Zoë-CM2™

User Guide

emulate

emulate

Zoë® Culture Module

Zoë means life. Zoë-CM2 Culture Module is designed to sustain the life of cells within Organ-Chips.

The instrument automates the precise conditions needed for simultaneous cell culture of up to 12 Organ-Chips. It supplies the dynamic flow of media and recreates the mechanical forces of breathing motions or peristalsis that help Organ-Chips recreate the microenvironment cells experience in the body.

Zoë-CM2 gives users the ability to independently control the flow rate of media through both the top and bottom channels of Organ-Chips. It also allows users to determine stretch parameters—including frequency and amplitude—of the Organ-Chip membrane. What's more, Zoë-CM2 Culture Module has automated algorithms to prime the fluidic channels of Organ-Chips with media and remove any bubbles from the fluidic channels.

This user guide has essential instructions for how to safely and effectively operate Zoë-CM2. Please ensure all users thoroughly read and understand this guide before operation.

This product is for research use only.

Zoë Culture Module

Table of Contents

1	2	3	4
Introduction	**Specifications**	**Safety**	**Use**
Page 6	Page 13	Page 15	Page 18

Introduction + Use

Zoë Culture Module

Table of Contents

Settings + Support

① Introduction

This section provides an overview of Zoë and its functions.
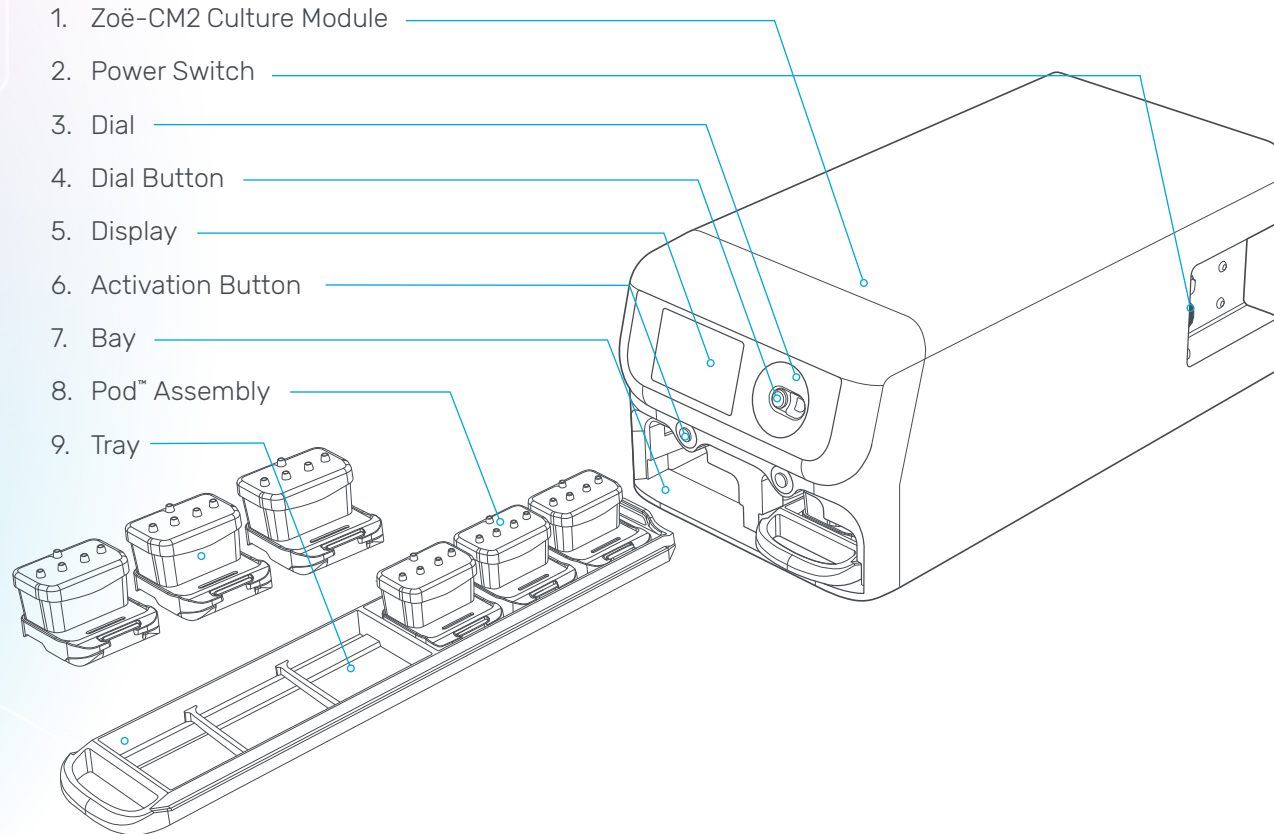
Equipment (what's in the box)

1.   Zoë-CM2 Culture Module
2.   Chip Cradles
3.   Gas & Vacuum Supply Line
4.   Zoë Core Update Cable
5.   SensorPush HT1 Temperature and Humidity Smart Sensor
6.   Metal Spudger Pry Tool
7.   24V Power Supply

Zoë-CM2 Culture Module

Components

1. Zoë-CM2 Culture Module
2. Power Switch
3. Dial
4. Dial Button
5. Display
6. Activation Button
7. Bay
8. Pod™ Assembly
9. Tray

Power Switch – Used to power the device on and off.

Dial – Used for selecting elements on the display, basic navigation, and adjusting values.

Dial Button – Used to confirm selections, parameters, and other edits to system settings.

Display – Shows the current Zoë parameters, displays system status, and provides alerts and messaging to the user.

Bays – Zoë has a left and right Bay. Each Bay holds up to six Pod® Portable Modules, or 12 total.

Bay Activation Buttons – Each of the two Bay Activation Buttons can be pressed to raise or lower the manifolds to engage the Pods and resume or pause flow independently in each Bay.

Tray – Each Tray holds up to six Pods. Each Zoë can accept two Trays.

Organic-Chip
Configuration

1. Bottom Channel Inlet Port
2. Top Channel Inlet Port
3. Vacuum Ports
4. Top Channel Indicator
5. Top Channel Outlet Port
6. Bottom Channel Outlet Port
7. Chip Body
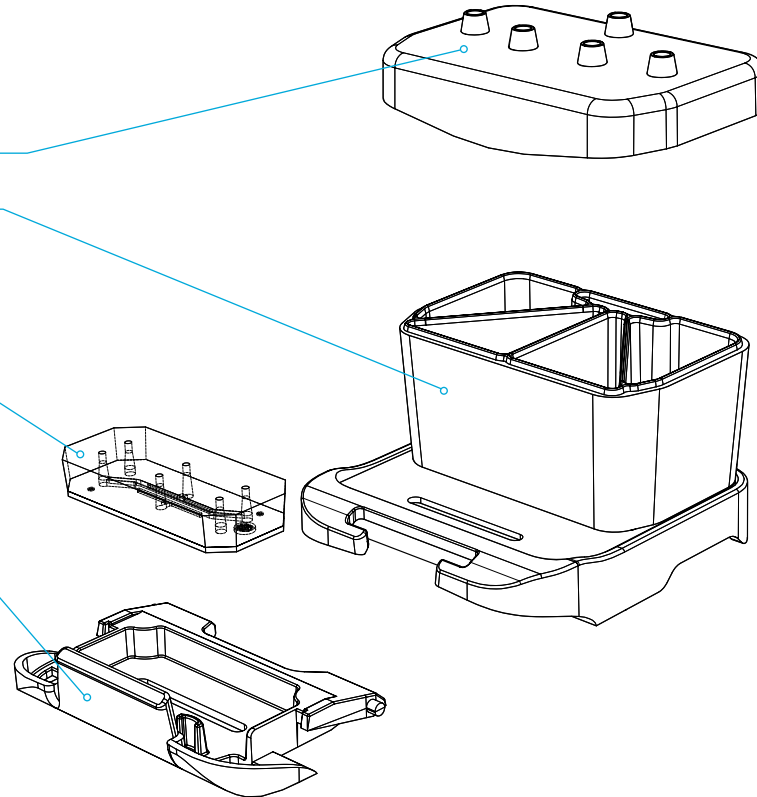8. Top Channel Indicator
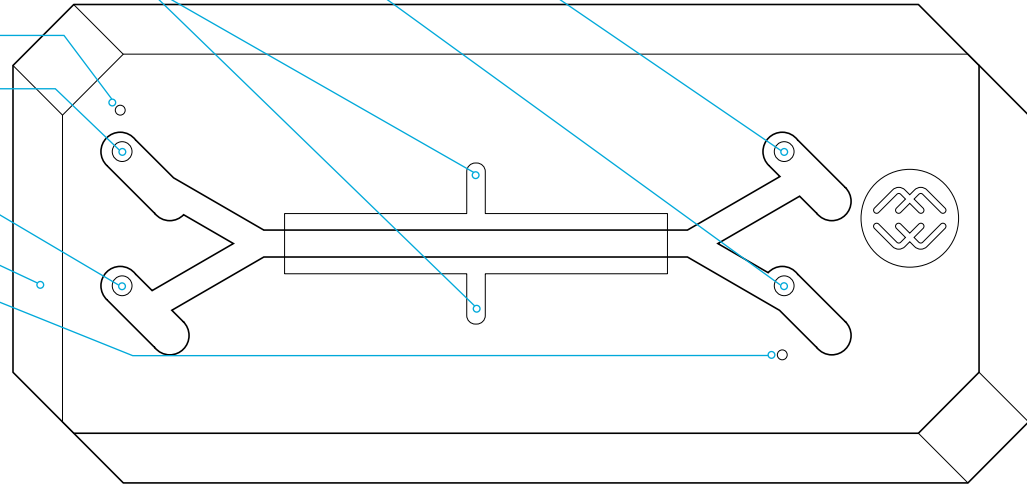
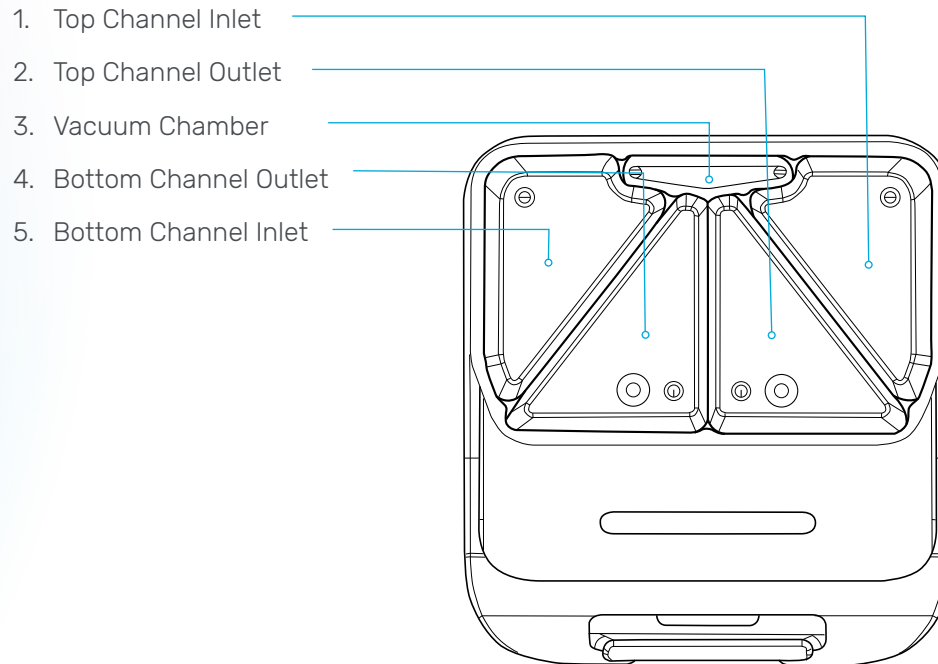# Pod
Configuration

1. Pod Reservoir Lid
2. Pod Reservoir
3. Organ-Chip
4. Chip Carrier

Pod
Components

1. Top Channel Inlet
2. Top Channel Outlet
3. Vacuum Chamber
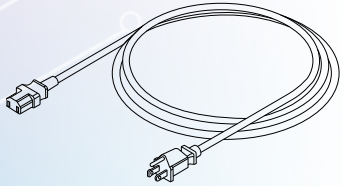4. Bottom Channel Outlet
5. Bottom Channel Inlet

Zoë-CM2

Items for Installation
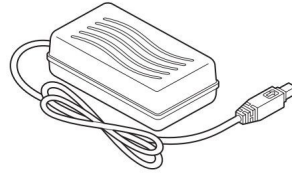
Please reach out to Emulate Support for detailed installation guidance.

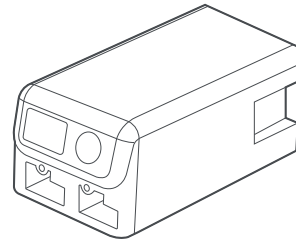Zoë-CM2 comes with the following items for installation:

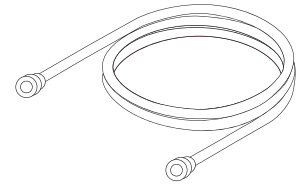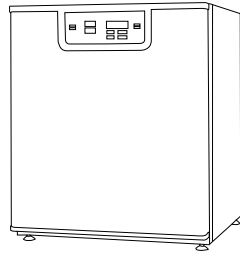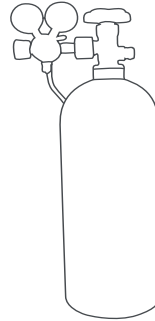| **1**	**2**	**3**	**4**
Power Cord	Power Supply	Zoë-CM2	Resource Bundle (Gas & Vacuum Supply Line)

Zoë-CM2
Items for Installation

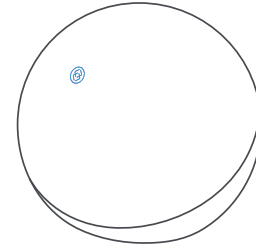The user will need to provide the following equipment for installation:

Incubator	100% CO_2 Gas Supply	Orb-HM1
5	**6**	**7**

**Note:** Contact Emulate for guidance on user-provided equipment.

2 Specifications

This section provides specific technical information and operational requirements. Included are system dimensions, thermal and gas requirements, and modes of operation.

Zoë-CM2
Specifications

Manufacturer	Emulate, Inc. 27 Drydock Avenue Boston, MA 02210
Assistance	Contact support@emulatebio.com
Use	Zoë-CM2 Culture Module is for research use only
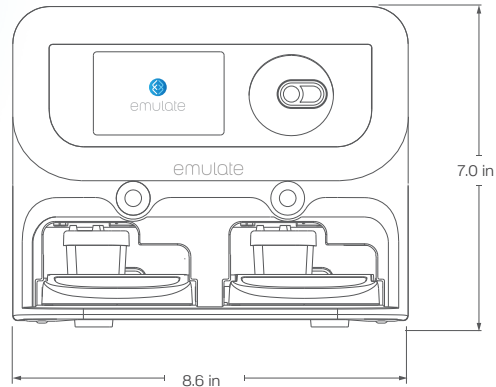
General
Model: CM2
Weight: 10.9 kg (24 lbs.)
Power Consumption: 13W
Capacity: 12 Pods

Operating Requirements
Instrument Rating: 24 VDC, 3.5 A
Gas Input Pressure: 276 kPa +/- 35 (40 psig +/- 5)
Gas Input Composition: 5% CO_2, balance air
Vacuum Input Pressure: -70 kPa (-10.2 psig)

Environmental
Operating Temperature: 20–38°C (68-100. 4°F)
Relative Humidity: 0–95%
Max Altitude: 2,000 meters (6,562 feet)
Storage Temperature: -5–40°C (23–104°F)
Storage Humidity: 30-85%, non-condensing

Technical
Flow Range: 0 µL/h, or 10–1,000 µL/h +/- 10%*
Stretch Range: 0–12%
Stretch Frequency: 0.00—0.40 Hz

*Flow tolerances may vary. Tolerance is based on Zoë-CM2 with firmware 1.3.0 or above. Please refer to the troubleshooting table (page 41) for best practices.

7.0 in

8.6 in

16.9 in

3 Safety

This section includes recommended precautions when handling and using Zoë-CM2. The information here describes how users can minimize the chance of harming themselves or the module during operation.

Zoë-CM2

Safety

The Instructions Symbol

The product is marked with this warning symbol where it is necessary for the user to refer to the instructions in the user guides.

Regulatory Compliance and Testing

This product has been tested to the requirements of:

61010-1 (IEC, EN, UL, CSA)

IEC 61010-2-10 Safety Requirements for Electrical Equipment for measurement, control, and laboratory use

EMC Testing to EN61326-1:2013, FCC Part 15 Subpart B:2021, ICES-003 Issue 6, EN 55032:2015/AC:2016

Zoë-CM2
Caution Statements

It is essential that all instructions are followed, and all warnings are understood. Failure to adhere to the instructions or operate the equipment within the stated specifications may cause injury, damage to the instrument, or issues with chip performance.

Zoë-CM2 is not sterile out of the box. Clean thoroughly with 70% ethanol before placing in the incubator to decrease the risk of contamination.

Never attempt to maintain or sanitize Zoë without first disconnecting from the power source.

Vent and disconnect all Gas Supply Lines before moving, sanitizing, or maintaining Zoë.

Zoë is heavy, so exercise care when moving it. Incubator shelving may not support Zoë when it is partially pulled out of the incubator. Make sure the instrument is placed on a secure and sturdy surface.

Never insert fingers or foreign objects into the Bays. Injury or instrument damage may result.

Always follow in-house safety protocols before handling compressed gas.

Users are responsible for the proper disposal of any single-use components that encounter biological material.

Service and maintenance should only be completed by Emulate-certified personnel. Never attempt to disassemble or repair Zoë without assistance.

Please be considerate of the instrument temperature range. Do not attempt to operate Zoë-CM2 in a temperature range outside of the one presented in this manual (36-37.5°C).

⚠️ **To power Zoë-CM2, only use the 24V Power Supply and Power Cord provided with the instrument. Note that this Power Cord is different from those of Orb and Zoë-CM1. Do not plug in the Power Supply provided with the Orb or Zoë-CM1 into Zoë-CM2.**

If installing your first Zoë in an incubator, it is recommended that it is placed on the top shelf for optimal equilibration. If two Zoës are being placed in an incubator, arrange them on separate shelves.

4 Use

This section describes proper interaction with, and operation of, Zoë-CM2. The instrument should always be used in an incubator while following aseptic procedures.

Zoë-CM2

Use

Getting Started

Zoë-CM2 Interface

a.   Display

b.   Dial

c.   Dial button

d.   Bay Activation Buttons

Powering On

To power Zoë on, push the Power Switch located at the rear of the system where the gas and power connections are located. Zoë will then go through its startup routine until it displays the status screen.

Note: For stable operation, please keep the Zoë **ON** at all times while it is placed in the incubator.

Zoë-CM2

Use

Running the Prime Cycle

The Prime Cycle perfuses media through the Pod before it is connected to a seeded chip to ensure no air is trapped when a chip is connected to the Pod.

1. Prepare Pods per desired organ-specific protocol.

2. Insert Tray with up to six Pods into a Zoë Bay.

3. Repeat Step 2 in the opposite Bay if priming more than six Pods.

4. Using the Dial, hover over "Prime Cycle" on the display. Press the Dial Button to select.

5. Rotate the Dial to bring up the "Start" option.

Zoë-CM2

Use

Running the Prime Cycle

6. Press the Dial Button to select "Start," which will initiate the Prime Cycle. This will cause the manifolds to lower.

7. A status bar and timer will appear to show the progress of the Prime Cycle.

Zoë-CM2

Use
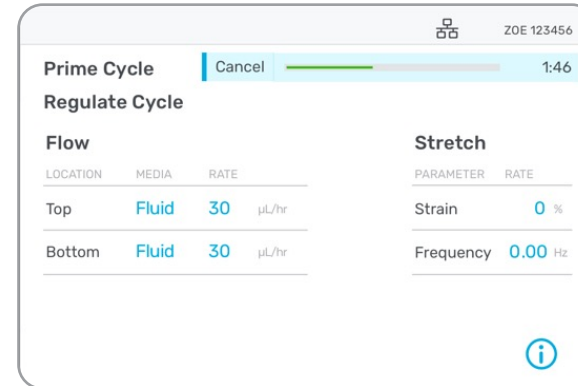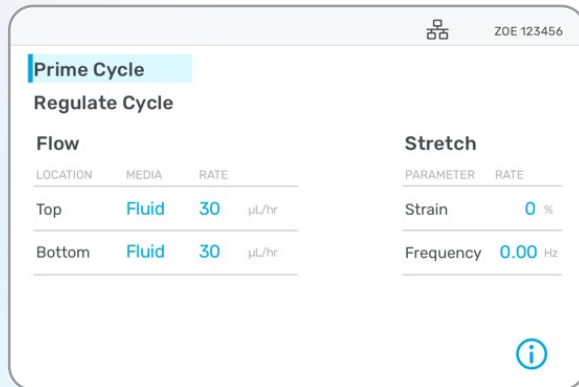
Running the Prime Cycle

8. Once the Prime Cycle is complete, the status bar and timer will disappear, the manifolds will rise, and the Bay(s) will be deactivated.

9. Remove the primed Pods from Zoë and attach the prepared chips to the Pods. Reference organ-specific protocols for instructions on chip preparation prior to attachment.
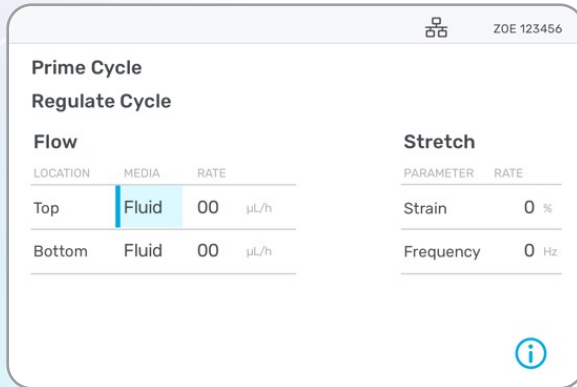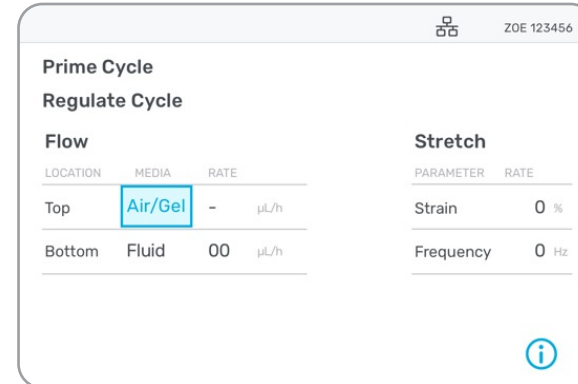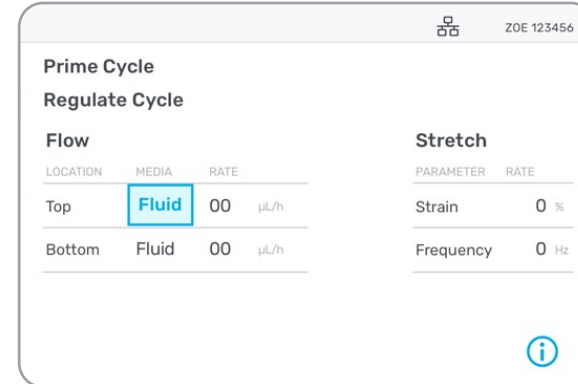
Zoë-CM2

Use

Selecting Media Type

1. Using the Dial, hover over the areas below "Media" denoting the "Top" and "Bottom" channels.

    Prime Cycle
    Regulate Cycle

    Flow

LOCATION	MEDIA	RATE	
Top	Fluid	00	µL/h
Bottom	Fluid	00	µL/h

    Stretch

PARAMETER	RATE	
Strain	0	%
Frequency	0	Hz

    ZOE 123456

2. Press the Dial Button to edit the "Media" type. Rotate the Dial to select between Fluid and Air/Gel:

    Prime Cycle
    Regulate Cycle

    Flow

LOCATION	MEDIA	RATE	
Top	Fluid	00	µL/h
Bottom	Fluid	00	µL/h

    Stretch

PARAMETER	RATE	
Strain	0	%
Frequency	0	Hz

    ZOE 123456

    Prime Cycle
    Regulate Cycle

    Flow

LOCATION	MEDIA	RATE	
Top	Air/Gel	-	µL/h
Bottom	Fluid	00	µL/h

    Stretch

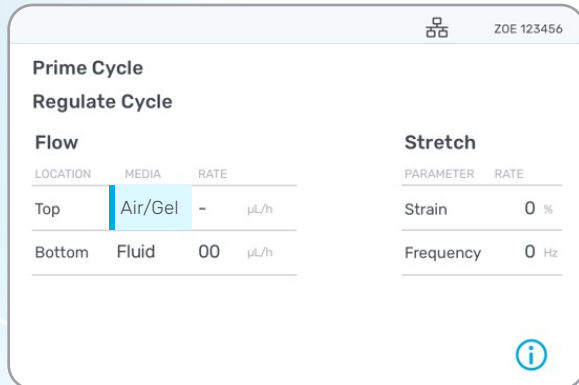 | PARAMETER | RATE | |
    |---|---|---|
    | Strain | 0 | % |
    | Frequency | 0 | Hz |

    ZOE 123456

Zoë-CM2

Use

Selecting Media Type

3. After hovering over the desired media type, press the Dial Button to confirm.

    a. Note: If selecting Air/Gel, the flow rate will automatically be set to 0 to prevent media flow, as there is no flow in the channel when "Air/Gel" is selected.

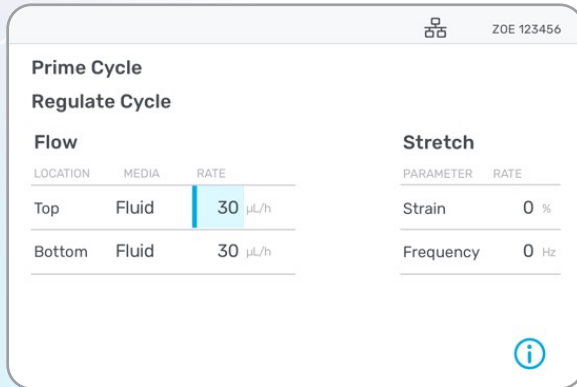4. These settings will now take effect on Zoë.

Zoë-CM2

Use

Programming Flow Rate

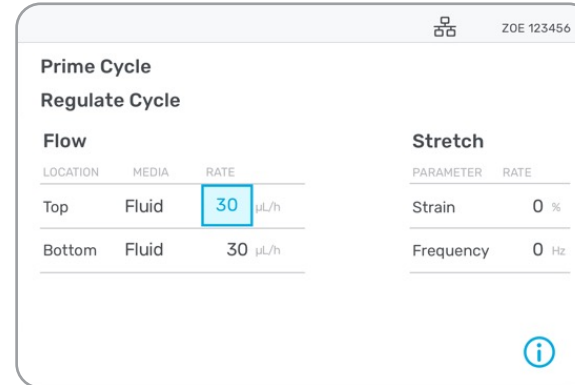1. Using the Dial, hover over the areas below "Rate" denoting the "Top" and "Bottom" channels.

2. Press the Dial Button to begin editing flow rate. Rotate the Dial to adjust the flow rate between 10 and 1,000 µL / hr.
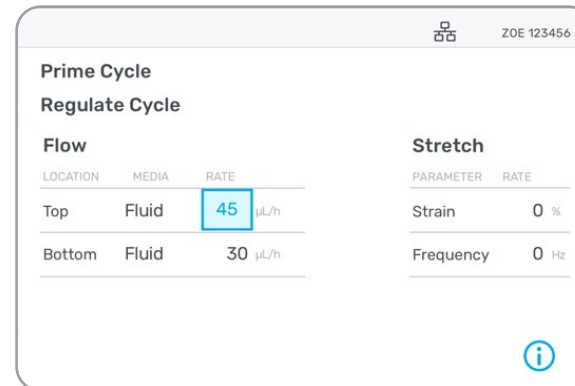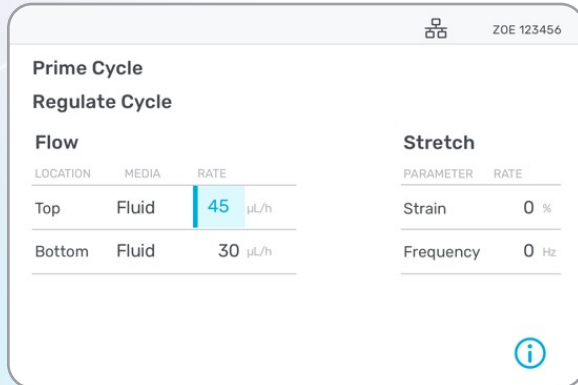
Zoë-CM2

Use

Programming Flow Rate

3. After rotating to the desired flow rate, press the Dial Button to confirm.

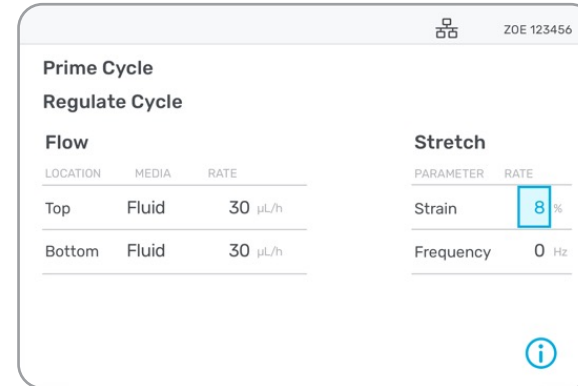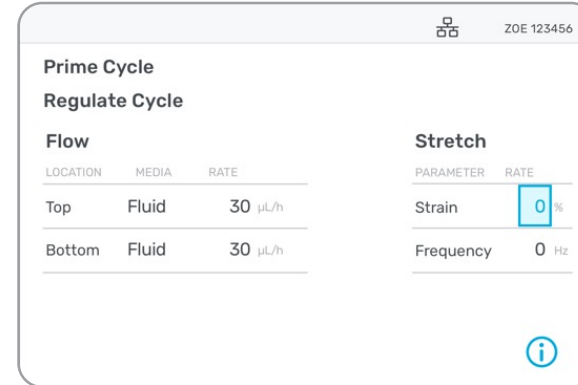4. These settings will now take effect on Zoë.

Zoë-CM2

Use

Programming Stretch Parameters

1. Using the Dial, hover over the "Strain" parameter. This option allows you to set the amount of stretch on the chips.
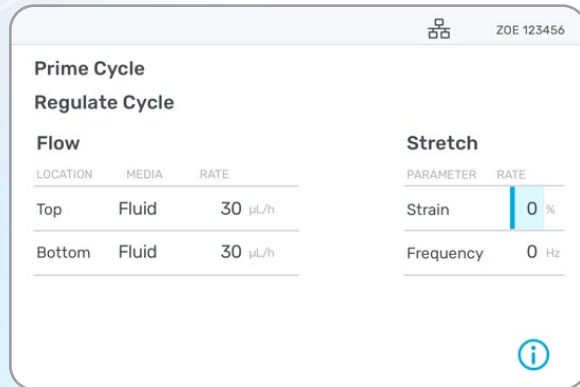
2. Press the Dial Button to begin editing the strain. Rotate the Dial to adjust the level of strain between 0% and 12%.
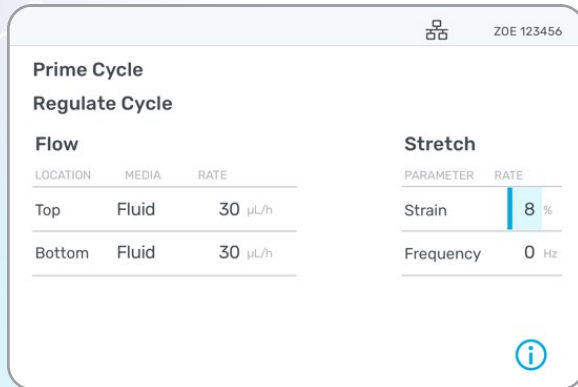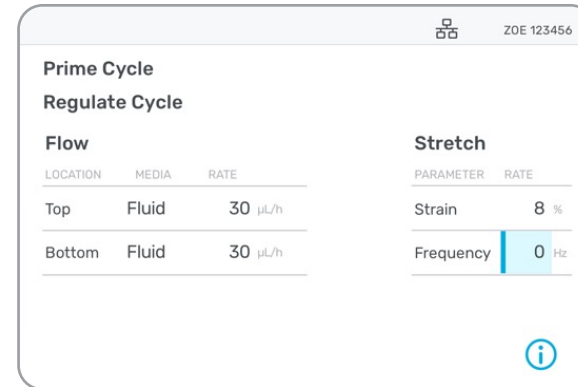
Zoë-CM2

Use

Programming Stretch Parameters

3.   After reaching the desired level of strain, press the Dial Button to confirm.

⊞	ZOE 123456				

Prime Cycle

Regulate Cycle

Flow

LOCATION	MEDIA	RATE			**Stretch**		
					PARAMETER	RATE	
Top	Fluid	30 µL/h			Strain	8 %	
Bottom	Fluid	30 µL/h			Frequency	0 Hz	

ⓘ

4.   Using the Dial, hover over the "Frequency" parameter. This option allows you to set the frequency of stretch.

⊞	ZOE 123456				

Prime Cycle

Regulate Cycle

Flow

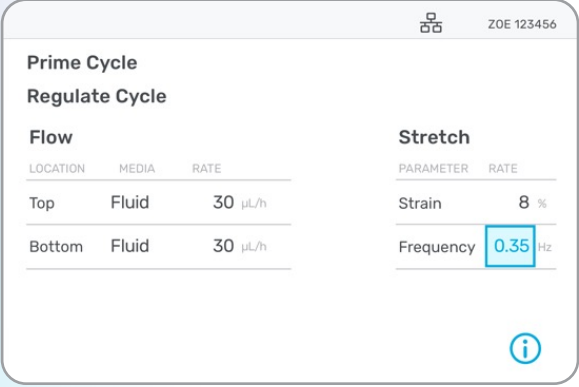| LOCATION	MEDIA	RATE			**Stretch**		
					PARAMETER	RATE	
Top	Fluid	30 µL/h			Strain	8 %	
Bottom	Fluid	30 µL/h			Frequency	0 Hz	

ⓘ

Zoë-CM2

Use

Programming Stretch Parameters

5. Press the Dial Button to begin editing the frequency. Rotate the Dial to adjust the frequency between 0.00 and 0.40 Hz.

6. After reaching the desired frequency, press the Dial Button to confirm.

Zoë-CM2

Use

Running Regulate™ Cycle

The Regulate Cycle is designed to remove any microbubbles that may have been introduced during the activation and seeding steps.

> Note: If modeling ALI or filling the top/bottom channel with gel, be sure to select "Air/Gel" for the "Media" field on the main screen prior to running the Regulate Cycle. This ensures that Regulate will run properly and will not disrupt gel or ALI conditions. To avoid drying out the reservoir during the Regulate Cycle, ensure there is sufficient media in all Pods. Reference the relevant cell culture protocol for more details.

1. If no connected Pods or chips are present in Zoë, insert the desired quantity into each Bay of Zoë.

2. Using the Dial, hover over "Regulate Cycle" on the display. Press the Dial Button to select.
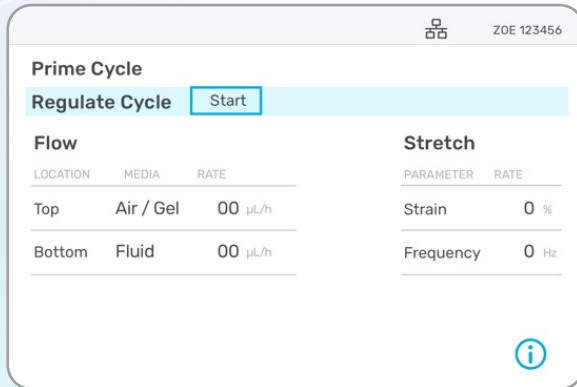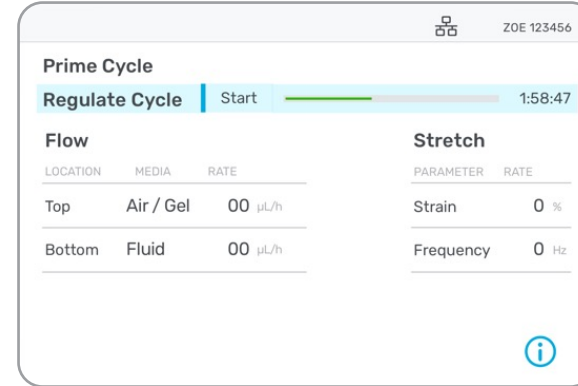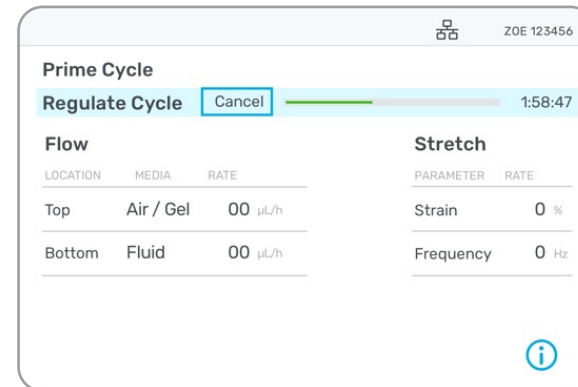
Zoë-CM2

Use
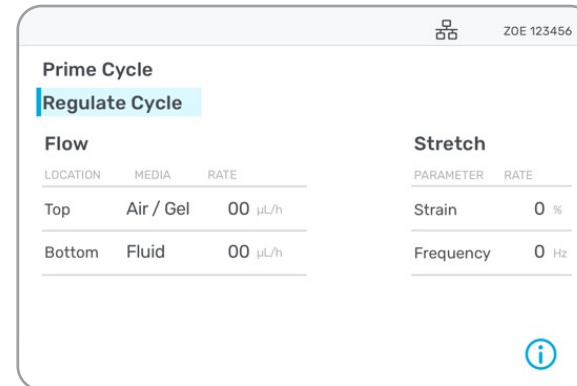
Running Regulate™ Cycle

3. Rotate the Dial to bring up the "Start" option. Press the Dial Button to select "Start," initiating the Regulate Cycle.

4. A status bar and timer will appear and show progress of the Regulate Cycle.

To cancel the Regulate Cycle, rotate the Dial to bring up the "Cancel" option. Press the Dial Button to select.

Zoë-CM2

Use

Running Regulate™ Cycle

5.   Once the Regulate Cycle is complete, the status bar
      and timer will disappear, and the system will revert to
      the preset flow and stretch parameters.

Prime Cycle				
Regulate Cycle				
Flow			**Stretch**	
LOCATION	MEDIA	RATE	PARAMETER	RATE
Top	Fluid	30 µL/h	Strain	0 %
Bottom	Fluid	30 µL/h	Frequency	0 Hz

ZOE 123456

Shutting Down

Press the Power Button on the front of Zoë.

5 Settings

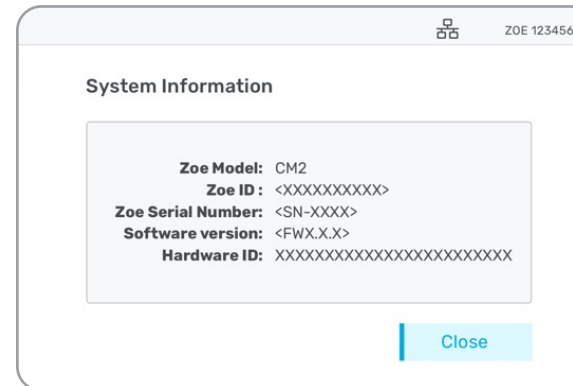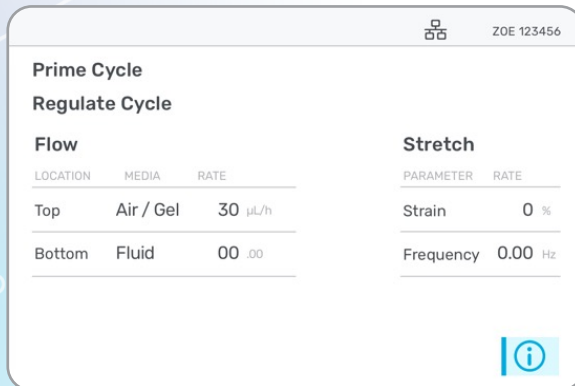# Zoë-CM2

Settings

System Information

The "System Information" screen provides details on Zoë Model, Name (ID), Serial Number, Software Version, and Hardware ID. This screen can be accessed by hovering over and selecting the ⓘ icon on the lower right of the screen.

To close the "System Information" screen, hover over and select the "Close" option.

6 Updating Firmware & Downloading Logs

Zoë-CM2

Updating Firmware & Downloading Logs
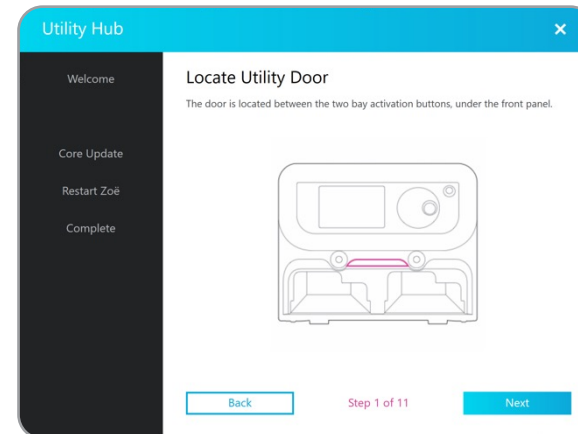
Updating Zoë Firmware

To update the Zoë firmware, download the "Utility Hub" application from emulatebio.com/utility-hub.

The application is compatible with computers running Windows 10 or a later version.

1. Once Utility Hub has been downloaded, open the application and select "Update Firmware".

2. Follow the instructions displayed on Utility Hub to update the Zoë firmware.
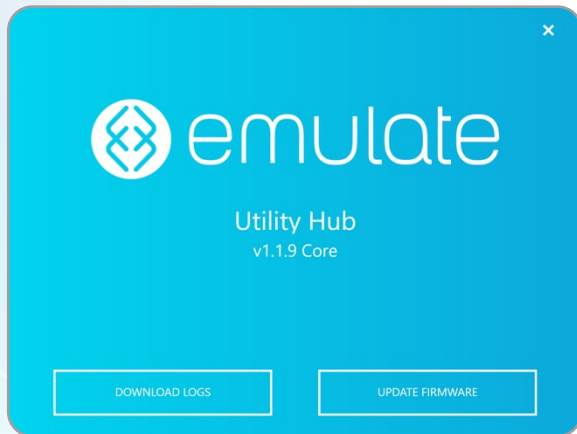
Zoë-CM2

Updating Firmware & Downloading Logs

Downloading Logs

1. Open Utility Hub and select "Download Logs".

2. Follow the instructions displayed on Utility Hub to download the logs from Zoë-CM2.

7 Help & Support

Contact Emulate Support for any issues with Zoë-CM2.
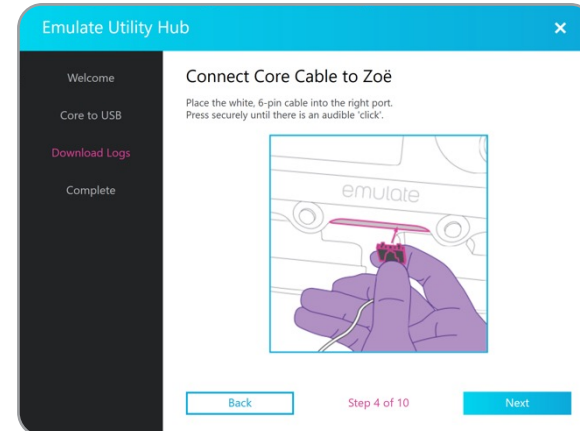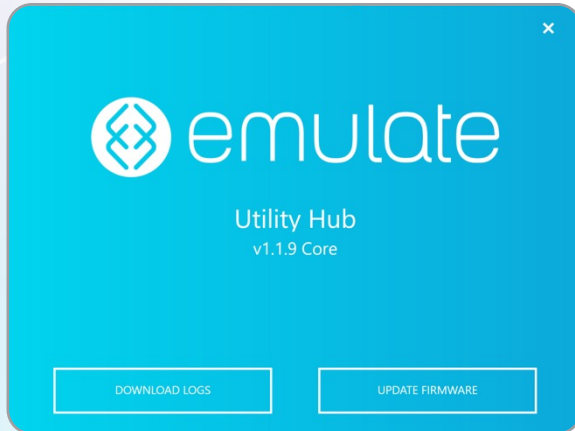
Email: support@emulatebio.com

Website: emulatebio.com/contact-support

Phone: +1 844-902-4477 (Toll Free)
+1 781-583-3515

8 Care

Zoë-CM2

Care

Cleaning & Maintenance

Care for Zoë includes periodic cleaning. Preventative maintenance should be performed by a qualified Emulate Field Engineer at least once per year.

Contact Emulate Support for additional details and to request an appointment. Regular checks and record keeping provide helpful information should any troubleshooting be required.

Zoë does not require significant maintenance. However, it is necessary to clean the exterior of the module and Trays with 70% ethanol prior to each use. The module should be cleaned in place and not removed from the incubator. All maintenance activities should be recorded in a lab notebook or equivalent.

Troubleshooting

Problem	Possible Reason	Recommended Solution
Zoë Culture Module will not power on	The Power Cord has become unplugged from the Zoë Culture Module.	The power cord may disconnect if the module or incubator is moved. It is recommended to minimize any tension/strain on the Power Cord. Avoid letting the power brick hang freely by using the supplied mounting hardware.
	There is an unknown internal error with Zoë.	Contact Emulate for troubleshooting.
	The Power Cord is damaged.	Replace Power Cord; contact Emulate for replacement.
Bay will not activate	Bay is empty or Tray is not fully inserted into the Bay.	Insert Tray until the Tray snaps into place.
	Gas & Vacuum Supply Line is not connected to Zoë or is not connected to the gas hub.	Connect the Gas & Vacuum Supply Line to rear of the Zoë Culture Module and the other end of the Gas Connector Line to the gas hub.
	The Orb Hub Module is powered off.	Refer to the Orb User Guide.
Bay will not de-activate	Bay was activated with empty Tray inserted, and empty Tray was removed before de-activating Bay.	Insert empty Tray and press the Activation Button Refer to the Orb User Guide.
Zoë is frozen or unresponsive	Outdated firmware.	Power Zoë off and back on again. Ensure Zoë is updated to the latest firmware. **IMPORTANT:** If problem persists, contact Emulate support.
Pods or Tray stuck in Zoë	Pod lid not secured on Pod.	Gently wiggle the Tray to the right and left while sliding it out, making sure to keep it level. **IMPORTANT:** If problem persists, contact Emulate support.
	Tray is catching inside the bay.	
Pods not flowing properly or evenly	If there are large fluctuations in flow rates, bubbles are the likely cause.	• Remove the chip from the Pod • Flush the chip with media • Re-prime the Pod with degassed media • Connect the chip to the Pod • Run the Regulate Cycle
There is a visible difference in media volume between the outlet reservoirs despite identical flow settings	The defined flow tolerance specifications are regulator and channel specific. Excess volume of media added to the inlet reservoirs can result in additional gravity driven flow.	Fill the inlet reservoirs no more than 1.5x the expected flow volume over time. For example, if flow is set to 30 µL/hr for 24 hours, ensure that the inlet reservoirs are filled to 1.1 mL and replenished daily. If the inlet reservoirs are filled up to 3.5 mL, expect an additional flow of ~6 µL/hr after the first day due to gravity.

emulate