data off the system for you to review with a companion app. Currently, it will copy your data in a special format onto a plugged-in USB flash drive, but that file is not human-readable. We are currently working on making the companion app for the data review that will work in conjunction to the transfer function.

If you are willing and want to have input into data review companion app, we would appreciate if you would share your data with us via email (to **sales@arometrix.com**). This is completely optional. If you do decide to share any of your data with us, we will transfer your data into a human-readable format, which we will give back to you, and will perform analytics on it. This will also give you the opportunity to give us feedback about what you'd like to see displayed in the companion app. And, as always, we appreciate any feedback you give.

Section 7: Factory Repairs and Calibrations

The Fraction Finder assembly is designed to provide years of trouble-free service. No field servicing of the unit is recommended, but factory servicing and calibration are available at a nominal cost with a typical 24 hours turn-around time.

Section 8: Understanding Optical Measurement and Qualitative Data

The compute module displays optical information in AU (arbitrary intensity units) so named to highlight the fact that the unit is for reference, and to assess trends. It is not for quantitative analysis.

Quantitative vs. Qualitative

Quantitative measurement is a number that represents a characteristic in known, well understood units. For example, your speedometer reads a quantitative number – speed. You know how fast you are going based on that number. Qualitative measurement lacks the reference of a number. The Fraction Finder gives qualitative measurement – and is used to assess trends, not absolute potency.

Section 9: Attachments and Illustrations

Specifications

Specifications	
Power:	100-240VAC 50/60 Hz CE Rated (12 Volt 1 Amp into Compute Module)
Interface:	Size 29 or Size 24 Glass
Sensor cable length:	3 feet
Wifi Range:	100 feet line of site
Units:	AU – Arbitrary Intensity Units
Mount	Laboratory stand mount, pole up to ½”
Display	7 inch LCD TFT display
Optical detection range	300 – 1000 nanometers
Controls	7 amp, 250 Volt (If applicable)
Telemetry Options	WIFI, USB (future)

Ambient light can be a problem. If your readings are too noisy, you may want to cover the condenser and optical assembly with light absorbing, non reflective materials. Below is a list that could work well.

Ambient light can be a problem. The May 2018 design of the new optical sensor and use of silicon tape should solve the ambient light pollution issue completely. If you feel your readings are too noisy, you may want to cover the condenser and optical assembly with light absorbing, non reflective materials. Below is a list that could work well.

Ambient Light Reduction	
Good	**Bad**
Cardboard	Paper
Cotton	Polyester
Wool	Polyurethane

Section 10: Terms and Conditions

TERMS OF USE, LIMITED WARRANTY & LIABILITY WAIVER

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