



VO2 Master Analyzer Product Manual

By: VO2 Master Health Sensors Inc.

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VO2 Master does not assume liability for mistakes made in interpreting this documentation or for casual or consequential damages in connection with the provision, representation, or use of this documentation.



VO2 Master Health Sensors Inc.

+1 (833) 862-6787
info@vo2master.com
www.vo2master.com

2906 33 St,
Vernon, BC V1T 5S7,
Canada

1. Legal Information

Important Safety and Product Information

To set up and maintain your VO2 Master Analyzer, go to: www.vo2master.com/support

Your VO₂ Device comes with the “Getting Started” information booklet containing:

1. Quick Start Guide
2. Mobile App Guide
3. Important Safety and Product Information
4. Limited Warranty Information
5. Risk and Release of Liability

CAUTION: For your safety, always read and follow all operating and cleaning instructions carefully before using your VO₂ Device.

CAUTION: Consult your doctor before use if you have any pre-existing medical or health conditions that might be affected by your use of this VO₂ Device.

Warnings

1. Use this device only for its intended use as described in the Getting Started information booklet and the Manual. Failure to do so may result in serious injury.
2. Do not expose your VO₂ Device to extremely high (above 45 degrees Celsius) or low (below 15 degrees Celsius) temperatures.
3. Do not use your VO₂ Device in a sauna, steam room, or shower.
4. Use your VO₂ Device outdoors at your own risk.
5. Do not place in or submerge in water or other liquids.
6. Do not insert any object into, or otherwise block, any opening on the VO₂ Device. Keep all openings free of hair, dirt, or other debris.
7. Do not use your VO₂ Device if it has been dropped or damaged, submerged in water, or if you see any cracks on the mouthpiece. If such an event occurs, return the device to an authorized service centre for examination and repair.
8. Do not use abrasive cleaners to clean your VO₂ Device.
9. Remove your VO₂ Device if it feels warm or hot.
10. Substances in this product and its battery may harm the environment or cause injury if handled and disposed of improperly.
11. Do not use or operate the VO₂ Device while driving or in other situations where distractions could be hazardous. Always be aware of your surroundings when exercising.
12. This product is not a toy. Do not allow children or pets to play with your VO₂ Device. The product may contain small components that can be a choking hazard.
13. The VO₂ Device may pose risks to users with certain health conditions. Consult your doctor prior to use if you:
 - a. have a heart, respiratory, or other cardiovascular condition;
 - b. are taking any medication;
 - c. suffer from claustrophobia;
 - d. have epilepsy or are sensitive to blinking lights;
 - e. have reduced circulation or bruise easily; or
 - f. have neck, upper back, or other musculoskeletal disorders.
14. Consult your doctor before beginning or modifying any exercise program.
15. Risks of using the VO₂ Device may include, but are not limited to:
 - a. inhaled or contacted contaminants (particulates or microbes) causing trauma or illness;
 - b. irritation, abrasion, or ulceration caused by the friction of the facial mask;
 - c. biological effect on mucous, lungs, or skin;
 - d. excessive re-breathing of exhaled air from increased airway dead space or breathing resistance causing an imbalance of blood gases, strain, or atelectasis; and
 - e. flow diverted or leaked from or into the oxygen sensor gas circuit causing erroneous test results.
16. If you notice any skin irritation, difficulty breathing, or other health or medical irregularity while or after wearing your VO₂ Device, remove your VO₂ Device immediately, discontinue use, and consult your doctor.
17. **This product is not a medical device and is not intended to diagnose, treat, cure, or prevent any disease. Regarding accuracy, the VO₂ Device has leading hardware and algorithms to track volume of oxygen consumed by the body. We are constantly improving our products to calculate measurements as accurately as possible. The accuracy of VO₂ Devices is not intended to match medical devices but is intended to give you the best information available in a wearable VO₂ analyzer**

Regulatory Information

Federal Communications Commission (FCC) Statement [USA]



Contains FCC ID: 2AA9B05

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.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 1) Reorient or relocate the receiving antenna.
- 2) Increase the separation between the equipment and receiver.
- 3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- 4) Consult the dealer or an experienced radio/TV technician for help.

Caution: changes or modifications to the VO₂ Device could void the user's authority to operate the equipment.

Industry Canada Radio Standards Specifications (RSS)-310 Compliance Label:

VO2 Master Health Sensors Inc.
Model: VO2 Master Pro
Canada 310
Contains IC ID: 12208A-05

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Declaration of Conformity with Regard to Red 2014/53/EU

This device complies with RED 2014/53/EU.

For other regional-specific compliance information, please contact us by visiting:

www.vo2master.com/support



Patent No. 11284814 | PATENTS PENDING

Limited Warranty

To register your VO₂ Master Analyzer for support and warranty, visit: www.vo2master.com/warranty

Limited Product Warranty

VO2 Master Health Sensors Inc. (“VO2 Master”) warrants to the original purchaser that your VO2 electronic device (the “Product”) shall be free from defects in materials and workmanship under normal use for a period of one (1) year from the date of purchase, except that if you reside in the European Economic Area (EEA) and you purchased your VO2 Device in the EEA, the warranty period is two (2) years from the date of purchase. (the “Warranty Period”). VO2 Master does not warrant that the operation of the Product will be uninterrupted or error-free. VO2 Master is not responsible for damage arising from failure to follow cleaning or operating instructions relating to the Product’s use. This Limited Warranty does not cover software embedded in the Product and the services provided by VO2 Master to owners of the Product. Refer to the license agreement accompanying the software and the VO2 services terms of use for details of your rights with respect to their use. This Limited Warranty does not cover the replacement of consumable sensors like the oxygen sensor, which must be replaced approximately annually.

Remedies

If a hardware defect arises and a valid claim is received by VO2 Master within the Warranty Period, VO2 Master will, at its option and to the extent permitted by law, either: (1) repair the Product at no charge, using new or refurbished replacement parts; or (2) replace the Product with a new or refurbished Product. In the event of a defect, to the extent permitted by law, these are your sole and exclusive remedies. Shipping and handling charges may apply except where prohibited by applicable law. This Limited Warranty is valid only in the jurisdictions where the Products are sold by VO2 itself or through its authorized reseller or agent, and is valid to the extent permitted by applicable laws of such jurisdictions. Any replacement hardware product will be warranted for the remainder of the original Warranty Period or thirty (30) days, whichever is longer, or for any additional period of time that may be applicable in your jurisdiction.

How To Obtain Warranty Service

To obtain warranty service, you must deliver the Product, in either its original packaging or packaging providing an equal degree of protection, to the address specified by VO2 Master. In accordance with applicable law, VO2 Master may require that you furnish proof of purchase details and/or comply with registration requirements before receiving warranty service. It is your responsibility to backup any data, software, or other materials you may have stored or preserved on the Product. It is likely that such data, software, or other materials will be lost or reformatted during service, and VO2 Master will not be responsible for any such damage or loss. For specific instructions on how to obtain warranty service on your Product, contact us by visiting: vo2master.com/contact.

Exclusions and Limitations

This Limited Warranty applies only to the Product manufactured by or for VO2 Master that can be identified by the “VO2 Master” trade name, or logo affixed to it. The Limited Warranty does not apply to any: (a) VO2 products and services other than the Product; (b) non-VO2 Master hardware products; (c) consumables (such as batteries); or (d) software, even if packaged or sold with the Product or embedded in the Product. This warranty does not apply to a Product or part of the Product that has been altered or modified (e.g. to alter functionality or capability) by anyone who is not a representative of VO2 Master. In addition, this Limited Warranty does not apply: (a) to damage caused by use with non-VO2 Master products; (b) to damage caused by accident, abuse, misuse, flood, fire, earthquake, or other external causes; (c) to damage caused by operating the Product outside the permitted or intended uses described by VO2 Master; or (d) to damage caused by service (including upgrades and expansions) performed by anyone who is not a representative of VO2 Master. Recovery and reinstallation of software programs and user data are not covered under this Limited Warranty. No VO2 reseller, agent, or employee is authorized to make any modification, extension, or addition to this Limited Warranty. If any term is held to be illegal or unenforceable, the legality or enforceability of the remaining terms shall not be affected or impaired.

Implied Warranties

EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, ALL IMPLIED WARRANTIES (INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) SHALL BE LIMITED IN DURATION TO THE DURATION OF THIS LIMITED WARRANTY. Some jurisdictions do not allow limitations on the duration of an implied warranty, so the above limitation may not apply to you.

Limitation of Damages

EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, VO2 MASTER HEALTH SENSORS INC. SHALL NOT BE LIABLE FOR ANY INCIDENTAL, INDIRECT, SPECIAL, OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, REVENUE, OR DATA, RESULTING FROM ANY BREACH OF EXPRESS OR IMPLIED WARRANTY OR CONDITION, OR UNDER ANY OTHER LEGAL THEORY, EVEN IF VO2 MASTER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Some jurisdictions do not allow the exclusion or limitation of special, indirect, incidental, or consequential damages, so the above limitation or exclusion may not apply to you.

Governing Law

This Limited Warranty shall be governed by the laws of the Province of British-Columbia, Canada, without giving effect to any conflict of laws principles that may provide the application of the law of another jurisdiction.

National Statutory Rights

Consumers in some jurisdictions may have legal rights under applicable national or local legislation governing the sale of consumer goods, including without limitation, national laws implementing EC Directive 99/44. These rights are not affected by the warranties in this Limited Warranty.

ASSUMPTION OF RISKS AND RELEASE OF LIABILITY

BY USING THE VO2 MASTER ANALYZER OR BY ACCESSING THE SITE OR SERVICES YOU WILL GIVE UP CERTAIN LEGAL RIGHTS, INCLUDING THE RIGHT TO SUE.

THE VO2 MASTER ANALYZER IS NOT A MEDICAL DEVICE AND THE INFORMATION AND DATA COLLECTED FROM YOUR USE OF THE VO2 MASTER ANALYZER, AND USE OF THE SITE OR SERVICES, ARE NOT TO BE USED FOR MEDICAL DIAGNOSIS, TREATMENT OR ADVICE.

ASSUMPTION OF RISKS

YOU ACKNOWLEDGE AND AGREE THAT PARTICIPATION IN PHYSICAL ACTIVITIES, AND THE USE OF THE VO2 MASTER ANALYZER DURING PHYSICAL ACTIVITIES, CARRY INHERENT RISKS WHICH MAY INCLUDE, BUT ARE NOT LIMITED TO, HEART ATTACKS AND THE RISK OF CATASTROPHIC INJURIES, INCLUDING PARALYSIS AND DEATH.

YOU SHOULD CONSULT WITH A PHYSICIAN BEFORE USING THE VO2 MASTER ANALYZER TO ENSURE IT IS APPROPRIATE FOR YOU. IF YOU SUFFER FROM DIABETES, CLINICAL OBESITY, CHRONIC OBSTRUCTIVE PULMONARY DISEASE OR ANY PRE-EXISTING RESPIRATORY OR CARDIOVASCULAR CONDITIONS, YOU SHOULD ONLY USE THE VO2 MASTER ANALYZER WITH YOUR PHYSICIAN'S EXPRESS APPROVAL AND UNDER YOUR PHYSICIAN'S DIRECT SUPERVISION.

BY USING THE VO2 MASTER ANALYZER, YOU ACKNOWLEDGE AND VOLUNTARILY ACCEPT ALL RISKS, DANGERS AND HAZARDS, INCLUDING INJURY OR DEATH, THAT MAY RESULT FROM YOUR USE OF THE VO2 MASTER ANALYZER.

RELEASE OF LIABILITY

BY USING THE VO2 MASTER ANALYZER, YOU UNCONDITIONALLY AND IRREVOCABLY WAIVE, RELEASE, AGREE NOT TO SUE, AND FOREVER DISCHARGE VO2 MASTER HEALTH SENSORS INC. AND ITS DIRECTORS, OFFICERS, EMPLOYEES, CONTRACTORS, AGENTS, PROFESSIONAL ADVISORS, REPRESENTATIVES, SUCCESSORS AND ASSIGNS (COLLECTIVELY, THE "RELEASEES") FROM ANY AND ALL CLAIMS, LIABILITY, OR RIGHTS OF ACTION YOU MAY HAVE THAT ARE RELATED TO, ARISE OUT OF, OR ARE IN ANY WAY CONNECTED WITH YOUR USE OF THE VO2 MASTER ANALYZER, INCLUDING FOR BODILY INJURY AND DEATH, AND INCLUDING IN THE EVENT OF ANY NEGLIGENT ACTS OR OMISSIONS OF ANY OF THE RELEASEES. YOU FURTHER ACKNOWLEDGE AND AGREE THAT THIS RELEASE IS BINDING ON YOUR HEIRS AND SUCCESSORS.

YOU ACKNOWLEDGE AND AGREE THAT THE FOREGOING ASSUMPTION OF RISKS AND RELEASE ARE INTENDED TO BE AS BROAD AND INCLUSIVE AS IS PERMITTED BY LAW AND THAT IF ANY PORTION THEREOF IS HELD INVALID, THE BALANCE SHALL NOTWITHSTANDING THAT INVALIDITY CONTINUE IN FULL LEGAL FORCE AND EFFECT.

HOLD HARMLESS

YOU ACKNOWLEDGE AND AGREE TO INDEMNIFY AND HOLD THE RELEASEES HARMLESS FROM ANY AND ALL CLAIMS, LIABILITY, RIGHTS OF ACTION, DAMAGES, LOSSES, FINES, PENALTIES AND COSTS (INCLUDING LEGAL FEES AND EXPENSES ON A FULL INDEMNITY BASIS) BROUGHT AGAINST, SUFFERED OR INCURRED BY ANY OF THE RELEASEES AS A RESULT OF YOUR USE OF THE VO2 MASTER ANALYZER.

Intended Uses

The VO₂ Master Analyzer is a portable VO₂ analyzer that collects respiratory data through a mask to determine the amount of oxygen consumed by the body in different scenarios. This information is used to gain interesting and applicable knowledge about cardiac, respiratory, and muscular systems.

The normative values of heart rate, VO₂ Max, and Body Mass Index (BMI) are based on mature population and should not be applied to developing individuals.

Contraindications

The VO₂ Master analyzer may pose risks to users with certain health conditions. Consult your doctor prior to use if you:

- Have a heart, respiratory, or other cardiovascular condition;
- Are taking any medication;
- Suffer from claustrophobia;
- Have epilepsy or are sensitive to blinking lights;
- Have reduced circulation or bruise easily; or
- Have neck, upper back, or other musculoskeletal disorders.

You may wish to have your client answer “yes” or “no” to the following questions before beginning a CPET test:

1. Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?
2. Do you feel pain in your chest when you perform physical activity?
3. In the past month, have you had chest pain when you were not performing any physical activity?
4. Do you lose your balance because of dizziness, or do you ever lose consciousness?
5. Do you have a bone or joint problem that could be made worse by a change in physical activity?
6. Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?
7. Do you know of any other reason why you should not engage in physical activity?

If your client has answered ‘no’ to all the above questions and you are confident that there are no other concerns, then you may choose to proceed. If your client has answered ‘yes’ to any of the questions above or are unsure, refer to a medical doctor or allied health professional before commencing physical activity.

2. Package Contents

Included with the VO2 Master Analyzer

Hard Shell Case



The hard-shell case ensures your unit stays safe no matter where life takes you.

The VO2 Master Analyzer



The VO2 Master Analyzer is the main component containing the electronics and sensors. Installed from the factory is the Medium User Piece and a filter

Package Components



The case will contain the following items:

- VO2 Master Analyzer
- Resting, medium, and large user pieces
- Calibration Syringe Adapter
- Calibration Syringe Adapter Silicone Seal
- Getting Started Booklet
- 50 single use filters
- Replacement desiccant cartridge
- Hans Rudolph mask
- Cleaning supplies
- Heart rate strap

On the VO2 Master Analyzer you will find:

Battery Door



Power Button



Indicator Light



User Piece Interface



User Pieces

Large



- Ventilation display range **25-250 L/min**
- Ventilation accurate range **40-220 L/min**
- Used on high-performance athletes
- Indicated by the emboss "L"

Medium



- Ventilation display range **15-180 L/min**
- Ventilation accurate range **30-160 L/min**
- Used on the majority of athletes
- Indicated by the emboss "M"

Resting



- Ventilation display range **3-50 L/min**
- Ventilation accurate range **5-40 L/min**
- Test Resting Metabolic Rate (RMR)
- Measure caloric expenditures at rest
- Indicated by the emboss "R"

Locking Nut



- Secures the user piece to the mask

Hans Rudolf Face Mask



- Provides a comfortable air-tight interface between the VO2 Master Analyzer and the user's face
- Five-point harness resists the vibration often caused by rigorous exercise

Polar H10 Heart Rate Strap



- Measure heart rate during testing
- Necessary for complete reporting

Batteries



- If shipped within North America, each VO2 Master Analyzer comes with five AAA batteries

Single-Use Filter Pack



- Acts as a sanitary barrier
- Protects the sensors from moisture

Information package



- Getting Started booklet Containing:
 - Quick Start Guide
 - Mobile App Guide
 - Important Safety and Product Information
 - Limited Warranty Information
 - Risks and Release of Liability
 - Mask sizing gauge

Cleaning Kit



- Basics for cleaning around the sensor sampling ports behind the filter

Proper Storage



- Keep your analyzer and its accessories safe by storing them in the carrying case when not in use.
- Ensure everything is clean and dry before storing in the case.
- Keep fresh desiccant packs in the hard-shell case to avoid long-term humidity build up during storage.
- Store in a cool, dry place. Avoid storing any of the components in direct sunlight. Avoid storing in areas of increased humidity. Long term, store the device within 15-40°C.
- If safe to do so, after a test, leave the case open for air movement to help reduce condensation and humidity.
- Avoid storing with a battery installed.
- If a silica packet ruptures or silica dust leaks from the packet, properly clean and remove all silica dust before use.

3. Getting Started

Assemble Hardware

- 1) Allow all hardware to sit in the testing environment for 30 minutes prior to assembly.
- 2) Remove installed user piece. Remove battery door.

- 3) Install AAA battery. Replace battery door. The battery door is not secure until you install the user piece.



- 4) Ensure you have a clean filter. Place filter into VO2 Master Analyzer.



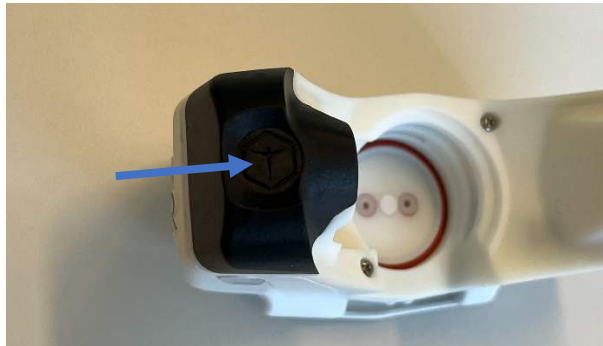
- 5) Determine which user piece you need. See chart in section “How to Perform a Test.”
- 6) Insert user piece.



- 7) Turn clockwise until the brim is flush with the analyzer and the breathing vent is shown centered in the analyzer breathing port.



8) Turn on the unit by pressing in the black embossed on/off button for two seconds.



9) **Keep the VO2 Master Analyzer motionless** for at least 10 seconds until the dark blue light turns white. White pulsing light indicates the VO2 Master Analyzer is powered on and ready to be flow and gas calibrated.



Light Color	Meaning
Dark Blue (On start up)	Pressure sensor initialization
White	Analyzer ready to use, No breathing
Dark Blue	Exhaling
Green	Inhaling
Red	Analyzer Powering off
Purple	Syringe calibration Idle
Orange	Syringe calibration breathing

Setting Up the App

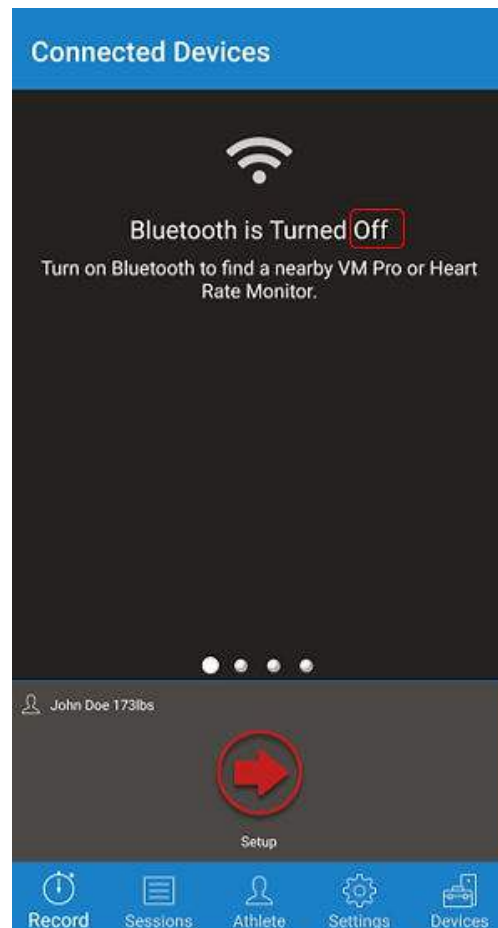
- 1) On your mobile device, download the *VO2 Master Manager* app.



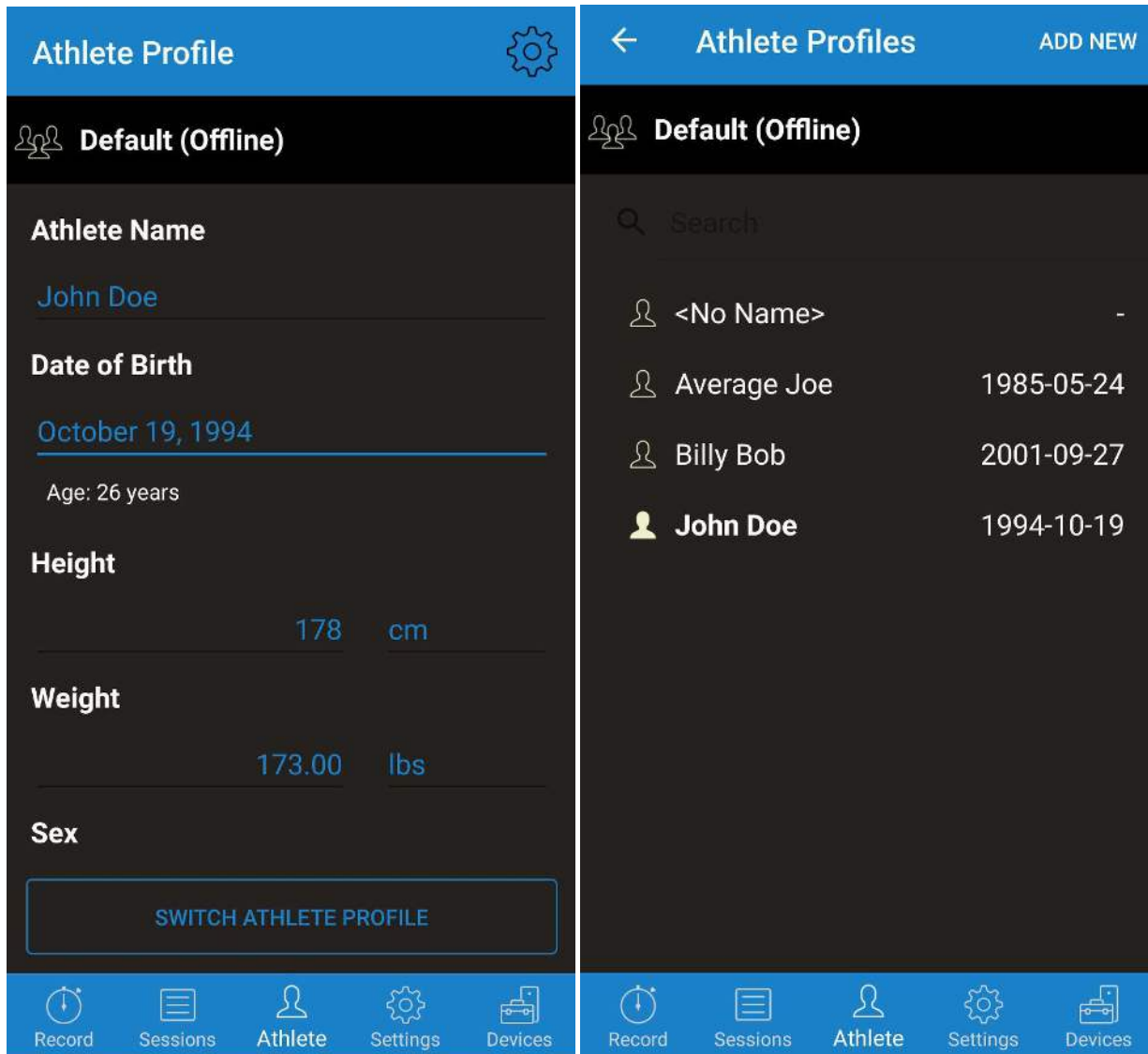
- 2) Open app.



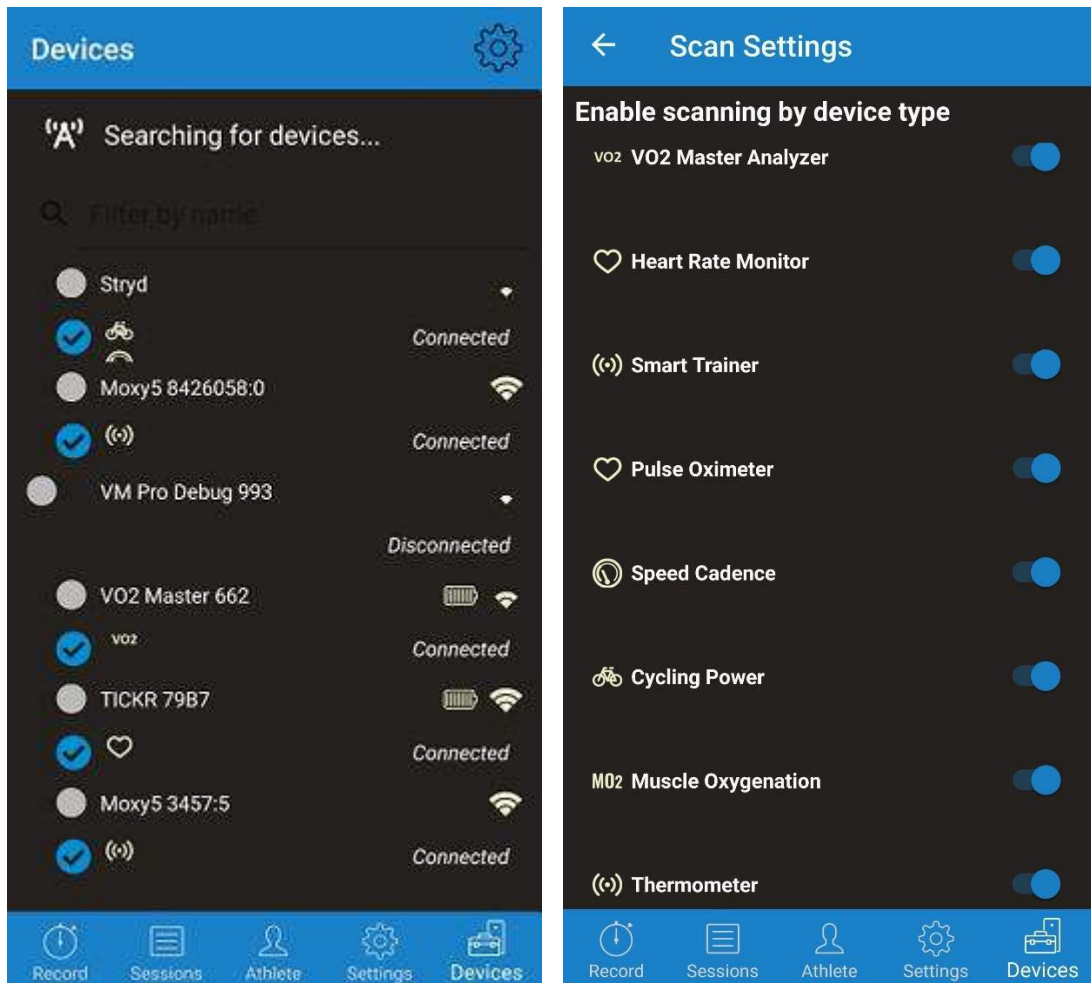
You may see a request for the app to use Bluetooth. Tap "OK". The record screen will show you if your Bluetooth is turned off or on.



- 3) Tap the “Athlete” tab at the bottom of the screen to enter the user’s information. For accurate reporting, it is crucial that this information is correct. This profile is be saved in the app for repeat testing.



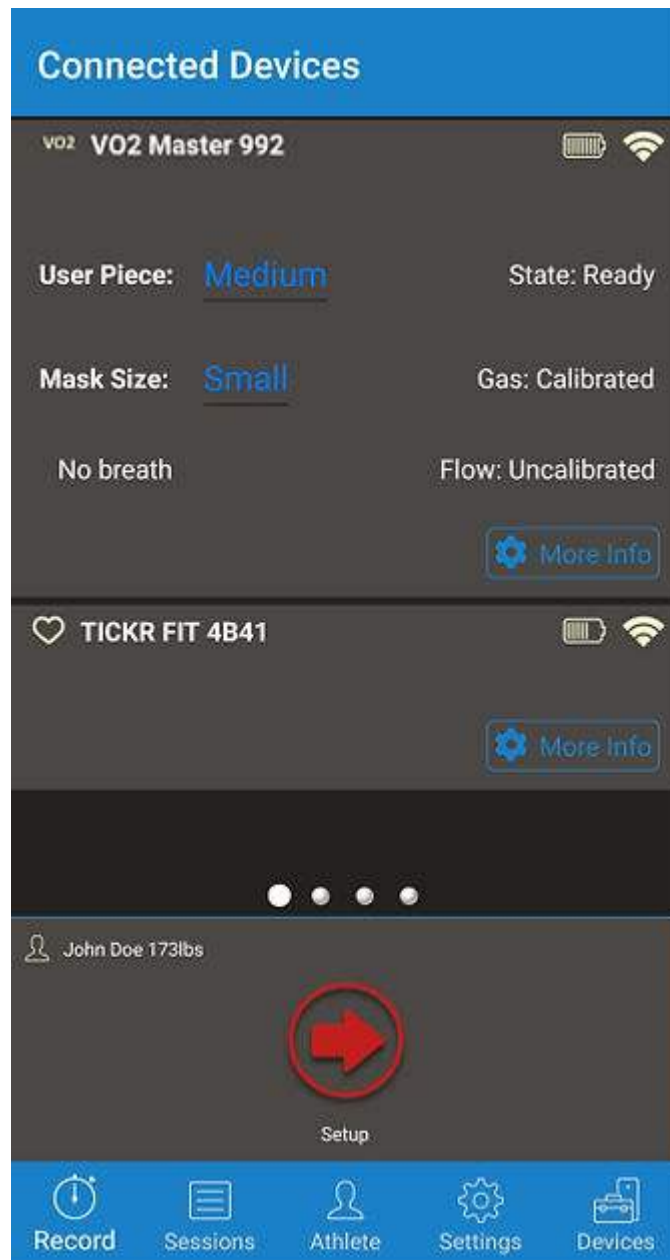
- 4) Tap the “Devices” tab at the bottom of the screen to see the devices you wish to connect to the VO2 Master Manager. After a few seconds, a list of available Bluetooth devices will appear. Tap on the devices you wish to connect to the app. The app remembers devices that it previously connected to and will connect to them automatically for future tests. If you cannot find your device on the list, ensure the device is turned on and not connected to another mobile device. Additionally, tap on the gear icon in the top right corner to bring up the advanced connection details. This feature allows the users to customise the devices they are looking for. The VO2 Master Analyzer will show up as “VO2 Master #” when searching for devices.



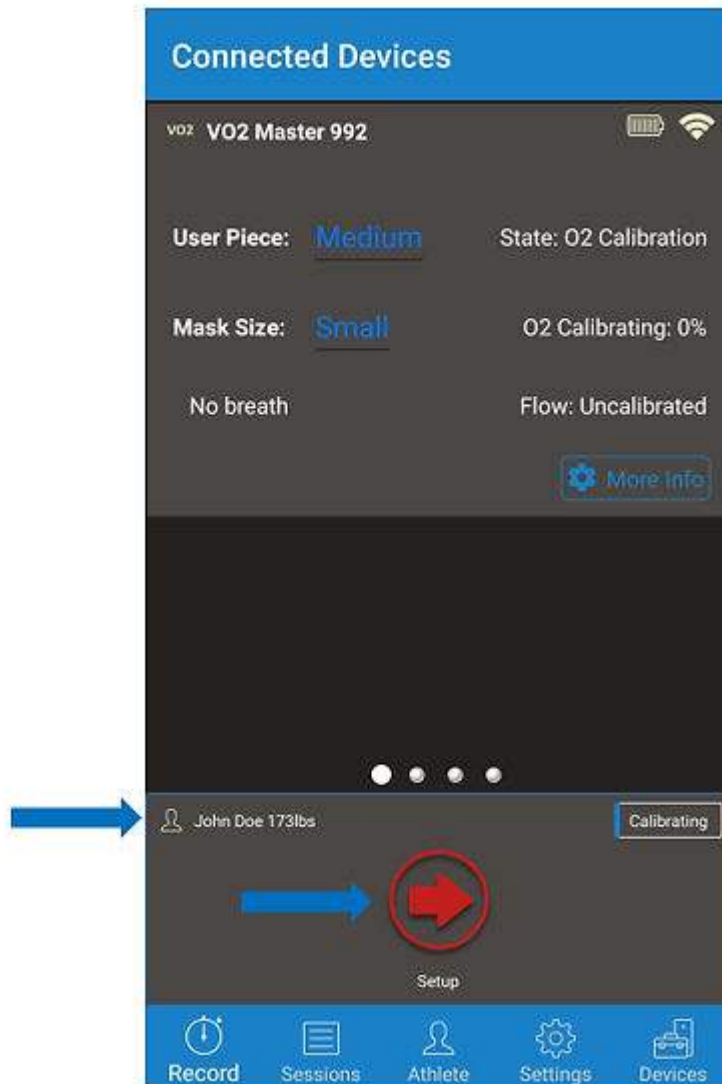
Preparing the Analyzer for a Test

Note: See section “Mobile Application Details” for an in-depth description of each app view.

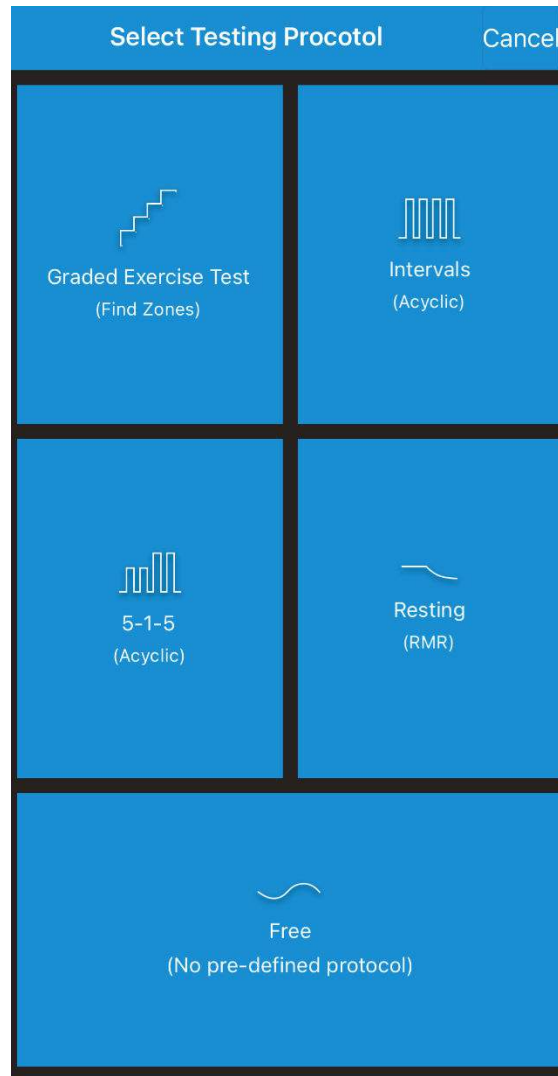
- 1) Once the hardware is installed in the unit (Battery, Battery door, Filter, and User Piece), and the app is set up, tap on the bottom tab “Athlete” to ensure the correct athlete profile is selected.
- 2) Navigate back to the “Record” tab. Ensure you can see all your sensors in the Connected Devices view. Below shows an example of the VO2 Master Analyzer and Wahoo Heart Rate monitor connected.



3) Tap the red “Setup” button to begin the test setup.



- 4) Tap on the desired protocol. For more information on selecting a protocol, see section “Protocols.” In this example we will tap “Graded Exercise Test.”



Check out the Testing Protocols section for more information.

- 5) Enter your desired Warm-Up, Test, and Cool-Down parameters. If using “Speed” as your performance measure, it will default to kilometers per hour. To change the speed units, navigate back to the “Record” screen then tap the “Settings” tab. Under the “Speed Units” header, tap on the currently selected units (“Miles per Hour” or “Kilometer per Hour”) and select the desired one you wish to see in the record screen and the app report. Tap “Next” once the protocol has been set up.

The screenshot shows a mobile application interface for configuring a "Graded Exercise Test". At the top, there is a navigation bar with a back arrow, the title "Graded Exercise Test", and a "Cancel" button. Below this, the "Performance Measure" is set to "Speed". The interface is organized into four main sections, each with a blue header:

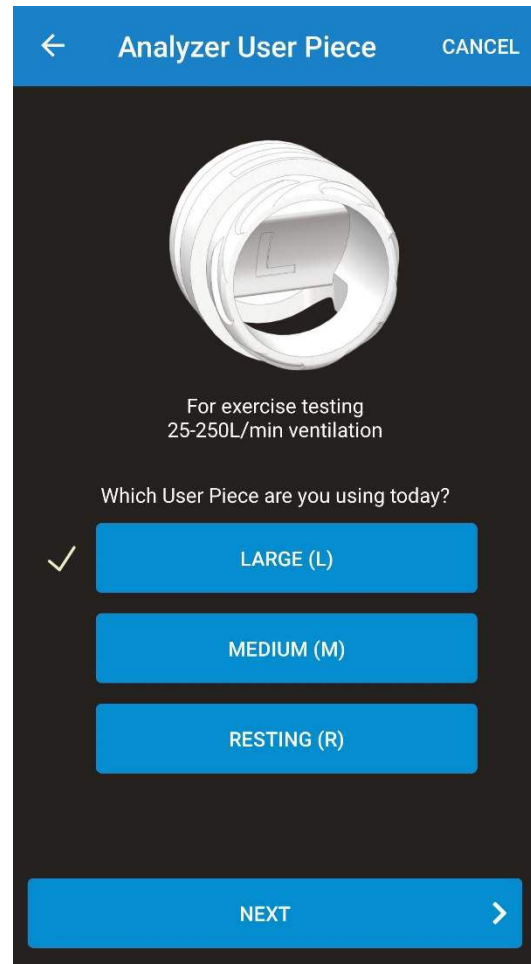
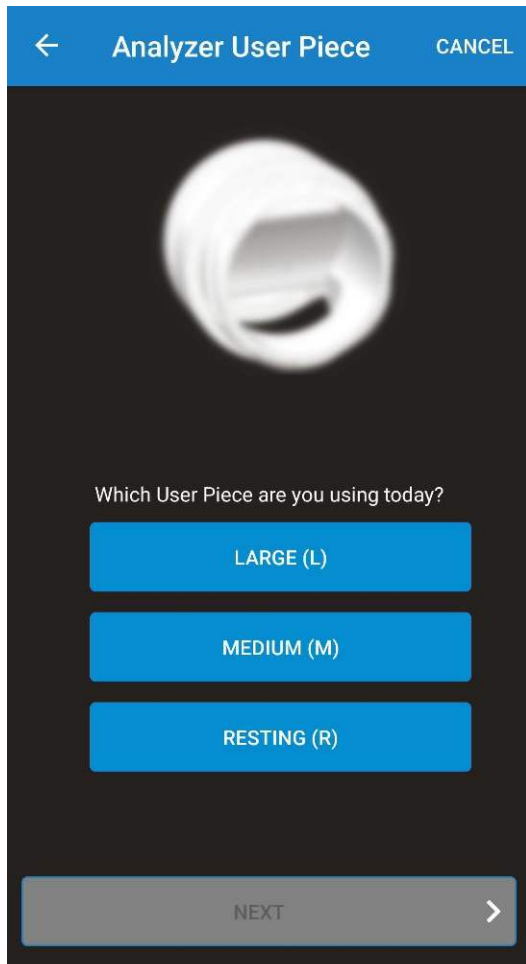
- Warm-Up:** Intensity (mph) is set to 10.4, and Duration is 5 min.
- Test:** Starting Intensity (mph) is 11.7, Step Size (mph) is 1.3, and Step Duration is 2 min.
- Cool-Down:** Intensity (mph) is 16.7, and Duration is 5 min.

At the bottom of the screen, there is a large blue button labeled "Next >".

6) Tap on the user piece size you installed into your unit. Tap “Next”

User Piece Size	Ventilation Range [L/min] (Display Range)	Ventilation Range [L/min] (Accurate Range)
Resting (RMR)	3 -50	5-40
Medium (M)	15 - 180	30-160
Large (L)	25 - 250	40-220

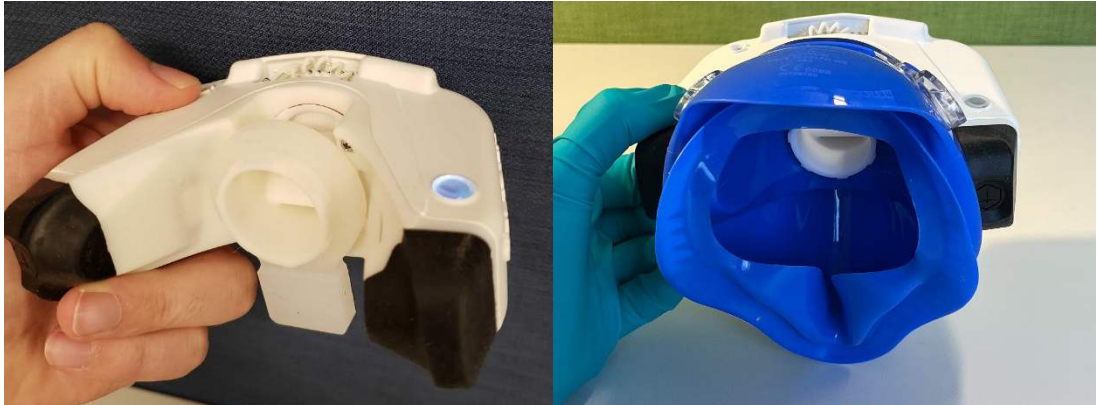
It is crucially important that the app user piece selection matches the hardware installed in your VO2 Master Analyzer. If there is a discrepancy, the data produced will be erroneous. See the Technical Specifications section for more information.



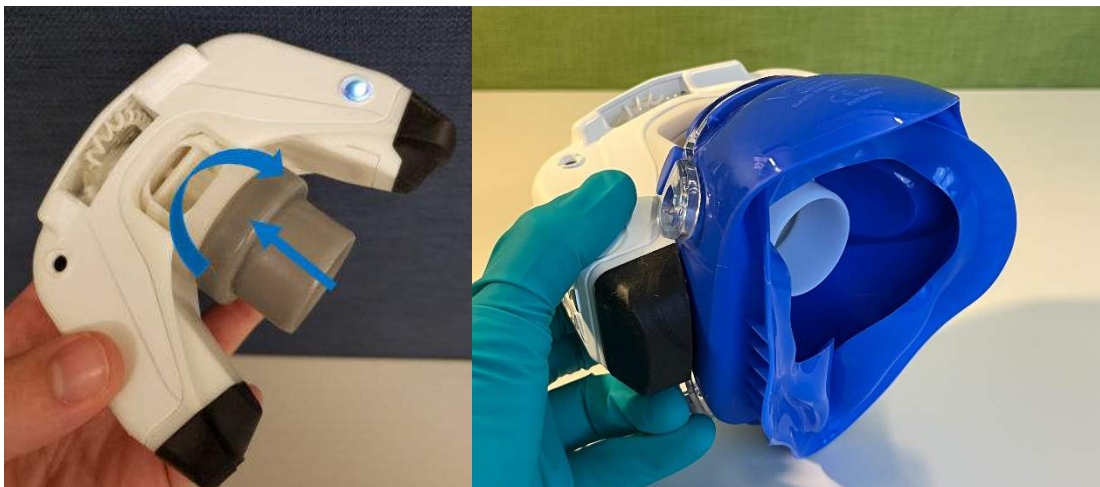
7) Performing Flow and Gas Calibration of the VO2 Master Analyzer on Syringe

Set up the analyzer following the steps below:

- a. Slide the “Calibration Syringe Adapter Silicone Seal” onto the user piece with the square end facing towards the top of the device. Alternatively, the mask may be used instead of the “Syringe Adaptor Silicone Seal”.



- b. Install the “Calibration Syringe Adapter” by aligning the grooves and pressing it inwards and twisting it clockwise.



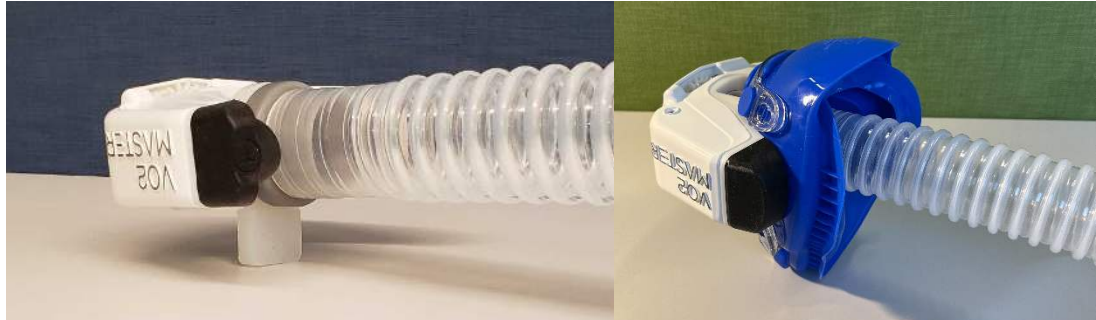
- c. Place the “Calibration Syringe Flexible Tubing” onto the 3L Calibration Syringe by gripping it close to the end. **To prevent tearing of the tubing always handle it by the ends and not the center of the tubing, especially when removing it from the syringe.**



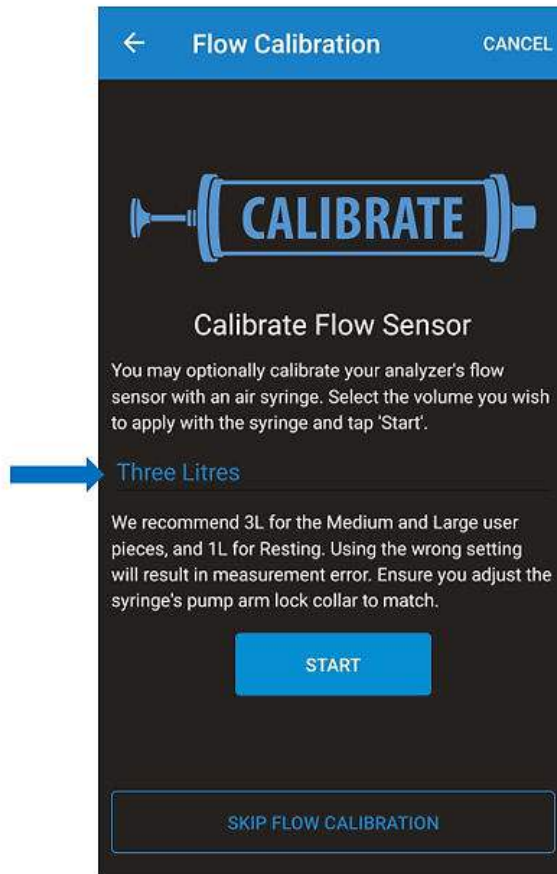
- d. Slide the “Calibration Syringe Adapter” into the “Calibration Syringe Flexible Tubing”. Make sure you have enough space to fully operate the syringe.



- e. The VO2 Master Analyzer should rest on the “Calibration Syringe Adapter Silicone Seal” or mask as shown. The analyzer should be upside down with the user piece opening facing upwards.



- f. The app will ask for the syringe volume being used to calibrate the flow sensor. For the **Medium** and **Large** user pieces **3L** volume is recommended. For the **Resting** user piece **1L** volume is recommended. **Skipping flow calibration is not recommended!** Tap the start button once steps a-e have been completed and the light color is now white. If the light is dark blue let the analyzer sit until the color changes. Once the start button has been tapped the light will switch to purple.

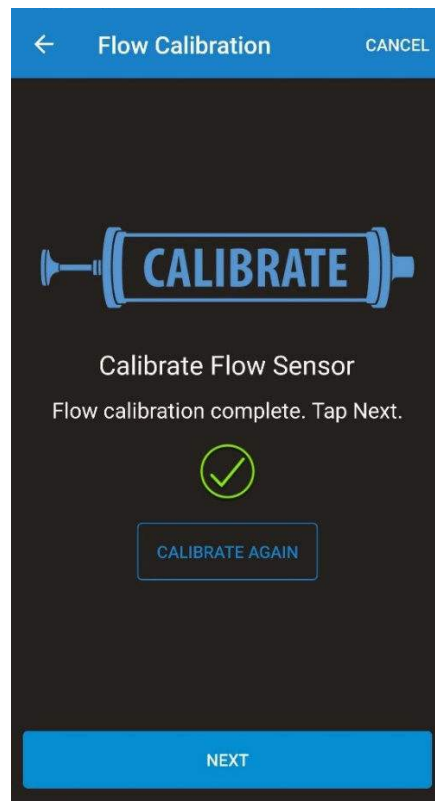
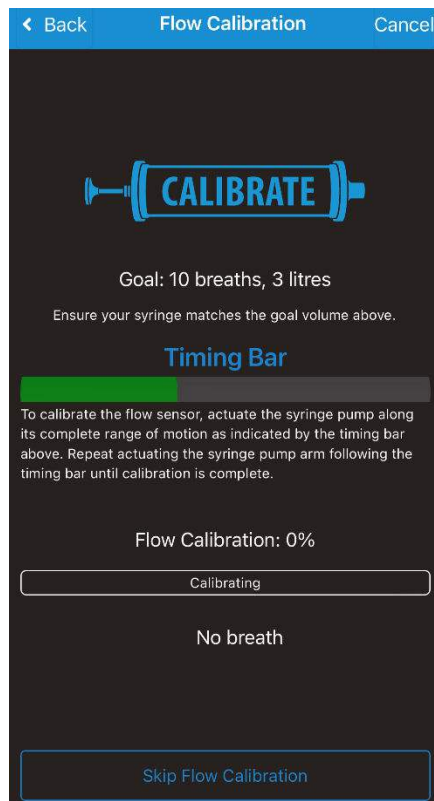


To change the locking collar position, use the hex screwdriver that comes with the syringe and loosen the lock collar screw. Slide the lock collar to the end stop for the 3L set point and just over the 1L marking for the 1L setpoint and tighten the screw.

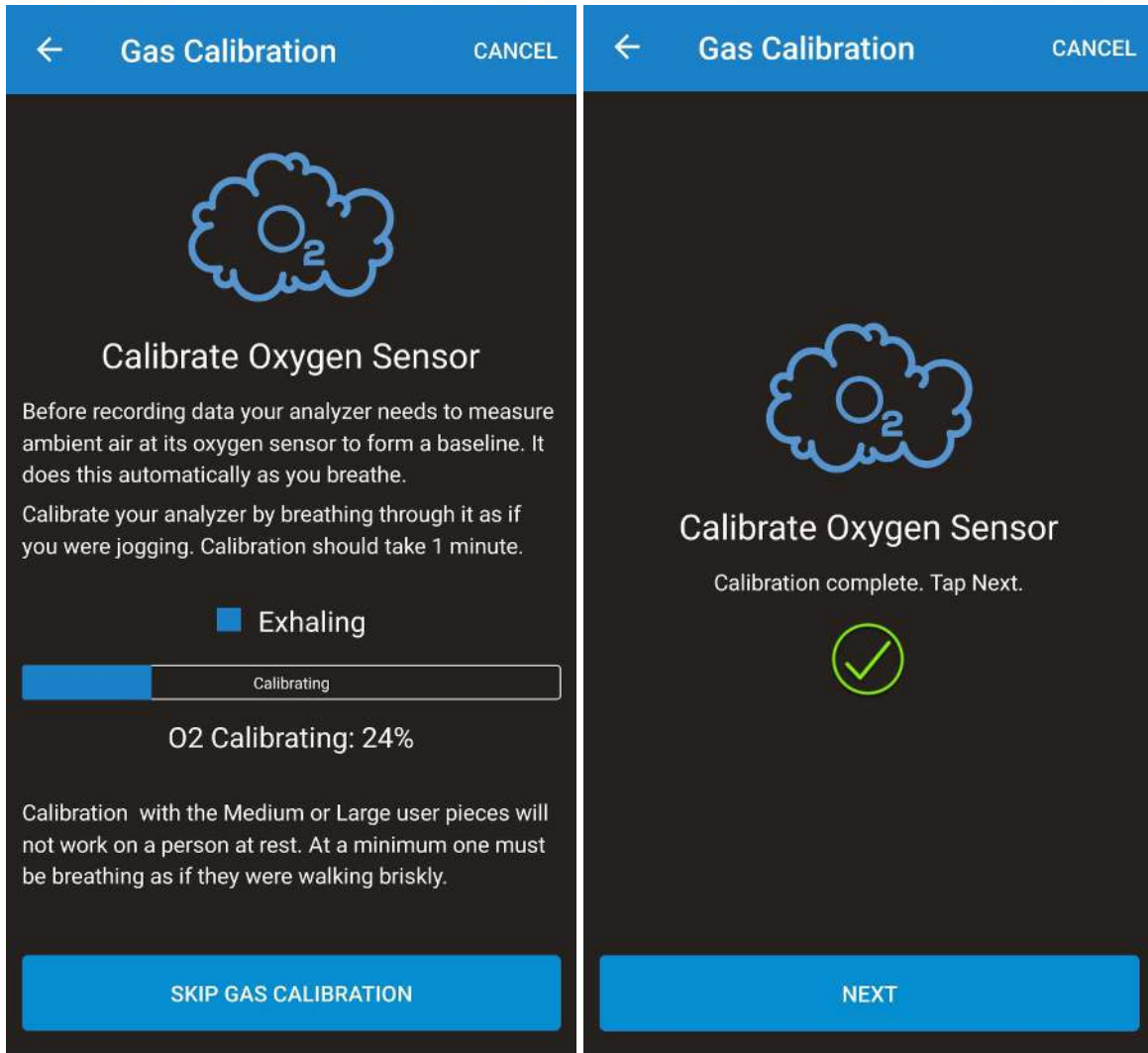


- g. Calibrating the flow sensor should be done by pumping the syringe at the rate of the metronome shown in the app. Make sure to gently hit both end stops while calibrating the device. The app will show a green check mark once the calibration process is complete. Calibration can be redone by tapping the “Calibrate Again” button. Tap “Next” to proceed to the gas calibration.

Note: If the user piece that is installed is different than the user piece selected in the app syringe calibration will not complete.



- h. The app will display a progress bar for the calibration. Pump the syringe at a rate of 20 strokes per minute. The Medium and Large user pieces will take approximately 1 minute to calibrate. The Resting user piece will take approximately 2 minutes to calibrate. Once the calibration is complete a green check mark will be displayed. Tap “Next” to continue.



*The “Skip Calibration” button allows you to bypass this screen to allow you to finish the setup while the analyzer is calibrating. **This does not stop the analyzer from calibrating!***

Note: If you would like data to be reported at the very beginning of the test, wait until the state updates to “Ready” (See Step 9).

- i. Once the flow and gas calibration process is complete, it is important to stop the user piece from rotating while handling the device. To do so hold the “Calibration Syringe Adapter Silicone Seal” against the VO2 Master Analyzer while removing the analyzer off of the syringe and removing the “Calibration Syringe Adapter”.

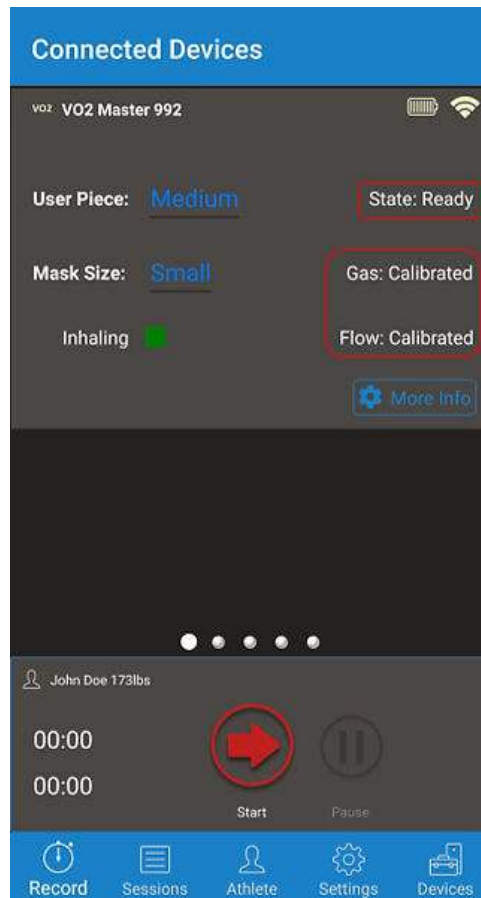


8) Gas Calibration on Person (Only use if calibration syringe is unavailable)

The analyzer can be calibrated on person as well as on syringe. The unit must be placed on the user before calibration can begin. Instruct the user to breathe normally. If the user’s ventilation is too low and outside the breathing range of the chosen user piece the analyzer will not calibrate and will reset the calibration to 0%. If the user is unable to maintain the ventilation at rest, instruct them to take deeper breaths, or allow them to start exercising. **The user must be breathing a minimum of 10 breaths per minute. Calibration takes approximately *one minute with the Medium or Large user pieces, and two minutes with the Resting user piece.***

*Note: The VO2 Master Analyzer calibrates to ambient air. **Simply start the test.** Once the minimum calibration volume has passed through the analyzer and the minimum ventilation is reached for the selected user piece, **the analyzer will start reporting data.** This may take several minutes. If you would like data to be reported at the very beginning of the test, wait until the state updates to “Ready” (See Step 9).*

- 9) Once calibration is completed the blue calibration bar will disappear, and a subtle message “State: Ready” will appear. If calibration was successful, “Calibrated” will be shown next to the Flow and Gas headers.



- 10) Once calibration is completed you are ready to start testing.
 See “When to Recalibrate” and “How to Recalibrate Manually” sections for more information on the calibration process

- 11) Your VO2 Master unit is now setup, calibrated and ready to begin testing.

When to recalibrate the Gas

- Once per hour
- After a temperature change of 5°C in less than 10 minutes
- After Changing the User Piece
- After Changing the Filter

When to recalibrate the Flow

- After Changing the User Piece
- After Changing the Filter

Session Duration and Downtime

- Maximum duration per session is 1 hour
- Minimum downtime between tests is 30 minutes
- Maximum of 8 sessions per day with downtime

Fitting Mask to Face

- 1) Attach VO2 Master Analyzer to mask, ensuring “VO2 Master” is right way up by inserting the user piece through the hole in the mask. Be careful not to rotate the user piece within the analyzer’s housing.



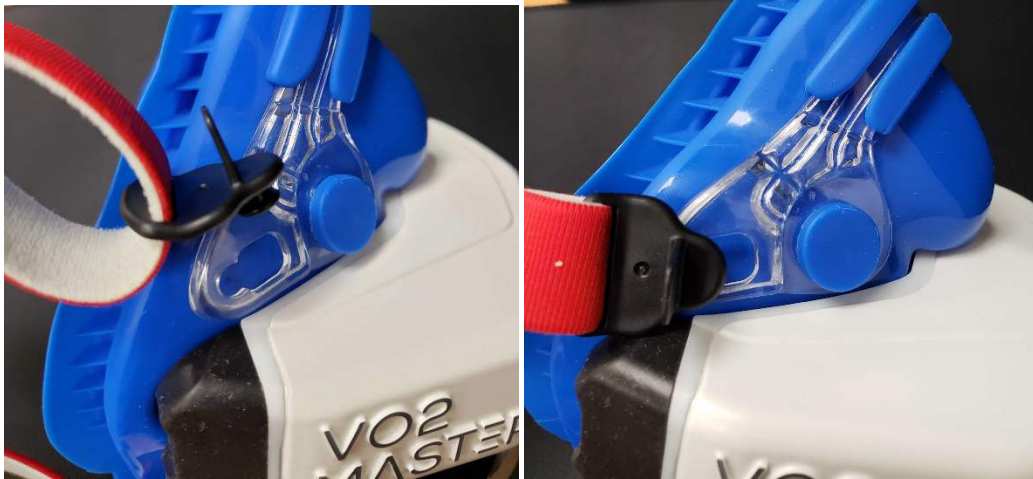
- 2) The fit will be snug. Take your time working the user piece through the mask opening. Make sure the nubs are completely through the masks.



- 3) Attach the locking nut by lining up the nubs on the user piece with the slots on the nut and turning clockwise.



- 4) Connect one side of the head gear to the mask by sliding the black fasteners into the clear receivers on the mask. Hold onto the mask, not the analyzer, when clicking clips in place.



- 5) Ensure the tag side of the head gear is away from the user's head. The Velcro tighteners not associated with mask clips will sit on the top of the user's head.



- 6) For an easier fitting, loosen the Velcro tabs and place them off-center to easily access later when tightening the fit.



- 7) Have users apply a slight pressure to the mask while holding the mask to their face. This will reduce the likelihood of a mask leak.



- 8) Secure clips on opposite side of facemask. Ensure proper location of head straps.



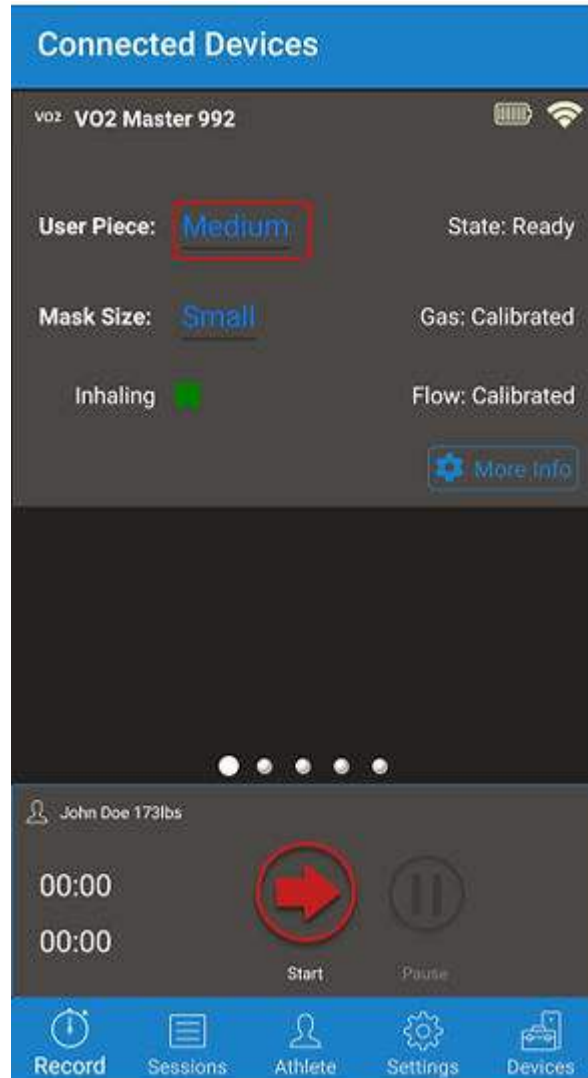
- 9) For correct fit release both lower Velcro tabs; with the user holding mask in place, pull back on the tabs to tighten evenly. Attach Velcro to head gear to lock in place. Repeat with middle straps and end with upper straps on top of head.



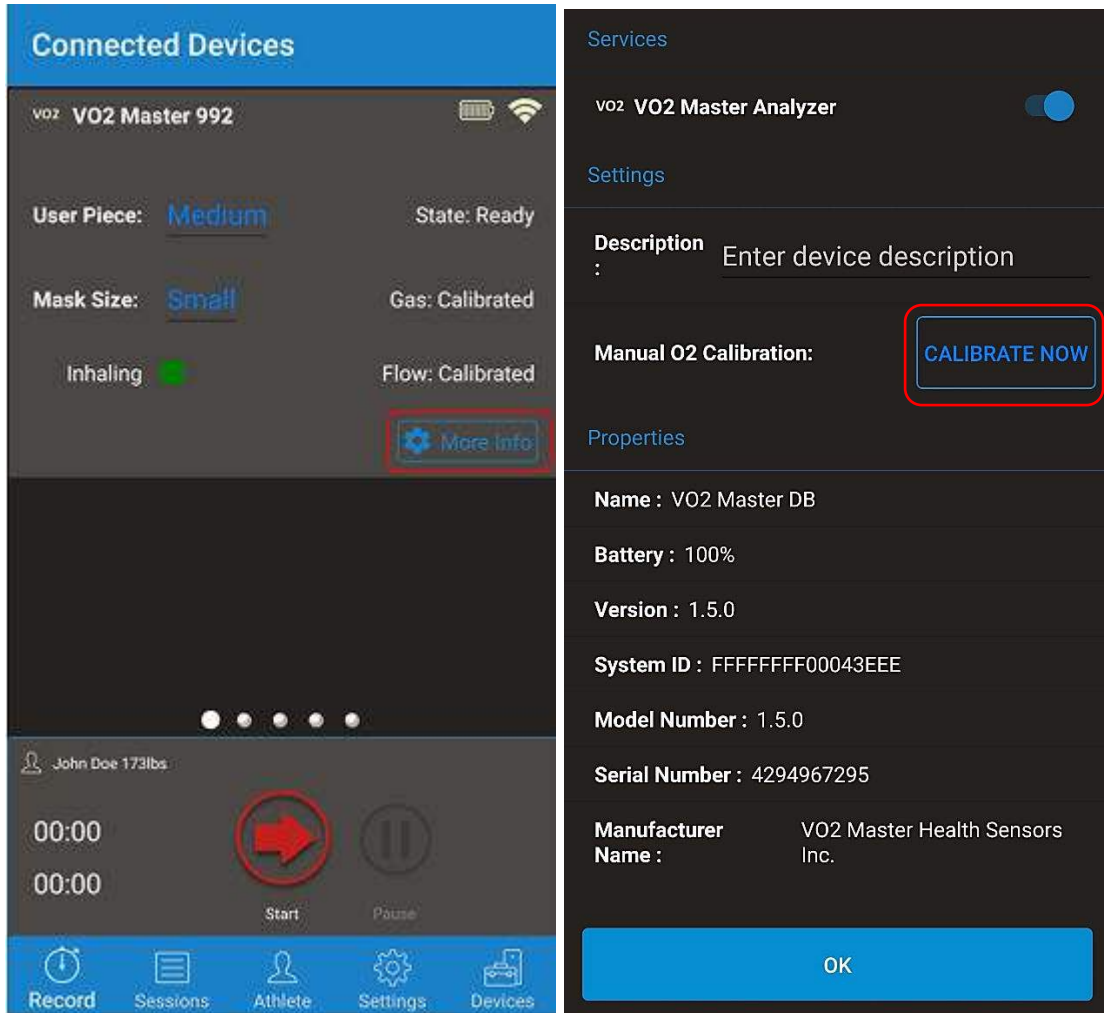
- 10) Adjust mask as necessary to ensure a tight fit. **Do not pull directly** on the VO2 Master Analyzer once headgear is tight as you may pull it from the mask.

How to Recalibrate Manually

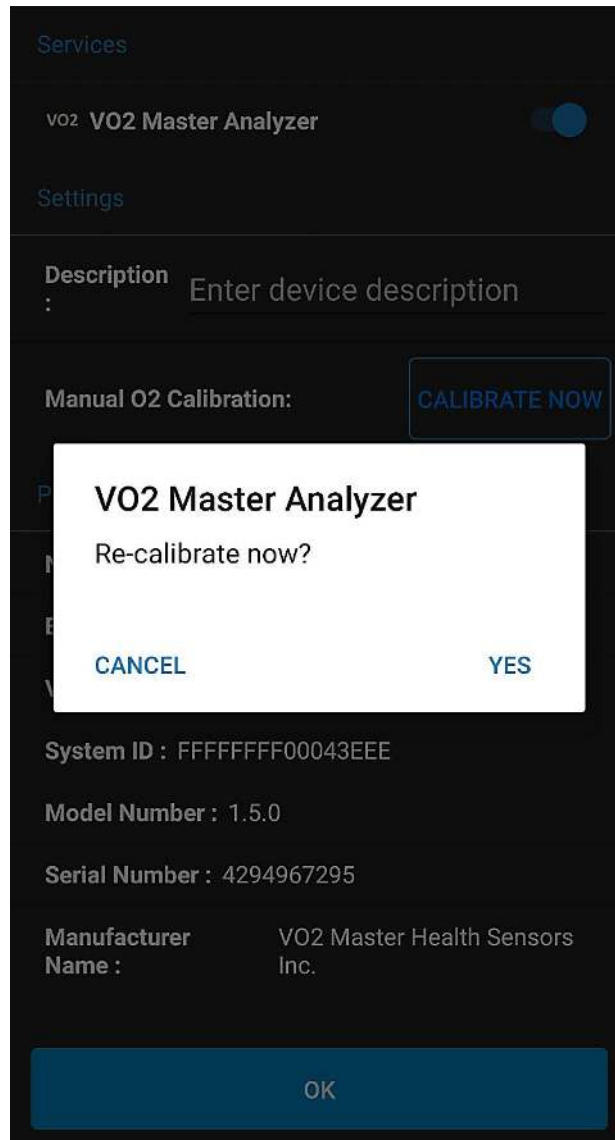
- 1) The VO2 Master Analyzer will recalibrated Flow and Gas each time the unit is powered on; previous calibrations are not saved when the unit is powered off. Ensure the installed user piece size matches the value in the *Record tab* of the app.



- 2) Tap the *Record* icon. In the *Connected Devices View*, in the *VO2 Master Analyzer Tile*, tap “More Info”. Beside Manual O2 Calibration: Tap “*Calibrate Now*”.



- 3) When prepared, tap Yes, and follow the regular calibration procedure explained previously in “Preparing the Analyzer for a Test”.

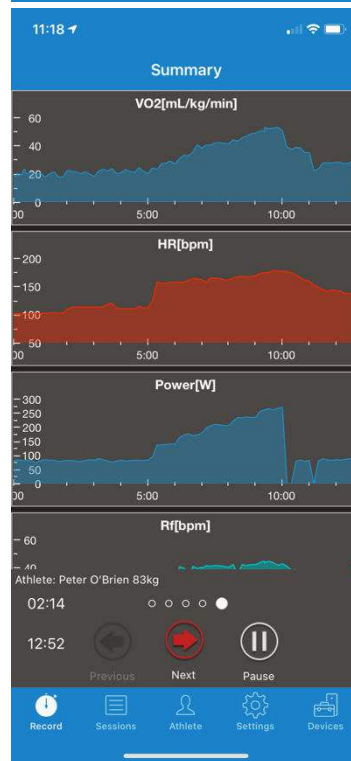
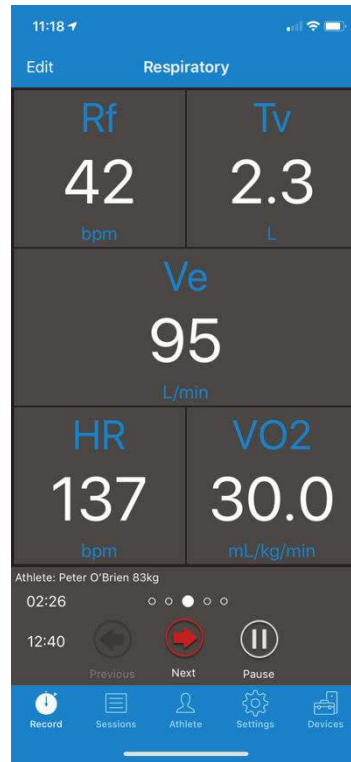
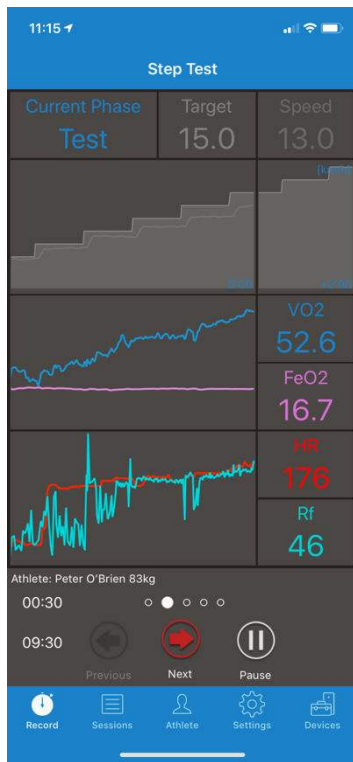


Perform a Test

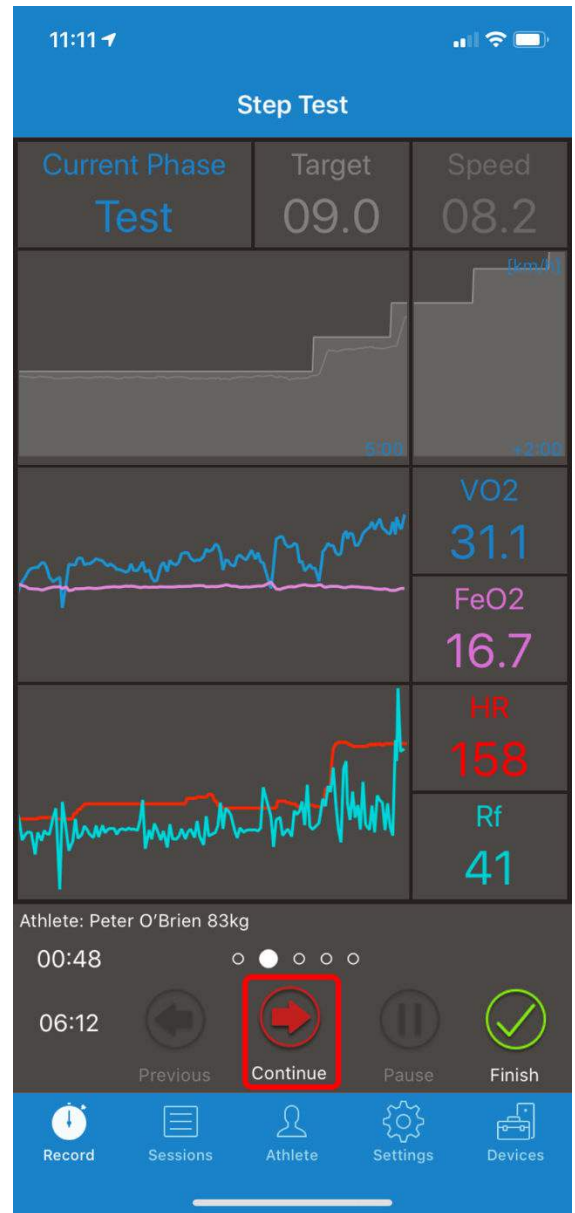
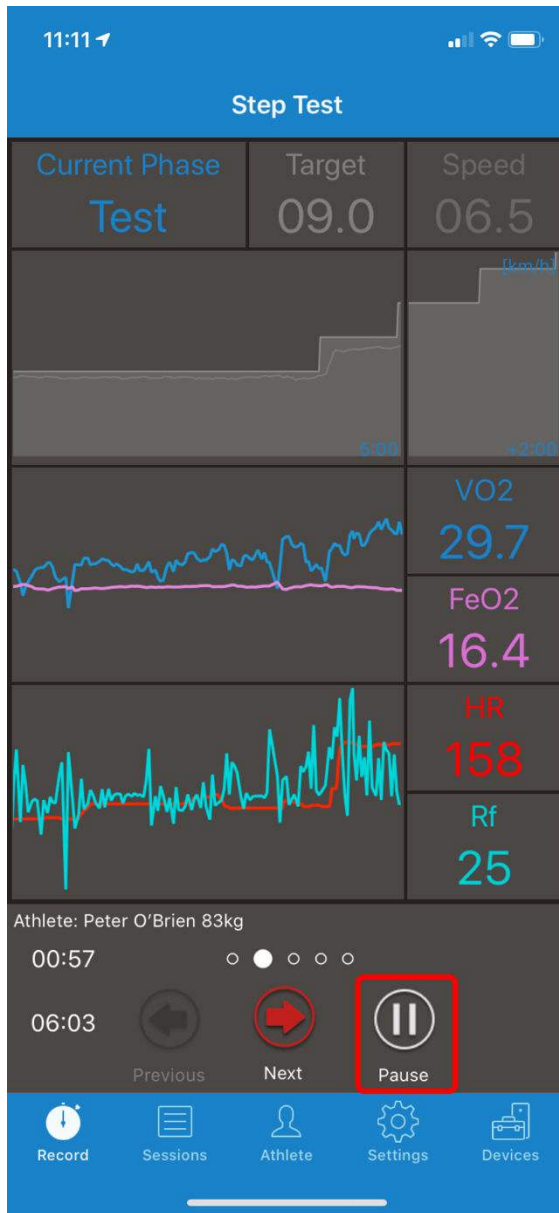
- 1) Follow the previous steps in the Getting Started section. In the “Record” tab, tap the “Start” red button.



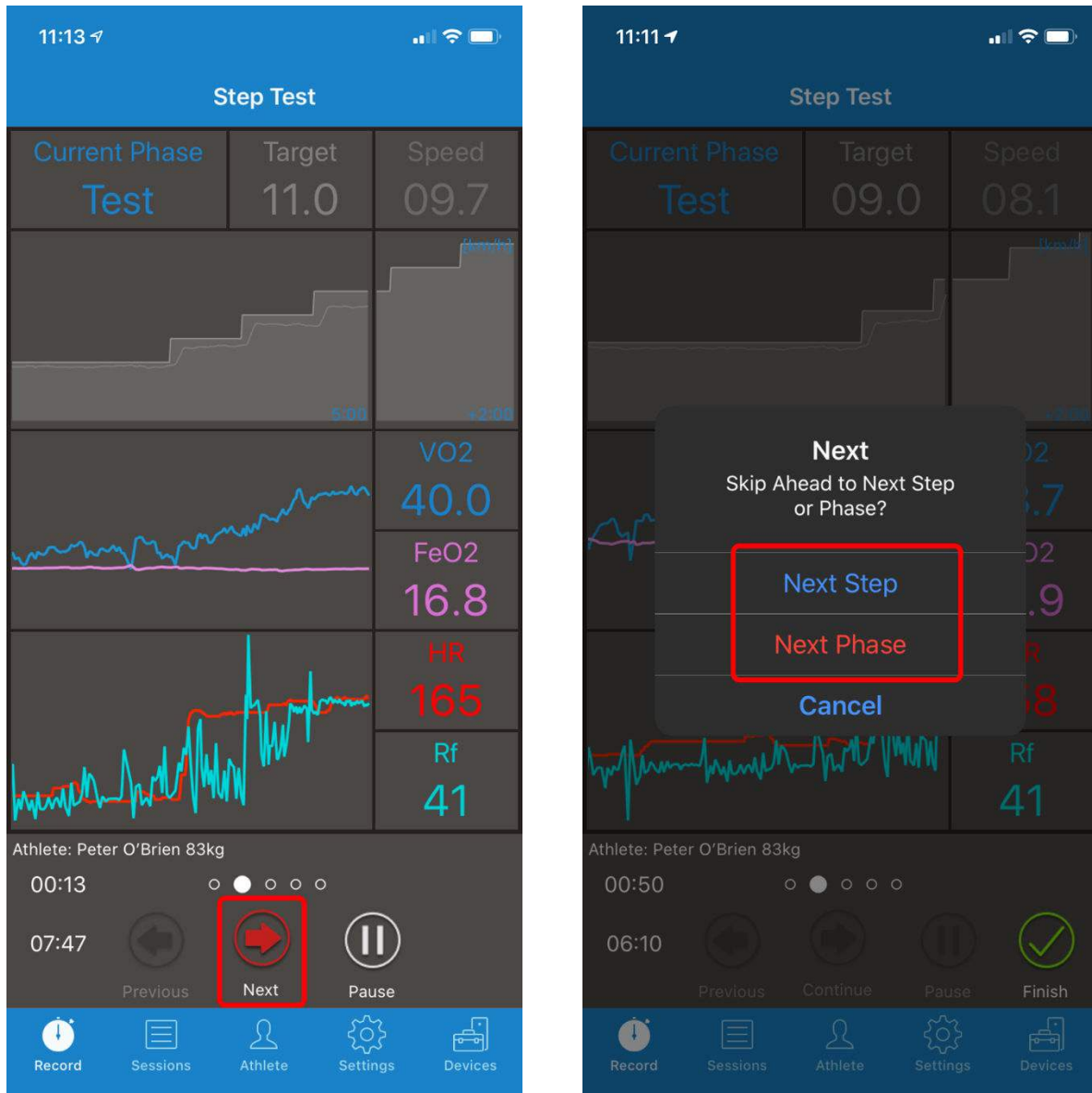
- 2) You will see your data values in real time. Swipe left and right to change data views. Follow the prompts to manually adjust intensity on your bike or treadmill to match the Target.



3) Tap "Pause" if necessary, tap "Continue" to resume.

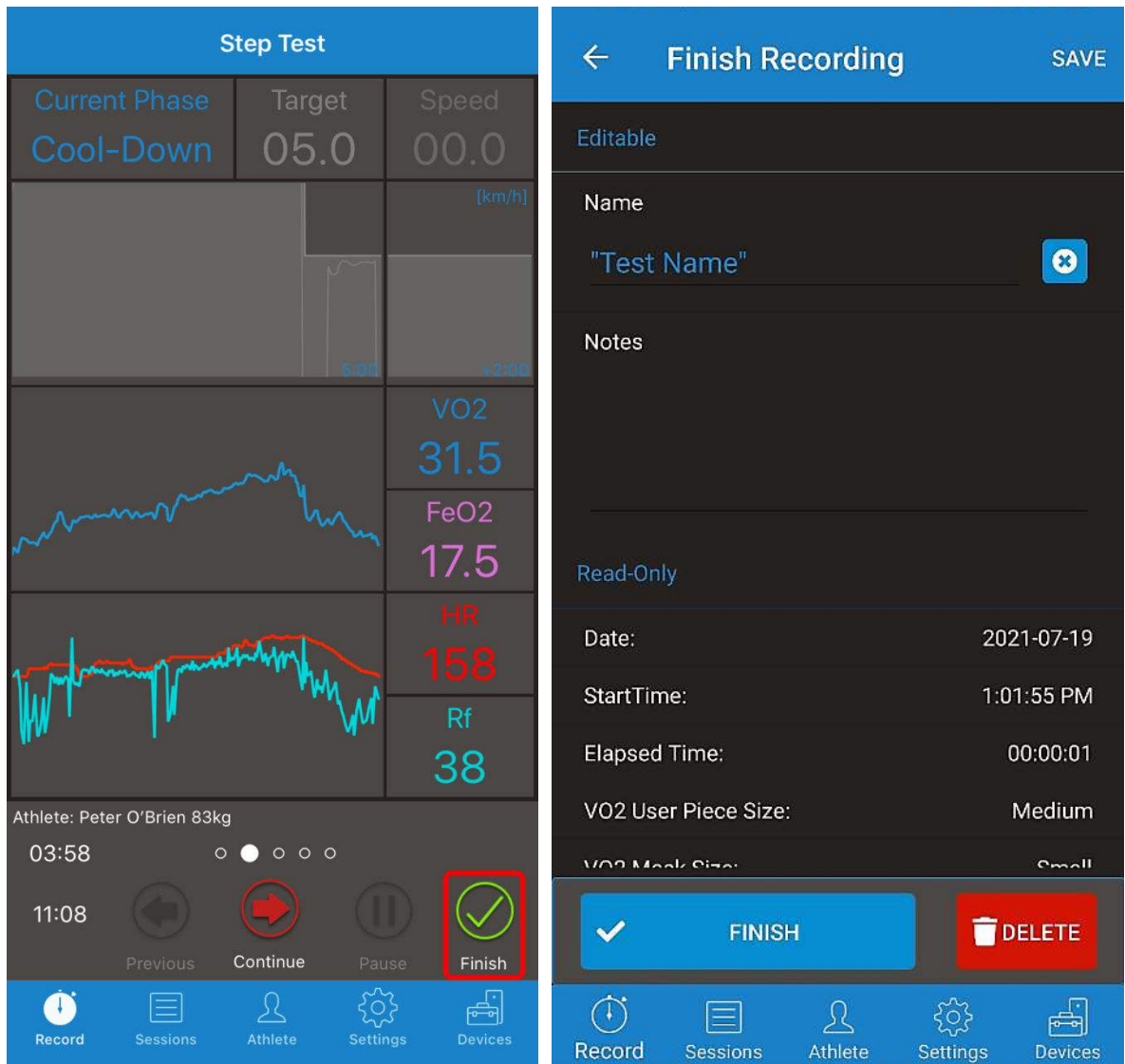


- 4) You have the option to skip to the next *Step* or *Phase*.
- Skipping to the next step immediately updates to the next intensity.
 - Skipping to the next phase will cause a jump from the current phase to the next in this order: *Warm-Up*, *Test*, *Cool-Down*, *End of Test*.



- 5) Once the user comes to the end of the testing phase you will enter the cooldown phase by tapping "Next Phase".
- Skipping a step or phase is not an option in the Resting Testing protocol.*

6) Tap the green check mark to finish a test.



You may tap Back in upper left corner to resume test.

7) Remove VO2 Master Analyzer from user.

Note: some users may be eager to remove the mask immediately following a test.

- 8) Name the recording. Depending on the protocol followed, there may be additional data fields to complete. This information allows for the generation of the PDF report. This information **can always be altered later.**

The screenshot shows the 'Finish Recording' screen in the VO2 Master Manager App. The screen is titled 'Finish Recording' and has a blue header with a back arrow, the title, and a 'Save' button. Below the header, there is an 'EDITABLE' section with a 'Name' field containing 'New Recording 2' and a 'Notes' field. Below that is an 'Activity Level' dropdown set to 'Sedentary', a 'Goal Weight (kg)' field set to '0.0', and a 'Weekly Loss Goal (kg)' dropdown set to 'Maintain Weight'. Below these fields is a 'READ-ONLY' section with a blue 'Save' button and a red 'Delete' button. At the bottom is a navigation bar with icons for Record, Sessions, Athlete, Settings, and Devices.

For a more in-depth explanation of these fields, see the Testing Protocols section.

Graded Exercise Test

Enter additional notes.

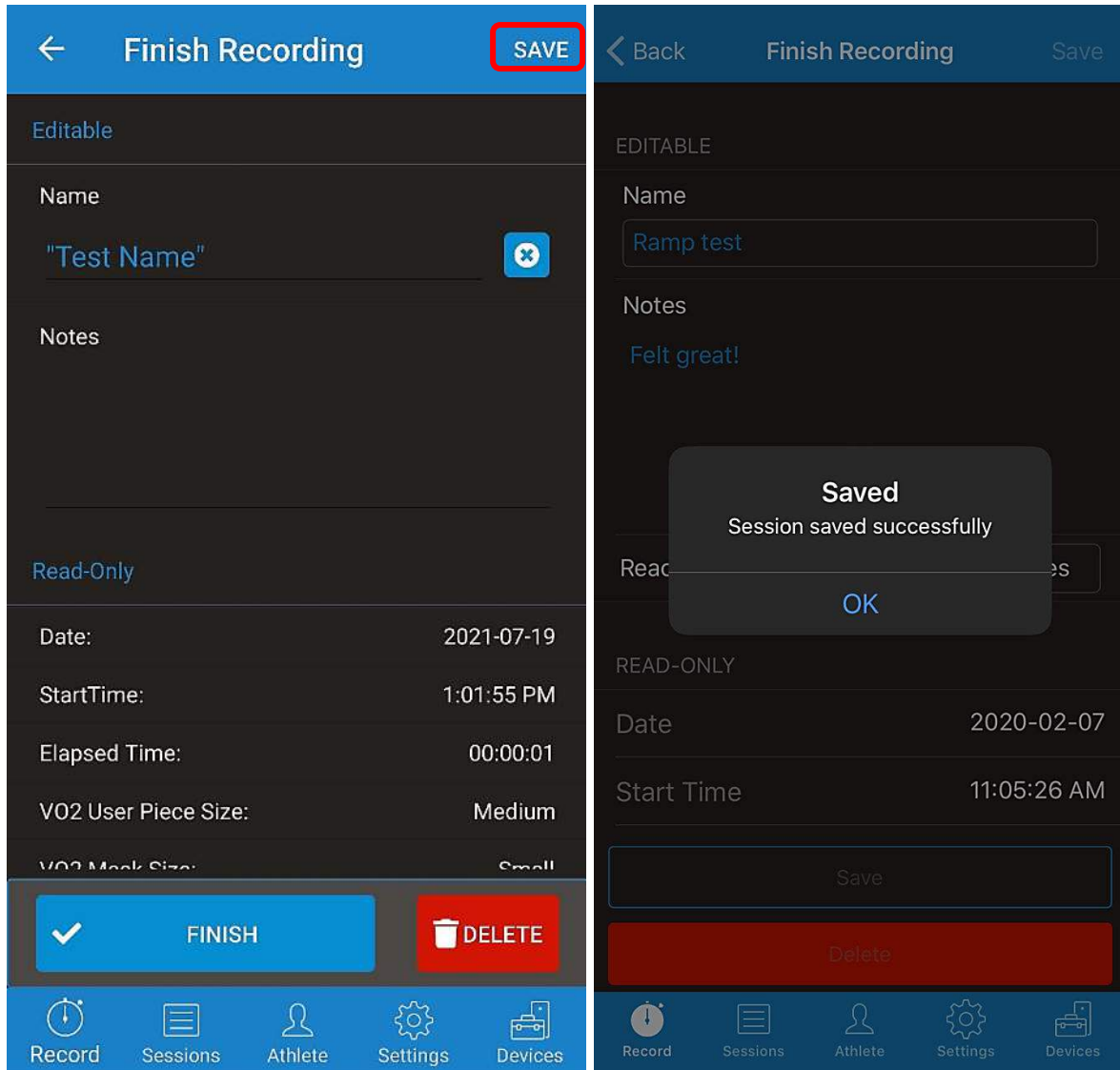
Intervals, 5-1-5, Free

Enter additional notes.

Resting (RMR)

Enter *Activity Level*, *Goal Weight*, *Weekly Loss Goal*. The *VO2 Master Manager App* will use this information to create a Daily Caloric Ingestion Goal and determine how many weeks it may take to achieve your Goal Weight. See Appendix for Activity Level definitions.

9) Choose *Save*. Retrieve the test from *Sessions* tab to share or print.



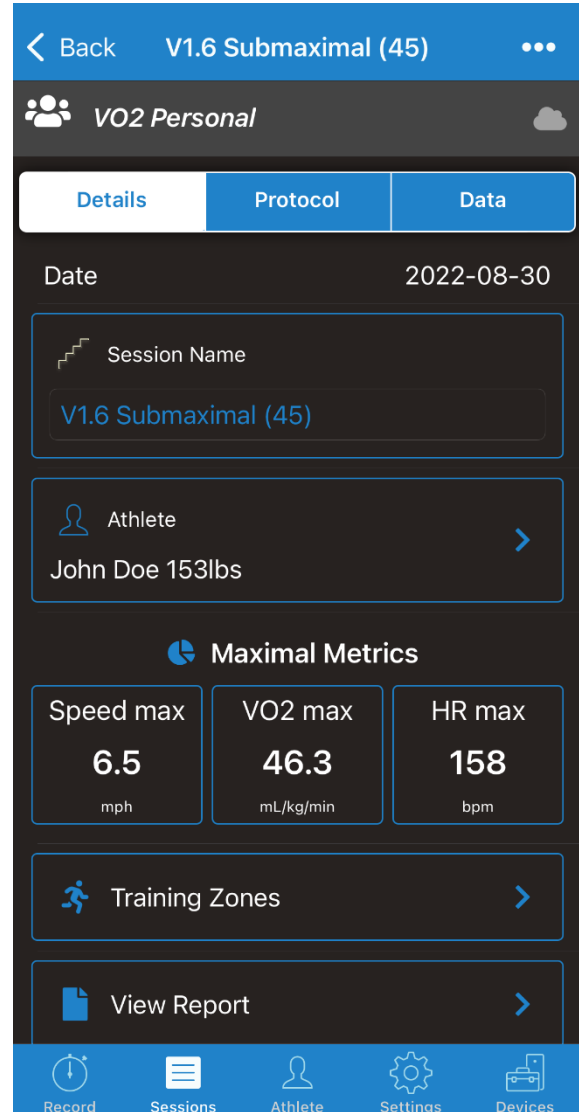
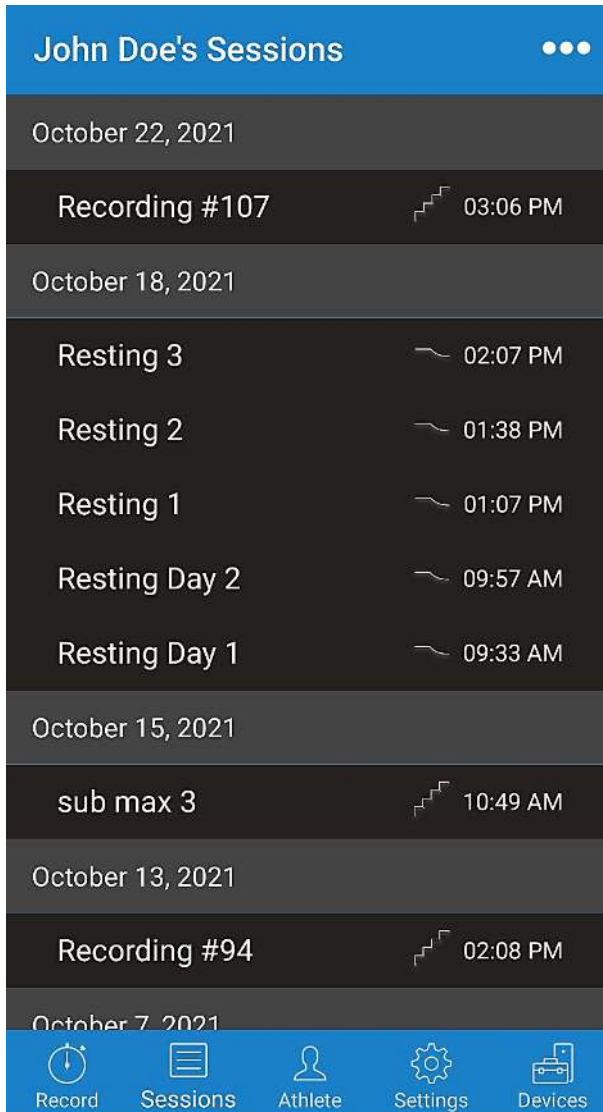
- 10) Turn off VO2 Master Analyzer by holding the power button until it starts slowly blinking red.
- 11) Follow the cleaning instructions in the Maintenance section to keep the analyzer clean and at top performance.

Review and Share Test

- 1) Navigate to the “Sessions” tab. From the list tap on a workout.
- 2) To generate the PDF report and CSV data files, tap on the top right three dots.

Share Report generates an email template to send to the user.

View Report opens the PDF in-app, for review and printing.



3) The Report Options determine details of the shared PDF and CSV files.

Report Style

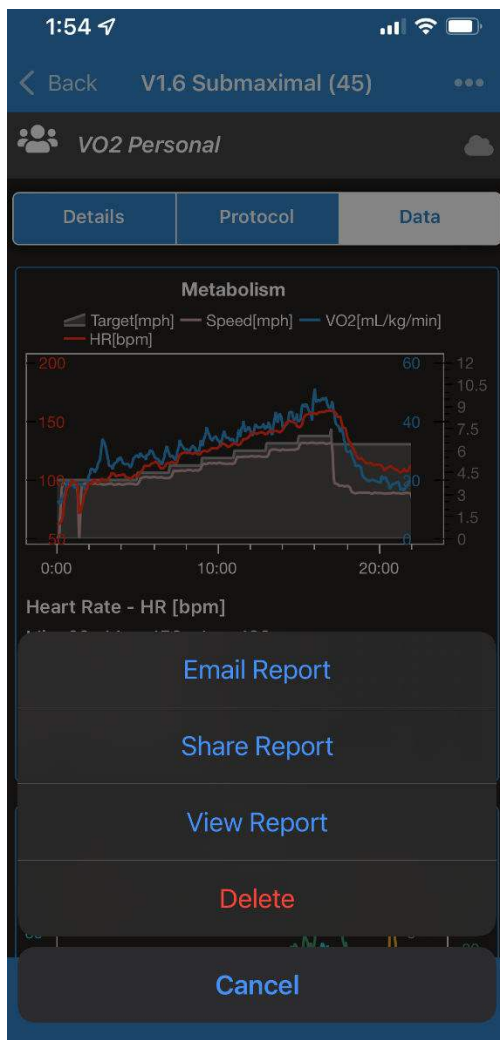
Simple shares the PDF and a summary CSV table. Detailed includes all information the app received: a CSV for each sensor's raw data, a summary table, the PDF report, and diagnostics.

Average Interval

This determines the moving average for the DataAverage.csv summary CSV data table. This does not affect the PDF report algorithms.

Page Size

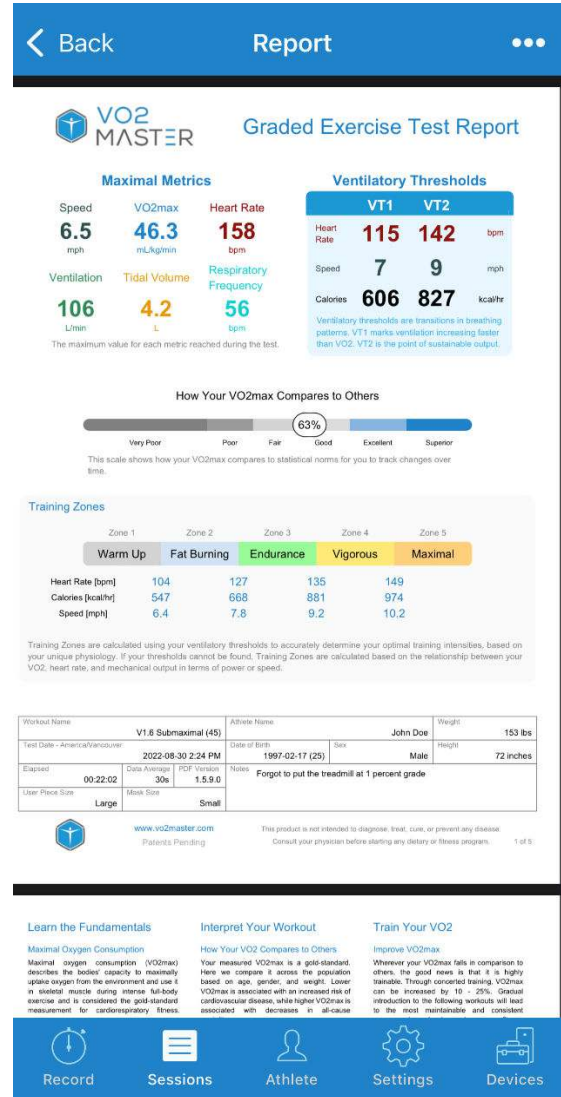
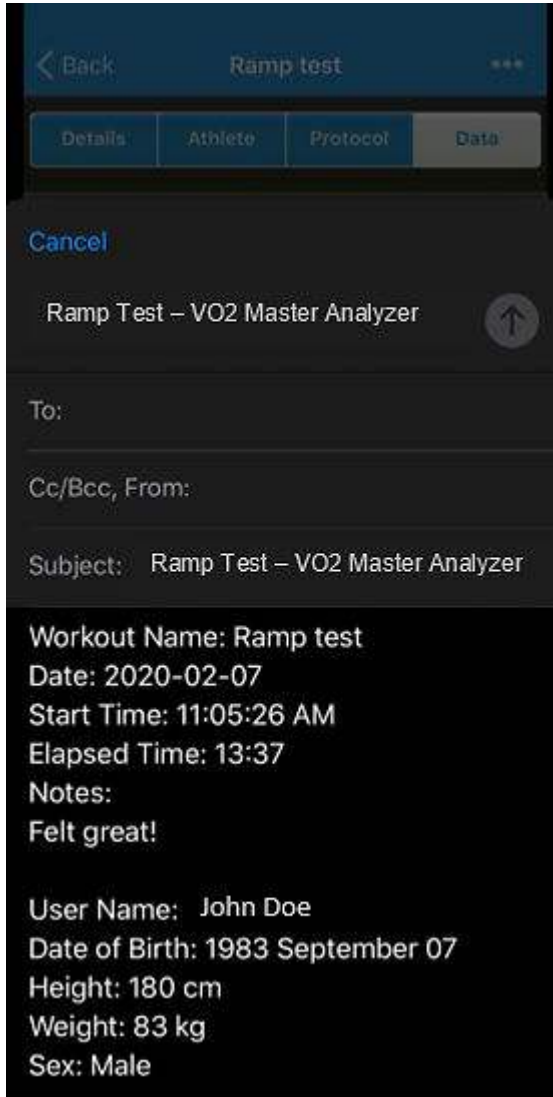
Supports common North American and European page sizes.



The screenshot shows the 'Session Report' settings screen. It has a blue header with a 'Back' button. The main content area is dark grey and contains several settings: 'Report Style' is set to 'Detailed' with a description: 'A PDF report, summary table, raw table for each sensor, full meta, and diagnostics.'; 'Advanced Options' includes 'Report Logo' with a 'Use Custom Image' toggle (currently off) and a custom image icon; 'Table Average Interval' is set to '30s' with a description: 'Used for DataAverage.csv time interval. This does not affect metrics like VO2max or caloric expenditure.'; and 'Table Format' is set to 'CSV'. At the bottom, there are 'Cancel' and 'Next >' buttons. A bottom navigation bar contains icons for 'Record', 'Sessions', 'Athlete', 'Settings', and 'Devices'.

Left: an automatically generated share email from the “Share Report” option.

Right: a preview of the PDF report from the “View Report” option.



4. Mobile Application Details



Guided performance and metabolism testing with the VO2 Master Analyzer.
Produce actionable reports for all users.



Powerful and simple data collection

Free phone application guides you through customizable testing protocols.



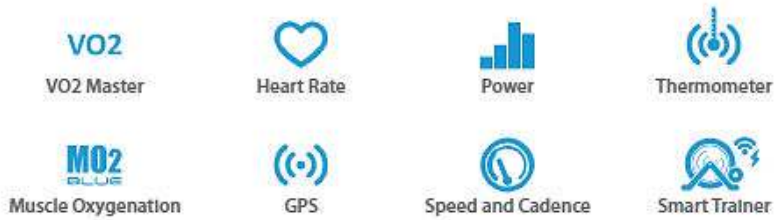
Performance Analysis

The app guides the athlete through a step test in as little as 15 minutes. It automatically generates a report with **thresholds, training zones, VO2max**, and performance ranking versus the norm.

Resting Metabolic Testing

The app guides the user through a period of rest and automatically generates a weight loss **management report**. This includes caloric expenditure, whether one has a fast metabolism, and a cardiac indicator of longevity.

Measure Everything



Main View Descriptions

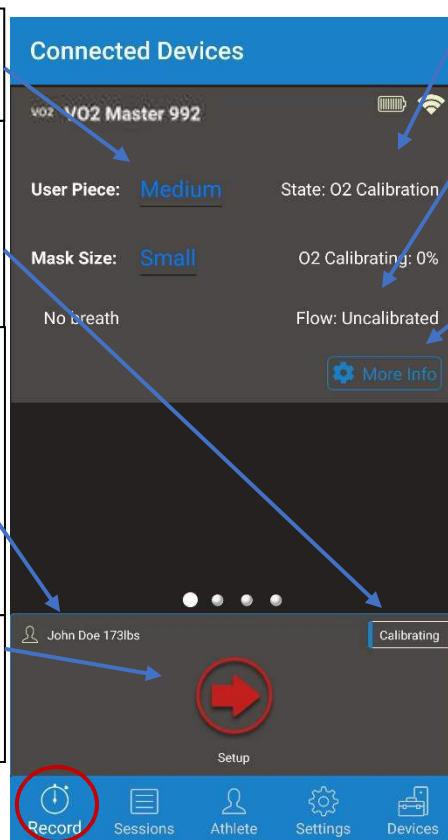
The following is an in-depth description of each app view. Use the tool bar located at the bottom of the screen to navigate between the main app views.



Record View

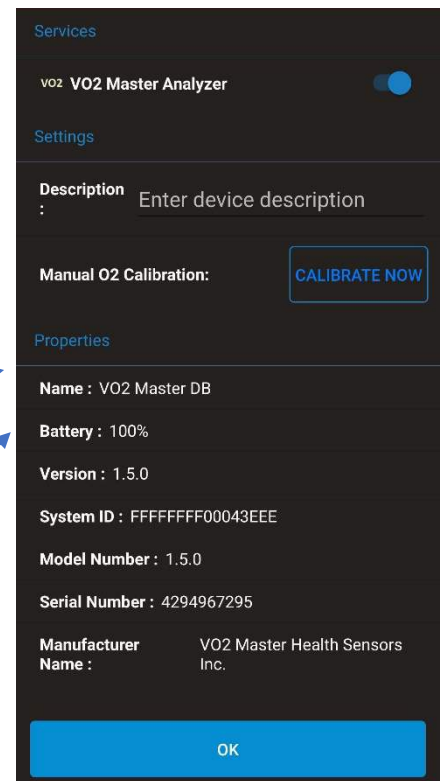
Allows you to record a session and swipe left or right to see live data

- Displays chosen User Piece. Tap to change.
- Calibration bar is displayed during calibration. It will turn blue as calibration progresses.
- Make sure athlete's name shown near bottom left matches athlete you are testing. Ensure the weight is correct and up to date.
- Tap Red Start arrow to select a Protocol and start a test.



- Displays percentage of calibration. Will read "State: Ready" once calibration is complete.
- Displays calibration condition for the flow sensor, will show Uncalibrated or Calibrated
- Tap "More Info" to open a new screen that allows you to change select settings, manually calibrate, and list *Unit Properties*.

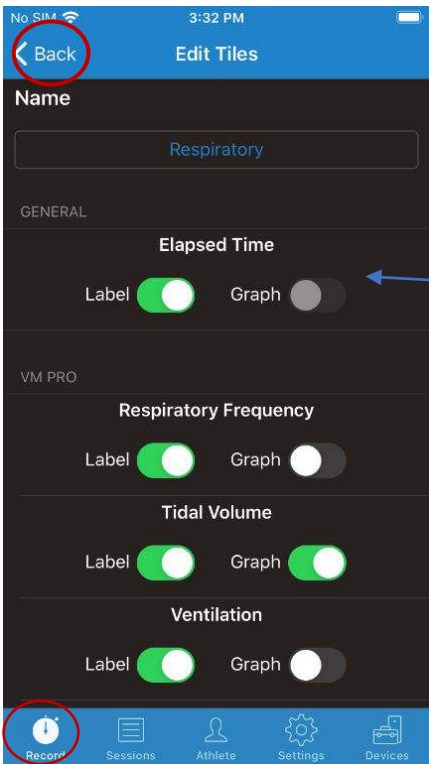
- Properties** is where you will locate *Model Number* and *Serial Number*.
- Battery** will display 100% or 20%. 20% indicates there is approximately 1 hour of run time left.



Tap **"Edit Tiles"** in the top right corner to open a new screen that allows you to customize your displays.

Tap on each tile to remove (X), increase (+) or decrease (-) size.

Swipe left and right to see additional screens.



Tap on **"Graph"** or **"Label"** for each measurement to choose which tiles will display live data under *Record* tab.

Tap **"Back"** or **"Record"** icon to return to *Record* screen where selected tiles will be displayed.

Athlete View

Allows you to set up new athlete profiles and switch between saved profiles

The screenshot shows the 'Profile' screen with the following fields: Name (Amy M), Date of Birth (1984-01-25), Height (162 cm), Weight (62 kg), and Sex (Female). A 'Switch Athlete Profile' button is at the bottom. The bottom navigation bar has icons for Record, Sessions, Athlete (circled in red), Settings, and Devices.

Tap on each section to insert athletes' information. Fill in profile completely and accurately.

Tap "Switch Athlete Profile" to open a new screen where you can **Add a New Athlete** or to find previously saved athlete.

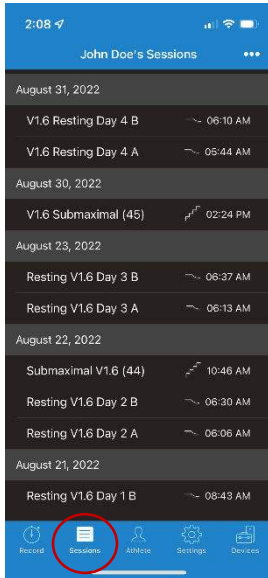
Athlete Profile will automatically save when you tap on any of the other tool bar icons.

The screenshot shows the 'Athlete Profiles' screen with a list of profiles: Default (Offline), <No Name>, Average Joe (1985-05-24), Billy Bob (2001-09-27), and John Doe (1994-10-19). An 'ADD NEW' button is in the top right corner. The bottom navigation bar has icons for Record, Sessions, Athlete (circled in red), Settings, and Devices.

Tap "Add New" in top right corner to open a new Profile screen where you can input your athlete's information.

Sessions View

Will give you a list of all recorded sessions in order by date for your chosen athlete



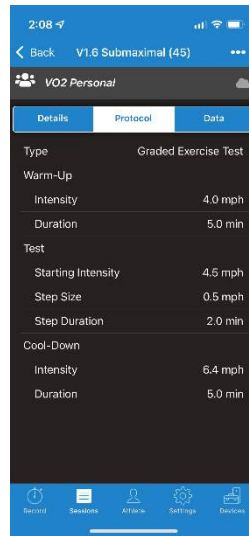
Tap on "Session" to open a new screen to see recorded data of completed tests.

The next screen has an upper tool bar with *Details*, *Protocol* and *Data*



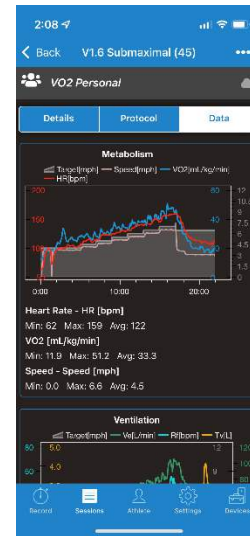
Details

Option to change the name of test and to add notes



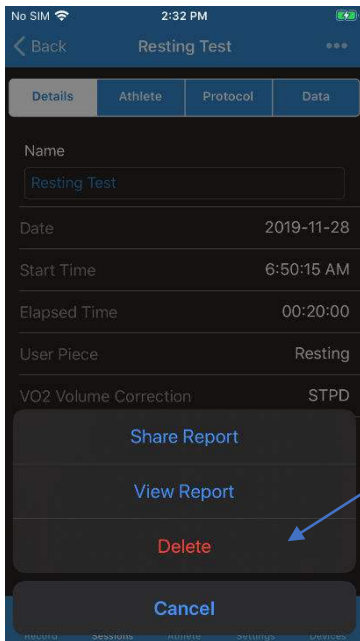
Protocol

Options will be different depending on which Protocol you used for your test.



Data

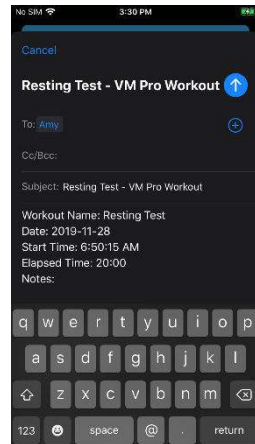
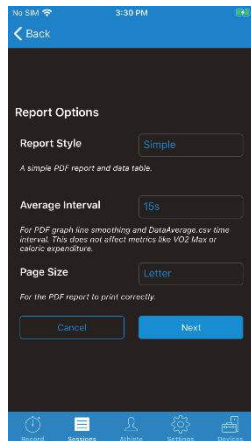
Provides graphs of collected respiratory data



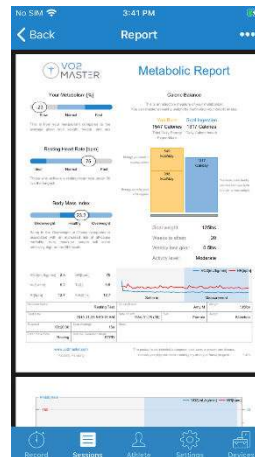
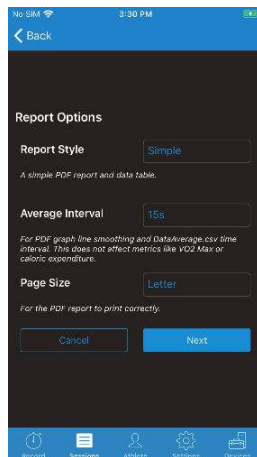
Tap on 3 dots in upper right corner to *Share*, *View* or *Delete* Test.

Tap **"Delete"** to prompt question *'Are you sure you want to delete?'*
Tap **"cancel"** to return to Athlete Profile.

Tap **"Share"** to open a new screen.
Choose Report Style, Average Intervals and Page Size.
Tap **"Next"** to open a new screen.
Type in e-mail address.
Tap blue circle with upwards arrow to send.

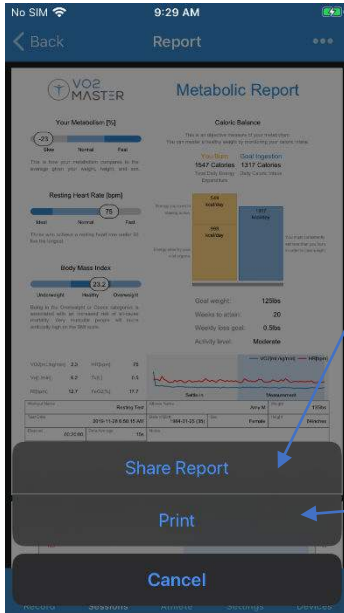


Tap **"View"** to open a new screen.
Choose Report Style, Average Intervals and Page Size.
Tap **"Next"** to open a new screen and instantly see report.



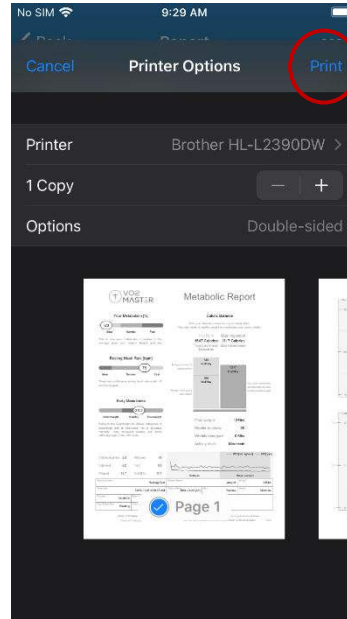
Tap three dots in upper right corner to **Print**. This will open a new screen.

The look of the report will vary depending on the type of test protocol you chose.



Tap **"Share"** to send report by e-mail.

Tap **"Print"** to open a new screen with printing options.



Select from available Bluetooth Printers.

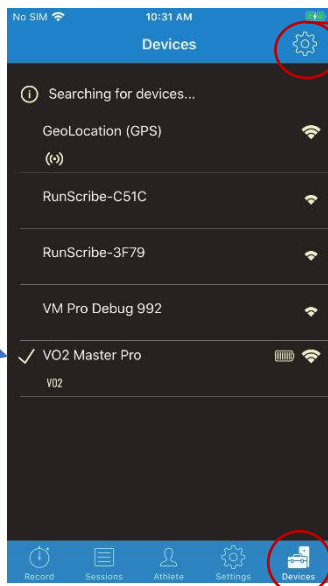
Select *Number of Copies, Options*.

Tap **"Print"**.

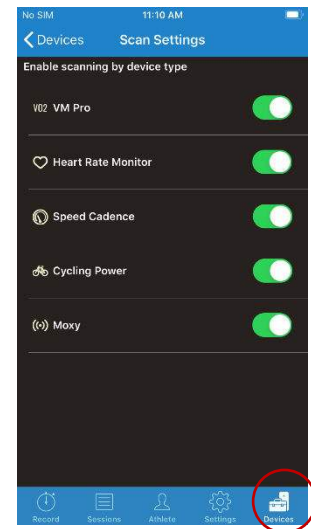
Devices View

All powered on Bluetooth measuring devices in range will automatically show up here. Tap on your desired devices to pair.

Check mark indicates analyzer is paired*.



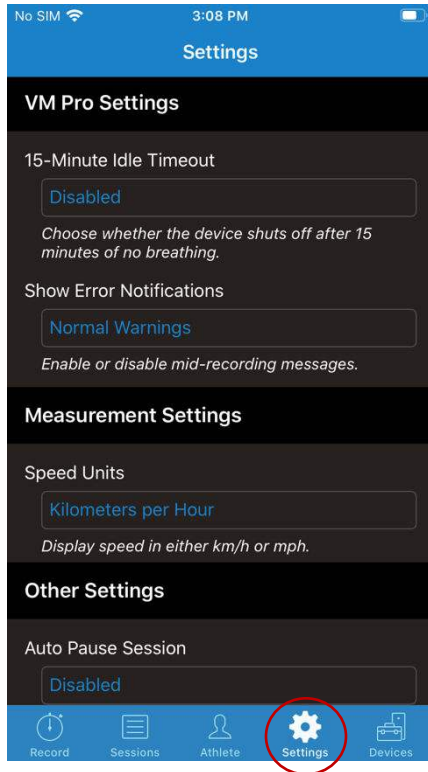
Tap **"here"** to open a new screen to enable which devices are able to be paired.



*The VO2 Master Analyzer can be attached to only one mobile device at a time. If you cannot find your VO2 Master Analyzer on the list of devices, check that the indicator light is flashing ensuring your analyzer is on and check that it is not paired with another mobile device.

Settings View

Where you set global settings for the device



15 Minute Idle Time Out

Decide if the VO2 Master Analyzer should power down after 15 minutes of no breath detected. Enable to save battery. Disable if testing swimmers.

Show Error Notifications

Enable or disable mid-test recording messages.

Speed Units

Display in either Km/h or mph.

Auto Pause Session

Enable or Disable - when no data is received for 3 minutes the active session will be paused.

Protocol Change Notification

Choose from *Both, Vibrate, Sound, Disabled*. When a change in speed or power should happen during your test, you are notified to manually make the change on your smart trainer or treadmill.

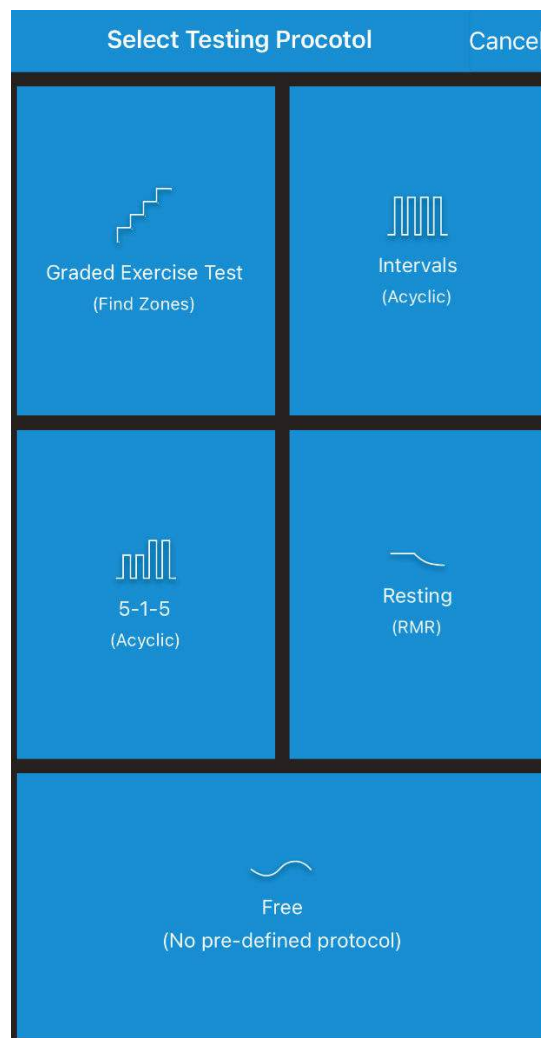
5. Testing Protocols

App-Guided Testing Protocols

VO2 Master Manager has four programmed protocols as well as a *Free* section where you are free to follow your own protocol. You will choose your protocol once you have pressed *Start* on the *Record* screen.

Graded Exercise Test, *Intervals* and *5-1-5 (Acyclic)* are all considered Cardiopulmonary Exercise Tests (CPET) designed to assess one's heart and lung function. In athletes, this information can be used to predict performance and develop training plans.

Resting Metabolic Rate (RMR) Testing measures individualized caloric expenditure for use in nutritional and weight loss planning.



Graded Exercise Test Protocol

The *Graded Exercise Test* is designed to measure aerobic fitness and exertion level, and produces automatic training zones, ventilatory thresholds and maximal metrics. Incremental increases in workload elicit an increase in oxygen uptake. Maximal oxygen uptake (VO2 max) is one of the best predictors of endurance performance and is highly correlated to health outcomes. Therefore, measuring, tracking, and improving VO2 max over time is an important marker for health and performance outcomes.

In the *VO2 Master Manager* app tap on each option to set up the following:

Test

- Performance Measure
Wattage or Speed
- Starting Intensity
Determine based on participant
- Step Size
How much to increase intensity
- Step Duration
How long to stay at each intensity

Warm-Up

- Intensity
Determine based on participant
- Duration
For how long to warm up

Cool-Down

- Intensity
Determine based on participant
- Duration
For how long to cool down

The screenshot shows the 'Graded Exercise Test' configuration screen. At the top, there are navigation options: '< Back', 'Graded Exercise Test', and 'Cancel'. The screen is organized into sections with blue headers. The 'Performance Measure' section is set to 'Speed'. The 'Warm-Up' section has 'Intensity (mph)' set to 10.4 and 'Duration' set to 5 min. The 'Test' section has 'Starting Intensity (mph)' set to 11.7, 'Step Size (mph)' set to 1.3, and 'Step Duration' set to 2 min. The 'Cool-Down' section has 'Intensity (mph)' set to 16.7 and 'Duration' set to 5 min. A large blue button with 'Next >' is located at the bottom of the screen.

The app will provide a report showing the VO2 max based on a 60-second rolling average. Based on these results the app will show where the athlete compares to the rest of the population based on their sex and age.

Intervals Protocol

The intervals protocol is designed to measure acyclic aerobic fitness and exertion levels. This protocol is best for athletes who compete in a team or repeated sprint sport (e.g., football, soccer, basketball, and hockey). Measuring repeated sprint ability in team sports is a great way to monitor sport specific fitness. The VO2 Master Analyzer is completely portable allowing for testing to be done in a broad range of locations; however, exposure to direct sunlight and wind will reduce the accuracy of the device.

In the *VO2 Master Manager* app tap on each option to setup the following:

Test

- Performance Measure
Wattage or Speed
- Interval Intensity
Load at upper intensity
- Interval Duration
Time spent at upper intensity
- Recovery Intensity
Load during lower intensity
- Recovery Duration
Time spent at lower intensity

Warm-Up

- Intensity
Determine based on participant
- Duration
For how long to warm up

Cool-Down

- Intensity
Determine based on participant
- Duration
For how long to cool down

Intervals Settings

Test

Performance Measure: Wattage

Interval Intensity (W): 200

Interval Duration: 3 min

Recovery Intensity (W): 100

Recovery Duration: 3 min

Warm-Up

Intensity (W): 100

Duration: 5 min

Cool-Down

Intensity (W): 100

Duration: 5 min

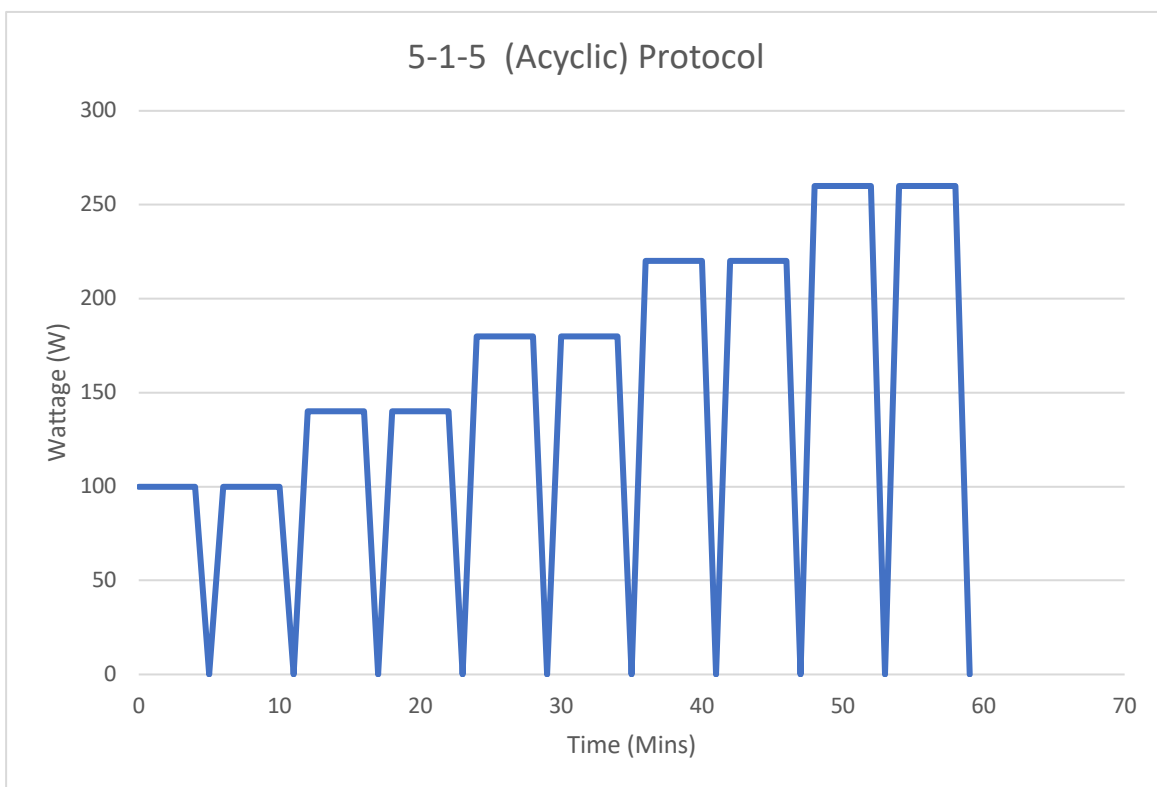
Next

At the end of the test, you will be able to determine an athlete's repeat sprint ability. This test is good for measuring fitness levels in athletes who compete in sports that require bouts of sprinting followed by rest (e.g., soccer, basketball, hockey, etc.). Understanding how an athlete can repeatedly sprint and recover can give insights to training and substitution strategies.

5-1-5 (Acyclic) Protocol

Designed to identify limiters (lung, heart, or skeletal muscle) of an athlete's physiology. This is best done through a combination of measurements from the VO2 Master Analyzer, heart rate, and muscle oxygenation sensors. 5-1-5 does not require maximal effort, instead it is used to measure how the body reacts to sustainable loads. Due to the relatively low intensity of the first phase of the test, there is no warm-up period prescribed; instead, it is worked in as part of the testing procedure.

By default, during the testing phase the participant maintains an intensity for 4-5 minutes, followed by a 1-minute complete rest; they then resume the same intensity for another 5 minutes, followed by another 1-minute of complete rest. The sequence is then repeated at a higher intensity. Ultimately you would like to see your athlete go through 4-5 phases of the test such that phase 3 represents Functional Threshold Power (FTP) or slightly higher. For example, if FTP = 180 Watts, Phase one workload = 100 Watts, rest load = 0 Watts, steps increases = 40 Watts. Therefore, your test would look like the following:



There is no need to push this test to exhaustion. When the athlete cannot comfortably maintain the intensity, the test is over. Please see the 5-1-5 report for possible interpretations of the results.

In the VO2 Master Manager app tap on each option to setup the following:

Test

- Performance Measure
Wattage or Speed
- Starting Intensity
Initial load
- Interval Duration
Time spent at upper intensity
- Step Size
How much to increase the intensity by between stages
- Recovery Duration
Time spent at rest. 1 minute recommended.

Cool-Down

- Intensity
Determine based on participant
- Duration
For how long to cool down

At the end of the test, you will be able to determine an athlete's major limiting factor (e.g., lungs, heart, or muscle). This is explained in more detail in the 5-1-5 report but is useful because the 5-1-5 assessment allows coaches to specifically target the most limiting factor in order to improve an athlete's individual fitness. In combination with a maximal exercise step test this assessment can provide extremely useful information to help master one's potential for performance.

The screenshot shows the '5-1-5 Interval Settings' screen in the VO2 Master Manager app. At the top, there are navigation options: a back arrow, the title '5-1-5 Interval Settings', and a 'Cancel' button. Below this, the 'Performance Measure' is set to 'Wattage'. The 'Test' section is highlighted in blue and contains the following settings: 'Starting Intensity (W)' set to 150, 'Interval Duration' set to 5 min, 'Step Size (W)' set to 30, and 'Recovery Duration' set to 1 min. The 'Cool-Down' section is also highlighted in blue and contains: 'Intensity (W)' set to 100 and 'Duration' set to 5 min. At the bottom of the screen, there is a blue 'Next' button.

Resting Metabolic Testing (RMR) Protocol

Metabolic Rate is a measure of how quickly your body expends energy - your 'caloric burn rate'. Resting metabolic rate testing determines how many calories your body burns at rest, giving you the information required to plan a successful weight loss, weight gain, or weight maintenance plan.

Prior to your test:

- Do not eat, exercise, or drink coffee or alcohol for 5 hours
- Do not smoke 2 hours prior
- Do not participate in vigorous or high-intensity weight training 12 hours prior
- Arrive rested and relaxed

In the *VO2 Master Manager* app tap on each option to set up the following:

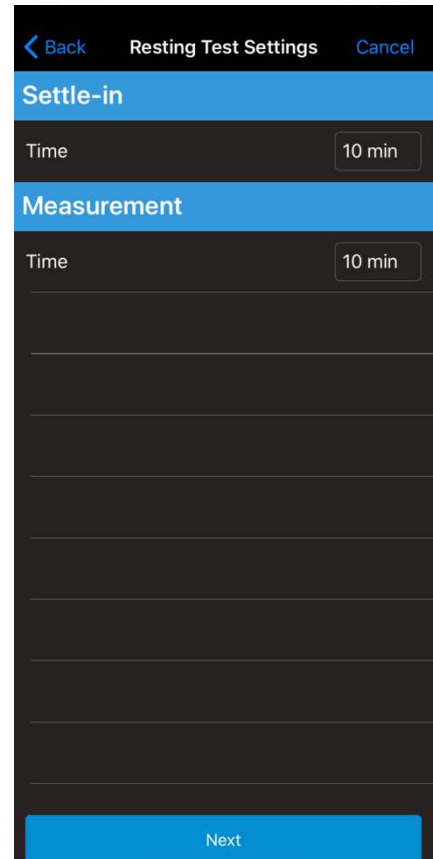
Settle-in

- *Time. 10 minutes recommended.*

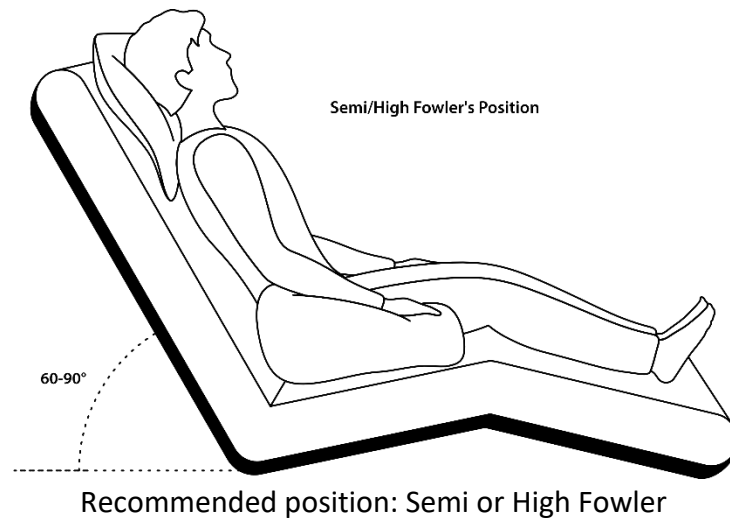
Measurement

- *Time. 10 minutes recommended.*

It is recommended that the participant should rest for 10-20 minutes quietly before an RMR test. Research has shown that a 10-minute test which includes a 5-minute Settle-in, and a 5-minute Measurement phase is sufficient. It is important to have the user in a relaxed sitting or inclined lying position. Advise the user to relax and breathe "normally" – initially the user may be conscious of their breathing but after a few minutes of relaxed breathing, this will no longer be an issue. Avoid artificially long, slow breathing like yoga breathing.



The user should find a comfortable position sitting or lying where the analyzer logo is not pointed upwards. The Fowlers Position or semi Fowlers position is optimal. Other acceptable positions include left or right lateral recumbent (side sleeping position) or the prone position (stomach). Ensure the ports on the analyzer are not obstructed by blankets, clothing, or pillows.



At the end of the test, you will be able to determine resting energy expenditure. This along with recommendations for using RMR are explained in more detail in the RMR report. This information can be used to start a weight management program. An RMR test can be repeated easily, and regularly to track how one's resting metabolism is changing over time.

"Free" Protocol

This is a recording without a pre-defined protocol. Use this "protocol" for assessments that do not fit the other options. This protocol is commonly used by researchers for custom data aggregation. The app report will display Min, Max, and Average metric statistics. NOTE: "VO2 Max" from this report is different from the VO2max display on the Graded Exercise Test Report.

Additional Testing Protocols

Incremental Swim Tests

VAMEVAL

This is a progressive test used for elite swimmers. The athlete starts at a speed 1 m/s, with the speed increasing by 0.05 m/s every minute until failure.

Modified Swim Graded Exercise Test

The VAMEVAL test can be modified by completing a set distance at each speed, rather than changing speeds every minute. Data can be collected for 15 seconds at the end of each step, during a 20 second rest period, before the athlete attempts the next step. Assistance is required to help keep track of speeds achieved, as well as respiratory and heart rate data collected. A brief description of this modified test is provided below:

Graded Exercise Test in Pool

You will need an assistant to record the data and help with timing.

- 1) Warm up thoroughly before beginning the test.
- 2) The test consists of 100 m repeats with 20 seconds rest in between.
- 3) Swim the first 100m at a very easy pace.
- 4) At the end of each 100m, record pulse rate and respiratory data using the VO2 Master Analyzer and associated app.
- 5) Leave for the next 100m swim at the end of your 20 second rest period.
- 6) Increase the speed on each 100m so that your time decreases by approximately 2-3 seconds/100m.
- 7) Repeat until the athlete can no longer continue.
- 8) Cool down when finished.

Warning: The VO2 Master Analyzer is not waterproof. Damage may occur if the analyzer contacts water. Use at your own risk around bodies of water.

Incremental Treadmill Tests

Conconi Test

A sports medicine test focused on measuring heart rates at varying loads, requiring the athlete to increase intensity at set intervals until exhaustion. Modifications to this test have been suggested over time, making it one of the most studied testing methods available.

Balke

This protocol maintains a constant speed and increases grade by 1% each minute.

Bruce

The Bruce protocol increases both speed and grade every three minutes.

Ellestad

Increases speed each stage until the 10th minute, then increases grade to 5%, followed by subsequent increases in speed.

Astrand

Maintains a constant running speed, with a 2.5% increase in grade every 2 minutes

6. Maintenance

The components received in the VO2 Master case are shipped clean but are not disinfected. Proper disinfecting of the unit following the cleaning instructions provided is recommended before use. Your analyzer should be powered off with the battery removed prior to cleaning and disinfecting. Cleaning the VO2 Master Analyzer Body and disinfecting the user piece and locking nut should be done regularly to maintain measurement accuracy.

Cleaning Definition: Removing the unwanted substances, like dirt, microbes, and other contaminants from a surface. This can be done using a dry or wet solution.

Disinfecting Definition: The process of killing microscopic organisms (Disinfecting products claim this on their labels). This greatly reduces the risk of spreading infections. Cleaning needs to be done before disinfecting.

Warning: Make sure you read all the warning labels of the cleaning supplies you chose to use.

Cleaning the VO2 Master Analyzer

After completing a test, it is important to clean the VO2 Master Analyzer and prepare it for the next test. A few precautions between tests ensure continued optimum performance of your analyzer.

Warning: Do not get any liquid inside the locations noted by red arrows below.



- 1) Disassemble your VO2 Master Analyzer by removing the locking nut from the user piece of the VO2 Master Analyzer. Gently pull the mask free from the VO2 Master Analyzer and unscrew the user piece. Remove and dispose of the used filter.

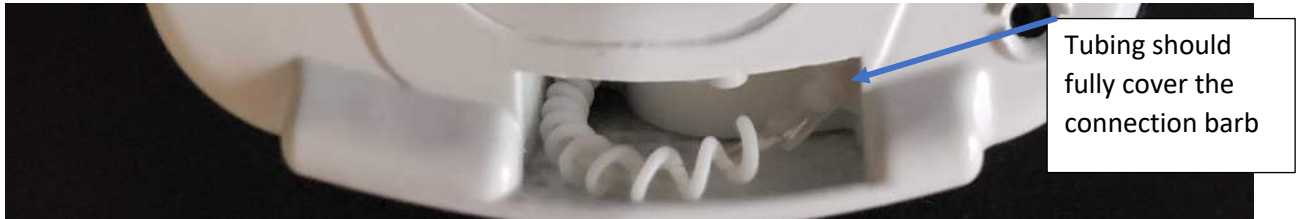


Ensure the VO2 Master Analyzer is held in such a way that the User Piece points towards the floor as you uninstall the user piece and remove the filter. This will help diminish the chance of getting condensation into the sensing ports. Make sure you remove the battery door, so it does not fall out risking damage.



- 2) Continuing to hold the VO2 Master Analyzer in this fashion, take a lint free paper towel or cloth and dry any residual condensation around the device.

- 3) Inspect the drying desiccant tube for any cracks, and confirm that the tube is still connected to the VO2 Master Analyzer
 - a. The drying desiccant tube needs to be replaced at least every 12 months, or every 50x tests based on usage. If your analyzer's humidity warning "Oxygen Sensor Too humid" has been reached multiple times the drying desiccant tubing should be replaced. Contact VO2 Master to find the best replacement option for your needs.



- 4) Turn the VO2 Master Analyzer over to visualize where the user piece inserts and completely dry the area.

Precaution: Do not pour any liquid into these ports as sensor damage can occur!



- 5) Using a 70% isopropyl alcohol wipe and tapered cotton swab, clean the area of the filter and user piece interface.



Disinfecting the User Piece and Locking Nut

1) User Piece and Locking Nut Cleaning

- a. Create a bath of 70% isopropanol and 30% water solution large enough to submerge the user piece. Higher concentrations of isopropanol can be used but are less effective. Concentrations of isopropanol less than 50% are not recommended.
- b. Submerge the user piece and locking nut into the solution for 1-2 minutes and agitate. **(Do not exceed 3 minutes)**
- c. Let user piece dry completely before reinstalling into the VO2 Master Analyzer or placing it into the storage case.

2) Once everything is completely dry the VO2 Master Analyzer can be reassembled.

- a. Install new filter
- b. Install new battery (Only insert a new battery if testing again soon)
- c. Install the battery door
- d. Screw in the user piece locking in the battery door and the filter. (If testing again soon make sure the correct user piece is inserted)

Note: Do not dry components in direct sunlight as this can eventually weaken the materials. Only return components to the hard-shell case once they are completely dry.

Mask Maintenance

The mask has a limited-service life. Mask and headgear when maintained and reprocessed per these instructions are expected to stay in service for minimum of 25 disinfections or steam sterilization cycles and the headgear 25 cleaning cycles. Visual inspection of the components during reprocessing will identify any defects. If defects are identified dispose of mask and or the headgear and do not use.

Precaution: Do not use bleach, chlorine or alcohol-based solutions to clean mask or headgear. These solutions can damage components. Direct sunlight exposure (UV Light) on mask and headgear can cause deterioration and reduce product life.

Cleaning the Mask and Headgear

- 1) Separate the headgear from the mask leaving the clear plastic braces attached to the mask.



- 2) Cleaning the face mask
 - a. Soak the mask for 5 minutes in warm water with mild detergent (neutral pH of 7). Most dish soaps will work.
 - b. Handwash the mask with sponge or soft brush; then rinse with warm tap water
 - c. Place the mask in warm water bath and agitate for two minutes
 - d. Rinse in clean tap water for at least 1 minute
 - e. Allow the mask to completely air dry or dry with clean, lint free cloth
- 3) Cleaning the headgear
 - a. Submerge headgear in warm soapy tap water; gently rub all areas
 - b. Rinse in clean tap water for 1 minute or until all soap is removed; air dry

Disinfecting the Mask and Headgear

- 1) High level Disinfection of the mask can be done in two ways, Liquid chemical disinfection, or hot water pasteurization. **Do not use any alcohol or chlorine-based solutions.**

- 2) Liquid Chemical Disinfection
 - a. Soak the mask in the liquid chemical solution per the manufacturer's instructions. We recommend soaking the mask in a Metricide solution for 30 minutes.
 - b. Remove the mask and soak in 1500 ml of water (preferably sterile) for a minimum of 1 minute.
 - c. Repeat step 2 in a new fresh water and then dry the mask with a clean lint free cloth (preferably sterile)

- 3) Hot Water Pasteurization (Can be used to replace step 2)
 - a. Immerse the mask in hot water with the temperature between 71.1° C – 76.6° C for 30 minutes.
 - b. Dry the mask with a clean lint free cloth (preferably sterile)

Desiccant Cartridge Replacement

The desiccant cartridge needs to be replaced after any of the following:

- Annual oxygen sensor replacement
- After a water ingress (any time water is seen in the cartridge tubing)
- After 50 tests (or 50 filters)

The Desiccant Cartridge should be replaced with caution. We recommend that an experienced technician completes the replacement. Contact your local VO2 Master distributor for replacement options should you feel uncomfortable performing the service yourself. The following User Replacement Guide shows the steps to replace the desiccant at home, at your own risk.

1. For each of the steps below you will need:

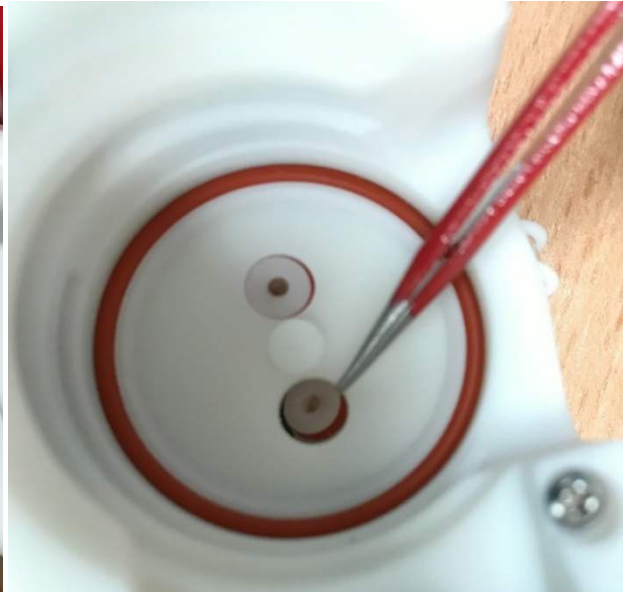
- A replacement desiccant cartridge assembly
- Straight tweezers
- VO2 Master Analyzer

2. Carefully slide the silicone (left) off the barb



3. Gently slide the lever arm counter-clockwise (to the right) until the middle of the level arm is touching the right wall.

4. While holding the lever arm all the way to the right, using tweezers push the bottom of the coil assembly out of the hole.



5. Once the coil assembly is out of the hole gently slide the coil assembly out.

6. Finished removal process. Note to aim for the slots in the back of the port for reinsertion.



7. Carefully slide the assembly into the unit with the lever arm pointing out.



8. Looking through the face plate, line up the short nub from the coil assembly with the groove on the other side of the faceplate.



9. Using tweezers gently push the assembly down into the hole. Each tong of the tweezers should be on each side of the tubing to apply equal force on the assembly.

Top View



10. Once the assembly is seated, and while applying a downward pressure with the tweezers, turn the lever clockwise until it is firmly positioned under the locking nub.



11. Slide the silicone over the connection barb.



Disposal of Components

- 1) Batteries should be disposed of according to your local and federal regulations.
- 2) Mask, headgear, filters, battery door, user pieces, and silicone end pieces can be disposed of as solid waste in accordance with local and federal regulations.
- 3) The VO2 Master Analyzer should be treated as electronics and disposed of according to your local and federal regulations.
- 4) The VO2 Master Analyzer oxygen sensor contains a caustic material and should be disposed of according to your local and federal regulations.

Warning: Do not smash the VO2 Master Analyzer as the plastic shards may cause injury to yourself or others in the immediate area!

The crossed-out wheel bin indicates that the product should not be discarded as unsorted waste and must be sent to separate collection facilities for recovery and recycling.



Annual Service

The VO2 Master Analyzer is equipped with a high quality oxygen sensor that is consumable - it must be replaced annually (See Appendix II for replacement). Annual service also includes the replacement of the drying desiccant tubing; this tubing needs to be replaced at minimum once yearly to maintain optimal performance. VO2 Master will administer performance tests to ensure that the accuracy of your analyzer is as good as the day it was first made.

You may replace the oxygen sensor yourself or send it to an authorized service center. Contact us at support@vo2master.com to begin this process. Analyzers produced prior to September 2022 must be shipped to VO2 Master for service as they are not end-user serviceable.

Register your VO2 Master Analyzer's warranty here:

<http://vo2master.com/warranty/>



7. Technical Specifications

Physical Design

Dimensions (without mask)	134mm x 92mm x 53mm
Weight	350g (230g unit, 120g mask)
User Interface	On/Off button, RGB LED indicator, phone and tablet application
Wireless Capability	Standard Bluetooth Protocol Range* Bluetooth 4- 30ft (10m) Bluetooth 5- 90ft (30m)
Mask	Hans Rudolf 7450 V2
Internal Protection Rating	IP33 rating. Safe from particles over 2.5mm and water falling up to 60° from vertical
Humidity Control	Drying desiccant tubing and hydrophobic filter
Local Storage	None. All data is collected into the phone app or Garmin data field.

**It is not recommended to operate the analyzer at the extremity of its wireless range since this could lead to data loss and connectivity issues.*

Sensor Measurements

O2 Accuracy (0-100%)	± 1%
Flow Accuracy with syringe calibration	± 2%
Flow Accuracy without syringe calibration	± 4%
Flow Sensor Type	Differential Pressure
Oxygen Sensor Type	Galvanic Fuel Cell
Gas Sampling System	Passive, pump-less
Oxygen Sensor Replacement Interval	12 Months, or less when testing heavily, daily.
Drying Desiccant Tube Replacement Interval	12 Months, or 50 tests, or after a water ingress
Calibration	Ambient. Optional calibration for flow using a syringe
Pressure (300-1100 mbar/ 50-110 kPa)	±0.25%
Humidity (0-99%RH) *	±3%
Temperature (15-45°C) *	±1°C

*Readings are not ambient readings and are based on the sampled flow through the analyzer

Ventilatory Ranges

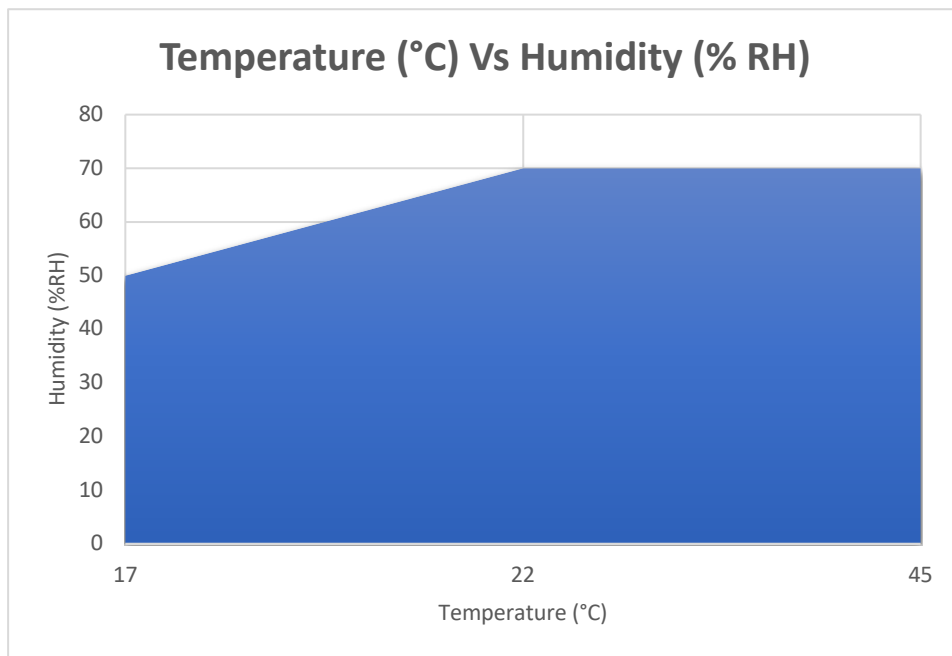
	Resting User Piece (RMR)	Medium User Piece (M)	Large User Piece (L)
Ventilation [L/min] (Display Range)	3 - 50	15 - 180	25 - 250
Ventilation [L/min] (Accurate Range)	5 - 40	30 - 160	40 - 220
Tidal Volume [L]	0.25 - 10	0.25 - 10	0.25 - 10
Respiratory Frequency [bpm]	3 - 55	10 - 80	5 - 80

Session Duration and Downtime

Maximum testing duration	1 hour
Minimum downtime between sessions	30 Minutes
Maximum sessions per day	8 with downtime
Filter change time	Every session, or 1 hour

Environmental conditions

- Temperature Range: 17-45° C
- Altitude: Up to 10,000 ft
- Headwind: Headwind decreases accuracy.
- Pressure: 300-1100 mbar (50-110 kPa)
- Humidity: 0-70% Non-Condensing Ambient Air. Avoid testing in the rain. The chart below specifies the humidity range the analyzer can be used in. For example, at 17°C the max ambient humidity is 50% Relative Humidity (RH).



For best results, test inside with adequate ventilation, and in a dust free location. Avoid pointing a fan directly at the analyzer – instead, place a fan behind a stationary user for optimal accuracy.

Power Supply

- Battery Type: Single AAA
- Battery Life: 8 hours +
- Charge Ports: None

Health and Safety

Single-Use Filter Disc Filtration Performance

NaCl Penetration at 32 LPM	< 3.00%	Tested in accordance with TSI8130 NaCl 0.1-micron particle size
NaCl Efficiency at 32 LPM	> 97.00%	Tested in accordance with TSI8130 NaCl 0.1-micron particle size
Pressure Drop at 32 LPM	< 0.8mm H ₂ O	Tested in accordance with TSI8130 NaCl 0.1-micron particle size
Bacterial Filtration Efficiency (BFE)	> 99.945%	Tested in accordance with Spec MIL-M-36954C By Nelson Labs
Virial Filtration Efficiency (VFE)	> 99.909%	Tested in accordance with Spec MIL-M-36954C By Nelson Labs
Air Permeability	> 200 CFM	Tested in accordance with ASTM Spec ASTM D373

- Material Specifications are in accordance with ASTM Standards for Evaluating Non-Woven Textiles
- The tolerances are based on an average of data points taken in a defined area of the roll goods
- These specifications are void once the material has been converted
- All tolerances and data subject to change.
- The filter disc does not filter the entirety of exhaled and inhaled air. It filters the air between the user's breath and the proximal sensor ports.

Airway materials	Mask adapter and oxygen sensor gas channel cartridge are made of a high-grade polymer
VO2 Master Analyzer Outer Shell and Main Body	High-grade polymer
Mask Material	Autoclavable silicone

Analyzer Certifications

Wireless Transducer	Contains a BMD-350 pre-certified wireless module
Bluetooth Declaration ID	D037593
FCC ID	2AA9B05
IC RSS-210 modular qualification	12208A-05
Additional Safety Standards met	CE EN 60950-1: 2011-01 3.1 (a) Health and Safety of the User CE EN 301 489+17 V2.2.1 3.1 (b) Electromagnetic Compatibility CE EN 300 328 V1. 8.1 3.2: Effective use of spectrum allocated

Phone Application

Supported Platforms	iOS, Android
Bluetooth Sensor Compatibility	VO2 Master Analyzer, Heart Rate, Cadence, Speed, Power, Muscle O2 Saturation
Graphical Display	Live graphs, live numbers, whole test summary, post-test graphs
Sharing Capabilities	Email data and report, and print report from app

8. Accessories

Face Mask

Proper Fit

It is imperative to have a properly fitted mask while conducting VO₂ testing. Any amount of air leakage will result in incorrect data.

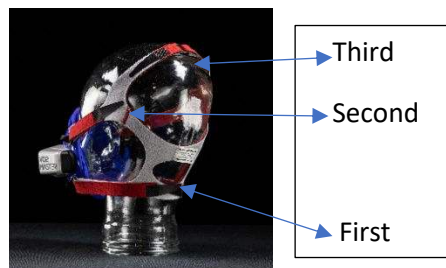
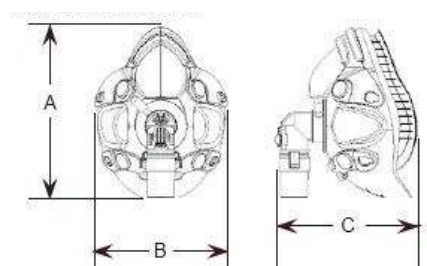
- 1) Use the sizing chart to determine correct mask size and coordinated correct head gear. If you are between sizes, it is best to choose the smaller size.
- 2) Tighten bottom side straps first and simultaneously, middle side straps second, top head strap third. See chart below.

Signs of Improper Fit

- Visual gaps between mask and skin
- Feeling of air seeping in around mask- especially around nose bridge
- Data being totally out of range, being non-sensical
- People with facial hair may experience leakage

Sizing Chart

	<u>Large (L)</u>	<u>Medium (M)</u>	<u>Small (S)</u>	<u>Extra Small (XS)</u>	<u>Petite (P)</u>
A (inches)	5.9	5.6	5.2	4.8	4.6
B (inches)	3.7	3.4	3.2	3.1	3.0
C (inches)	4.2	4.2	4.0	3.9	3.9
Weight (gm)	128	118	100	89	83



Recommended Headgear Sizes for each Mask Size

MASK	L	M	S	XS	P
HEADGEAR	L	M	M	S	S

Warning

To avoid skin irritation, never clean with harsh chemicals. Wash with mild detergent and hot water. Discontinue use if irritation or allergic reaction develops due to the mask.

Materials

Face Piece with Brace	<i>Silicone Rubber Blue, Polycarbonate Thermoplastic</i>
Headgear	<i>Polyurethane Foam Black, Nylon UBL Gray and Nylon Fabric Red</i>
Headgear Hook	<i>Nylon, Black</i>
Headgear Strap Clips (4)	<i>Polypropylene, Black</i>
Custom Mask Adapters	<i>Polycarbonate Thermoplastic, Silicone Rubber</i>

Mask Specifications

- Steam autoclave, cold chemical, pasteurization, and dishwasher safe
- Users with facial hair, especially beards, may experience mask leakage and may require shaving their hair
- Temperature: 5°C to 40°C
- Relative Humidity: 0% to 95% (non-condensing)

Service Life

Face masks when maintained properly should function with specifications for a minimum of 25 autoclaves and uses. Visual inspection of all the components during each reprocessing cycle will identify any defects.

User Pieces



The user pieces are reusable flow inserts. Each size is optimized for certain flow range and application. Having additional user pieces enables fast switching between users. Here is a list of the flow ranges for each user piece.

User Piece Size	Ventilation Range [L/min] (Display Range)	Ventilation Range [L/min] (Accurate Range)
Resting (RMR)	3 -50	5-40
Medium (M)	15 - 180	30-160
Large (L)	25 - 250	40-220

Compatible Sensors

You can connect to these Bluetooth devices simultaneously:

- 1 VO2 Master Analyzer
- 1 Heart Rate Strap
- 2 Power Meters
- 1 Speed and Cadence
- 7 Muscle Oxygenation
- 1 Thermometer
- 1 Smart Trainer*
- 1 Pulse Oximeter

*Indoor bike trainers that support FTMS, FEC over BLE (Tacx® NEO 2T)

Note: Maximum concurrent Bluetooth connections may differ per mobile device: some mobile devices may be able to connect to as few as 7 sensors and as many as 22.

Compatible Testing Devices - Bluetooth Standard Protocol

This list is not exhaustive. If you have devices that conform to the Bluetooth Standard, they may pair with the VO2 Master Manager App. Below is a list of known devices that pair.

Moxy Monitor*	www.moxymonitor.com
Wahoo Heart Rate	www.wahoofitness.com
Stryd Power Meter*	www.stryd.com
Polar H10 Heart Rate Strap*	www.polar.com
SUUNTO	www.suunto.com
4iiii Heart Rate	www.4iiii.com
Tacx® Neo 2 Smart Trainer*	www.garmin.com/tacx/
Wahoo Kickr	ca.wahoofitness.com/devices/indoor-cycling/bike-trainers
Core Temperature Monitor	corebodytemp.com/
Train.Red Fyer Sensor	https://train.red/

*Manufacturers' Recommended Choice

Third-Party Software

VO2 Master is developer-friendly and welcomes those who wish to use the VO2 Master Analyzer in their software projects. Please contact us to request the software development kit.

9. Appendix I: Terminology

Common Terminology

Activity Level	The amount of physical movement one does on a given day determined by habitual activities including occupation, exercise, leisure, commuting and household activity.
Sedentary	Little to no physical activity – i.e., elderly person in powered wheelchair
Light	Some physical activity required for household chores and personal care – i.e., person who drives to work, sits at a desk, does minimum cooking, cleaning, and grooming at home, or light exercise 1-2 times per week.
Moderate	Physical activity required throughout the day – i.e., person whose work requires movement such as walking with a load, or light exercise 3-5 times per week
Very	High amount of physical activity required throughout the day – i.e., person who works in non-mechanized agriculture or construction, does non-mechanized household chores, or performs high aerobic exercise 6-7 times per week
Extra	Very high amount of physical exercise required throughout the day – i.e., person who hauls drinking water, does non-mechanized labour, or performs high amounts of high aerobic exercise 1-2 times per day
Acyclic	Not displaying or forming part of a cycle.
BMR	Basal Metabolic Rate - The amount of energy expended (calories burned) while at rest in order to keep vital functions going, such as breathing.
BPM	Breaths Per Minute or Beats Per Minute.
Caloric Expenditure	The amount of energy the body uses (calories burned) in a certain period of time. Each activity will require a different caloric expenditure.
CPET	Cardiopulmonary Exercise Test - involves high intensity exercise. It can be used to determine how well the lungs, heart and muscles work individually and together.
Free Protocol	Testing which does not fall into one of the pre-determined protocols.
Interval	A period between two events. In exercise testing, an interval is a set time (i.e., 1 minute) and intensity (i.e., 65 watts). Intensity may be held steady or increasing in equal amounts at the set time.
VO₂ max	Is the maximum rate of oxygen consumption measured during incremental exercise. By definition, you are looking at maximal intensity exercise to find VO ₂ max.
Phase	A distinct period or stage in a series of events – i.e., warm up, test, cool down are all a phase of a test.
RMR	Resting Metabolic Rate – the calories you burn while at rest. This is differentiated from BMR by the fasting time used prior to testing – 4 hours for RMR and 12 hours for BMR.

Graded Step Test

Graded exercise testing (GXT) is the most widely used assessment method to examine the dynamic relationship between exercise and integrated physiological systems. The information from GXT can be applied across the spectrum of sport performance, occupational safety, research, and clinical diagnosis.

Training Zones

Is a range that defines the upper and lower limits of training intensities.

Ventilatory Threshold 1

Ventilator threshold 1 (VT1) identifies the intensity of exercise which results in the first noticeable increase in breathing effort. The increase in breathing that is noticeable during increasing levels of exercise intensity is a response to the production of carbon dioxide (CO₂) in the working muscles. There are a number of different methods that can be used to determine VT1. The most common method is to identify a non-linear increase in ventilation (V_e) when compared to the volume of oxygen being used (VO₂). This value is also sometimes identified as the predicted level at which lactate would also begin to accumulate in the blood, and in some cases referred to as an “aerobic threshold”.

Ventilatory Threshold 2

Ventilatory threshold 2 (VT2) identifies a higher level of intensity than VT1, at which the breathing has become significantly laboured, and often correlates with a rapid rise in lactate levels. Hence, many people associate VT2 with the lactate “threshold” or “anaerobic threshold”. It marks the limit between moderate and high intensity exercise and identifies the upper limit of intensity that can be sustained during prolonged exercise.

System Measurements

Symbol	Unit Measurement	Parameter
VO ₂	mL/min	Absolute Oxygen Consumption
VO ₂	mL/kg/min	Oxygen Consumption relative to weight
T _v	L	Tidal Volume; volume breathed in a breath
R _f	bpm	Respiratory Frequency; breaths per minute
V _e	L/min	Ventilation; air moved by lungs
HR	bpm	Heart Rate
FeO ₂	%	Fraction of Oxygen in expired breath
EE	Kcal/day	Energy Expenditure

10. Appendix II: Oxygen Sensor Replacement

We recommend that an experienced technician at an authorized dealer performs the following steps, however, one can perform this replacement at home at their own risk. VO2 Master takes no responsibility for damaged product by user replacement of the oxygen sensor. Contact your local dealer or VO2 Master directly for necessary replacement parts and replacement options.

Step 1: Remove silicone cover by gently pulling at the edges by hand



Step2: Remove both retaining screws and the retainer



Step 3: Unplug and remove the oxygen sensor



Step 4: Ensure the black, silicone o-ring is still in place at the front of the oxygen sensor. Do not remove.



Step 5: Dispose of the **old** oxygen sensor according to local regulations

Step 6: Assemble **new** oxygen sensor and O-ring



Step 7: Insert the oxygen sensor and O-ring

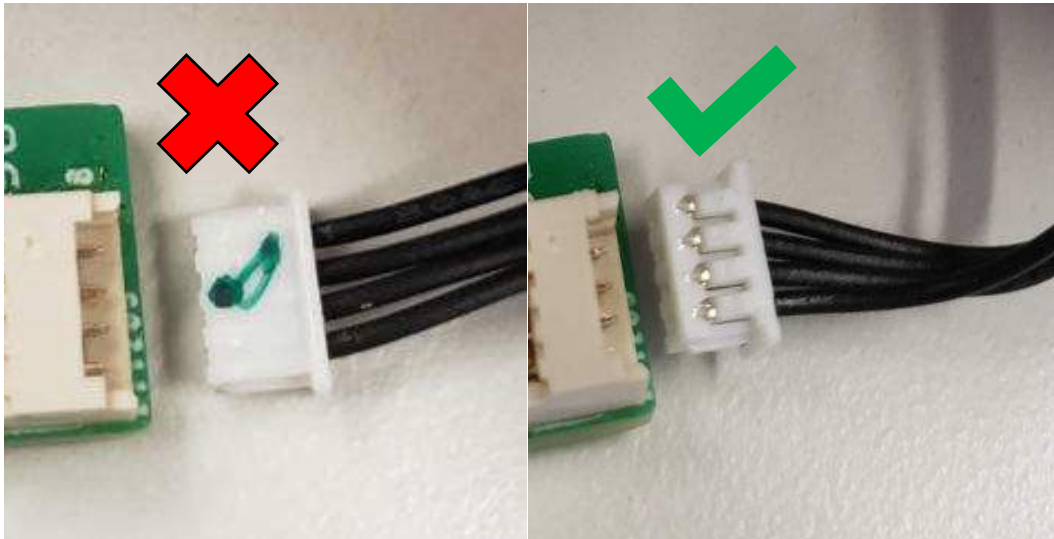


Step 8: With tweezers, connect the cable making sure the connector is in the correct orientation

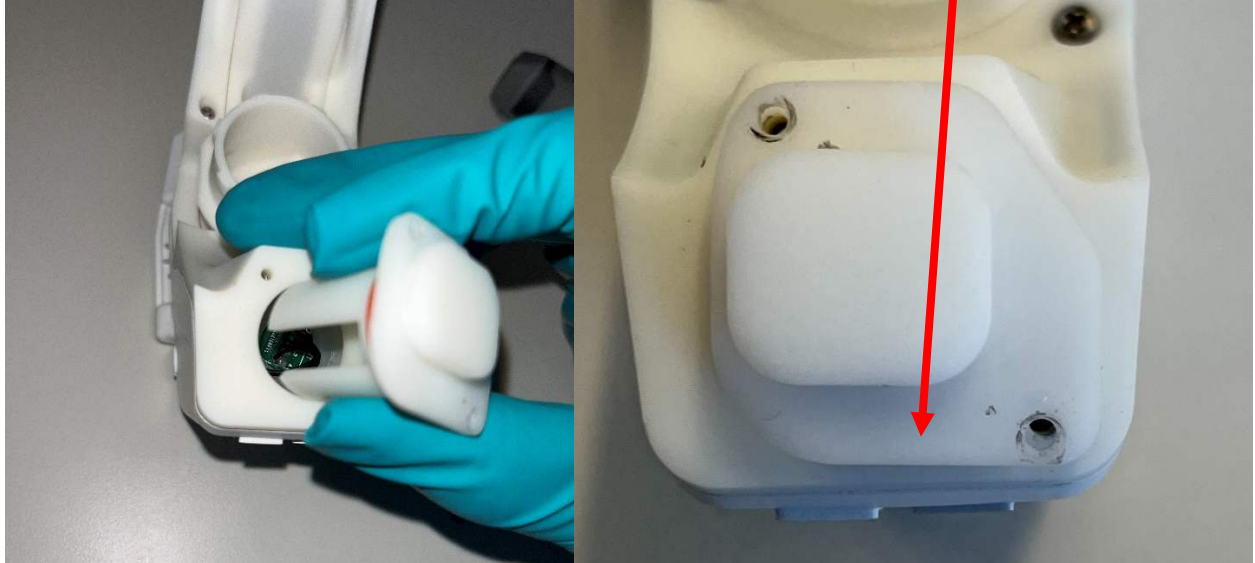


Left Image: Incorrect cable orientation, connector male end will not slide into connector female end and can cause damage to the connector. It is possible to damage this connector receptacle if the connector is forced in the wrong orientation or alignment.

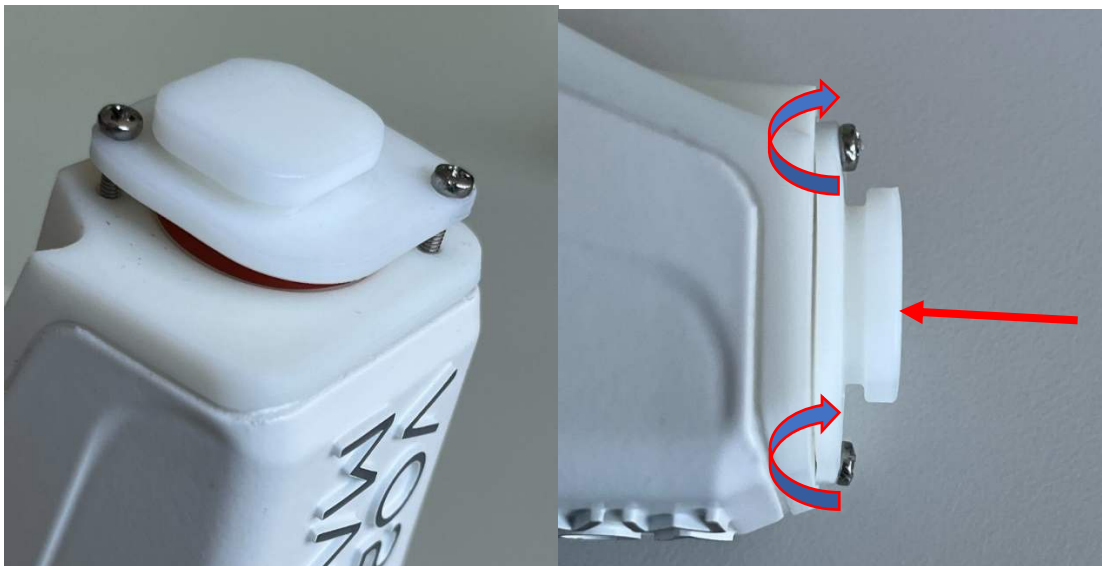
Right Image: Correct cable alignment, exposed metal side of the connector male end should be on the same side as the cut out in the connector female end.



Step 9: Insert the retainer and screws. When inserting the retainer make sure to align the slot in the retainer over the cables such that they are not pinched. The retainer should slide in easily over the cable until the red O-ring rests on the edge of the body. At this point insert the screws. (Align the long flat edge with the outside of the analyzer)



Step 10: Tighten screws to 0.2 Nm using a torque screwdriver. VO2 Master will not accept responsibility for damage caused by screw over-tightening. We strongly recommend purchasing a torque screwdriver. To ensure an even compression of the red O-ring, alternate turning each screw one rotation until the edge of the retainer touches the unit body. The retainer will deform slightly and will not sit perfectly flush as seen in the below, right photo.



Step 11: Replace the silicone cover by hand and wiggle into place.

