



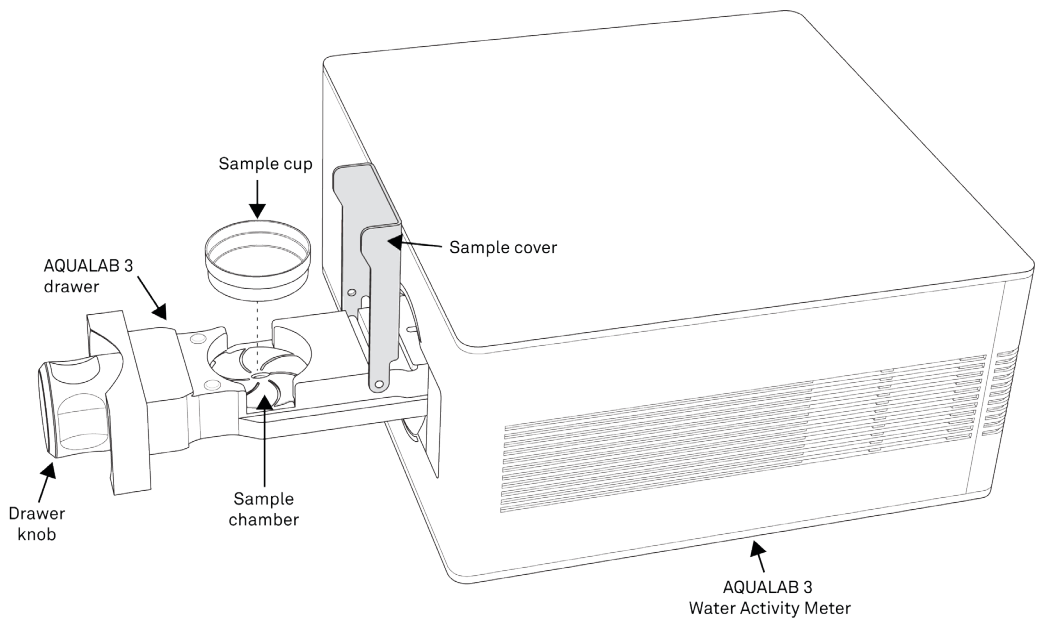
METER

AQUALAB 3

TABLE OF CONTENTS

1. Introduction.....	1
2. Operation	3
2.1 System Network Requirements	3
2.1.1 Connection Options	5
2.1.2 Using a METER Data Logger	5
2.2 AQUALAB 3 First Time Setup	6
2.2.1 Connect AQUALAB 3 and NEXUS	6
2.2.2 Connect iPad and Download SKALA Mobile App	7
2.2.3 Register New Company Site	9
2.2.4 Connect First NEXUS	13
2.2.5 Enter SKALA Mobile First Time	15
2.2.6 Create First Product.....	16
2.3 Enter Existing Company Site.....	19
2.3.1 Add Additional iPads to Existing System	20
2.3.2 Add Additional NEXUSES	21
2.3.3 Add Additional Water Activity Products	23
2.3.4 Remove Products	26
2.3.5 Select Market Groups (Subscription Required).....	28
2.3.6 Add First Total Moisture Product (Subscription Required)	31
2.3.7 Remove Products	34
2.4 Add a Batch.....	35
2.5 Take a Reading	38
2.5.1 Water Activity Reading.....	39
2.5.2 Total Moisture Reading	46
2.5.3 One-Minute Water Activity Reading Mode	54

2.5.4	Setting Up Isotherm-Determined Moisture Content	54
2.5.5	Performing a Linear Offset	60
3.	System.....	63
3.1	Specifications.....	63
3.2	Components	65
3.2.1	Sensor Block.....	65
3.2.2	Sample Drawer	66
3.2.3	Drawer Knob Indicator Lights.....	67
3.2.4	NEXUS	68
3.3	Modes and Tests	69
3.3.1	One-Minute Water Activity Mode	69
3.3.2	Total Moisture	69
3.4	Theory.....	70
3.4.1	Water Content.....	70
3.4.2	Moisture Content	70
4.	Service.....	74
4.1	Performance Verification	74
4.2	Cleaning.....	77
4.3	Troubleshooting	81
4.4	Customer Support.....	82
4.5	Terms and Conditions	83
	Reference.....	84



1. INTRODUCTION

Thank you for choosing the AQUALAB® 3 water activity meter from METER Group. The AQUALAB 3 uses a chilled-mirror dew point sensor and capacitive hygrometer and is controlled and operated through the SKALA® Mobile by METER application using an Apple® iPad® device.

Verify all AQUALAB 3 system components are included and appear in good condition:

- AQUALAB 3 Water Activity Meter with calibrated sensor block
- AQUALAB Accessory Kit
 - ◆ Power cord (2.29 m, 7.5 ft)
 - ◆ USB A to USB B cable (1.83 m, 6 ft)
 - ◆ 250 disposable sample cups
 - ◆ Cleaning kit
 - ◆ Standards kit
 - ◆ SDS booklet
- SKALA NEXUS Benchtop Unit
- SKALA NEXUS Accessory Kit
 - ◆ AC adapter (micro USB)
 - ◆ Ethernet cable (1.83 m, 6 ft)
 - ◆ USB A to USB A cable (1.28 m, 6 ft)
- iPad stand
- Apple iPad (optional)

NOTE: Prior models of AQUALAB 3 are compatible with a SKALA Hub. If setup assistance with a SKALA Hub is needed, please contact [Customer Support](#).

SKALA Mobile by METER, an application available from the Apple App Store, will need to be downloaded onto the iPad. The app is used to register a new customer site, create products and batches, and operate the equipment. Everything that is created in SKALA Mobile is stored in the SKALA Control cloud service.

SKALA Control is a cloud-based software program where data can be analyzed and downloaded and where more advanced settings can be made. SKALA Control stores all historic readings, displays readings in charts, modifies customer site settings and users, modifies existing tests, plus much more.

Freemium version. The first time a customer site is set up, there is no charge for the use of basic features available in the SKALA Mobile app (referred to as Freemium). In the Freemium version, only water activity features are available.

Subscriptions. Monthly SKALA Control subscriptions are needed to utilize additional features such as total moisture readings ([Section 2.5.2](#)) and one-minute reading mode ([Section 2.5.3](#)). To learn more about SKALA Control subscription plans, contact [METER Sales](#).

SKALA training [documents](#) and [videos](#) can assist when learning how to use SKALA Control.

For more information on SKALA Control, please contact [Customer Support](#).

2. OPERATION

Please read all instructions before operating the SKALA Mobile app and the AQUALAB 3 meter to ensure everything performs to its full potential.

Please observe the following considerations carefully.

- Only allow personnel who have been qualified by METER to carry out service work on the electrical components.
- Only operate this instrument with the main power voltage specified (100 to 240 VAC at 50 to 60 Hz).
- Plug the instrument into a grounded outlet or power strip.
- Only use the fuse type and rating specified for this instrument ([Section 3.1](#)).

If the instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

PRECAUTIONS

METER instruments are built to the highest standards, but misuse or neglect may damage the device and possibly void the manufacturer's warranty. Before using the AQUALAB 3, follow the recommended user instructions and arrange proper protections to safeguard the instrument from damage.

2.1 SYSTEM NETWORK REQUIREMENTS

METER recommends the following as the network requirements for the SKALA deployment environment (the environment where the NEXUS and Apple® iPad® mobile digital device are installed). Implement the security controls that are appropriate for the sensitivity of the data.

- Internet connection—standard 1 GbE network or faster.
- The devices must be able to connect to the following destinations:
 - ♦ skalacontrol.com—the primary endpoint for the SKALA server, hosted by METER.
 - ♦ websocket.skalacontrol.com—the functional endpoint for the websocket communications layer.
 - ♦ *.zoho.com—utilized for the METER secure remote support tool.
- The iPad and NEXUS devices must be able to communicate over ports listed in [Table 1](#).

All communication between the NEXUS, iPad, and client PC is bidirectional. No communication will be directly initiated by an outside device.

[Table 1](#) lists the ports that must be available for the SKALA system to function properly.

Table 1 Ports for SKALA

Port	Direction	Destination	Usage
443	In/Out	*.skalacontrol.com CHINESE SERVER *.skalacontrol.cn	HTTPS over TLS communication, used to retrieve and post data to the SKALACONTROL server
443	In/Out	*.zoho.com	Utilized for the METER remote support tools, enables the METER team to help and resolve issues and outages
443	In/Out	iot-prod.skalacontrol.com	Communication between the NEXUS or iPad and AWS IoT Core Services
123	In/Out	*.ntp.org	Used for NTP time sync
80	In/Out	*.decagon.com	METER firmware updates
443	In/Out	*.metergroup.com	METER firmware updates

Figure 1 illustrates the network connections and communications protocols.

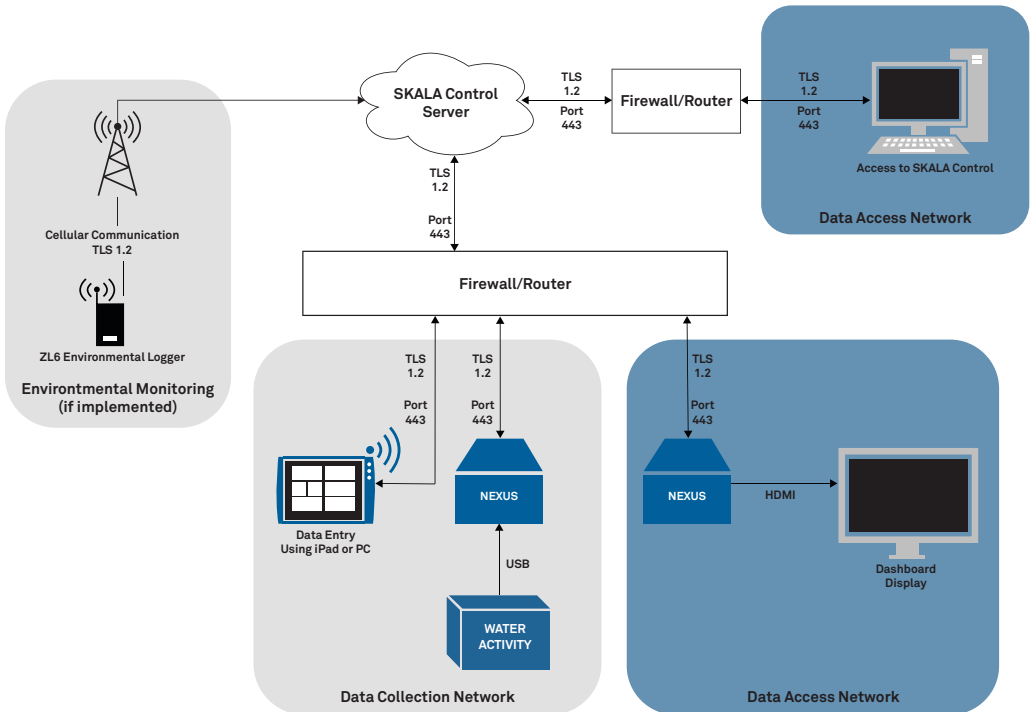


Figure 1 Network diagram

2.1.1 CONNECTION OPTIONS

METER recommends Ethernet connection for the components for connectivity stability, but the components can also be connected via a Wi-Fi® connection.

AQUALAB 3

AQUALAB 3 always connects to the NEXUS via a USB A to B cable.

APPLE IPAD

The Apple iPad connects to the network via a Wi-Fi connection or via an Ethernet cable through a lightning port-to-Ethernet adapter.

NEXUS

METER recommends connecting the NEXUS to the network via an Ethernet cable. Connecting the NEXUS to WiFi can be configured using the USB-to-USB cable (included) and the NEXUS Utility software (available at downloads.metergroup.com/software/NexusUtility_1.0.exe).

PC INSTEAD OF IPAD

The user will take readings via skalacontrol.io accessed from the user's PC web browser.

SKALA CONTROL

SKALA Control is accessible via a web browser:

- North American servers: skalacontrol.com
- European servers: eu.skalacontrol.com
- Japanese servers: jp.skalacontrol.com
- Chinese servers: china.skalacontrol.cn

METER recommends using Google Chrome for the best possible user experience.

2.1.2 USING A METER DATA LOGGER

METER data loggers do not require a Wi-Fi network or Ethernet. The data loggers have an LTE cellular modem that connects directly to METER cloud services. The loggers operate with T-Mobile® and AT&T® cellular carriers and usually find a good signal. If the location is notorious for poor cell coverage, inform METER so other hardware solutions can be considered.

Please review the network requirements prior to the arrival of a member of METER Professional Services to ensure a smooth, quick, and efficient installation process.

2.2 AQUALAB 3 FIRST TIME SETUP

Place the AQUALAB 3 on a clean, level surface in a location where the ambient temperature remains relatively constant.

NOTE: The AQUALAB 3 should be positioned well away from all heating and air-conditioning vents, open windows, outside doors, refrigerator exhausts, and other sources of temperature fluctuation.

This section explains how to connect the AQUALAB 3 and the NEXUS ([Section 2.2.1](#)), connect the iPad device to a local Wi-Fi® network, and download the SKALA Mobile app to the iPad device ([Section 2.2.2](#)), register a new company site ([Section 2.2.3](#)), connect and verify the first NEXUS ([Section 2.2.4](#)), enter SKALA Mobile the first time ([Section 2.2.5](#)), and set up the first product ([Section 2.2.6](#)).

2.2.1 CONNECT AQUALAB 3 AND NEXUS

The steps below explain how to connect the AQUALAB 3 and the NEXUS ([Figure 2](#)).

1. Plug the AQUALAB 3 power cable into the back of the AQUALAB 3 and into a grounded outlet or power strip.
2. Plug the NEXUS power cable into the micro USB port on the side of the NEXUS and into a grounded outlet or power strip.
3. Plug the USB A connector of the USB A to B cable into the USB A port on the NEXUS.
4. Plug the USB B connector of the USB A to B cable into the USB B port on the AQUALAB 3.
5. Plug the Ethernet cable into the NEXUS and into an Ethernet wall jack.

OPERATION

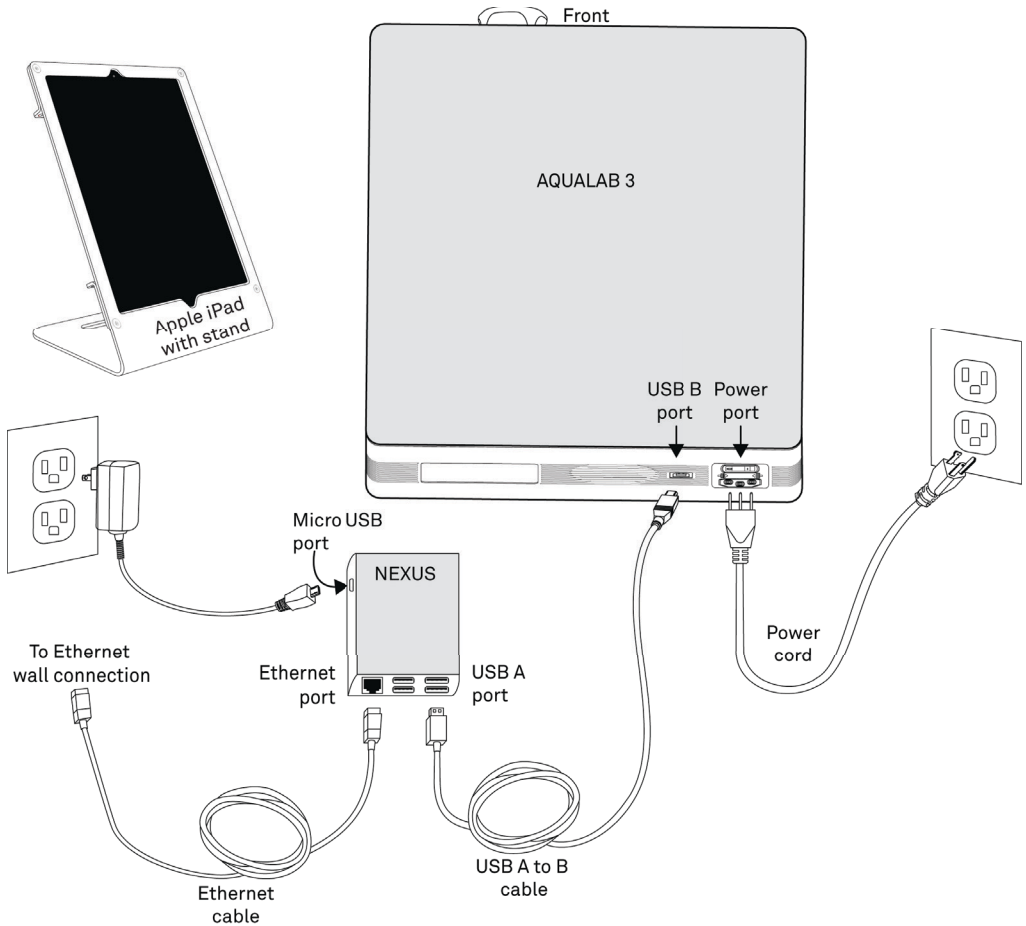


Figure 2 AQUALAB 3 system

Please see [Section 2.1](#) for additional setup information.

2.2.2 CONNECT IPAD AND DOWNLOAD SKALA MOBILE APP

The steps below explain how to connect the iPad ([Figure 3](#)) to the Wi-Fi network.

1. Connect the iPad mobile digital device to a Wi-Fi network (not cellular).

ATTENTION: The network must also be able to communicate with SKALA cloud-based servers (i.e., must have access to the internet).

2. Ensure the iPad is associated with a valid Apple ID.



Figure 3 Apple iPad with stand

3. Open the Apple App Store by scanning the QR code on the back of the NEXUS device ([Figure 4](#)).

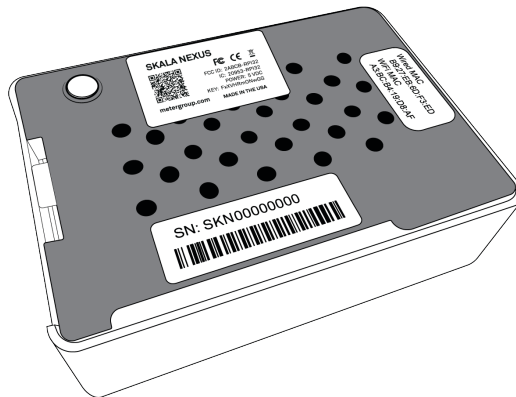


Figure 4 NEXUS back view

4. Download the SKALA Mobile by METER app ([Figure 5](#)).

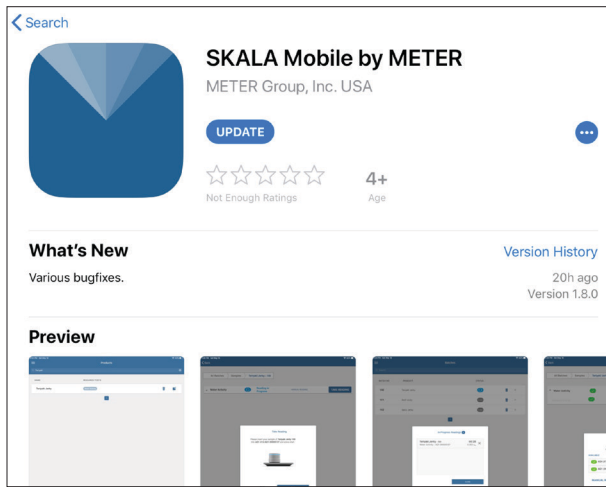


Figure 5 SKALA Mobile by METER screen

NOTE: The application can also be found by searching in the Apple App Store for SKALA Mobile by METER.

2.2.3 REGISTER NEW COMPANY SITE

Registering a new company site using the SKALA Mobile wizard bar is a one-time step. Figure 6 shows the wizard bar that appears at the top of SKALA Mobile screens when the wizard is active. The wizard is only available for the first setup.



Figure 6 SKALA Mobile wizard bar

The new company SKALA account is created and the initial AQUALAB 3 is registered (Figure 8 through Figure 11).

When setting up the AQUALAB 3 system for the first time, a setup wizard will take the user through the steps of registering the new company site (Section 2.2.3), connecting the first NEXUS (Section 2.2.1), and creating the first product (Section 2.2.6).

The Register device screen (Figure 7) will show up in the following situations.

- SKALA Mobile app is downloaded onto a new iPad on a new AQUALAB 3 system being set up for the first time.
- SKALA Mobile app is reloaded onto an iPad on an existing AQUALAB 3 system (Section 2.3.1).

The following steps explain how to go through the process of registering a new company site using the wizard. For subsequent additions or changes, refer to [Section 2.3](#). Contact [Customer Support](#) with any questions or issues.

1. Adjust the iPad Display Auto-Lock settings to the desired length of time to keep the SKALA Mobile active.

If the iPad goes to sleep during initial system setup, the SKALA Mobile app will close. When the SKALA Mobile app wakes up, the screen shown in [Figure 25](#) will appear and the user will need to log back into the app.

2. Open the SKALA Mobile app on the iPad to get to the Register device dialog window ([Figure 7](#)).

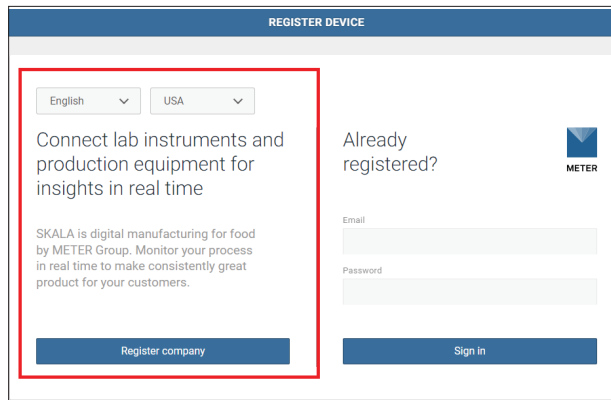


Figure 7 Register device window

3. Select the appropriate server (skalacontrol.com, eu.skalacontrol.com, or jp.skalacontrol.com).
4. Select the **Register company** button on the left ([Figure 7](#)).
5. Enter the company information in the upper half of the Register company window ([Figure 8](#)).

Back Register Company

Register a New Company

Company Information

Company Name ✓

Region ✓

Time Zone ✓

Figure 8 Company information section

6. Enter the administrator account information in the lower half of the Register company window (Figure 9).

Admin Information

Email ✓

Phone Number ✓

Username ✓

PIN ✓
PIN must be 4-10 digits

Password ✓
Password must be at least 8 characters

Confirm Password ✓

Figure 9 Admin information section

7. Enter a mobile phone number in the Connect Mobile Phone dialog window (Figure 10).
8. Select the **Send SMS** button.

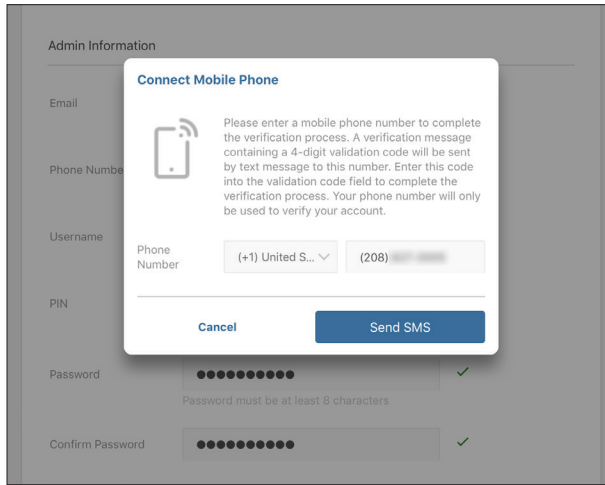


Figure 10 Connect Mobile Phone screen

A 4-digit code will be texted to the entered mobile phone number.

A Token Verification dialog window will appear (Figure 11).

9. Enter the received Token Verification code in the Enter Token field (Figure 11).
10. Select the **Verify** button (Figure 11).

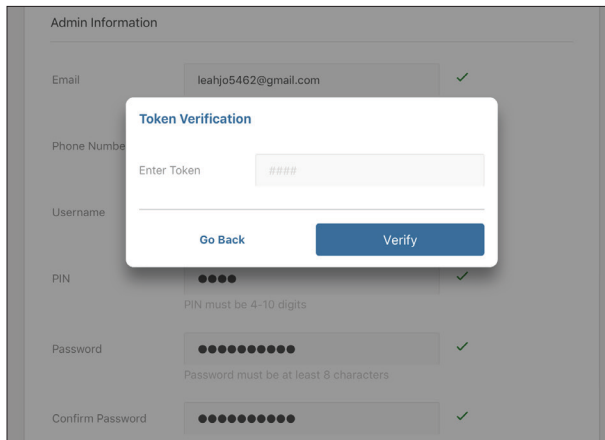


Figure 11 Token Verification screen

2.2.4 CONNECT FIRST NEXUS

The wizard automatically moves from the Register new company to Connect NEXUS. The following instructions explain how to register the first NEXUS.

1. Select **Ok** in the Register NEXUS dialog window (Figure 12).

This popup window automatically appears as part of the setup wizard function. If an error message appears, contact [Customer Support](#).

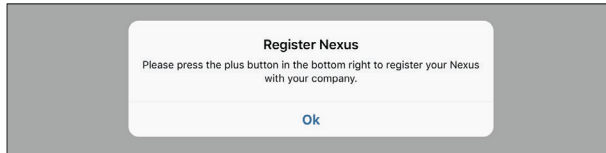


Figure 12 Register NEXUS inquiry window

2. Select the plus symbol on the screen to add a NEXUS (Figure 13).

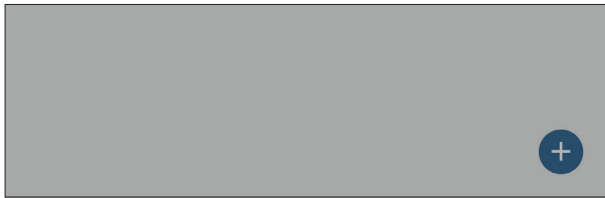


Figure 13 Plus symbol in blue circle

3. Select **Ok** in the Register NEXUS popup window (Figure 14).

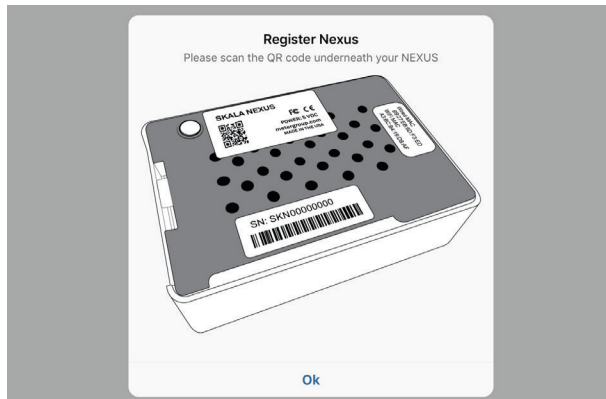


Figure 14 Register NEXUS window

The iPad camera app will open, and a dialog will appear asking for permission to access the camera (Figure 15).

4. Select **OK** in the Camera app dialog window message to give SKALA access to the iPad's camera (Figure 15).

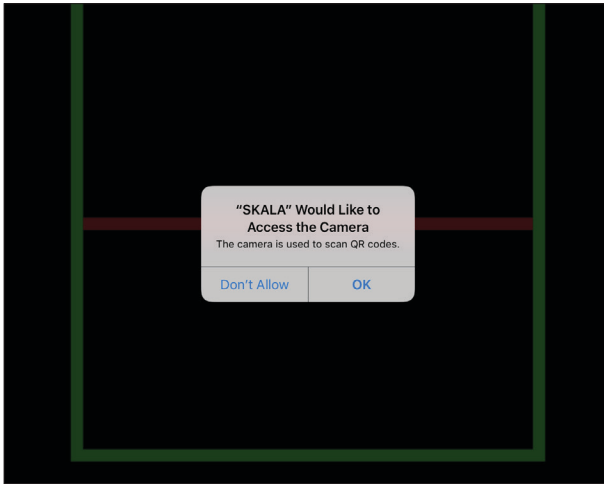


Figure 15 SKALA requests access to iPad camera

5. Turn the NEXUS over to show the labels on the bottom.
6. Place the QR code in front of the camera window and inside the green box ([Figure 16](#)).
When the camera recognizes the QR code, SKALA Mobile will automatically register the QR Code.

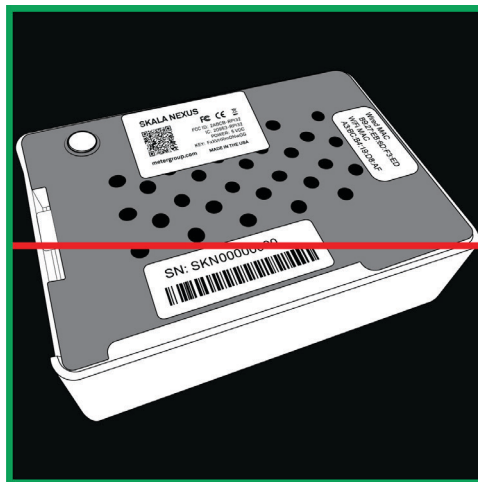


Figure 16 NEXUS in camera window

A dialog ([Figure 17](#)) will appear indicating registration success!

OPERATION

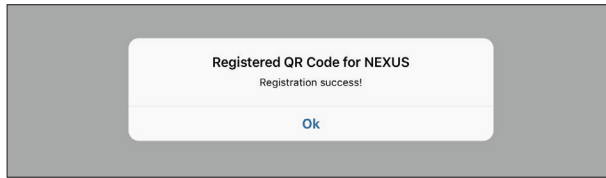


Figure 17 Registration success!

7. Select **Ok**.
8. Verify that the AQUALAB 3 system is able to locate registered NEXUSES by opening the NEXUS window from the SKALA Mobile app Main menu (Figure 18).

Any NEXUS devices should be listed here when properly registered and online.

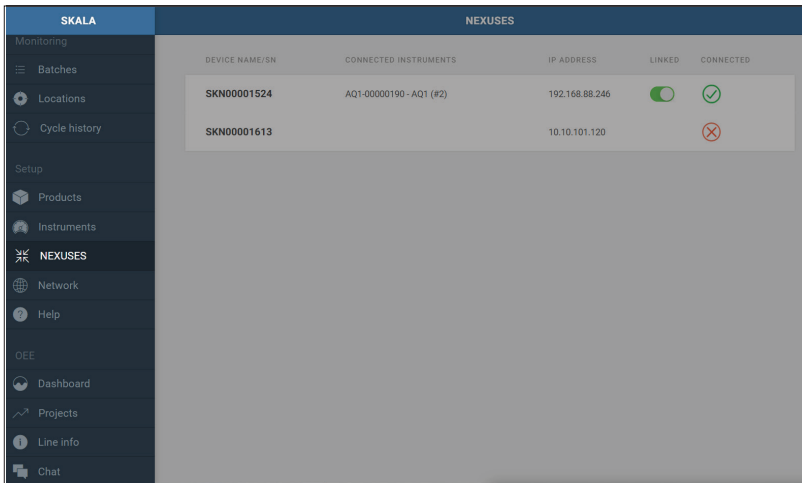


Figure 18 NEXUSES option on Main menu

The AQUALAB 3 system is now ready to add product and batch information. Please contact [Customer Support](#) if experiencing any problems registering a NEXUS.

2.2.5 ENTER SKALA MOBILE FIRST TIME

To enter SKALA Mobile the first time after registering the company, re-entering SKALA Mobile when the iPad goes to sleep, or to enter after downloading a new version of the SKALA Mobile app, please enter the following information into the Welcome to SKALA screen (Figure 19).

1. Select the dropdown menu.
2. Scroll through the list of usernames until the desired name appears.
3. Select the desired username.
4. Enter the PIN.
5. Select the **Login** button to enter the SKALA Mobile app.

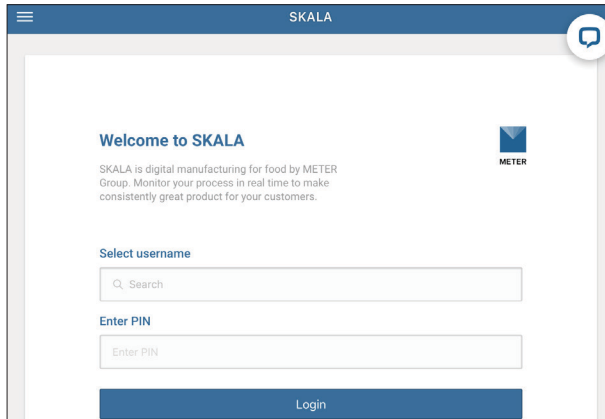


Figure 19 User login window

2.2.6 CREATE FIRST PRODUCT

Products (e.g., apple, beef jerky) must be created on SKALA Control (skalacontrol.com) or the SKALA Mobile app before readings can be run or at any time from the Products page ([Section 2.3.3](#)). Products must be added prior to adding a batch (a batch refers a grouping of the product given a batch number to separate it from other batches of the same product).

The first product being added will only be available for use with the water activity reading feature as it is in the freemium version of SKALA. Water activity tests are the only tests available through the freemium version. Additional tests and features can be accessed with a monthly subscription to a premium plan. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

To create the first product, use the following steps via the SKALA Mobile app wizard.

1. Select **Ok** to begin the process of adding the first new product ([Figure 20](#)).

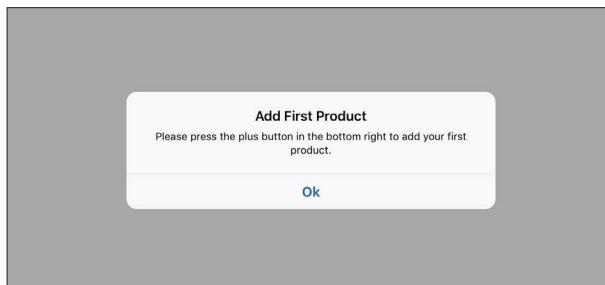


Figure 20 Add first product prompt

2. Select the plus symbol on the Products screen to add a product ([Figure 21](#)).

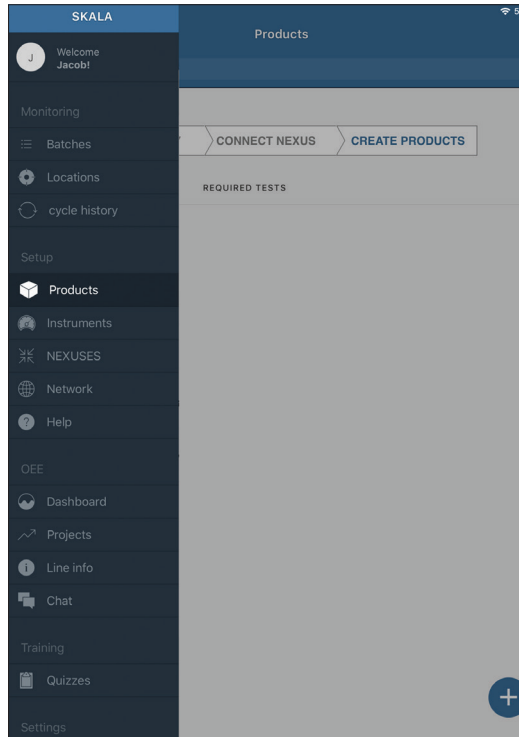


Figure 21 Plus symbol in blue circle

3. Enter the product name in the Name field (Figure 22).
4. Select Water activity from the Select test dropdown menu (Figure 22).
5. Set minimum and maximum reading values (Figure 22).

NOTE: The minimum and maximum values for a water activity reading should be integers to represent a_w values.

There is no need to do anything in the Moisture Content Model section for water activity readings.

6. Select the **Add product** button when all required information is entered (Figure 22).

NOTE: Water activity readings are the only readings available in the freemium version. Additional readings can be accessed when subscribed to a premium plan. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

Add a new product

Product information

Name

Add required test

Select test

Min value

Max value

Add required test +

Additional tests can be added on SKALA Control at:
profile.skalacontrol.com/#/products

Moisture Content Model

Cancel **Add product**

Figure 22 Add a new product window

Figure 23 will appear once a Product has been added.

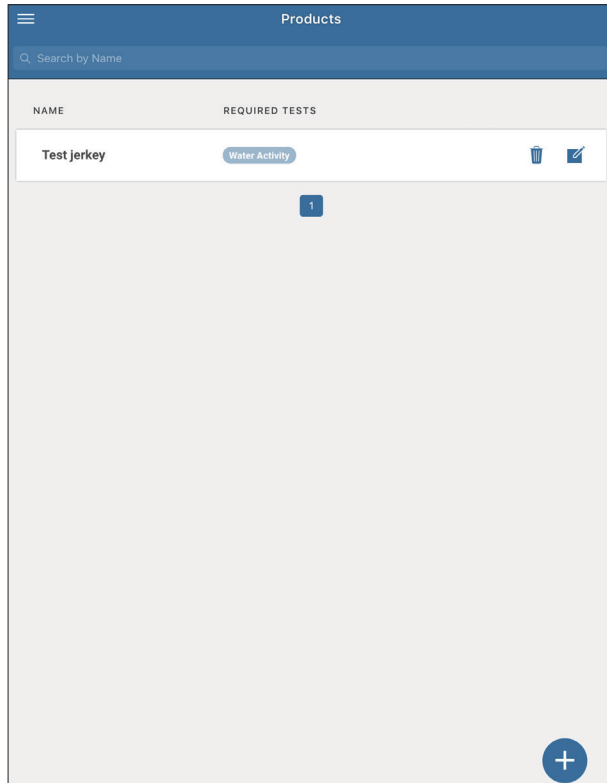


Figure 23 Products window

2.3 ENTER EXISTING COMPANY SITE

This section provide instructions to sign into an existing company account after using the wizard for the first set up. How to handle the following will be explained.

- Add additional iPads
- Add additional NEXUSES
- Add new water activity products
- Verify NEXUS is visible on network
- Select market groups (subscription required)
- Add new total moisture products (subscription required)
- Remove products

2.3.1 ADD ADDITIONAL IPADS TO EXISTING SYSTEM

If the SKALA Mobile app has been downloaded onto a new iPad in an existing system, follow the instructions below.

NOTE: If this is to set up a new system for the first time, please go to [Section 2.2.3](#).

1. Open SKALA Mobile app on the iPad.
2. Select the desired server to log into from the dropdown menu options in the Register device window ([Figure 24](#)).
3. Enter the company email address and password in the fields on the right side of the window.

Figure 24 Sign in to existing company

4. Select the **Sign In** button to go to the Welcome to SKALA window ([Figure 25](#)).

Figure 25 User log in window

2.3.2 ADD ADDITIONAL NEXUSES

If another NEXUS or additional NEXUSES need to be set up, please do the following:

1. Open the SKALA Mobile app menu using the menu icon located in the upper left corner of the screen.

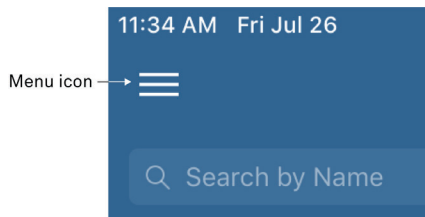


Figure 26 Menu icon

2. Select NEXUS in the menu under Setup to open a window with a list of currently registered NEXUSES (Figure 27).

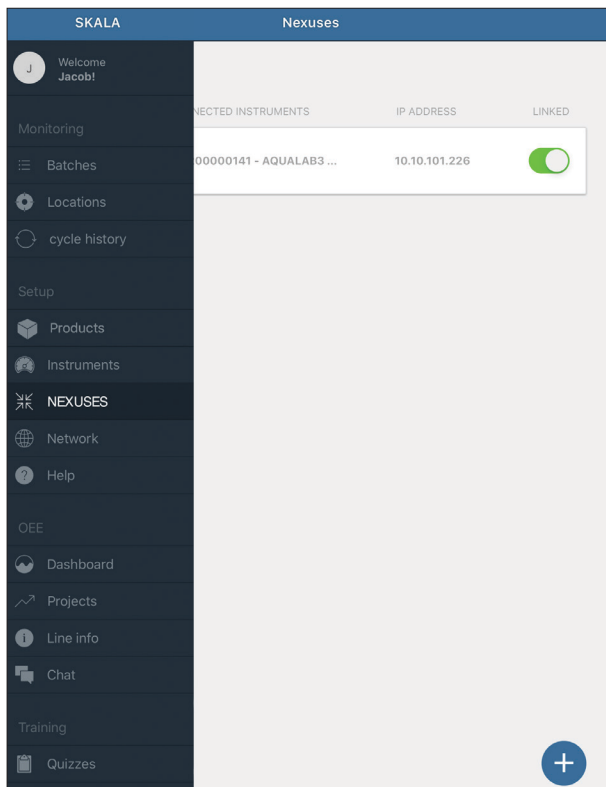


Figure 27 NEXUSES window

3. Select the plus symbol on the NEXUSES screen to register another NEXUS (Figure 27).
4. Select **Ok** in the Register NEXUS popup window (Figure 28).

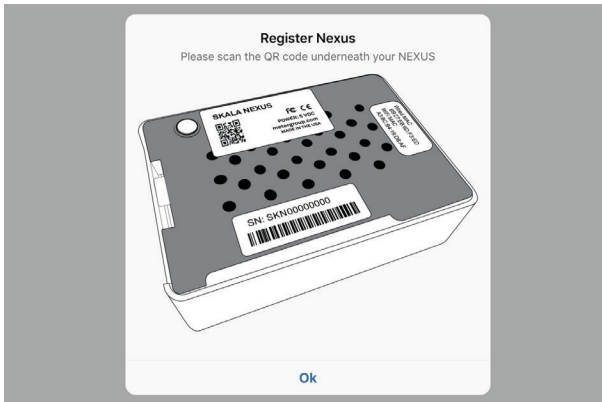


Figure 28 Register NEXUS window

The iPad camera app will open, and a dialog will appear asking for permission to access the camera (Figure 29).

5. Select **OK** in the Camera app dialog window message to give SKALA access to the iPad's camera (Figure 29).

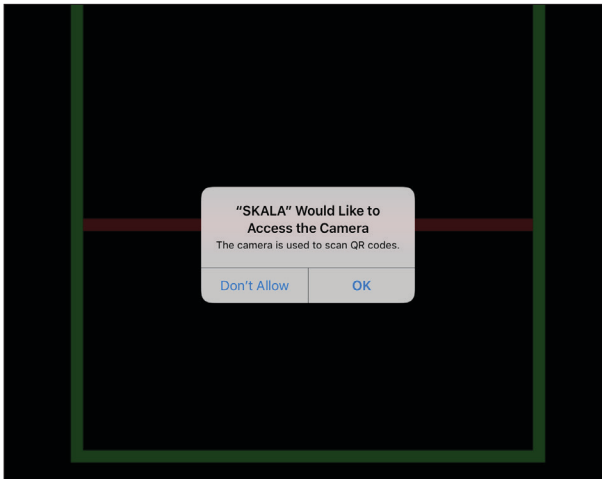


Figure 29 SKALA requests access to iPad camera

6. Turn the NEXUS over to show the labels on the bottom.
7. Place the QR code in front of the camera window and inside the green box (Figure 30).
When the camera recognizes the QR code, SKALA Mobile will automatically register the QR Code.

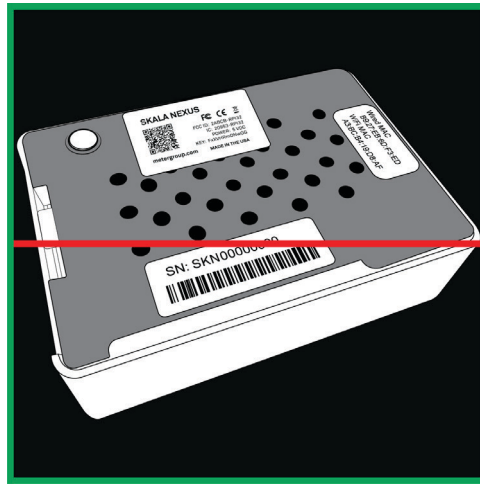


Figure 30 NEXUS in camera window

A dialog ([Figure 31](#)) will appear indicating registration success!

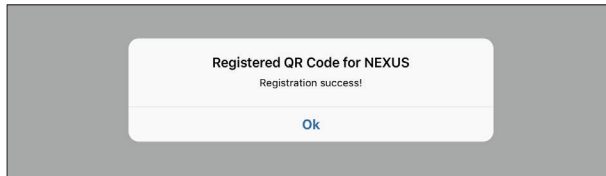


Figure 31 Registration success!

8. Select **Ok**.
9. Verify that the AQUALAB 3 system is able to locate registered NEXUSES by opening the NEXUS window from the SKALA Mobile app Main menu ([Figure 29](#)).
Any NEXUS devices should be listed here when properly registered and online.

The AQUALAB 3 system is now ready to add product and batch information. Please contact [Customer Support](#) if any problems arise while registering a NEXUS.

2.3.3 ADD ADDITIONAL WATER ACTIVITY PRODUCTS

Instructions explaining how to add additional Products are listed below. If no additional products are being entered, continue to [Section 2.4](#) to add a new batch.

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.
2. Select Products under Setup to open the Products window ([Figure 32](#)).

NOTE: Tap on the main screen (white or gray area) to the right of the menu to close the menu.

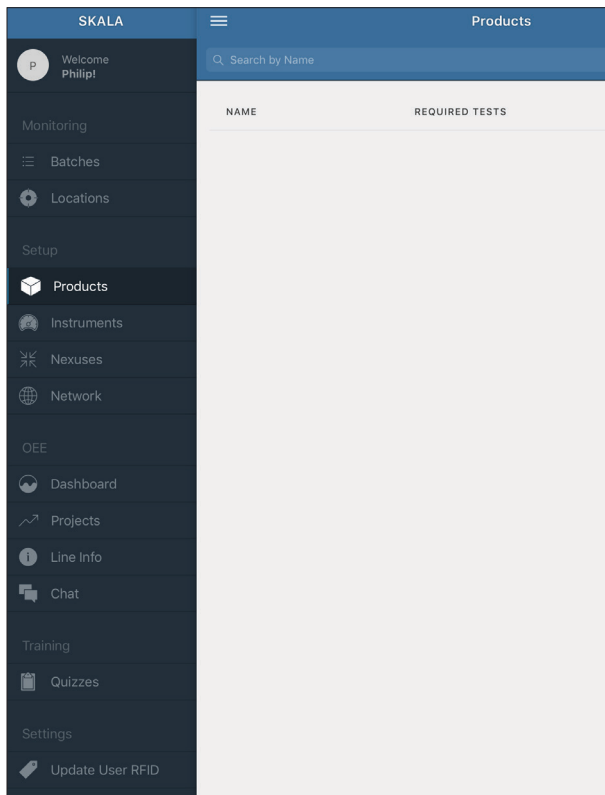


Figure 32 Products option in Main menu

3. Select the plus symbol on the Products screen to add a new Product (Figure 32).
4. Enter the product name in the Name field (Figure 33).

Figure 33 Add a new product window

5. Select Water activity from the Select test dropdown menu (Figure 33).
6. Set minimum and maximum reading values (Figure 33).

NOTE: The minimum and maximum values for a water activity reading should be integers to represent a_w values.

There is no need to do anything in the Moisture Content Model section for water activity readings.

7. Select the **Add product** button when all required information is entered (Figure 33).

NOTE: Water activity readings are the only readings available in the freemium version. Additional readings can be accessed when subscribed to a premium plan. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

Figure 34 will appear once a Product has been added .

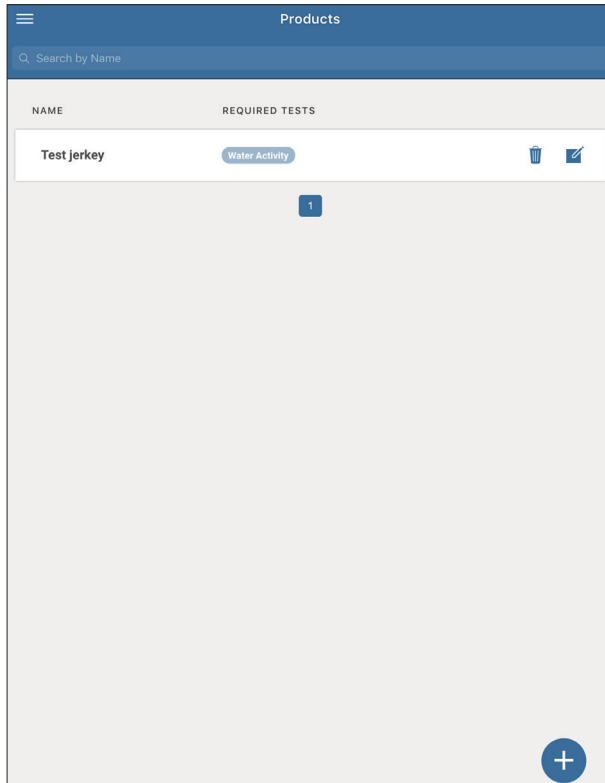


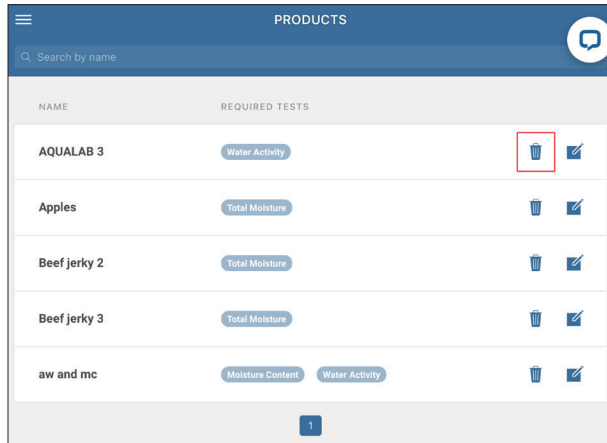
Figure 34 Products window











2.3.4 REMOVE PRODUCTS

If products need to be removed from SKALA Mobile, please follow the steps below:

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.

OPERATION



NAME	REQUIRED TESTS	
AQUALAB 3	Water Activity	 
Apples	Total Moisture	 
Beef jerky 2	Total Moisture	 
Beef jerky 3	Total Moisture	 
aw and mc	Moisture Content Water Activity	 

1

Figure 35 Products list

2. Select Products under Setup.
3. Press on the garbage can icon to remove the product (Figure 35).
The Remove Product dialog window like the one below will appear (Figure 36).
4. Select the **Remove** button.

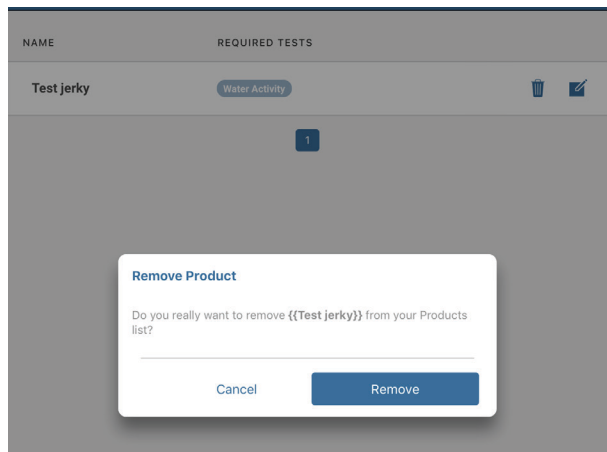


Figure 36 Remove Product dialog

Please contact [Customer Support](#) if any problems arise while adding or removing products.

2.3.5 SELECT MARKET GROUPS (SUBSCRIPTION REQUIRED)

Selecting specific market groups (maximum of two are allowed) reduces the moisture content models options list to include only those in the market groups selected. The option to select market groups is only available with one of the many subscriptions.

The first time after the subscription is activated, SKALA Mobile will require the user to select a maximum of two market groups.

These instructions explain how to select market groups.

1. Open the SKALA Mobile app after activating a subscription.
2. Log into the company site ([Figure 24](#)).
3. Select Products from the main menu to open the Products window ([Figure 41](#)).
4. Start the process to add a new product ([Section 2.3.3](#)).

The SKALA Mobile app will automatically open the Batches page with a message prompt to set market groups ([Figure 37](#)).

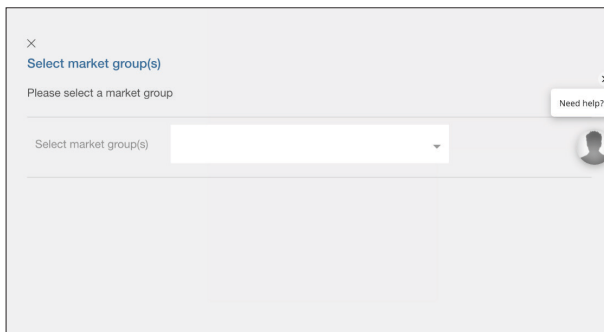


Figure 37 Market group setup message

5. Place cursor in Select market group(s) field to open a market group popup window ([Figure 38](#)).

A maximum of two market groups are allowed. An error message will appear if a third selection is attempted.

6. Select the **Confirm** button when selections are completed ([Figure 38](#)).

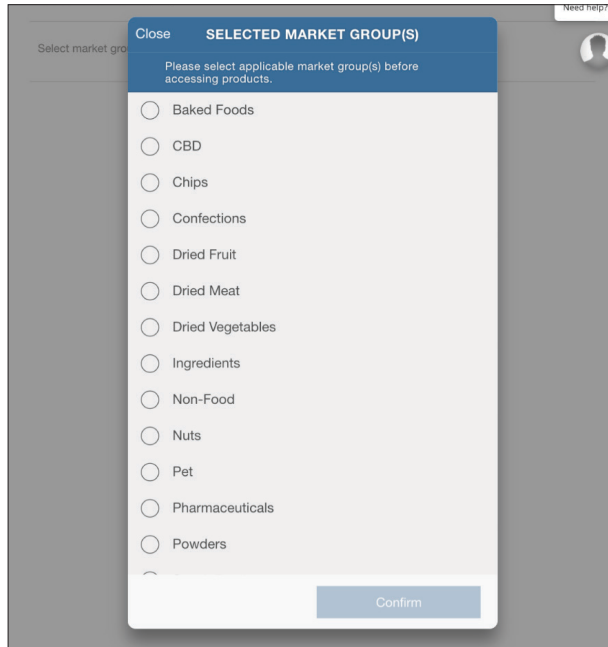


Figure 38 Choose market groups

7. Review the market groups listed in the Select market group(s) field (Figure 39).
8. Select the **Submit** button (Figure 39).

Make sure the listed market groups are correct. The only way to change market groups once submitted is to contact [Customer Support](#).

×

Select market group(s)

Are you sure about your market group selection? Once this has been set, this can only be changed by contacting support at 1-509-332-5601 or support.skala@metergroup.com.

Need help?

Select market group(s)

Dried Meat
Dried Fruit

Cancel Submit

Figure 39 Submit chosen market groups

9. Edit any products set up before defining market groups and update the Moisture Content Model selection (Figure 39).

After the market groups are submitted, the list of models in the Moisture Content Model in the Product screen will look like Figure 40.

Figure 40 Market groups in Product setup screen

2.3.6 ADD FIRST TOTAL MOISTURE PRODUCT (SUBSCRIPTION REQUIRED)

To add a new product for a total moisture reading, a monthly subscription to SKALA Control is required. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

Please use the following steps to add a new product for a total moisture reading using a water activity specification.

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.
2. Select Products under Setup ([Figure 41](#)).

This will open the Products window.

NOTE: Tap on the main screen (white or gray area) area to the right of the menu to close the menu.

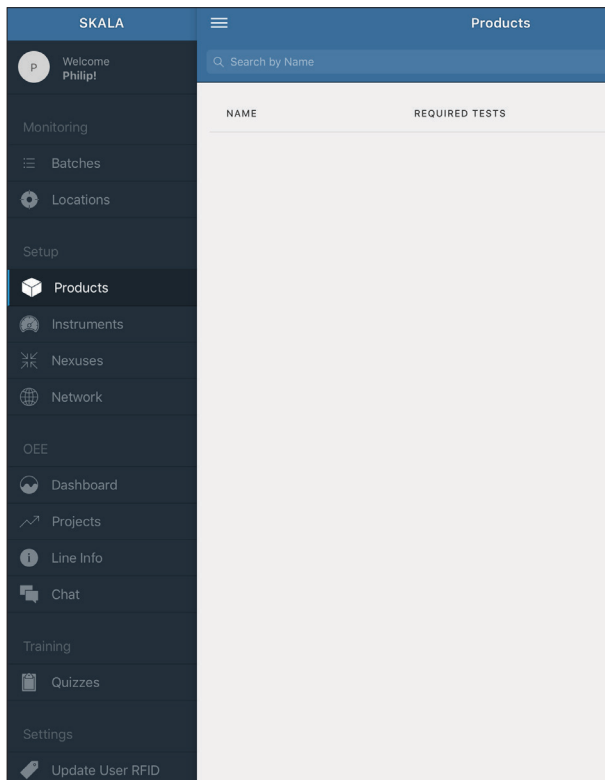


Figure 41 Products option in Main menu

3. Select the plus symbol on the Products screen to add a product.
4. Enter the product Name (Figure 42).
5. Select Total Moisture from the Select test dropdown menu (Figure 42).
6. Select Water activity or Total moisture from the Specification use dropdown menu (Figure 42).
7. Set minimum and maximum reading values based on the specification chosen in previous step (Figure 42).

NOTE: Total moisture reading values using water activity specifications should be indicated by integers to represent a_w values and moisture content specifications should use numbers representing a percentage.
8. Select the Moisture Content Model from the dropdown menu at the bottom of the window (Figure 42).
9. Select the **Add (Update) product** button (Figure 42) when all required information is entered.

NOTE: Water activity tests are always available. Additional tests can be added when subscribed to a premium plan. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

OPERATION

The screenshot shows the 'Add a new product' dialog box in the SKALA Control application. The dialog is titled 'Add a new product' and has a close button (X) in the top right corner. It is divided into several sections:

- Product information:** A text field for 'Name' containing the value 'Apples'.
- Add required test:** A section with three dropdown menus: 'Select test' (set to 'Total Moisture'), 'Specification use' (set to 'Water activity'), and 'Min value' (set to '0.3'). A 'Max value' field is set to '0.7'. A trash icon is visible to the right of the 'Select test' dropdown.
- Moisture Content Model:** A section with a 'Select model' dropdown menu set to 'Apple, Dried'.
- Footer:** A blue banner with the text 'Additional tests can be added on SKALA Control at: skalacontrol.com/#/products'. Below this are two buttons: 'Cancel' and 'Add product'.

Total Moisture—Water Activity (a_w)

The screenshot shows the 'Edit an existing Product' dialog box in the SKALA Control application. The dialog is titled 'Edit an existing Product' and has a close button (X) in the top right corner. It is divided into several sections:

- Product information:** A text field for 'Name' containing the value 'Apples'.
- Add required test:** A section with three dropdown menus: 'Select test' (set to 'Total Moisture'), 'Specification use' (set to 'Moisture Content'), and 'Min value' (set to '5'). A 'Max value' field is set to '10'. A trash icon is visible to the right of the 'Select test' dropdown.
- Moisture Content Model:** A section with a 'Select model' dropdown menu set to 'Apple, Dried'.
- Footer:** A blue banner with the text 'Additional tests can be added on SKALA Control at: skalacontrol.com/#/products'. Below this are two buttons: 'Cancel' and 'Update Product'.

Total Moisture—Moisture Content (%)

Figure 42 Add a new/edit existing product

The Product screen will appear with the newly added/updated Product listed ([Figure 44](#)).

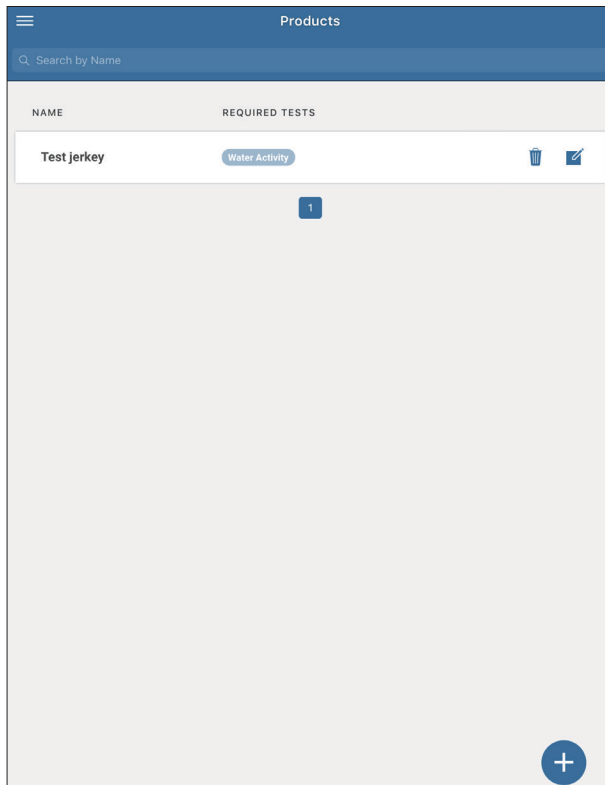
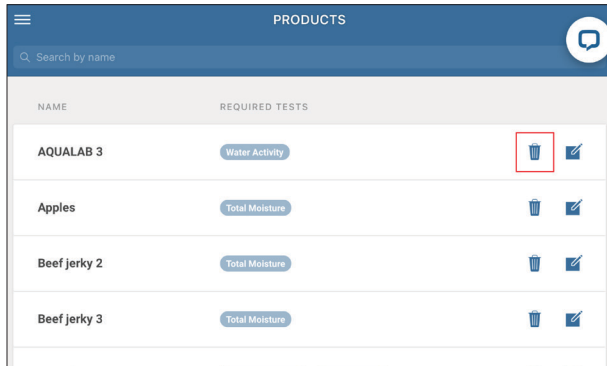


Figure 43 Products window

2.3.7 REMOVE PRODUCTS

If products need to be removed from SKALA Mobile, please follow the steps below:

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.











NAME	REQUIRED TESTS		
AQUALAB 3	Water Activity		
Apples	Total Moisture		
Beef jerky 2	Total Moisture		
Beef jerky 3	Total Moisture		

Figure 44 Products list

2. Select Products under Setup.
3. Press on the garbage can icon to remove the product (Figure 44).
The Remove Product dialog window like the one below will appear (Figure 45).
4. Select the **Remove** button.

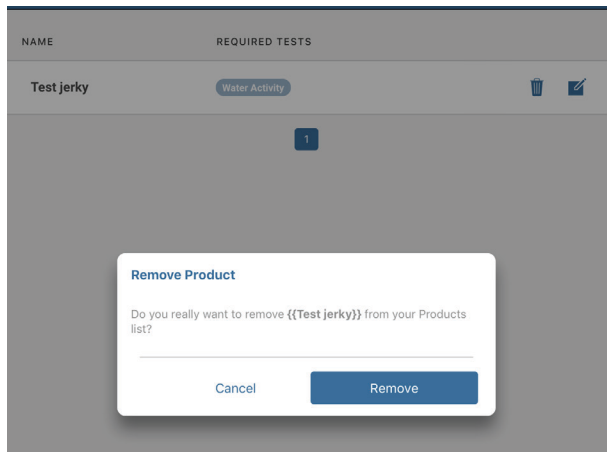


Figure 45 Remove Product dialog

Please contact [Customer Support](#) if experiencing any problems adding or removing products.

2.4 ADD A BATCH

The following steps explain how to add a batch. Adding a batch leads to setting up a sample, which is the first step in preparing for a reading ([Section 2.5](#)).

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.
2. Select Batches listed under Monitoring at the top of the Main menu.

NOTE: Tap on the main screen (white or gray area) area right of the menu to close the menu.

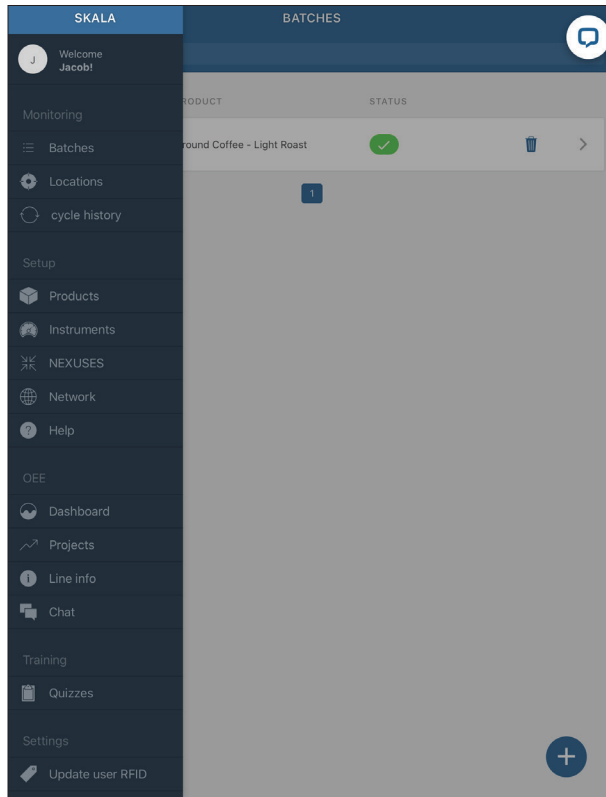


Figure 46 Batches window

3. Select the plus symbol on the Batches screen to add a Batch (Figure 46). This will open the Batches screen (Figure 47).

The screenshot shows a 'Add a new batch' dialog box. It has a title bar with a close button (X). The dialog contains four input fields: 'Product' with a search icon and the text 'Apples', 'Batch number' with the text '30001' and a help icon (?), 'Days active' with the text '2', and 'Line number' with a dropdown arrow. At the bottom, there are two buttons: 'Cancel' and 'Add batch'.

Figure 47 Add a new batch popup window

4. Select the product from the dropdown list ([Figure 47](#)).
5. Enter a batch number ([Figure 47](#)).
For information on autogenerated batch numbers, please contact [Customer Support](#).
6. Enter the number of days visible in SKALA Mobile in the Days Active field.
After that, the batch can be accessed in SKALA Control ([Figure 47](#)).
7. Enter the line number that identifies specific customer selected process line in the Line Number field ([Figure 47](#)).
This step is optional.
8. Select the **Add batch** button to save the new batch information ([Figure 47](#)).
The Batches window will open showing a list of batches ([Figure 48](#)).

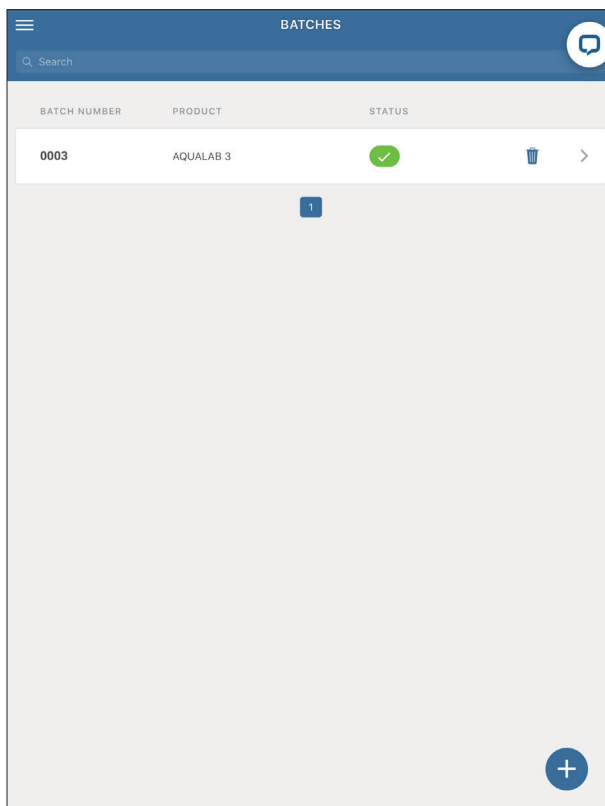


Figure 48 Example Batches page

2.5 TAKE A READING

The SKALA Mobile app handles the entire interface for setting up and taking readings with the AQUALAB 3. Water activity readings can be taken with an AQUALAB 3 system with either freemium or subscription access. Access to additional features can be added when a subscription to a monthly plan is activated. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

Before testing a sample, ensure that the AQUALAB 3 has warmed up for at least 30 min and that the sample chamber and cover are clean and dry.

NOTE: SKALA Mobile will prompt the user to verify the calibration of the AQUALAB 3 according to the frequency established by the administrator in SKALA Control ([Section 4.1](#)).

2.5.1 WATER ACTIVITY READING

This section contains information on taking water activity readings.

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.
2. Select Batches listed under Monitoring at the top of the menu.
This will open the Batches screen with a list of available batches.
3. Select the right-pointing arrow at the far right of the batch to be tested ([Figure 48](#)).
4. Select the plus symbol in the blue circle in the lower left corner of the Batches screen to open the Add sample popup window ([Figure 49](#)).
5. Select the **Add sample** button ([Figure 49](#)).

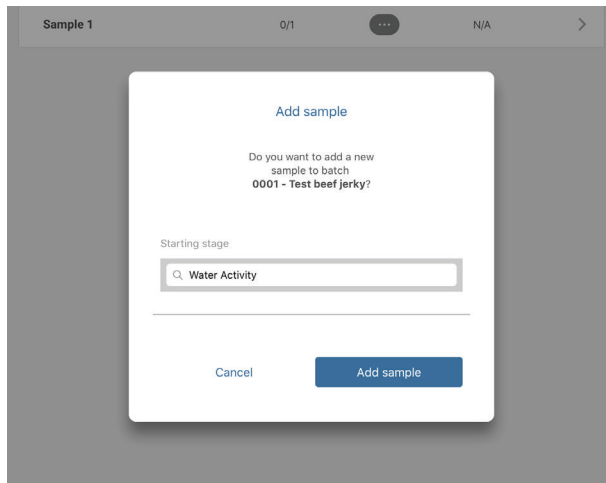


Figure 49 Add sample popup screen

6. Select the **Take reading** button to start the reading process ([Figure 50](#)).

NOTE: Products ([Section 2.2.6](#)) and batches ([Section 2.4](#)) must be added to the SKALA Mobile app before a reading can be taken.

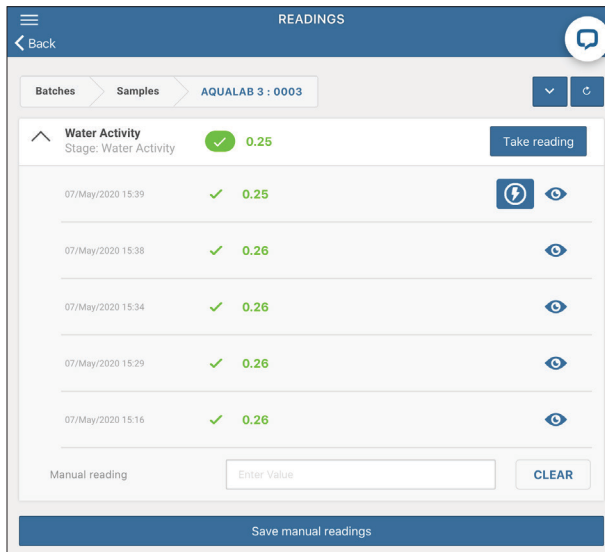


Figure 50 Take reading on Readings window

7. Select Take reading to the right of the device name shown in the Take reading popup window (Figure 51).

NOTE: A list of all available instruments in the network will appear in the Readings screen. If no instrument is listed, please see Troubleshooting.

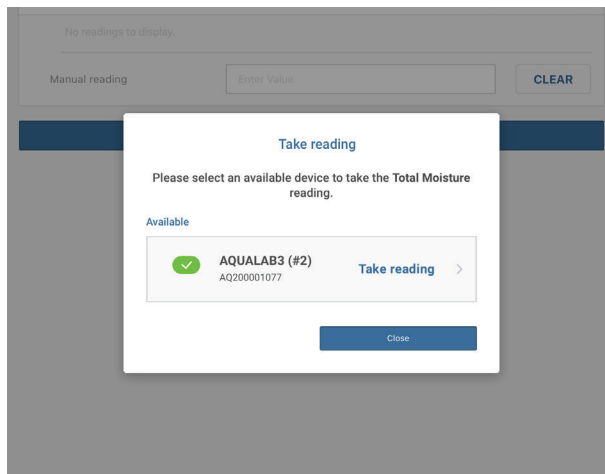


Figure 51 Take reading popup window

On the selected AQUALAB 3 device (Figure 52), the indicator light will turn blue and spin counterclockwise, indicating that the system is ready to collect a reading.

OPERATION

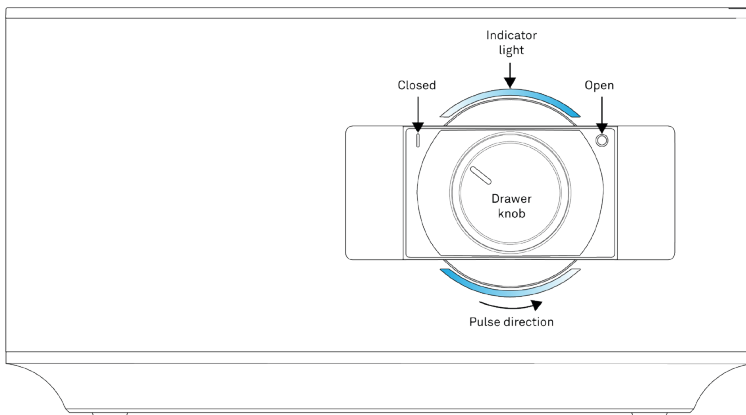


Figure 52 Front-panel drawer knob

8. Prepare the sample using clean sampling practices to ensure accurate and repeatable readings.
 - a. Wash hands thoroughly or put gloves on prior to using the instrument.
[Section 4.2](#) for detailed cleaning methods.
 - b. Fill the sample cup ([Figure 53](#)) enough to cover the bottom but no more than half full. Clean sample cup bottom, sides, and rim thoroughly with KIMWIPES® strips.



Figure 53 Sample Cup

Keep samples in sealed packaging or in a sample cup with a sample cup lid when a sample is not actively being read. Otherwise, the sample water activity will slowly equilibrate with the humidity in the ambient air.

NOTE: If the sample will be sitting for more than 2 h before being read, seal the sample cup edges with a piece of parafilm or a similar material.

9. Insert the sample cup into the AQUALAB 3 sample chamber ([Figure 54](#)):
 - a. Pull out sample drawer.
 - b. Lift the sample cover.
 - c. Place the sample cup (without the sample cup lid) into the sample chamber.
 - d. Lower the sample cover down over the sample cup.
 - e. Push the drawer closed.

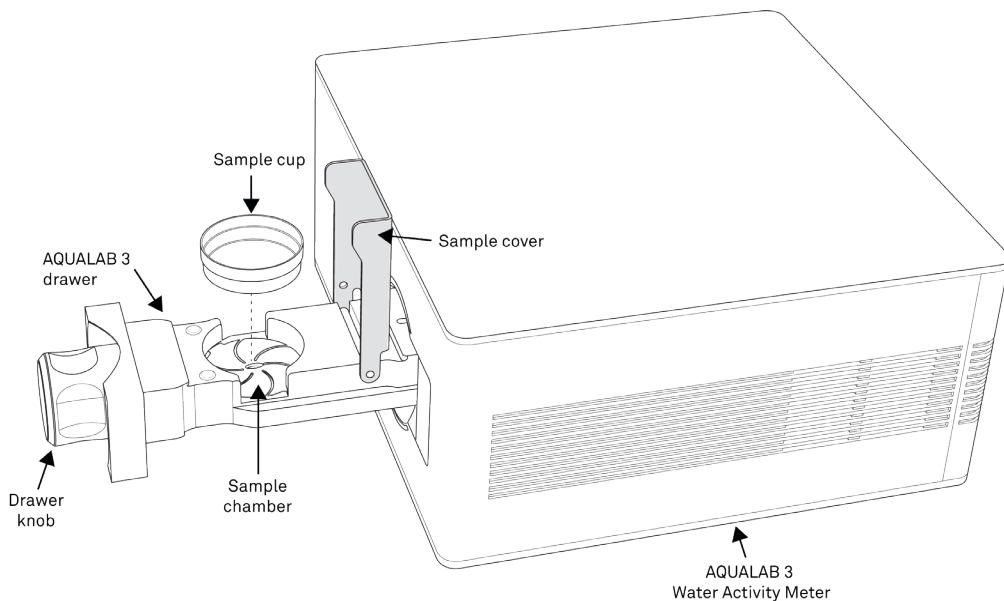


Figure 54 AQUALAB 3 Drawer Pulled Out

10. Choose method (a) or (b) described below to start the reading.

- a. Turn the drawer knob counterclockwise (left) to the Closed position to begin the reading (Figure 55).

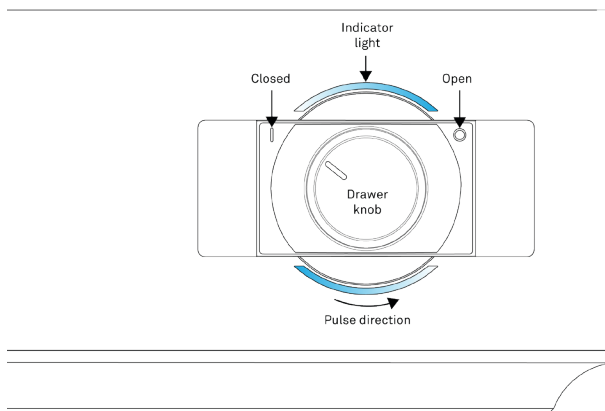


Figure 55 Front-panel drawer knob

This will automatically start the test.

The AQUALAB 3 will start the reading and a slow pulsing blue light will show on the front panel while the reading is in progress. A Reading in Progress message will appear on the app screen.

OPERATION

- b. Select the **Start** button on the Take Reading dialog box to start the reading if the sample is already loaded and the drawer knob is turned to the left (Figure 56).

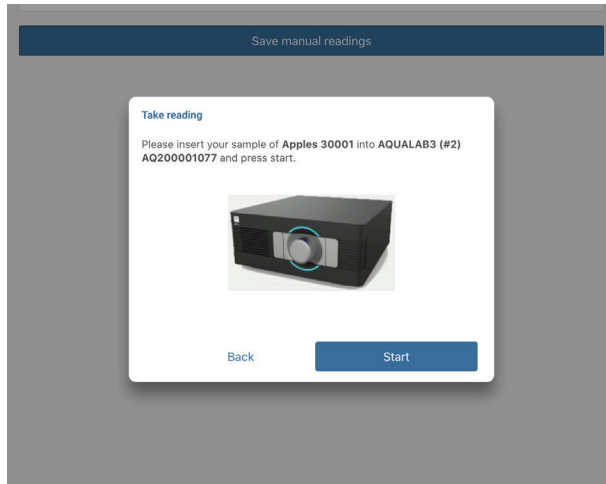


Figure 56 Take Reading popup

11. Select the **In-Progress Readings** button at the bottom of the Readings screen to see the In-Progress Readings dialog window with the reading status (Figure 57).

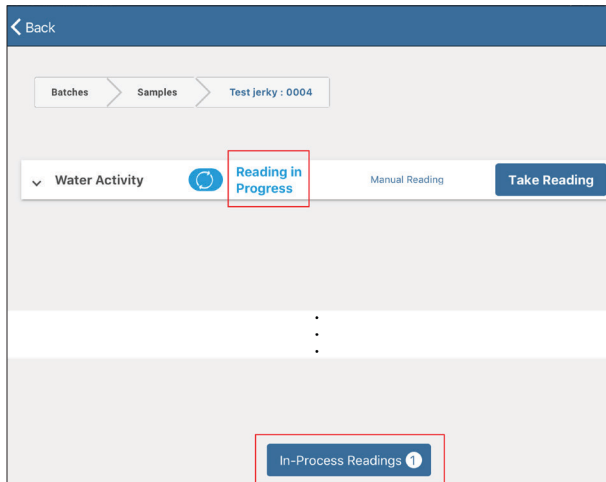


Figure 57 Reading in progress indicator

The In Progress Readings popup window will appear (Figure 58).

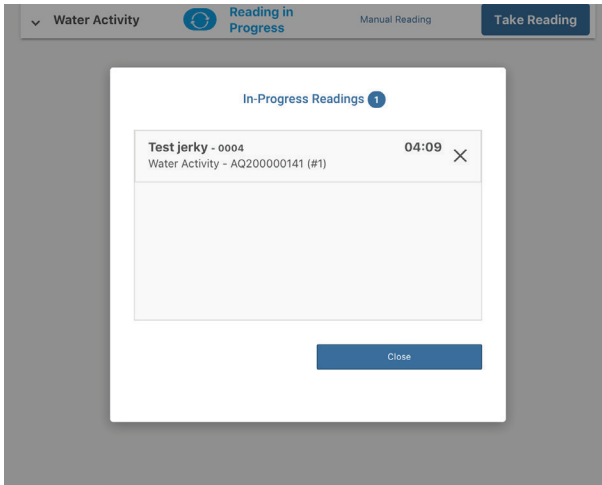


Figure 58 In Progress Reading popup window

12. Select the **Close** button to close the In-Progress dialog window and return to the readings window (Figure 58).
13. When the reading is finished, a dialog box will appear in SKALA Mobile with test details (Table 2).

The AQUALAB 3 indicator light (Figure 59) will turn either a solid green, yellow, or red, indicating the knob should be turned towards the **Open** position. The color signal corresponds to the reading received and should match the result in the SKALA Mobile dialog.

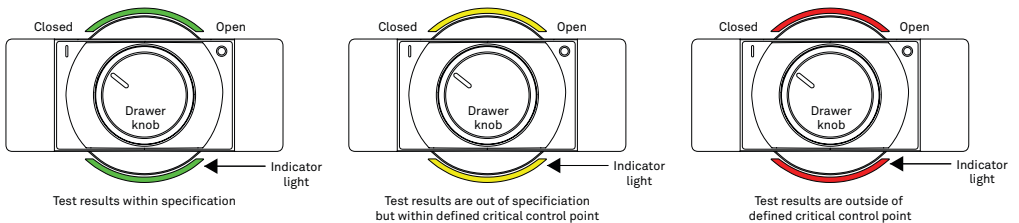



Figure 59 Front-panel indicator light

Table 2 shows the water activity reading indicators.

Table 2 Completed Water Activity Reading Indicator


You've just received a Reading for Review ×


Within Spec

Reading Type	Water Activity
Value	0.271 a_w
Batch	0004
Sample	1
Product	Test jerky
Date	29 Jul 2019 - 10:52
Instrument	AQ200000141 (#1)

Solid green indicates the reading is within defined target limits.


You've just received a Reading for Review ×


Outside of Operating Limits
Reading must be between 0.1 and 0.9

Reading Type	Water Activity
Value	0.998 a_w
Batch	11-02Aug191635
Sample	1
Product	TEST002AW
Date	02 Aug 2019 - 16:40
Instrument	AQ200000134 (#7)

Solid yellow indicates the reading is outside of defined target limits but within defined fail limits.

You've just received a Reading for Review ×


Outside of Fail Limits
Reading must be between 0.5 and 0.6

Reading Type	Water Activity
Value	1.002 a_w
Batch	11-02Aug191641
Sample	1
Product	TT001
Date	02 Aug 2019 - 16:51
Instrument	AQ200000134 (#7)

Solid red indicates that the reading is outside of defined fail limits.

See [Troubleshooting](#) for information on what to do if the indicator light is red.

A flashing red indicator light means there is an error associated with the AQUALAB 3. SKALA Mobile should indicate what the error is and how to fix the error. If the error is not actionable by the user, a message will be to contact [Customer Support](#).

- Turn the drawer knob clockwise and open the drawer ([Figure 55](#)).

The reading data will automatically be saved in SKALA Control with the associated product batch and information about the instrument used to test the sample. [Figure 60](#) shows a list of previous batch readings displayed in SKALA Mobile on the iPad.

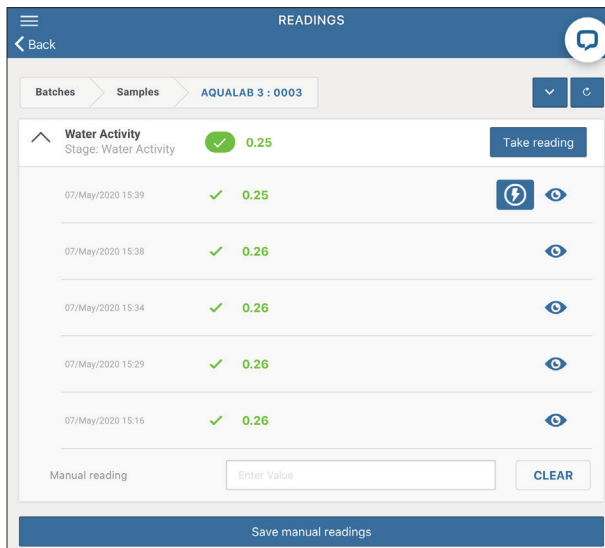


Figure 60 List of completed water activity readings

The AQUALAB 3 reports the reading when equilibrium is reached; for many products, equilibrium will occur in 5 min or less. However, some types of products may take longer, such as products with

- a moisture barrier (e.g., whole seeds and nuts),
- a high fat content (e.g., peanut butter),
- extremely low water activity, or
- multiple components (e.g., cakes with filling, cheese and crackers, cereal with fruit).

Contact [Customer Support](#) to help determine if the product requires longer read times and if any actions may shorten the read time.

2.5.2 TOTAL MOISTURE READING

This section contains information about taking total moisture readings which require a subscription. To learn more about SKALA Control subscription plans, contact [METER Sales](#).

Traditionally, companies are used to just getting half of the moisture picture by only measuring moisture content. Measuring and knowing just moisture content gives yield and some vague quality data. By also knowing moisture energy (water activity) you will get high-resolution quality and safety information of the product, like how it relates to lipid oxidation, browning, caking, and clumping. The difference between crisp and stale can be pinpointed by knowing the water activity and not moisture content.

With the invention of AQUALAB 3, food manufactures can get both moisture content and water activity in 1 min, which gives them the total moisture picture, product yield, quality, and safety. This allows food manufactures to decrease rework and waste while increasing product consistency and making a significant business impact.

Follow the instructions below to take a total moisture reading.

NOTE: Market Groups must be set up ([Section 2.3.5](#)) before the first Total Moisture reading is taken. The following instructions assume a subscription is active and Market Groups are set up.

1. Open the SKALA Mobile app menu by selecting the menu icon located in the upper left corner of the screen.
2. Select Batches listed under Monitoring at the top of the menu.
This will open the Batches screen with a list of available batches.
3. Select the right-pointing arrow at the far right of the batch to be tested ([Figure 48](#)).
4. Select the plus symbol in the blue circle in the lower left corner of the Batches screen to open the Add sample popup window ([Figure 61](#)).
5. Select the **Add sample** button ([Figure 61](#)).

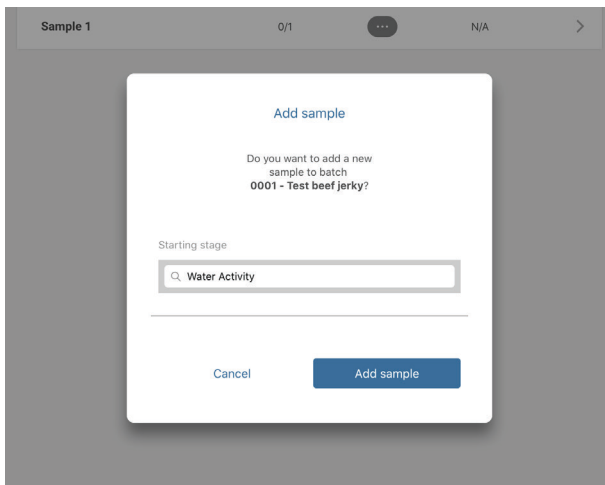


Figure 61 Add sample popup screen

6. Select the **Take reading** button to start the reading process ([Figure 62](#)).

NOTE: Products ([Section 2.2.6](#)) and batches ([Section 2.4](#)) must be added to the SKALA Mobile app before a reading can be taken.

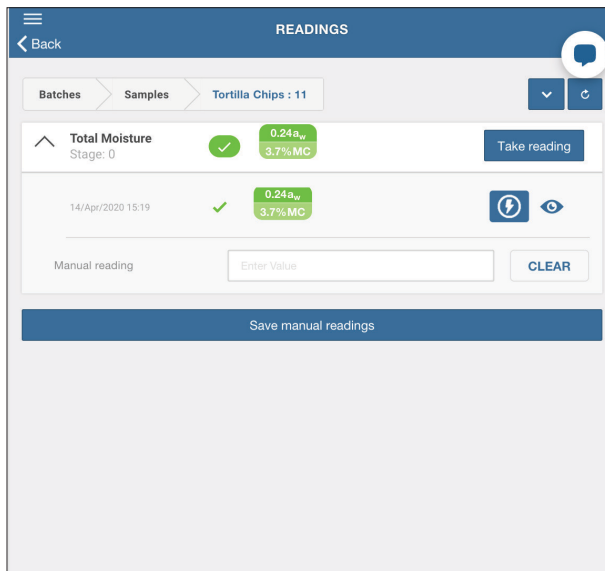


Figure 62 Take reading on Readings window

7. Select Take reading to the right of the device name shown in the Take reading popup window (Figure 63).

NOTE: If no instrument is listed, please see [Troubleshooting](#).

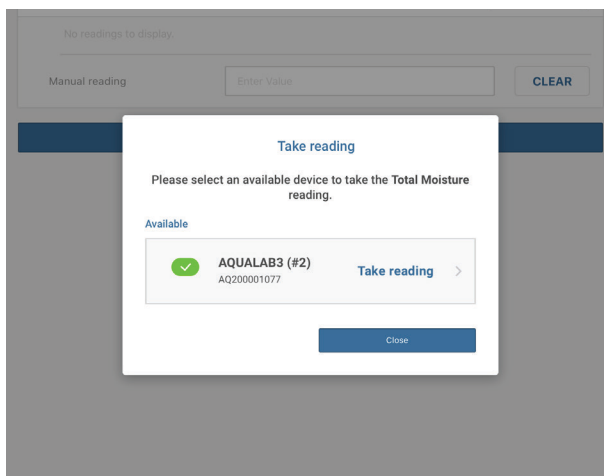


Figure 63 Take reading popup window

On the selected AQUALAB 3 device (Figure 64), the indicator light will turn blue and spin counterclockwise, indicating that the system is ready to collect a reading.

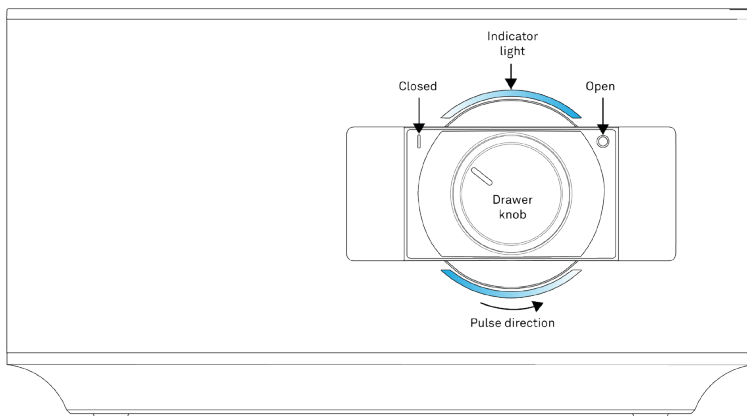


Figure 64 Front-panel drawer knob

8. Prepare the sample using clean sampling practices to ensure accurate and repeatable readings.
 - a. Wash hands thoroughly or put gloves on prior to using the instrument.
[Section 4.2](#) for detailed cleaning methods.
 - b. Fill the sample cup ([Figure 65](#)) enough to cover the bottom but no more than half full. Clean sample cup bottom, sides, and rim thoroughly with KIMWIPES® strips.



Figure 65 Sample Cup

Keep samples in sealed packaging or in a sample cup with a sample cup lid when a sample is not actively being read. Otherwise, the sample water activity will slowly equilibrate with the humidity in the ambient air.

NOTE: If the sample will be sitting for more than 2 h before being read, seal the sample cup edges with a piece of parafilm or a similar material.

9. Insert the sample cup into the AQUALAB 3 sample chamber ([Figure 66](#)):
 - a. Pull out sample drawer.
 - b. Lift the sample cover.
 - c. Place the sample cup (without the sample cup lid) into the sample chamber.
 - d. Lower the sample cover down over the sample cup.
 - e. Push the drawer closed.

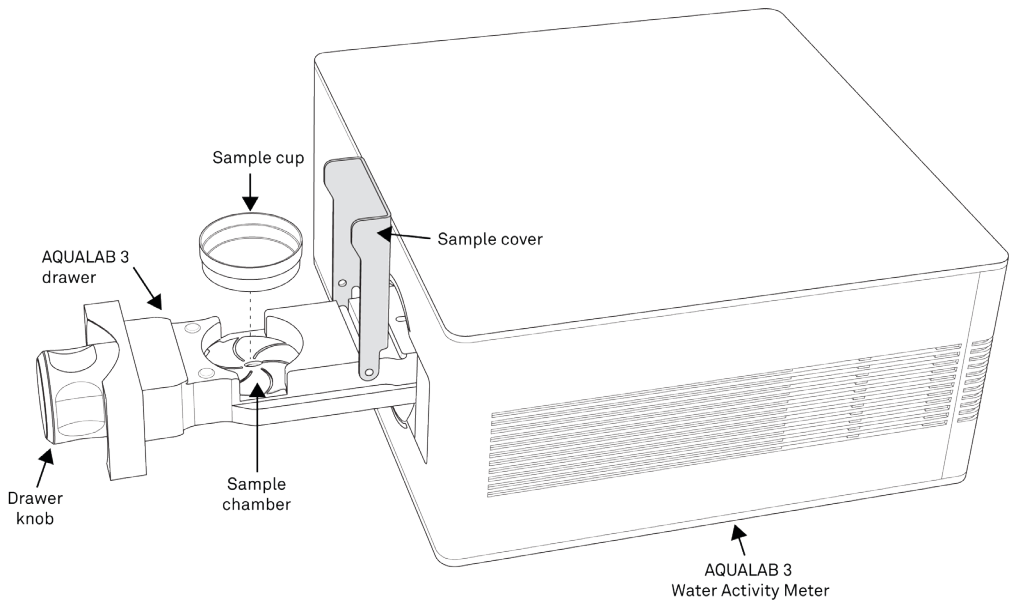


Figure 66 AQUALAB 3 Drawer Pulled Out

10. Choose method (a) or (b) described below to start the reading.

- Turn the drawer knob counterclockwise (left) to the Closed position to begin the reading (Figure 67).

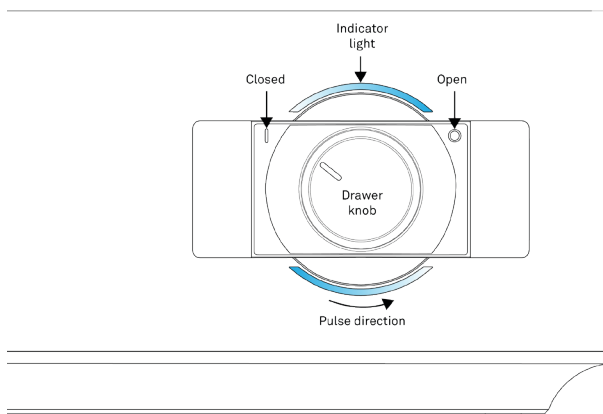


Figure 67 Front-panel drawer knob

This will automatically start the test.

The AQUALAB 3 will start the reading and a slow pulsing blue light will show on the front panel while the reading is in progress. A Reading in Progress message will appear on the app screen.

OPERATION

- b. Select the **Start** button on the Take Reading dialog box to start the reading if the sample is already loaded and the drawer knob is turned to the left ([Figure 68](#)).

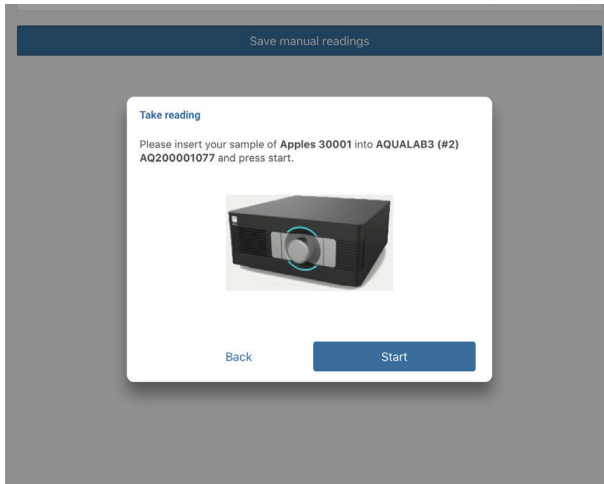


Figure 68 Take Reading popup

11. Select the **In-Progress Readings** button at the bottom of the Readings screen to see the In-Progress Readings dialog window with the reading status ([Figure 69](#)).

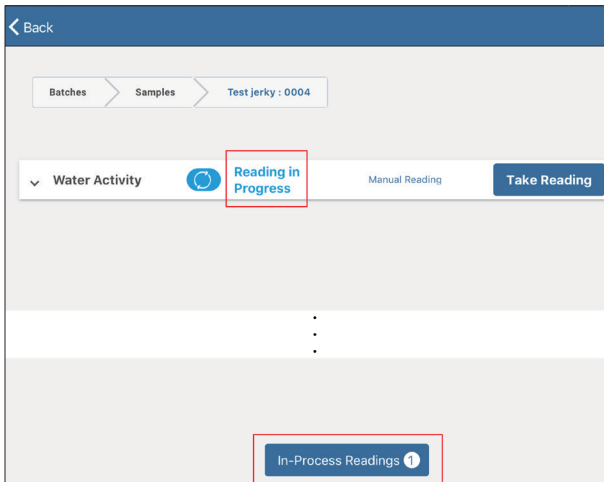


Figure 69 Reading in progress indicator

The In Progress Readings popup window will appear ([Figure 70](#)).

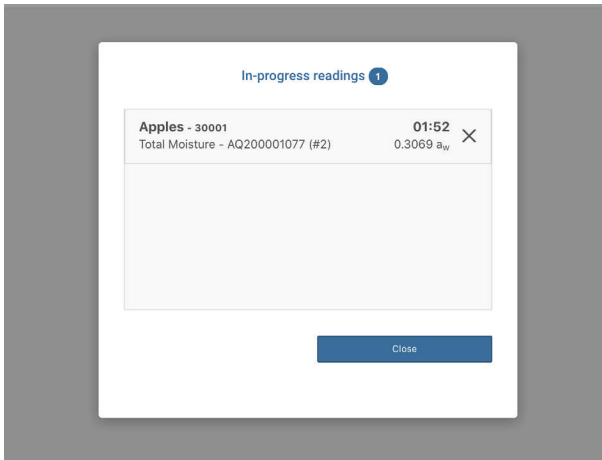


Figure 70 In Progress Reading popup window

12. Select the **Close** button to close the In-Progress dialog window and return to the readings window (Figure 70).
13. When the reading is finished, a dialog box will appear in SKALA Mobile with test details (Table 2).

The AQUALAB 3 indicator light (Figure 71) will turn either a solid green, yellow, or red, indicating the knob should be turned towards the **Open** position. The color signal corresponds to the reading received and should match the result in the SKALA Mobile dialog.

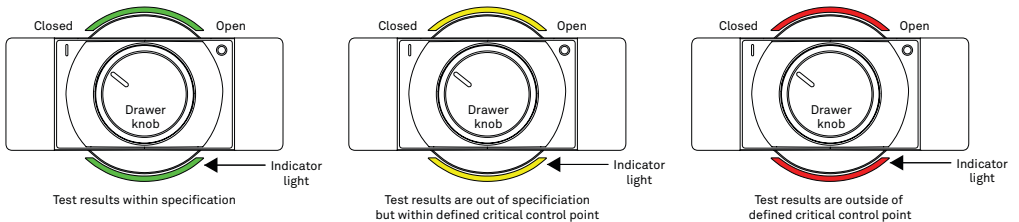


Figure 71 Front-panel indicator light

Table 3 shows the total moisture reading indicators.

Table 3 Completed Total Moisture Reading Indicator

You've just received a Total Moisture® reading for review

✓

0.299

Water Activity (aw)

6.65

Moisture Content (%)

Reading type	Total Moisture
Reading time	61 sec
Batch	30002
Sample	1
Product	Apples
Date	14 May 2020 - 17:05
Instrument	AQ200001077 (#2)
<div>Add comment</div> <div>Add cycle</div>	
Close	

Solid green indicates the reading is within defined target limits.

You've just received a Total Moisture® reading for review

⚠

0.309

Water Activity (aw)

6.81

Moisture Content (%)

Temperature24.54 °C

Reading type	Total Moisture
Reading time	190 sec
Batch	30001
Sample	1
Product	Apples
Date	14 May 2020 - 17:01
Instrument	AQ200001077 (#2)
<div>Add comment</div> <div>Add cycle</div>	
Close	

Solid yellow indicates the reading is outside of defined target limits but within defined fail limits.

You've just received a Total Moisture® reading for review

✗

0.240

Water Activity (aw)

6.50

Moisture Content (%)

Temperature24.42 °C

Reading type	Total Moisture
Reading time	228 sec
Batch	112
Sample	4
Product	White Beans
Date	21 Apr 2020 - 14:15
Instrument	AQ200000109 (#4)
<div>Add comment</div> <div>Add cycle</div>	
Close	

Solid red indicates that the reading is outside of defined fail limits.
See [Troubleshooting](#) for information on what to do if the indicator light is red.

A flashing red indicator light means there is an error associated with the AQUALAB 3. SKALA Mobile should indicate what the error is and how to fix the error. If the error is not actionable by the user, a message will be to contact [Customer Support](#). See [Troubleshooting](#) for information on what to do if the indicator light is red.

14. Turn the drawer knob clockwise and open the drawer.

Information about the product batch and other reading details are automatically saved in SKALA Control. [Figure 72](#) shows old batch readings displayed in SKALA mobile app on the iPad.

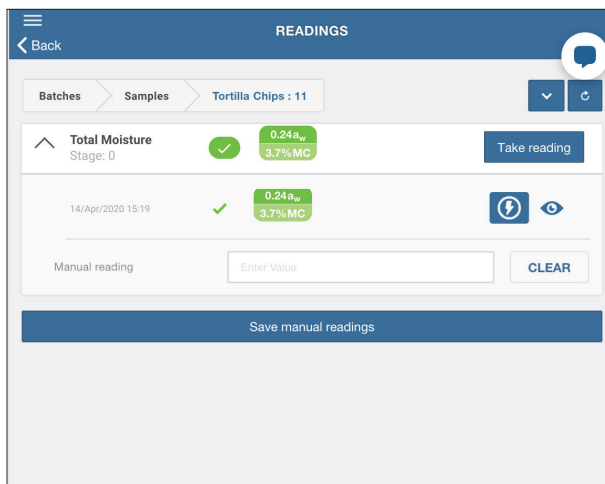


Figure 72 List of completed total moisture readings

The AQUALAB 3 reports the reading when equilibrium is reached; for many products, equilibrium will occur in 5 min or less. However, some types of products may take longer, such as products with

- a moisture barrier (e.g., whole seeds and nuts),
- a high fat content (e.g., peanut butter),
- extremely low water activity, or
- multiple components (e.g., cakes with filling, cheese and crackers, cereal with fruit).

Contact [Customer Support](#) to help determine if the product requires longer read times and if any actions may shorten the read time.

2.5.3 ONE-MINUTE WATER ACTIVITY READING MODE

The One-Minute Water Activity Mode feature enables a reading to complete after 1 min. This feature can be added when a monthly subscription is activated. [Figure 60](#) shows a lightning bolt next to a reading that was taken in one-minute water activity mode. To learn more about SKALA Control subscription plans and One-Minute Water Activity Reading Mode, contact [METER Sales](#).

2.5.4 SETTING UP ISOTHERM-DETERMINED MOISTURE CONTENT

The AQUALAB 3 calculates moisture content values based on water activity readings using a method known as isotherm-determined moisture content. Isotherm-determined moisture content relies on models stored in the SKALA isotherm library or on a custom isotherm model provided by METER Food Lab Services.

Because there is no standard for dryness, moisture content results vary between reference methods. These differences are typically linear, and offsetting the model to correlate with the preferred reference method is straightforward. METER recommends offsetting the model to a primary reference method ([Section 2.5.4](#)).

Once a moisture model is loaded on the AQUALAB 3, it will return a moisture content reading. Until a linear offset has been performed, this moisture content value should not be considered precise and should be discarded ([Section 2.5.4](#)). This reading is not a reference value that can be used to offset the model.

To assign a model to a product, follow these steps:

1. Open skalacontrol.com.
2. Select Products from the SKALA Main menu to open the Product groups page ([Figure 73](#)).

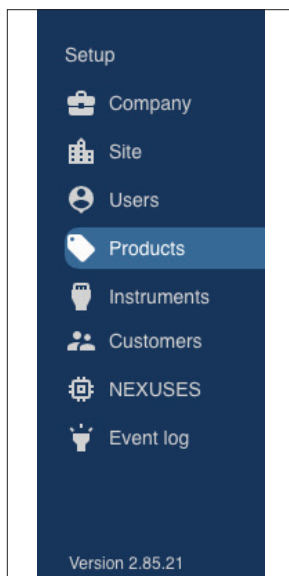


Figure 73 SKALA Main Menu

3. Select the product group that contains the product to be added as a model ([Figure 74](#)).

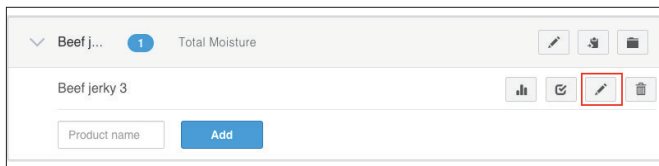


Figure 74 Select product

4. Select the product.

- Click the edit icon on the product row (Figure 74).
The Edit Product screen should appear (Figure 75).

Product

Name

Customer

Package validator

Shelf life Month(s) Day(s)

Default days active

Hourly production rate

Max seconds of downtime

Cost Per Gram

Product contains volatiles ☐

Disable fast aw readings ☐

[Add product ingredients](#)

> PRODUCT DETAILS

> CHECKWEIGHER SETTINGS

> SMOKEHOUSE SETTINGS

Moisture content model

[Add Model](#)

Figure 75 Edit Product screen

- Scroll to the Moisture Content Model section of the Edit Product screen (Figure 75).
- Click on the Add Model link (Figure 76).

Figure 76 Add Model

A dropdown will appear with two options:

- a. Predefined model from the SKALA isotherm library.
To set up the predefined model, follow [step 8](#).
- b. Custom model using data on the Custom Isotherm Model Coefficients sheet received from the METER Food Lab Services.

To set up a custom model, follow [step 9](#).

8. METER has created dozens of isotherms and compiled them into the SKALA isotherm library. Contact [Customer Support](#) with questions about the preset isotherm models.
 - a. In the dropdown box below the Moisture Content Model heading, select the Predefined model option ([Figure 77](#)).

Figure 77 Predefined model

- b. Under Market group, select the general classification for the type of model (Figure 78).

The first time the Product is edited, the list of Market groups will be quite long. A maximum of two market groups can be selected and a dialog will appear to confirm the selections. In future sessions, the Market group dropdown will only show the two groups selected in the initial product setup.

NOTE: Once Market groups are selected, they cannot be changed without contacting [Customer Support](#).

Figure 78 Market group

- c. Under Product name, select the product category that most closely matches the product being measured (Figure 79).

Figure 79 Product category

- d. Click the Save button.
- This will save the model associated with the product and close the Edit Product window, returning to the Product groups page.
- e. Before taking moisture content readings, perform a linear offset ([Section 2.5.5](#)).
9. To set up a custom model, the Custom Isotherm Model Coefficients sheet must be received from METER Food Lab Services. The information on the sheet will be added manually into SKALA. Contact [Customer Support](#) if the sheet was not received.
- a. In the dropdown box below the Moisture Content Model heading, select the Custom model option ([Figure 80](#)).

There are several isotherm model types. The Custom Isotherm Model Coefficients sheet will identify which type to use.

Figure 80 Custom model selection

- b. Click the radio button beside the model type identified on the Custom Isotherm Model Coefficients sheet ([Figure 81](#)).

NOTE: The DLP (double log polynomial) method is the most frequently used method.

Moisture content model

Custom

Predefined model

Custom

b_0

b_1

b_2

b_3

☐ DLP

Figure 81 Custom model type and coefficients

- c. Fill in the data fields by matching each field with the values on the Custom Isotherm Model Coefficients sheet.

NOTE: It is extremely important that the radio button remains activated or entered data will be lost.

- d. Click the Save button.
- e. This will save the model associated with the product and close the Edit Product window, returning to the Product groups page.
- f. Before taking moisture content readings, perform a linear offset ([Section 2.5.5](#)).

2.5.5 PERFORMING A LINEAR OFFSET

A linear offset must be performed every time a new model is implemented. In addition, the linear offset should be adjusted if moisture content values calculated by the AQUALAB 3 are consistently higher or lower than reference method values over several samples.

To perform a linear offset, select a reference moisture content method to use. Acceptable moisture content reference methods include ROS 1, loss-on-drying, and Karl Fischer titration. Secondary methods have increased margins of error, which will in turn increase the error in AQUALAB 3 moisture content measurements. If desired, an offset can be set to a secondary method (e.g., fast moisture analyzer, microwave analyzer, or NIR) to compare results with a previously used method.

To perform the linear offset, follow these steps:

1. Ensure the instrument is verified ([Section 4.1](#)).
2. Collect a large sample of the product for analysis.
3. Divide the large sample into three subsamples, ensuring that each is representative of the larger sample.
4. Place one subsample into a sample cup.

5. Read the water activity using the AQUALAB 3 ([Section 2.5](#)) and make a note of the water activity value.

This will be used in [step 13](#).

NOTE: The moisture content value has not yet been properly offset and should be ignored.

6. Use the reference method to determine the average moisture content of the other two subsamples.

This average is the reference moisture content value. This will be used in [step 14](#).

7. Open skalacontrol.com.

NOTE: Linear offsets must be performed on a product-by-product basis in the SKALA Control desktop application. This functionality does not appear in the SKALA Mobile app.

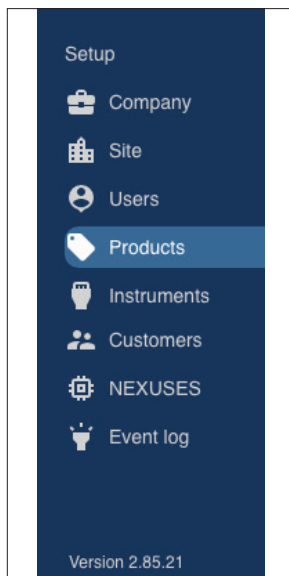


Figure 82 SKALA Main Menu

8. Select Products from the SKALA Main menu.
9. Select the Product group containing the product to be offset ([Figure 83](#)).

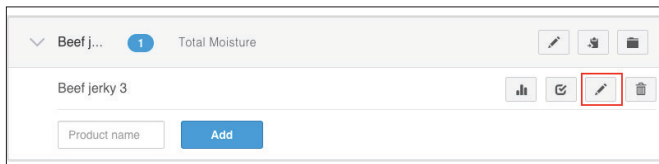


Figure 83 Product group

10. Click the edit icon next to the product to be offset ([Figure 83](#)).
11. Make sure the model has been selected or set as instructed in ([Section 2.5.4](#)).

12. In the Moisture Content Model portion of the Edit Product screen, scroll down to the Linear offset section ([Figure 84](#)).

The screenshot shows a form titled "Linear offset" with a text input field containing the value "0.8854726773004273". To the right, there are two more input fields: "Measured AW" with the value ".49" and "Measured MC" with the value "7.1". Below these fields is a blue button labeled "Calculate offset". At the bottom of the form, there is a link labeled "Add Model" and two buttons: a light gray "Cancel" button and a blue "Save" button.

Figure 84 Linear offset section

13. Enter the product water activity from [step 5](#) into the Measured AW field.
14. Enter the reference moisture content value from [step 6](#) into the Measured MC field.
15. Do NOT enter a value into the Linear Offset field.
This value will be calculated in SKALA Control from the numbers entered as Measured AW and Measured MC.
16. Click the Calculate offset button.
An offset value will appear in the Linear offset field.
17. Click the Save button.

3. SYSTEM

This section describes the AQUALAB 3 system.

3.1 SPECIFICATIONS

MEASUREMENT SPECIFICATIONS

Water Activity	
Sensor type	Chilled mirror dew point and capacitive hygrometer
Range	0.030–1.000 a_w
Resolution	0.001 a_w
Accuracy	$\pm 0.005 a_w$ (dew point) $\pm 0.015 a_w$ (capacitance)
Repeatability	0.002 a_w (dew point) 0.010 a_w (capacitance)
Moisture Content	
Accuracy	0.1%–0.5% to moisture content reference
Repeatability	0.02%
Operating Temperature	
Controlled at constant	25 °C
Resolution	0.1 °C
Accuracy	± 0.1 °C
Read Time	
Minimum	60 s (One-Minute Water Activity Mode; subscription required)
Maximum	>200 s (estimated)

PHYSICAL SPECIFICATIONS

Case Dimensions	
Length	23.4 cm (9.2 in)
Width	23.4 cm (9.2 in)
Height	12.1 cm (5.0 in)

Case Material

Polycarbonate-ABS (PC-ABS)

Sample Cup Capacity

7.5 mL (0.25 fl oz), partially full, recommended

15 mL (0.51 fl oz), full

Weight

5 kg (11 lb)

Operating Temperature Range

Minimum	15 °C
---------	-------

Typical	NA
---------	----

Maximum	35 °C
---------	-------

Operating Environment

0%–90% noncondensing

Data Communications

USB A to USB B

9,600 baud

Power

110–240 VAC

Reading Duration

Minimum	60 s (One-Minute Water Activity Mode; subscription required)
---------	---

Maximum	>200 s (estimated)
---------	--------------------

COMPLIANCE

Manufactured under ISO 9001:2015

EM ISO/IEC 17050:2010 (CE Mark)

3.2 COMPONENTS

This section describes the components associated with the AQUALAB 3 system.

3.2.1 SENSOR BLOCK

The AQUALAB 3 has been designed around a modular sensor block assembly. This allows the sensor block to be easily replaced—greatly reducing or even eliminating downtime due to annual factory calibration. The sensor block is easily removed from the main instrument chassis by loosening the two thumb screws and removing the ribbon cable. This allows the sensor block to be cleaned ([Section 4.2](#)).

The AQUALAB 3 sensor block contains both a chilled-mirror dew point sensor and a capacitance hygrometer. The chilled-mirror sensor measures the water activity of the equilibrated chamber by cooling the mirror surface until water begins to condense. This is known as the dew point temperature and is a direct measurement of the water activity in the head space. The capacitance hygrometer consists of a hygroscopic porous electrolytic polymer. As water is absorbed, the capacitance of the sensor changes.

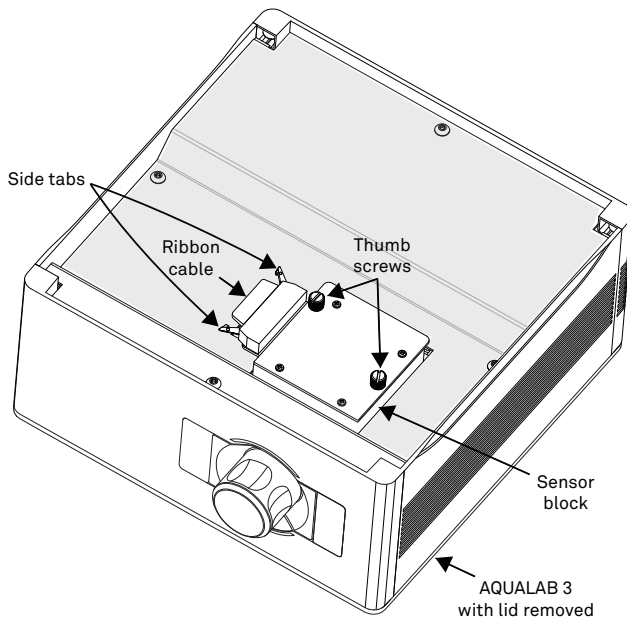


Figure 85 Sensor block in AQUALAB 3

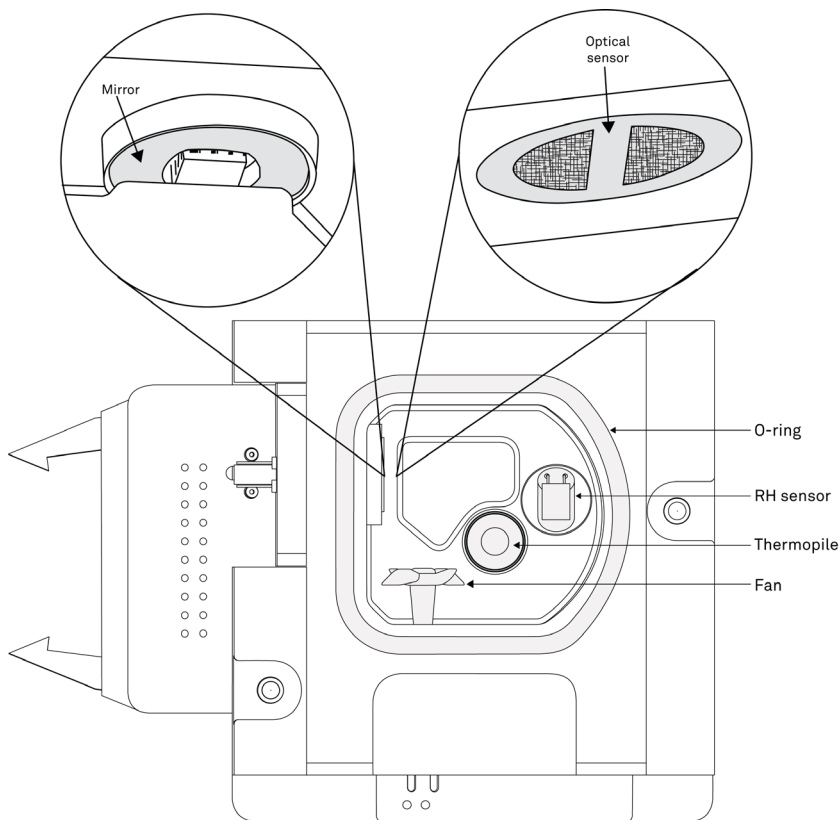


Figure 86 Dual sensor block back view

3.2.2 SAMPLE DRAWER

The AQUALAB 3 sample drawer is removable for easy cleaning and inspection. The sample drawer consists of a sample cover, main drawer assembly, and a metal disk. In order to remove the drawer, the sensor block must first be removed. When removing the drawer, care must be taken to ensure that all of the components are properly reassembled. Failure to do so will compromise subsequent water activity readings.

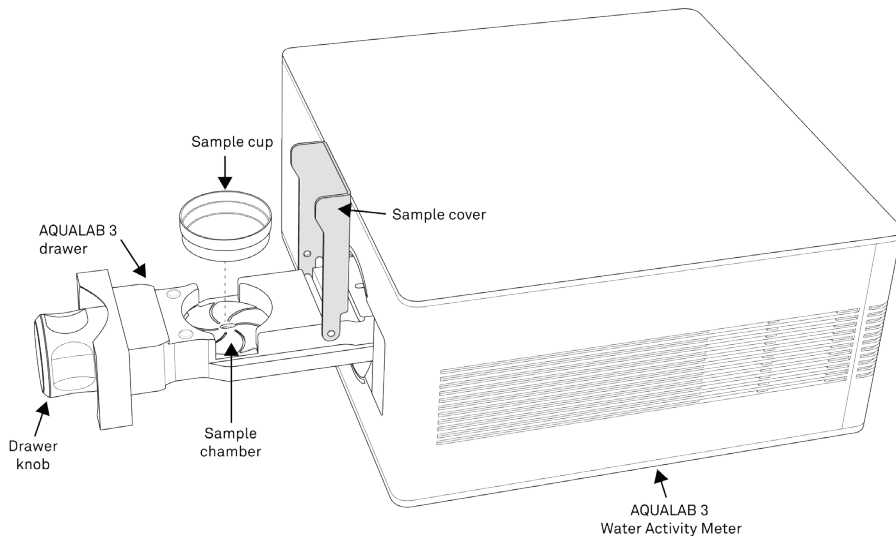


Figure 87 Sample drawer pulled out

3.2.3 DRAWER KNOB INDICATOR LIGHTS

The indicator lights on AQUALAB 3 can provide the user information on the status of the instrument at a glance.

- **Solid White**—A solid white indicates that the AQUALAB 3 is in standby mode and ready to take a reading.
- **Solid Blue**—Indicates that the reading has completed and no pass or fail limits were provided.
- **Solid Green**—Indicates the reading is complete and the measured water activity falls within provided specifications.
- **Solid Red**—Indicates the reading is complete and the measured water activity falls outside of the provided critical control values.
- **Solid Yellow**—Indicates that the reading is complete and the measured water activity falls within the required critical operating specifications but outside of desired specifications.
- **Blinking Blue**—Indicates that a reading is in progress.
- **Rotating Blue**—Indicates that a reading has been queued and the sample should be loaded and the test started.

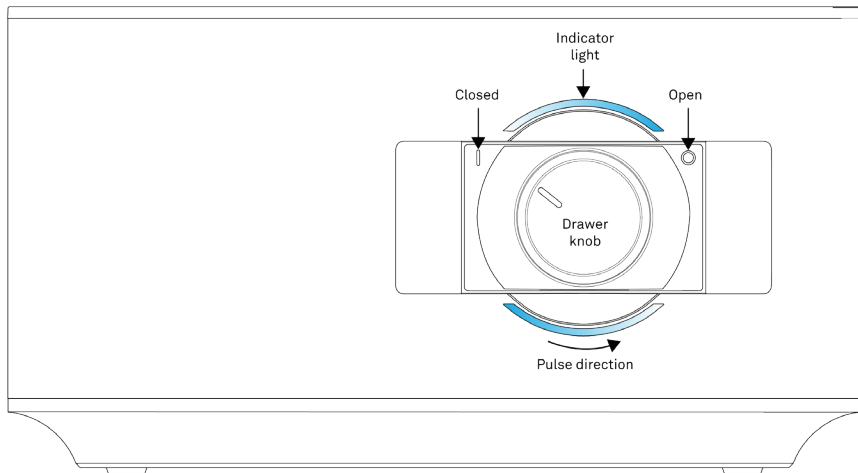


Figure 88 Front knob

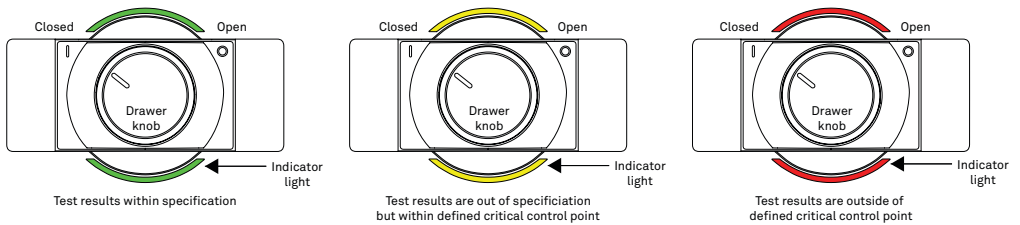


Figure 89 Completed test indicator light options

3.2.4 NEXUS

In order for the AQUALAB 3 to communicate properly with the iPad and SKALA Control, the AQUALAB 3 must be connected to a NEXUS device. Please follow the steps outlined in [Section 2.2](#) to ensure the NEXUS is properly connected and configured.

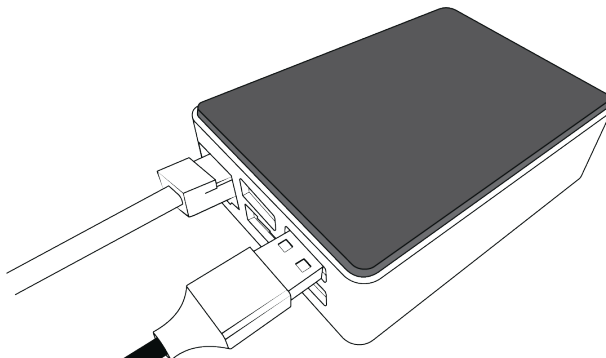


Figure 90 NEXUS connections

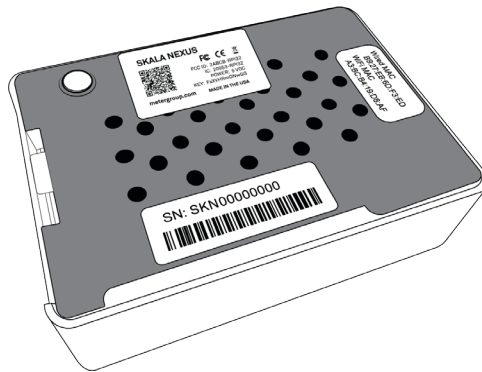


Figure 91 NEXUS back view with labels

3.3 MODES AND TESTS

This section describes the One-Minute Water Activity Mode and additional test types available with a monthly subscription. For more information or to upgrade an AQUALAB 3 to be able to use the One-Minute Water Activity mode or additional tests, please go to metergroup.com/skala-upgrade or contact [Customer Support](#).

3.3.1 ONE-MINUTE WATER ACTIVITY MODE

With a monthly subscription, AQUALAB 3 will run in One-Minute Water Activity mode on the fourth and subsequent readings of that product. The One-Minute Water Activity mode uses a proprietary algorithm that predicts the final water activity based on product specific data collected and stored in SKALA. In most cases, this reading will complete in 1 min.

A product must be properly set up, including having correct target limits defined, within the SKALA Mobile app to generate a one-minute water activity reading. Three consecutive readings must be taken for a new product before the one-minute water activity mode is activated. Once the first three readings have been taken, all following readings for that product will be in one-minute mode. One-Minute Water Activity readings cannot be taken when operating offline. Review [Section 2.3](#), [Section 2.4](#), and [Section 2.5](#) for instructions on how to set up products, batches, and take water activity readings.

3.3.2 TOTAL MOISTURE

Traditionally, companies are used to just getting half of the moisture picture by only measuring moisture content. Measuring and knowing just moisture content gives yield and some vague quality data. By also knowing moisture energy (water activity) product high-resolution quality and safety information, such as how it relates to lipid oxidation, browning, caking, and clumping, will be available. Knowing the water activity, not the moisture content, allows the user to pinpoint the difference between crisp and stale.

With the invention of the AQUALAB 3, food manufacturers can get both moisture content and water activity in 1 min, which gives them the total moisture picture, product yield, quality, and safety. This allows food manufacturers to decrease rework/waste and increase product consistency and make a significant business impact.

3.4 THEORY

Water is a major component of foods, pharmaceuticals, and cosmetics and influences the product texture, appearance, flavor, and shelf life. Quantifying these attributes require two basic types of water analysis: moisture content and water activity (a_w).

3.4.1 WATER CONTENT

Water activity (a_w) is a measurement of the energy status of the water in a system. The value indicates how tightly water is bound, structurally or chemically, within a substance. The lower a sample's water activity, the more tightly bound that water is within the sample. The concept of water activity is of particular importance in determining product quality and safety. It predicts safety and stability with respect to microbial growth, chemical and biochemical reaction rates, and physical properties.

Water activity is a measure of the energy status of the water in a system and is a far better indicator of product stability than moisture content. The figure below shows how the relative activity of microorganisms, lipids, and enzymes relate to water activity. While other factors, such as nutrient availability and temperature, can affect the relationships, water activity is the best single measure of how water affects these processes.

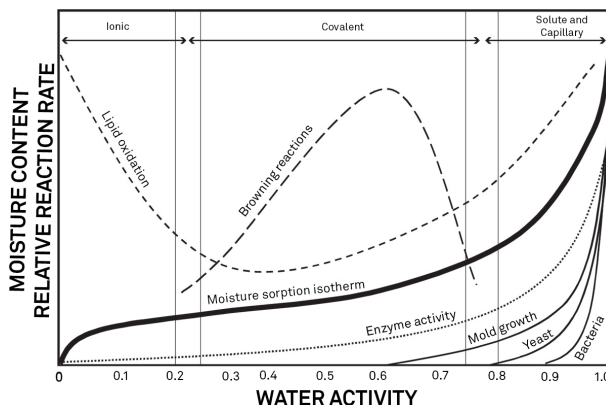


Figure 92 Water activity diagram adapted from Labuza (1976)

3.4.2 MOISTURE CONTENT

Moisture content implies a quantitative analysis to determine the total amount of water present in a sample. There are two primary methods for determining moisture content: loss on drying and Karl Fisher titration. Secondary methods, such as near infrared (NIR) and

nuclear magnetic resonance (NMR), may also be used. Moisture content determination is essential in meeting product nutritional labeling regulations, specifying recipes, and monitoring processes.

However, moisture content alone is not a reliable indicator for predicting microbial responses and chemical reactions in materials. The limitations of moisture content measurement are attributed to differences in the intensity that water associates with other components.

Researchers measure the water activity of a system by equilibrating the liquid phase water in the sample with the vapor phase water in the headspace and measuring the relative humidity of the headspace. In the AQUALAB 3, a sample in a sample cup is sealed inside the sample chamber, which contains a fan, a dew point sensor, and an infrared thermometer. The fan speeds equilibrium and controls the boundary layer conductance of the dew point sensor. The dew point sensor measures the dew point temperature of the air in the chamber, and the infrared thermometer measures the sample temperature. From these measurements, the relative humidity of the headspace is computed as the ratio of the dew point temperature saturation vapor pressure to the saturation vapor pressure at the sample temperature. When the water activity of the sample and the relative humidity of the air are in equilibrium, the measurement of the headspace humidity gives the water activity of the sample. Water activity is the relative humidity of air in equilibrium with a sample in a sealed chamber.

In addition to equilibrium between the liquid phase water and the vapor phase, the internal equilibrium of the sample is important. If a system is not at internal equilibrium, one might measure a steady vapor pressure (over the period of measurement) that is not the true water activity of the system. An example of this might be a baked good or a multicomponent food. Initially out of the oven, a baked good is not at internal equilibrium; the outer surface is at a lower water activity than the center of the baked good. One must wait a period of time in order for the water to migrate and the system to come to internal equilibrium. It is important to keep in mind that by this definition, water activity is an equilibrium measurement.

The water activity of a sample is influenced by factors that affect the binding of water. These factors include temperature, osmotic, matric, and pressure effects. Typically, water activity is measured at atmospheric pressure, so only the osmotic, temperature, and matric effects are important.

TEMPERATURE EFFECTS

Temperature plays a critical role in water activity determination. Most critical is the measurement of the difference between sample and dew point temperature. For water activity measurements to be accurate to 0.001, temperature difference measurements need to be accurate to 0.017 °C. The AQUALAB 3 infrared thermometer measures the difference in temperature between the sample surface and the sample block. The thermometer is carefully calibrated to minimize temperature errors; however, achieving 0.017 °C accuracy is difficult when temperature differences are large. Most accurate measurements are obtained when the sample is near sample chamber temperature.

Another effect of temperature on water activity occurs when samples are near saturation. A sample that is close to 1.0 a_w and is warmer than the sensor block will cause water to condense within the chamber. This causes errors in the measurement and in subsequent measurements until the condensation disappears. For example, a sample at 0.75 a_w only needs to be 4 °C above the sample chamber temperature to cause condensation to form. The AQUALAB 3 warns the user if a sample temperature is more than 4 °C above the chamber temperature, but for high water activity samples, the operator needs to be aware that condensation can occur if a sample is warmer than the sample block.

There are several advantages in having a temperature-controlled water activity meter. A few major reasons are detailed here.

1. Research purposes.

Researchers can use temperature control to study the effects of temperature on the water activity of a sample, make a comparison of the water activity of different samples independent of temperature, and conduct accelerated shelf-life studies or other water activity studies where temperature control is critical. There are many shelf-life, packaging, and isotherm studies in which temperature control would be very beneficial.

2. Compliance with government or internal regulations for specific products.

Though the water activity of most products varies by less than ± 0.02 per degree Celsius, some regulations require measurement at a specific temperature. The most common specification is 25 °C, though 20 °C is sometimes indicated.

3. Minimization of extreme ambient temperature fluctuations.

If the environmental and AQUALAB 3 temperatures fluctuate by as much as ± 5 °C daily, water activity readings may vary by $\pm 0.01 a_w$. Temperature control eliminates variations caused by changes in ambient conditions.

OSMOTIC EFFECTS

Osmotic effects are well known from biology and physical chemistry. Water is diluted when a solute is added. If this diluted water is separated from pure water by a semipermeable membrane, water tends to move from the pure water side through the membrane to the side with the added solute. If sufficient pressure is applied to the solute-water mixture to just stop the flow, this pressure is a measure of the osmotic potential of the solution. Addition of 1 mol of an ideal solute to 1 kg of water produces an osmotic pressure of 22.4 atm. This lowers the water activity of the solution from 1.0 to 0.98 a_w . For a given amount of solute, increasing the moisture content of the systems dilutes the solute, decreasing the osmotic pressure, and increasing the water activity. Since microbial cells are high concentrations of solute surrounded by semipermeable membranes, the osmotic effect on the free energy of the water is important for determining microbial water relations and therefore microbe activity.

MATRIX EFFECTS

The sample matrix affects water activity by physically binding water within its structure through adhesive and cohesive forces that hold water in pores and capillaries and to particle surfaces. If cellulose or protein were added to water, the energy status of the water would be

reduced. Work would need to be done to extract the water from this matrix. This reduction in energy status of the water is not osmotic, because the cellulose or protein concentrations are far too low to produce any significant dilution of water. The reduction in energy is the result of direct physical binding of water to the cellulose or protein matrix by hydrogen bonding and van der Waals forces. At higher water activity levels, capillary forces and surface tension can also play a role.

CHILLED-MIRROR DEW POINT LIMITATIONS

The limitation of the AQUALAB 3 is its ability to accurately measure samples with high concentrations (typically >1%) of certain volatile compounds such as ethanol or propylene glycol, which can condense on the surface of the chilled mirror. The extent of the effect is determined by how readily the material volatilizes, which is both concentration and matrix dependent. Therefore, even if a sample contains materials that could volatilize, it may still be possible to make accurate readings using the chilled-mirror dew point sensor. The AQUALAB 3 provides a solution for products containing volatile materials. The AQUALAB 3 uses a tunable diode laser which shines light of a controlled wavelength, specific to water vapor, at a detector that receives light from the laser. The vapor pressure of the headspace of the instrument in equilibrium is determined by the loss of signal strength from the laser caused by the presence of water vapor in the headspace. For more information, contact [Customer Support](#).

SORPTION ISOTHERMS

Changes in moisture content affect both the osmotic and matric binding of water in a product. Thus, a relationship exists between the water activity and moisture content. This relationship is called the sorption isotherm and is unique for each product. Besides being unique to each product, the isotherm changes depending on whether it was obtained by drying or wetting the sample. Typically, large safety margins are built into moisture content specifications to allow for these uncertainties.

While the sorption isotherm is often used to infer water activity from moisture content, one could easily go the other direction and infer moisture content from water activity. This is particularly attractive because water activity can be measured much more quickly than moisture content. This method gives particularly good precision in the center of the isotherm. In order to infer moisture content from water activity, an isotherm for the particular product is needed. METER sells an isotherm generator called the AQUALAB Vapor Sorption Analyzer (VSA) or METER can run the isotherm for a fee. Visit metergroup.com/food/services/water-activity-and-isotherm-testing for more information.

For example, if using the AQUALAB 3 to monitor the moisture content of dried potato flakes, measure the water activity and moisture content of potato flakes dried to varying degrees using the standard drying process for those flakes. That data is used to construct an isotherm and infer the moisture content using the measured water activity of samples and that isotherm.

4. SERVICE

This section contains performance verification, cleaning and maintenance guidelines, troubleshooting guidelines, customer support contact information, and terms and conditions.

4.1 PERFORMANCE VERIFICATION

Verification tests to validate instrument accuracy should be performed once per day or once per shift when the AQUALAB 3 is in use. Verification schedules and the selection of verification standards to use are set in SKALA Control.

The best way to verify the AQUALAB 3 is to use a technique called bracketing, which uses the verification standards of the closest higher and lower values to the expected water activity of the product. If measuring a cookie that typically has a water activity of 0.600 a_w , use the 0.500 a_w and 0.760 a_w standards to verify. If measuring milk powder with 0.300 a_w , use the 0.250 a_w and 0.500 a_w standards to verify. SKALA Mobile will display prompts to run a verification according to the set schedule and using the specified standards.

When SKALA Mobile indicates a verification is needed, perform a manual verification. Follow the steps listed below.

1. Wash hands thoroughly or put on lab gloves.
2. Prepare standard.

NOTE: The standard should be prepared outside of the sample chamber to avoid contaminating the chamber by spilling standard.

- a. Check the expiration date of the standards solution.
- b. The typical shelf life of standards is 18 months. Expired standards should not be used for verification.
- c. Read the standards in the order of increasing water activity if using more than one standard.
- d. Remove the cap on the standard vial by twisting counter clockwise.
- e. Empty the vial contents into a sample cup.
- f. The standard should cover the bottom of the cup.
- g. Place the standard cup in the sample chamber.
- h. Close the sample drawer and turn the knob to the left to lock the drawer.

NOTE: Do not contaminate the sample chamber by spilling standard inside the sample chamber.

3. In the SKALA mobile app, navigate to the Instruments page.
4. Select VERIFY located at the far right of the AQUALAB 3 line (Figure 93).

The Instrument Verification dialog window will appear (Figure 94). This section contains information on taking water activity readings.

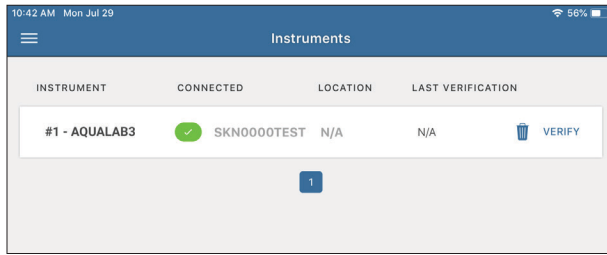


Figure 93 Instrument online and visible to NEXUS

- Follow the directions on the Clean Device tab to make sure the sample drawer and sensor block are clean ([Section 4.2](#)).

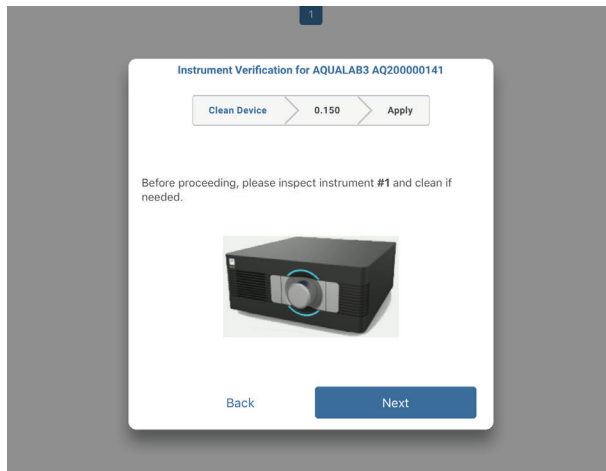


Figure 94 Verify correct instrument

- Select the **Next** button.

The standard tab will appear ([Figure 95](#)). The tab heading will show the selected standard for the verification test.

If an error message indicates there are no assigned standards for the instrument, go to skalacontrol.com and select a standard to use.

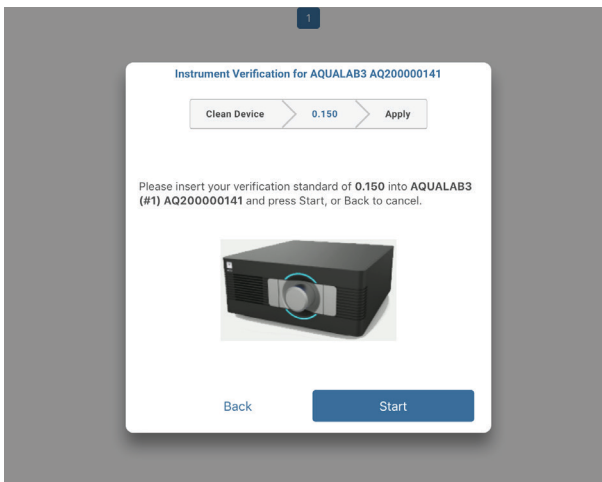


Figure 95 Verify correct standard

7. Insert the standard in the sample chamber.
8. Close the sample cover.
9. Push the sample drawer in.
10. Turn the drawer knob counter-clockwise (left) to close the drawer.
11. Select the **Start** button on the SKALA Mobile app screen to start the reading.
12. Select the **In-Process Readings** button at the bottom of the Take a Reading window to see the progress of readings ([Figure 96](#)).

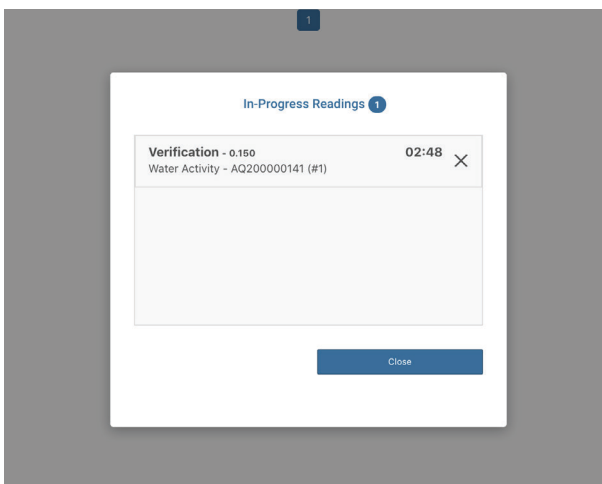
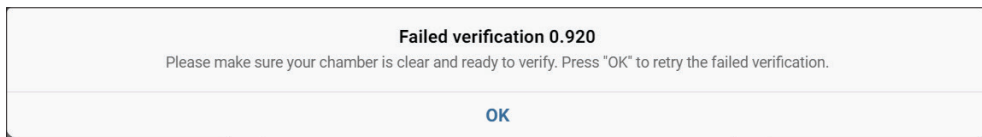
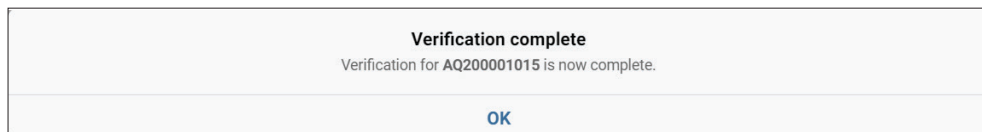


Figure 96 In-Progress Reading screen

When the verification reading is finished, a dialog window will appear in SKALA Mobile if the verification passed or failed ([Table 4](#)).

Table 4 Example Completed Verification Reading Indicators



A flashing red indicator light means there is an error associated with the AQUALAB 3. SKALA Mobile should indicate what the error is and how to fix the error. If the error is not actionable by the user, a message will be to contact [Customer Support](#).

4.2 CLEANING

It is extremely important to keep the instrument clean to make sure it is performing accurately. It should be cleaned when contamination is seen. However, some types of contamination are not visible. The best way to check for contamination is by running verification standards daily or at the start of each shift. If the verification standards are not within specification, cleaning the AQUALAB 3 sensor block is recommended. The AQUALAB 3 comes with a cleaning kit that contains the following items:

- Cleaning swabs
- KIMWIPES strips (1.25 in)
- Cleaning solution (in bottle with white lid)
- Deionized water (in bottle with blue lid)

NOTE: Regulations regarding hazardous materials prevent METER from shipping isopropyl alcohol in the cleaning kits, but it is often the best cleaning agent, particularly when measuring samples with a high fat content.

Use the following process to clean the AQUALAB 3.

1. Power off the AQUALAB 3 and disconnect the SKALA NEXUS.
2. Put on lab gloves.
3. Wipe the drawer and detachable sample cover clean, making sure that no sample residue remains.
Ensure that the sample cover and drawer are thoroughly dried prior to measurement.
4. Lift off the top of the AQUALAB 3 to expose the interior.

Only the sensor block and ribbon cable will be visible.

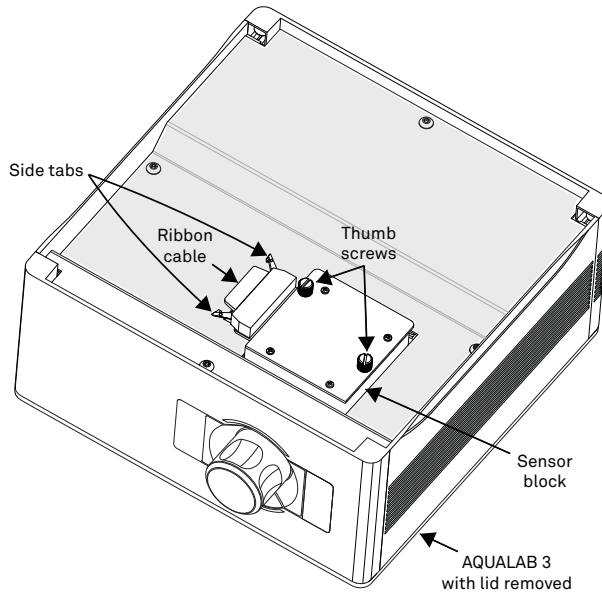


Figure 97 Sensor block in AQUALAB 3

5. Pull out on the side tabs to unplug the ribbon cable (Figure 97).
6. Loosen the thumbscrews and lift sensor block to remove (Figure 98).

NOTE: The block has been designed to be ESD resistant, however, care should be taken when cleaning and handling the AQUALAB 3 block.

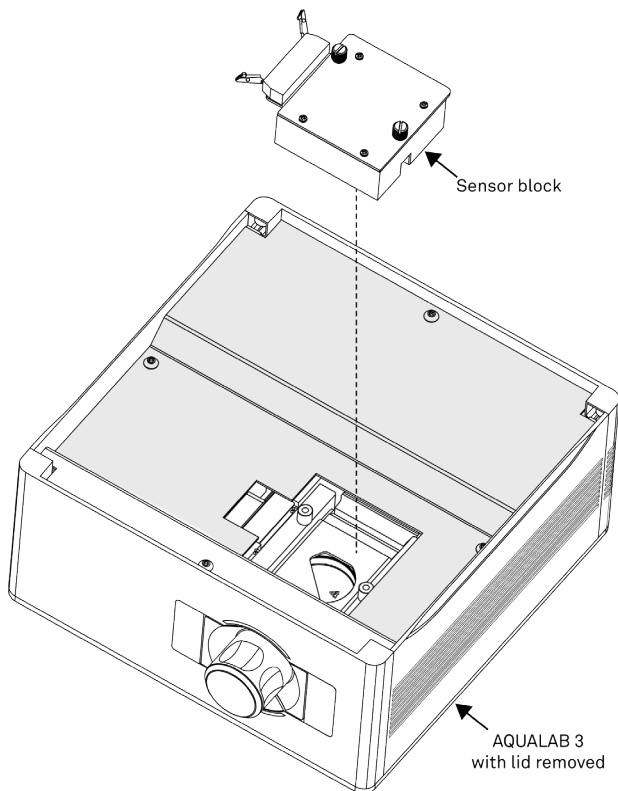


Figure 98 Remove sensor block

7. Turn the sensor block over so the sensor chamber area is visible, and clean the sensors and sensor block (Figure 99).
 - a. Wrap a KIMWIPES strip around a cleaning swab by folding the wipe over the head and twisting the swab until reaching the end of the strip.

View the [AQUALAB Cleaning Kit](#) video showing how to wrap a KIMWIPES strip around the cleaning swab.

NOTE: Cover the cleaning swab completely with the tissue to avoid scratching the components and surface of the chamber.
 - b. Moisten the KIMWIPES strip with some cleaning solution or isopropyl alcohol (concentration greater than 90% recommended).

To avoid contamination, do not dip a used KIMWIPES strip into the cleaning solution or alcohol.
 - c. Clean the mirror, optical sensor, and thermopile by gently wiping the KIMWIPES strips over the sensors.

Do not put too much pressure on the thermopile sensor, the mirror, or optical sensor.

Discard used KIMWIPES strips frequently during the cleaning process to get each component clean.

NOTE: Use the KIMWIPES strips supplied in the cleaning kit rather than facial tissue, paper towels, or commercial swabs. KIMWIPES strips are specially made for lab work. They do not contain adhesives or other contaminants and are made from low-lint fibers that will not scratch delicate surfaces when wet.

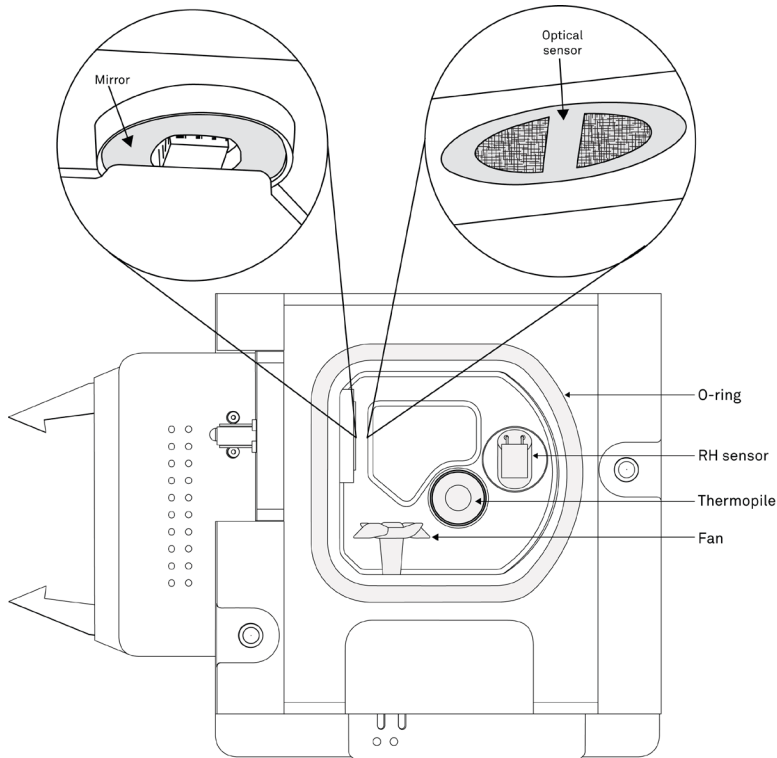


Figure 99 View of inside of removed sensor block

8. With additional moistened KIMWIPES strips, clean the remaining surfaces of the sensor block without wiping the KIMWIPES strips back over the sensors.
9. Moisten a fresh KIMWIPES strip wrapped around the cleaning swab with deionized water.
10. Clean the sensors and sensor block, following the same procedure outlined in [step 7](#). To avoid cross-contamination, do not dip used KIMWIPES strips into clean distilled water.
11. Use fresh dry KIMWIPES strips wrapped around the cleaning swab to remove moisture on the sensors and in the sensor block.

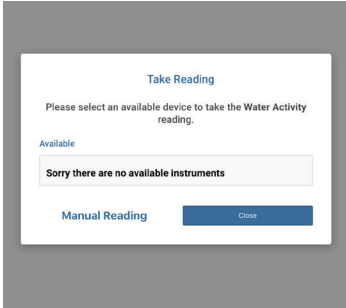
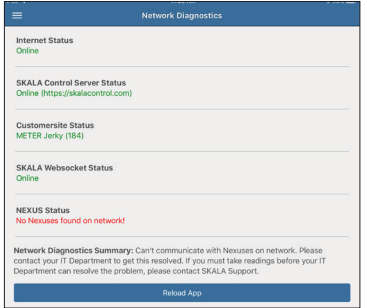
4.3 TROUBLESHOOTING

Table 4 lists common problems and their solutions. If the problem is not listed or these solutions do not solve the issue, contact [Customer Support](#).

Table 5 Troubleshooting the AQUALAB 3 System

Problem	Possible Solutions
AQUALAB does not turn on	<p>Ensure power cord is securely attached to the back of the instrument and plugged into the power outlet.</p> <p>A power surge may have caused a fuse to blow. To change the fuses:</p> <ul style="list-style-type: none"> • Unplug the power cord. • Locate the panel where the power cord plugs in. The fuse box is on the right side of that panel. Press the release tab and pull the fuse-holder out. • Pull the broken fuse out and replace with a 2-A, 250-V (5 mm × 20 mm) fuse. <p>CAUTION: Do not use any other kind of fuse to avoid risk of damaging the instrument or voiding the warranty.</p> <ul style="list-style-type: none"> • Replace the fuse holder and push it into the fuse well until the release tab snaps in place. • Connect the power cord and turn the instrument on. <p>If the fuse blows again, a failed component may be causing the problem. Contact Customer Support to make arrangements for repairs.</p>
The device is not reading correctly.	<p>Make sure that clean sampling practices Cleaning are being followed and that standards solutions have not expired.</p> <p>Check if the product being tested has special properties that need special consideration. Volatile compounds will affect the water activity readings of the AQUALAB 3. If products being tested contain volatiles, contact Customer Support for further assistance.</p> <p>Verify that the o-ring is seated properly by removing the sensor block and inspecting it.</p>
There are no assigned standards for instrument verification. Please assign a standard to the instrument in SKALA Control, and try again.	<p>Go to skalacontrol.com and select a standard to use in verification of the instrument.</p>

Table 6 Troubleshooting the AQUALAB 3 System

Problem	Possible Solutions
No AQUALAB 3 available in the app when trying to take reading.	<p>Make sure the AQUALAB 3 is properly connected to all wires and the power indicator is in the ON position.</p> <p>Make sure the NEXUS is properly connected to all wires and the power indicator light is ON.</p>
	<div>   </div> <p>Figure 100 No available instruments Figure 101 No NEXUSES found</p> <p>Disconnect and reconnect the NEXUS and the AQUALAB 3 to reboot them. Wait a few minutes for the NEXUS to reestablish an Ethernet connection.</p> <p>If the AQUALAB 3 still does not appear, contact Customer Support.</p>
AQUALAB 3 indicator light is red.	Instrument needs to be calibrated. Contact Customer Support for more information.

4.4 CUSTOMER SUPPORT

NORTH AMERICA

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 7:00 am to 5:00 pm Pacific time.

Email: support.food@metergroup.com
sales.food@metergroup.com
support.skala@metergroup.com

Phone: +1.509.332.5601

Fax: +1.509.332.5158

Website: metergroup.com

EUROPE

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 8:00 to 17:00 Central European time.

SERVICE

Email: support.europe@metergroup.com
sales.europe@metergroup.com
Phone: +49 89 12 66 52 36
Fax: +49 89 12 66 52 20
Website: metergroup.de

If contacting METER by email, please include the following information:

Name	Email address
Address	Instrument serial number
Phone	Description of the problem

NOTE: For products purchased through a distributor, please contact the distributor directly for assistance.

4.5 TERMS AND CONDITIONS

By using METER instruments and documentation, you agree to abide by the METER Group, Inc. USA Terms and Conditions. Please refer to metergroup.com/terms-conditions for details.

REFERENCE

Labuza, Ted P., K. Acott, S. R. Tatini, R. Y. Lee, J. Flink, and W. McCall (1976). "Water activity determination: A collaborative study of different methods." *Journal of Food Science* 41, no. 4: 910–917.

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