CRYODRY®

CD8 Freeze Dryer
User Manual

For Version 4.0.x

Rev. 2

Table Of Contents

1.Revision History

Revision	Date	Description
1	20/12/2023	Release
2	28/02/2024	Updated technical specifications

2. Disclaimer, Terms and Conditions

- CryoDry Terms and Conditions, 20.12.2012 apply.
- The intellectual property rights for this manual belong to CryoDry Pty Ltd (hereinafter referred to as “the Company”).
- The Company reserves the right to change product specifications without notice.
- The contents of this manual are subject to change without notice.
- The contents of this manual must not be copied, extracted, or modified in any form without the Company’s permission.

3.Safety

DANGER! (may cause serious damage to property and or casualties)

1. Please carefully read this User Manual prior to operating the instrument and observe and verify that all connections are properly secured.
2. Utility requirements: Please ensure that the electrical connections meet the local standards and that the power supply is compatible with the instrument nameplate. The power source must be properly grounded.
3. The chamber and shelves may be extremely cold or hot – please check temperature first before opening the chamber to avoid injury from frostbite or burns.
4. Do not force open the chamber door while the chamber is under vacuum. Doing so may cause serious injury and cause significant damage to the instrument.
5. Before conducting electrical work and disassembly of the instrument, switch the main power switch to the 'OFF' position, and disconnect the power cable.
6. Do not expose any body parts to vacuum.
7. This instrument has been exclusively designed for freeze drying of non-flammable, non-corrosive, and non-hazardous solids or liquid containing products.

WARNING! (may cause property damage or personal injury)

1. Do not place heavy objects on top of or stand on the instrument.
2. It is prohibited to install any non-manufacturer authorized software onto this instrument.
3. Keep hands away from the chamber door during pump down to prevent crushing injuries.
4. The instrument must not be opened and operated on unless performed by adequately trained and certified professional personnel.

ATTENTION! (may affect operational performance or service life)

1. The overall safe operation of the instrument is the responsibility of the owner of the instrument and their assigned operator(s), who in turn are responsible for ensuring the user manual guidance is applied to ensure the safety and protection of personnel and the instrument before, during and after freeze-drying operation.
2. Timely maintenance of the instrument MUST be conducted to ensure continued safe operation and optimize the instrument's service life.
3. Only accredited and qualified professional repair technicians can open the instrument or conduct required repairs. Persons performing repairs on the instrument other than those selected or approved by the Company shall operate to void any warranty contained here for the product.
4. The instrument must be used in a well-ventilated, dry environment.
5. The instrument should be kept in a shaded area without direct sunlight.

FIRE HAZARD!

1. The instrument uses flammable refrigerant.
2. In the case of refrigerant leak. DO NOT operate the instrument and contact support immediately.

4.Introduction

Users are advised to carefully read this manual prior to operating the instrument so that they are aware of all precautions outlined and to ensure operation is in accordance with the instructions contained within this manual.

4.1. After Sales Support

If problems are encountered or technical support is required when installing or using the instrument, please contact your local agent, or support@cryodry.biz.

The company may provide technical assistance and information regarding the instrument or equipment or service without charge at its sole discretion. The buyer assumes sole responsibility for any reliance on or use of such assistance and information, and the company makes no warranty thereon.

Upon contact the following information is required:

- Product serial number (located on the instrument nameplate).
- Description of issue or problem.
- Method and or operating steps that have undertaken towards resolution.
- Your contact details inclusive of telephone number and email address.

4.2. Proper Use

The instrument has been exclusively designed for freeze drying of non-flammable, non-corrosive and non-hazardous solids or liquid containing products. It must not be used in an underground environment and must not be used in environments with potentially hazardous or flammable atmosphere.

The instrument is primarily designed for non-residential use and is to be used only in conjunction with accessories recommended within this manual and by the manufacturer.

5.Technical Specifications

Model	(Subject to chosen configuration)
Product Name	CD 8
Product Weight	87 kg
Rated Voltage	(Subject to chosen configuration, see below)
Rated Frequency	(Subject to chosen configuration, see below)
Max Vacuum Pump Current	3 A
Total Condenser Volume	11 litres
Ice Condenser Capacity	8 kg
Condenser Performance	4 kg per 24 hours
Ice Condenser Temperature	< -40 °C
Ultimate Vacuum	1.5 x 10-1 mbar
Minimum Shelf Temperature	-35 °C
Maximum Shelf Temperature	+60 °C
Tray Dimensions (mm)	9-shelf tray: 200 (W) x 450 (L) x 12 (H)
	7-shelf tray: 200 (W) x 450 (L) x 15 (H)
	5-shelf tray: 200 (W) x 450 (L) x 20 (H)
	3-shelf tray: 200 (W) x 450 (L) x 20 (H)
Number of Trays	5
Shelf Stack Options	9, 7, 5, 3, 1 shelf
Shelf Stack Dimensions (mm)	465 (L) x 210 (W) x 240 (H)
Typical Product Capacity	9.6 kg at 80% moisture
Distance Between Trays	5-shelf: 40 mm
External Dimensions (mm)	770 (D) x 748 (W) x 507 (H)

Part Numbers	**Voltages & Frequencies**
1011060105T	110V 60Hz
3023050105T	230V 50Hz
3022060105T	220V 60Hz
301005060105T	100V 50/60Hz

6. Inspection

6.1. Packing List

Unpack the equipment carefully and check for any damage which may have arisen during transport. In the event of identified damage, please contact support.

The package includes the following items:

Item Description	Quantity
Main Unit	1
Vacuum Hose	1
Clamps	2
Sealing Ring	2
Drain Hose	1
USB-A to USB-B Update Cable	1
Tray	5

CAUTION

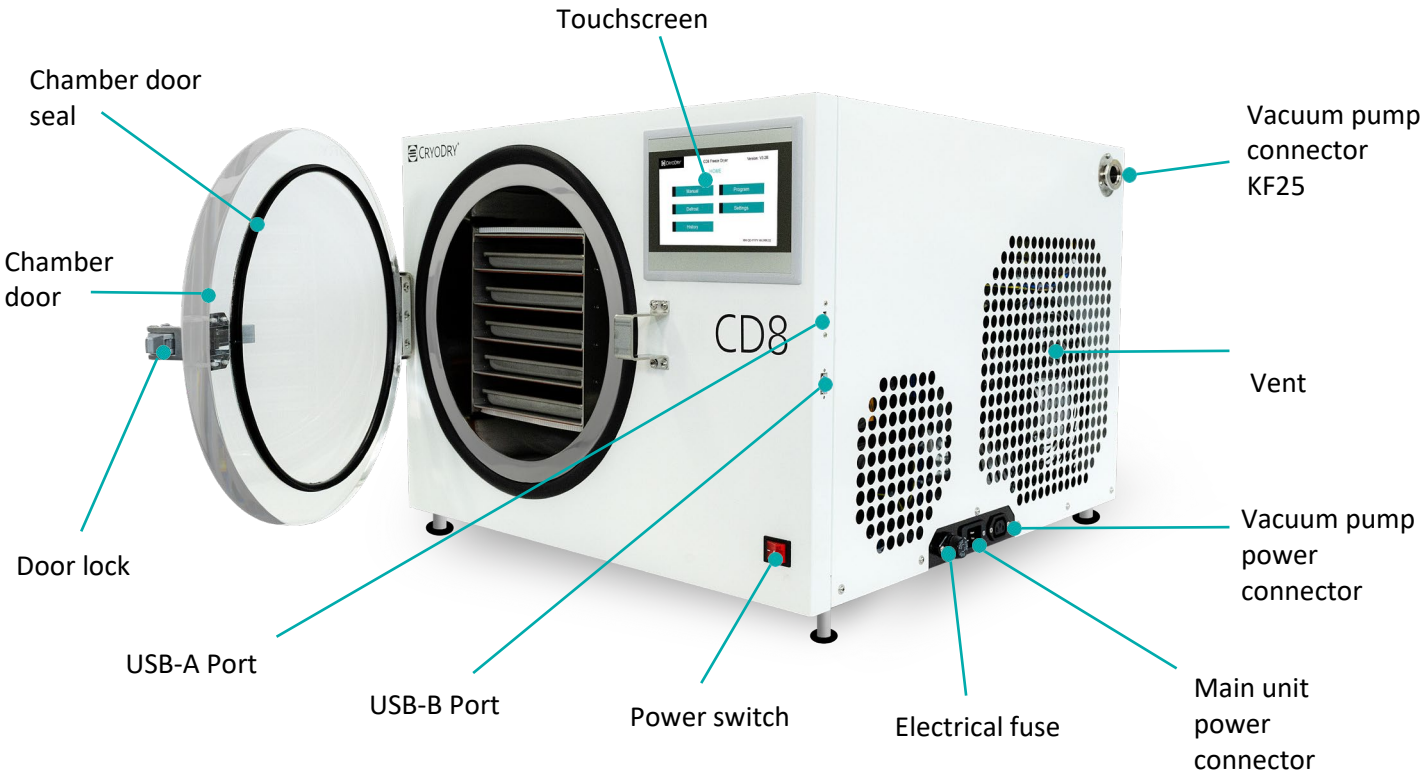
If there is any visible damage to the instrument, please do not connect the instrument to a power supply.

7.Precautions

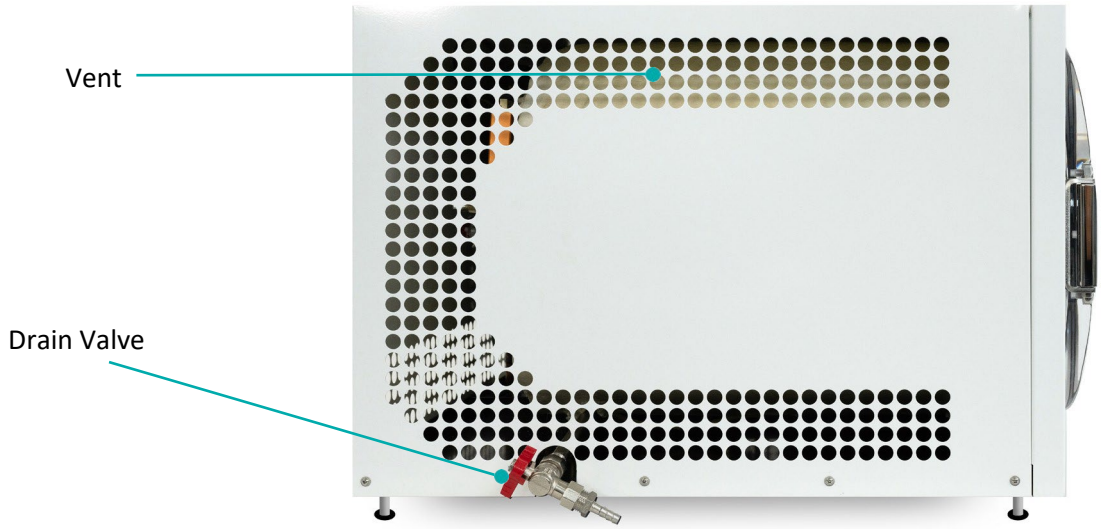
- The power supply should be connected to the electrical outlets safely and by authorized personnel only. It is important that anyone using this equipment does so with dry hands to minimize the risk of electric shock.
- A suitably fused power supply (according to the instrument nameplate) is required. An alternative supply voltage or frequency may damage the instrument or reduce its working lifespan.
- The electrical power cord is designed to be connected to the power outlet without knots, sharp bends, or heavy materials placed on the cord.
- If the power cord is damaged, please contact support for replacement.
- The instrument should be properly grounded according to local electrical codes.
- No residual water or foreign matter should be present inside the chamber prior to freeze-drying.
- If an abnormal sound, excessive heat, smoke, etc. is detected, stop the process immediately, disconnect the instrument from the power supply and contact support. The instrument operates with a low level of noise when running, if any significant changes occur, please stop and contact support.
- If a power outage occurs when operating the instrument, open the drain valve and let the chamber pressure return to normal before opening the door to retrieve the product.
- When the freeze-drying process has finished, first turn off the vacuum pump, followed by opening the drain valve.
- Be sure to keep the door seal ring and the chamber door clean. Only clean with soapy water and avoid using solvents or other cleaning agents.
- Do not rapidly power on/off the instrument. Please wait for at least a minute after powering off the instrument to power it back on again.
- It is recommended that the instrument be unplugged from the wall outlet, or the outlet be switched off when not in use.
- Water may escape from the instrument if it is operated outside of recommended operating conditions. Regularly check the vacuum pump for potential water contamination. Depending on pump, replace the oil and service as needed.
- During a drying run, regularly release the ballast valve on the vacuum pump to remove any moisture buildup.
- Do not rapidly enable the compressor, as it may damage the component. Wait at least 30 seconds before enabling it again.

8.Components & Assembly

8.1. Main Unit



The USB-A port is used to update the Display and download log data. The USB-B connector is used to update the Logic Controller. When updating the instrument, often both the Logic and Display need to be updated.

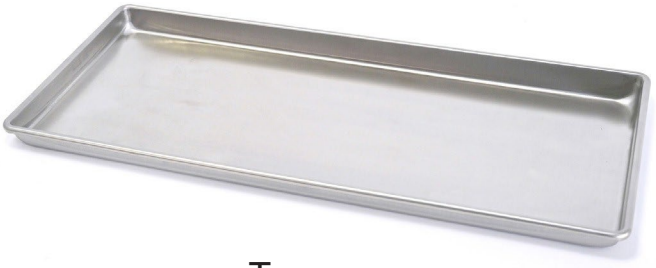


8.2. Other Components

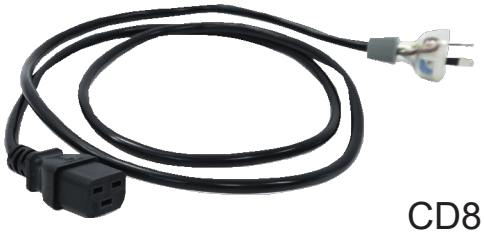
Vacuum hose and KF 25 connectors

Clamps and seal rings

Vacuum pump



Trays



CD8 power connector
(Plug dependent on region)

Drain hose

Vacuum pump power connector
(Plug dependent on region)

8.3. Assembling the Freeze Dryer

An instructional guide and video can be found at:

https://cryodry.biz/2023/06/installing-your-cd8-freeze-dryer/

8.3.1. Connecting the Vacuum Pump

The connector for the vacuum pump is located at the upper right corner at the back of the instrument (Figure 1).

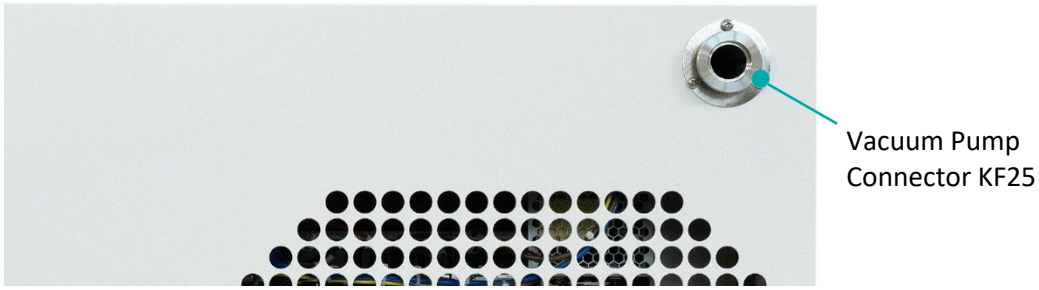


Figure 1

Hold the sealing ring up onto the vacuum pump connector (Figure 2). Align the vacuum hose to the sealing ring (Figure 3).

Figure 2

Figure 3

Wrap the clamp around the sealing ring and close the clamp (Figure 4). Tighten the wing nut as shown in Figure 5. Please note that the clamp only needs to be done up finger tight – excessive tightening may cause damage to the fittings.

Figure 4

Figure 5

Connect vacuum pump hose to the vacuum pump as shown in Figure 6.

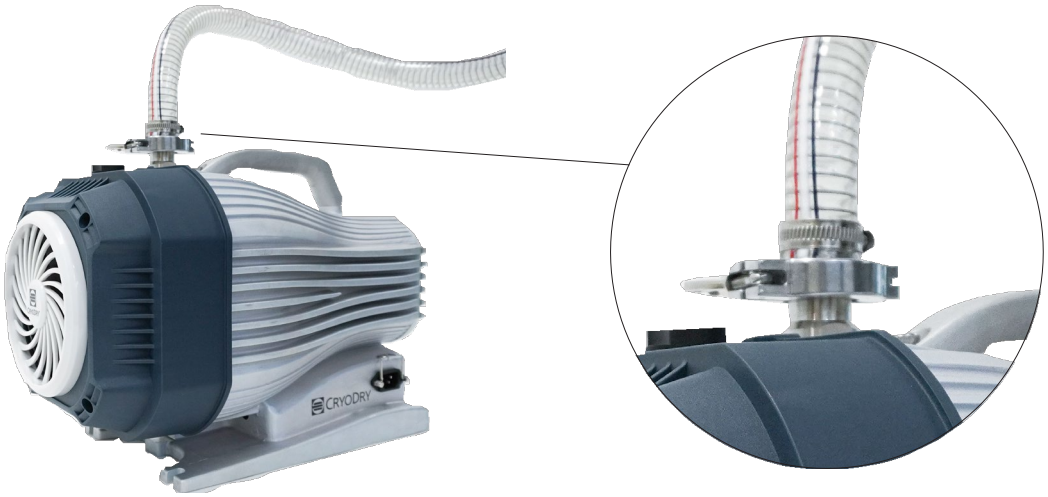


Figure 6

8.3.2. Connecting the Water Drain Hose

The connector for the drain hose is located to the left side of the instrument (Figure 7).

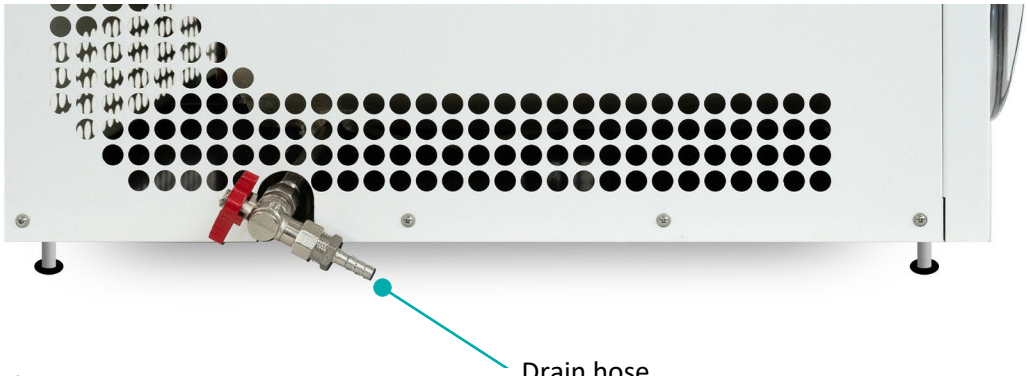


Figure 7

Connect the drain hose to the connector and as shown in (Figure 8). The other end should be placed in either a bucket or near a drain. It must be placed lower than the instrument to allow water to flow out.

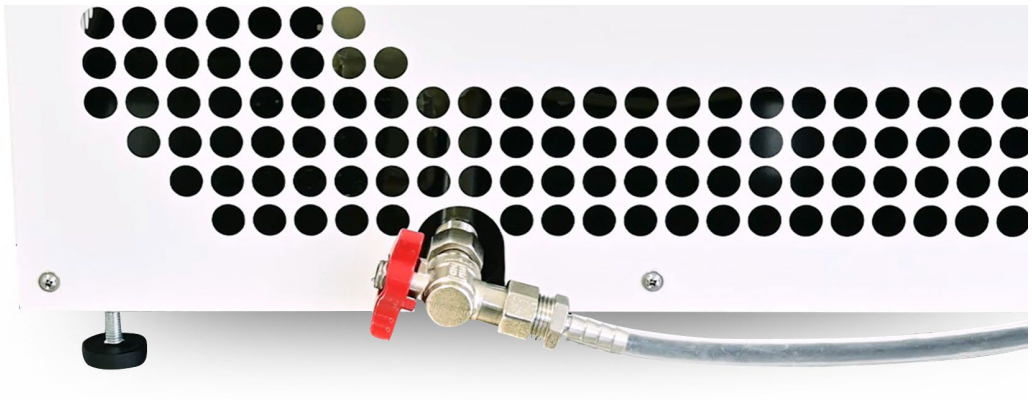


Figure 8

8.3.3. Connecting the Power Supply

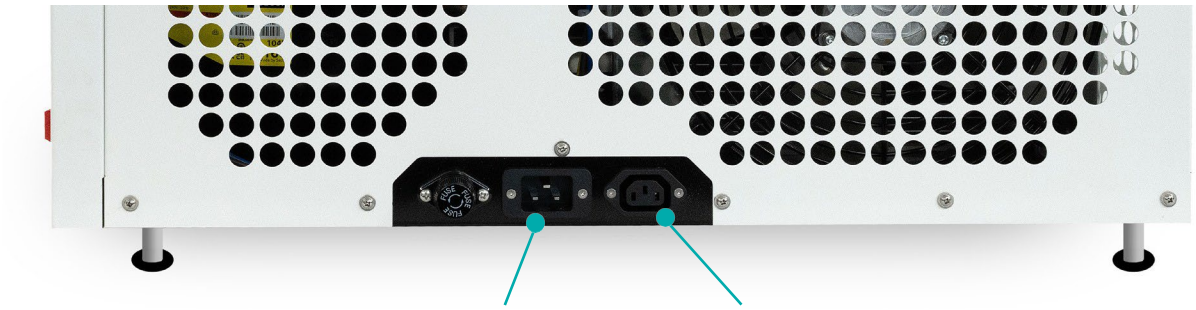


Figure 9

- Locate the power connectors for the main unit and the vacuum pump at the right side of the instrument (Figure 9).
- Connect the vacuum pump power plug to the vacuum pump power connector. Ensure the vacuum pump is switched to 'on' position.
- Connect one side of the power cord to the power connector and connect the other side to the electrical power outlet.

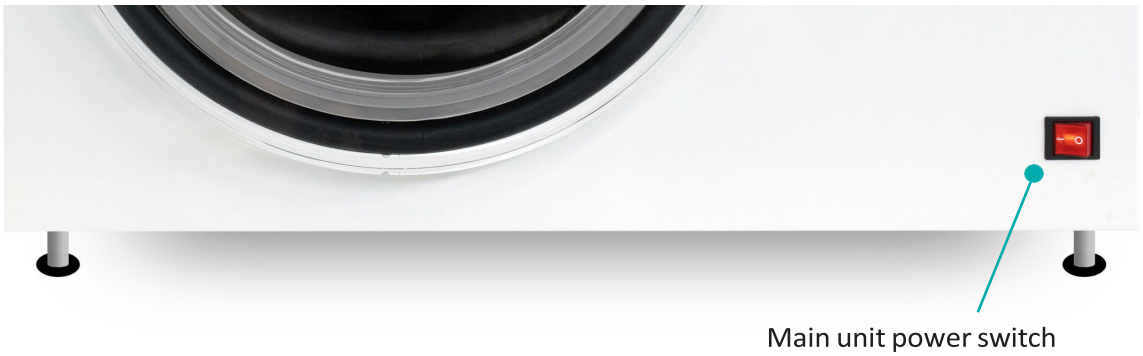


Figure 10

- Locate the main unit power switch under the touch screen.
- Turn the power switch to "ON". A red light will appear to indicate the power switch is "ON" as shown in Figure 10. The touch screen will also turn on.

8.3.4. Pfeiffer HiScroll Pump Setup

Pfeiffer HiScroll pumps do not automatically activate by default. “Autostart mode” must be enabled manually by performing the following:

1. Ensure the pump is powered. Either by directly connecting it to the wall, or by enabling it in Manual mode from the instrument (see section “**9.1 Manual Mode**”).
2. Press the power button to make the pump start.
3. While the pump is operating, hold the power button for 5 seconds. After releasing the button, the yellow LED flash for 1 second confirming the command.
4. Verify that it has worked by power cycling the pump. The pump should automatically start up after a short period.

After performing these steps, the HiScroll pump will now start pumping each time it is powered on.

Please note: If the pump is turned off using the power button, followed by a power cycle, it will not automatically start until the power button is pressed again to enable it. There is no requirement to repeat the above steps.

9.Operation

Before operating the instrument, please ensure that:

- There is no residual water or foreign matter inside the chamber.
- The drain valve is closed.
- The instrument's main unit is connected to the wall outlet and the vacuum pump is connected to the vacuum pump power connector. See Figure 9.
- The main power switch is turned on.

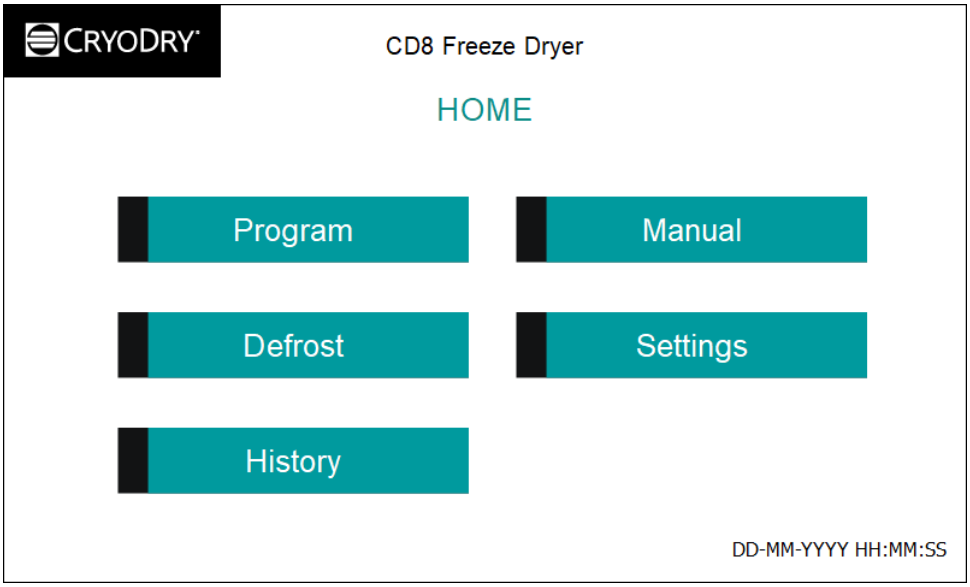


Figure 11

The home screen is shown once the touchscreen is powered on (Figure 11). There are five visible control buttons on the touchscreen: Manual, Program, Defrost, Settings, and History. To go back pages, tap the "Home Icon" that's present on most screens (Figure 12)

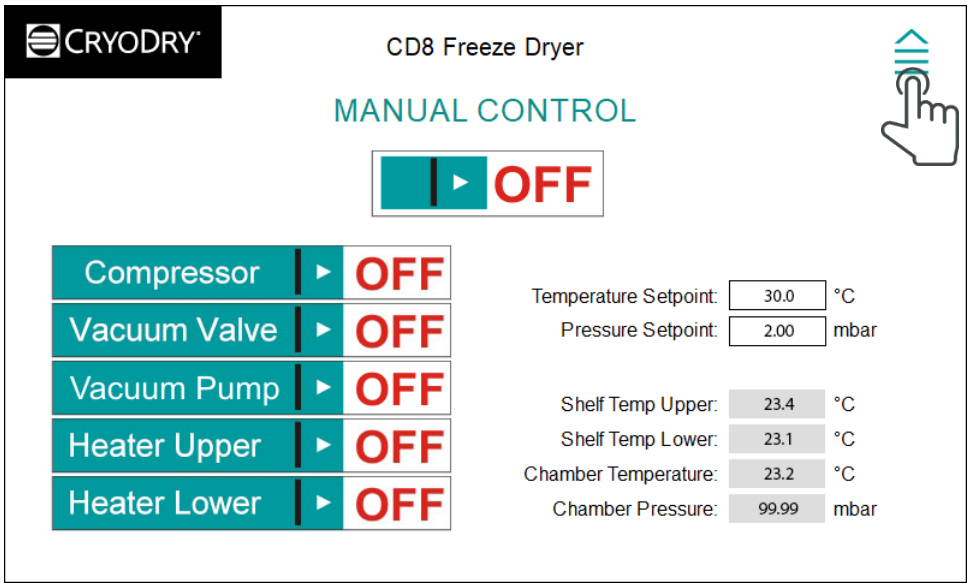


Figure 12

9.1. Manual Mode

To enter the “Manual Control” page, tap on the “Manual” button (Figure 13).

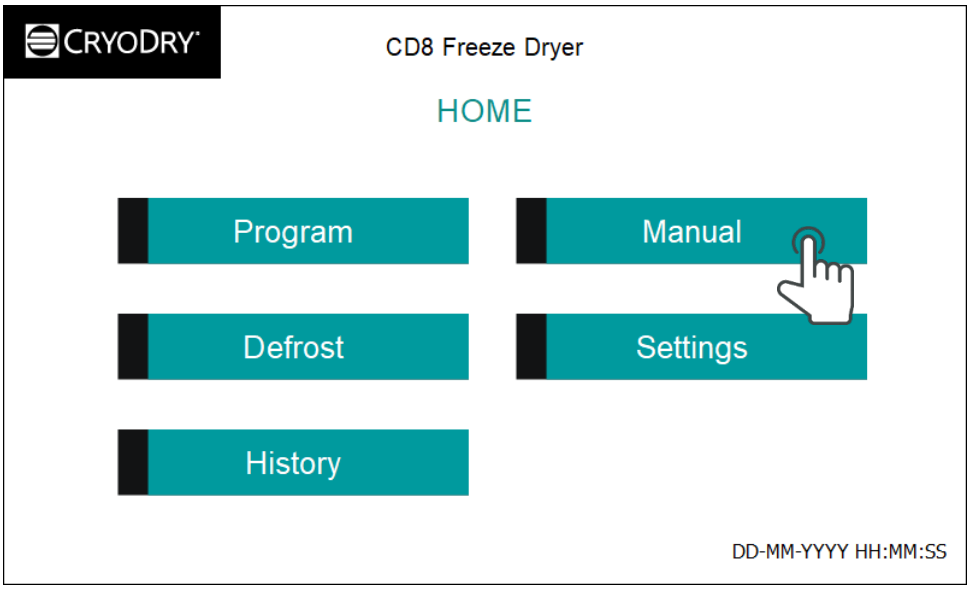


Figure 13

To enable manual control, tap on the main switch at the top (Figure 14). This screen provides full control over the instrument.

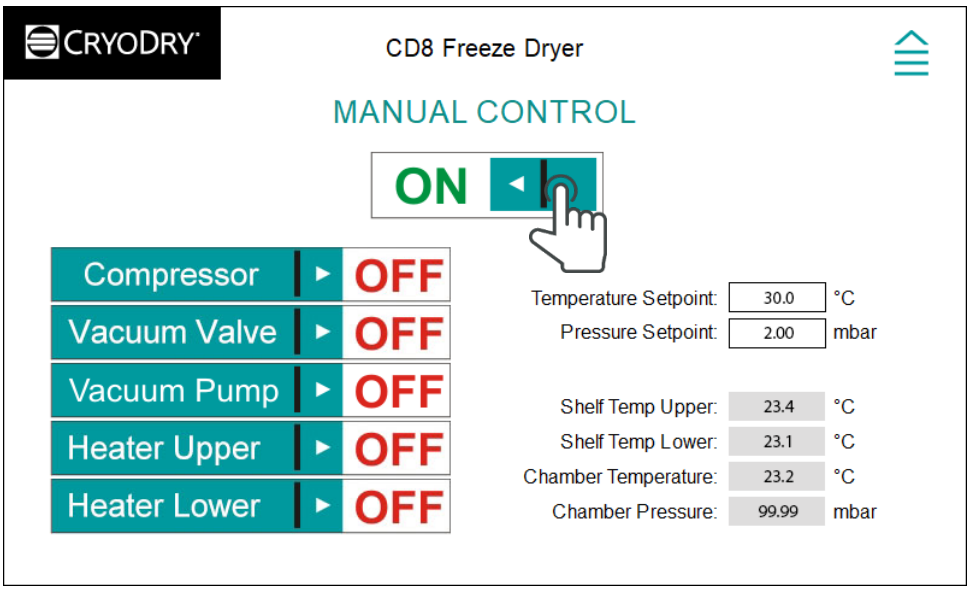


Figure 14

On the right-hand side (Figure 15), temperature and pressure setpoints can be specified for the instrument to maintain (if enabled).

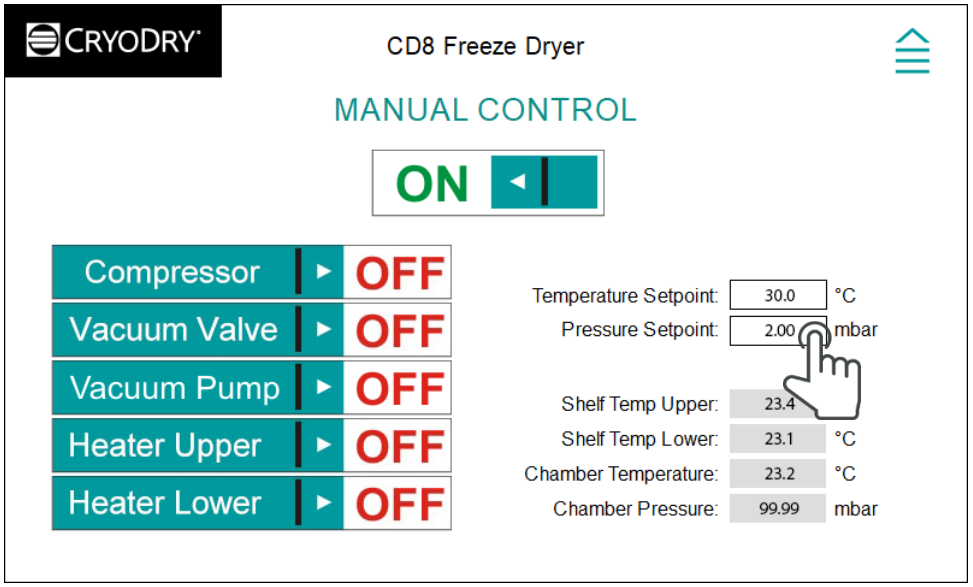


Figure 15

On the left-hand side (Figure 16), provides relay control of the instrument. They are as follows:

- Compressor
- Vacuum Valve
- Vacuum Pump
- Shelf Heaters (upper & lower)

Note: For the instrument to maintain the pressure setpoint, enable both the Vacuum Pump and Vacuum Valve.

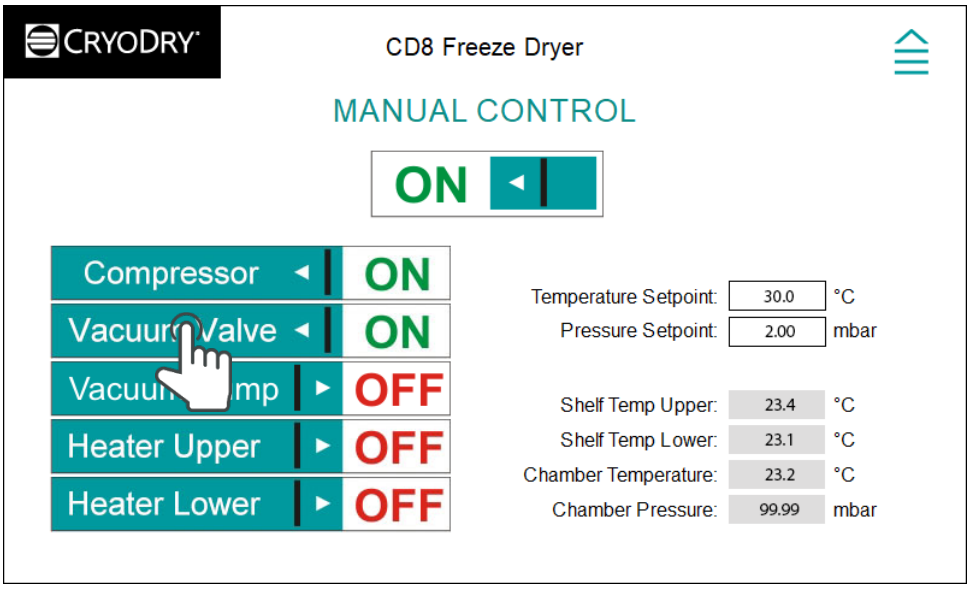


Figure 16

Please ensure that there are no liquids, and your product is fully frozen before opening the vacuum valve. Opening the vacuum valve while there is still liquid in the chamber may damage or cause premature wear to the vacuum pump.

While operating the vacuum pump, it's good practice to occasionally open the ballast valve on the pump to remove any of the moisture buildup inside the pump.

Warning: Do not open the vacuum valve while the pump is off, and the chamber is under vacuum. Allowing air to flow through the pump in the reverse direction will prematurely wear the pump and introduce pump material into the chamber.

9.2. Program Screen

Tap on “Program” on the home screen to enter the “Program Selector” page (Figure 17).

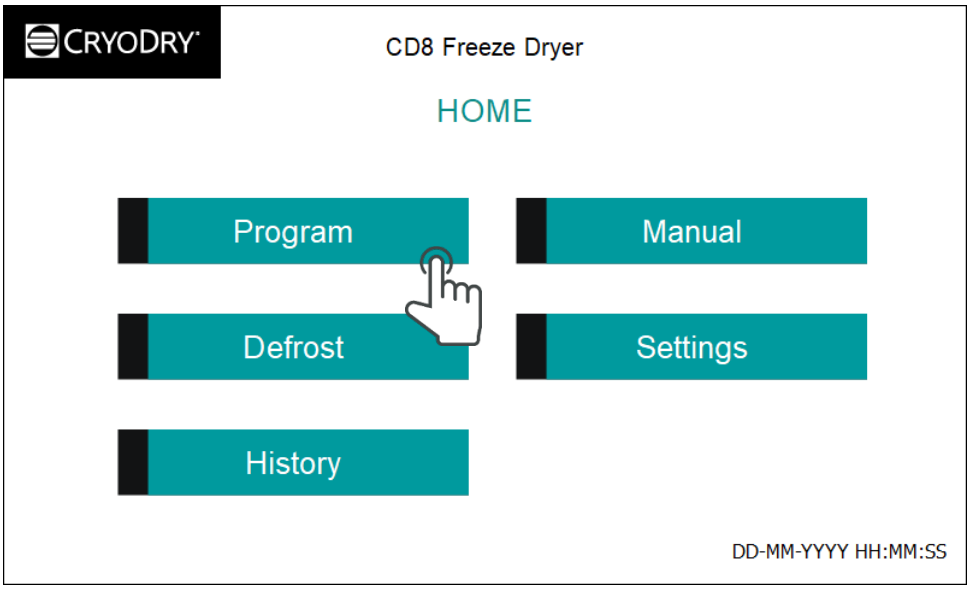


Figure 17

For the CD8, up to 4 different programs are available (Figure 18).

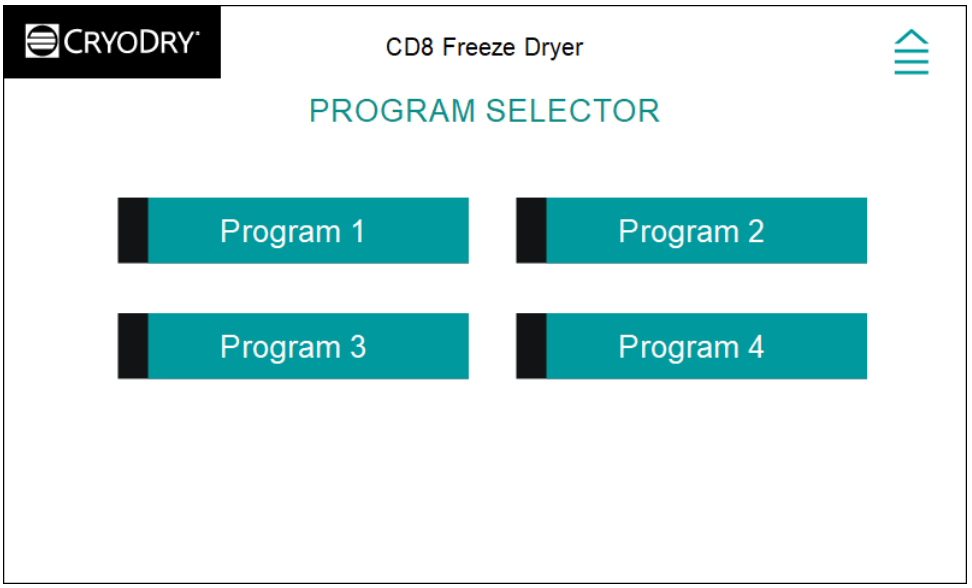


Figure 18

9.2.1. Programs Explained

A CD8 program is broken down into 4 stages. Freezing, Evacuation, Drying, and Storage. See section "**9.2.2 Writing a Program & Parameters Explained**" for more details for each of the parameters and how they control each stage. Each stage is very important to consider since they determine the outcome of the product. Here are the stages in more detail:

- Freezing: This is the first stage of a program. This stage is used to cool the shelves and trays down enough to avoid risking product melting during evacuation and drying. This stage generally lasts for a few hours.
- Evacuation: This stage reduces the pressure inside the chamber to the specified pressure. This stage generally lasts for up to a few minutes.
- Drying: This stage involves the sublimation process where energy (heat) is transferred to the product under extremely low pressures. The Drying stage offers more granular control over exactly how the product is to be dried. This is the longest process of a freeze-drying run and is the most important stage.
- Storage: This is the final stage of the freeze-drying process. This determines a safe pressure and temperature to leave the product at until it gets removed from the instrument.

9.2.2. Writing a Program & Parameters Explained

In this section, we will run through setup a program, and explain the parameters used. Tap on Program 1 to get to the program editor screen as shown in Figure 19.

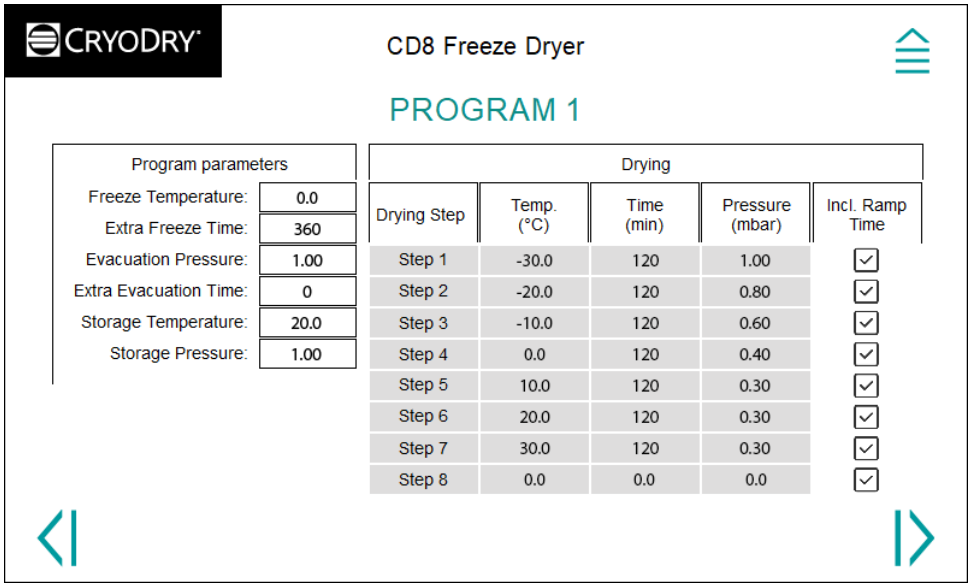


Figure 19

In Figure 19, use the numbers as a ballpark, as the parameters are dependent on the product.

9.2.2.1. Freezing Stage

The freezing stage (Figure 20) is controlled by Freeze Temperature & Extra Freeze Time. For a successful run, the product must be frozen. It's good practice to always allow additional freezing time after reaching the Freeze temperature. Specify the Freeze Temperature to around -20C to -30C and use 4-6 hours extra freezing time.

Note: Specifying the Freeze Temperature doesn't maintain the temperature. It's only for when the freezer timer should start.

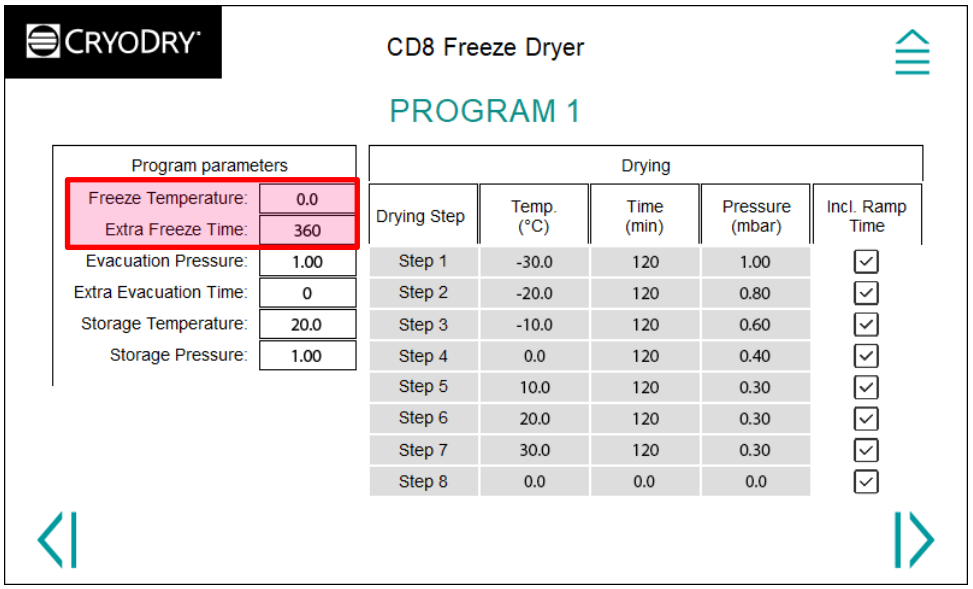


Figure 20

9.2.2.2. Evacuation Stage

The evacuation stage (Figure 21) is controlled by Evacuation Pressure and Extra Evacuation Time. The evacuation pressure should align with Drying step 1's pressure. Use extra evacuation time to evacuate to a low pressure if required. Otherwise in most cases using 0 is sufficient.

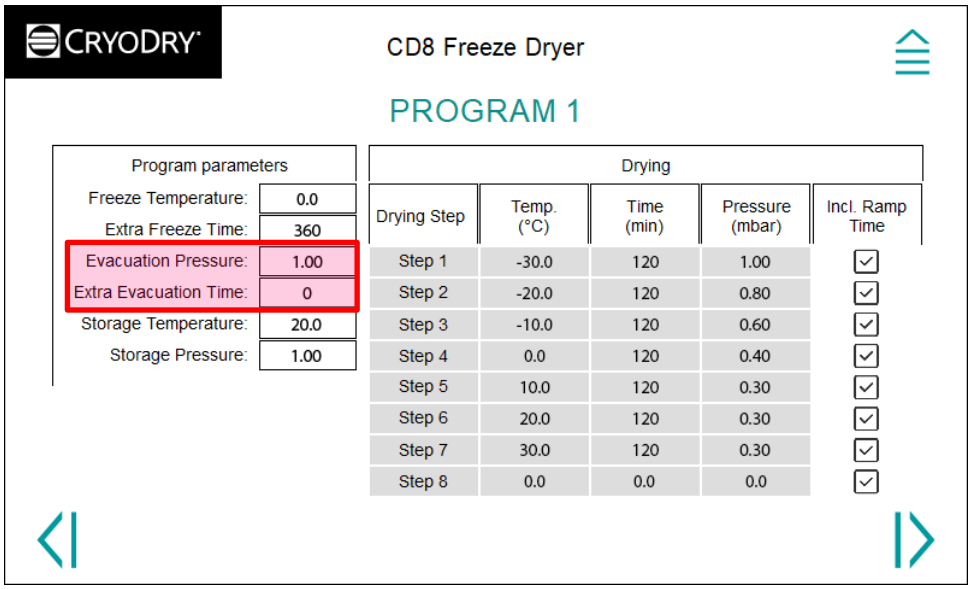


Figure 21

9.2.2.3. Drying Stage

In the drying stage (Figure 22), up to 16 drying steps can be specified. They run sequentially, composed of a temperature and pressure setpoint, time, and the option of 'Including ramp time'.

Incl. Ramp Time: This changes when the timer will start for the drying step. When the checkbox is checked, the timer will immediately start for the drying step. This means that the total process time equals the sum of all drying steps independent from how long it takes the instrument to 'ramp' from step to step. When the checkbox is unchecked, the timer will only start once when the shelves reach the temperature setpoint. For the most part, this checkbox can be left unchecked.

Setting the time to 0 will skip the step, however, it's good practice to keep the programs as clean as possible. For an example program, refer to section "**9.3 SafeDry Program**" for a very good generalized example of drying food products. Generally, the drying steps don't need to be complex and using up to 8 steps is enough.

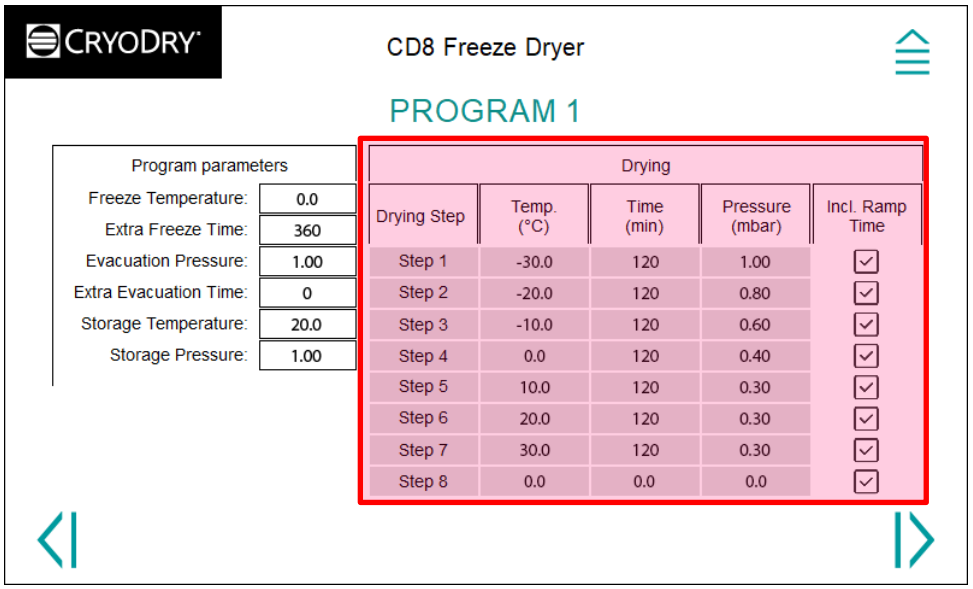


Figure 22

Only the first 8 steps are visible on the first page. Tap on the bottom-right arrow to navigate to the next screen, which contains the remaining 8 steps (Figure 23).

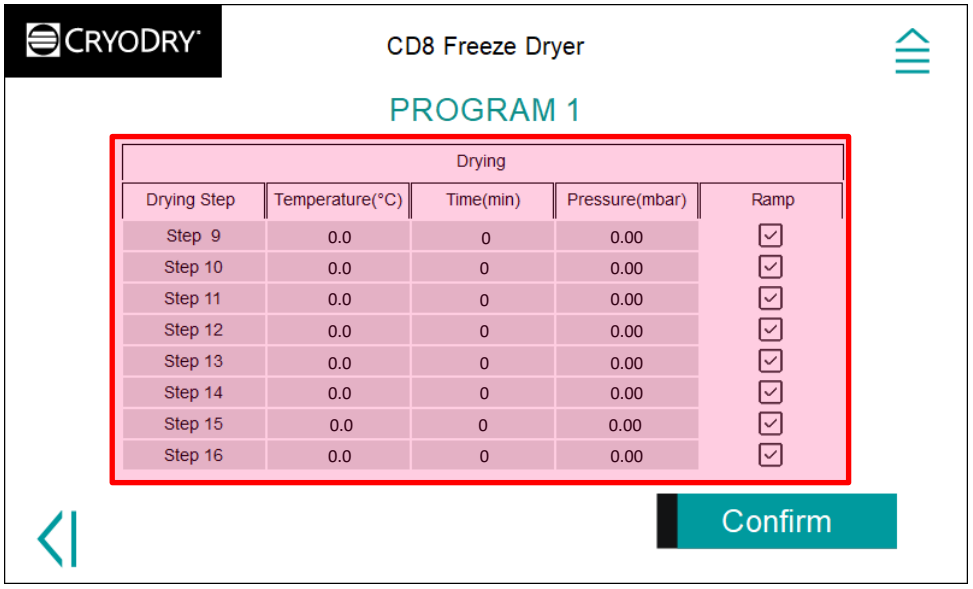


Figure 23

9.2.2.4. Storage stage

Finally, there is the storage stage (Figure 24). In this stage, the temperature and pressure are specified for the temperature and pressure condition the product will be left at once the run has finished. Specify pressure a little high such as 3-5 mbar to avoid additional drying (if preferred) and use a temperature closer to room temperature like 25C to prevent the product from absorbing moisture.

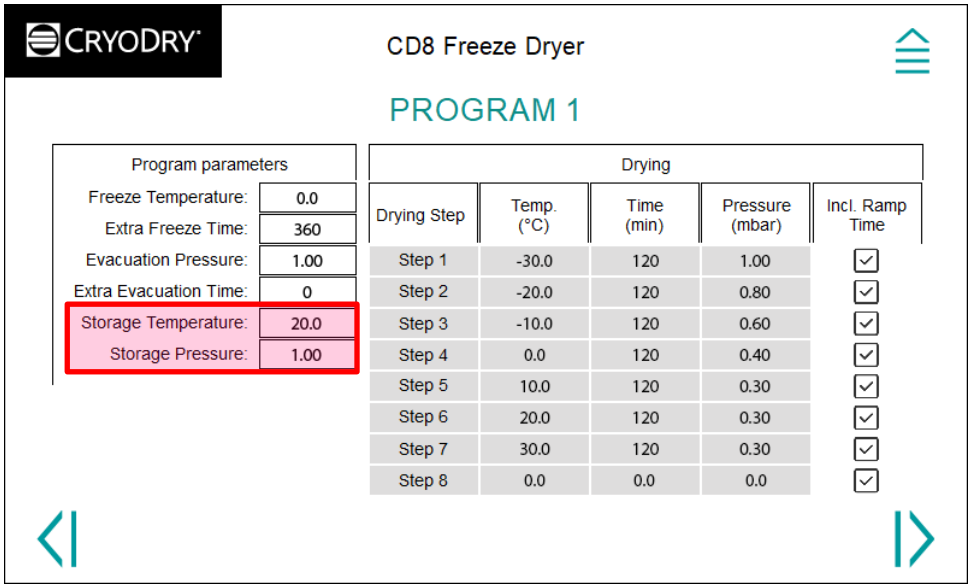


Figure 24

For additional information about drying various products, please refer to our “Freeze Drying Best Practices & Techniques” document.

9.2.3. Starting a Program

Before starting the program, please ensure the following:

- The product that needs to be freeze dried is evenly distributed between each tray for optimal drying.
- The drain valve is closed.
- The chamber is defrosted.
- Chamber door contact surface is clear of ice, and the door is closed.

On the program's second screen (Figure 23), tap on "Confirm" to navigate to the "Program Start" screen (Figure 25). In this screen, the program can be started when Manual mode is not engaged.

Please note, it's important to defrost the instrument before conducting another run. In addition, occasionally opening the ballast valve on the pump to release moisture buildup is recommended.

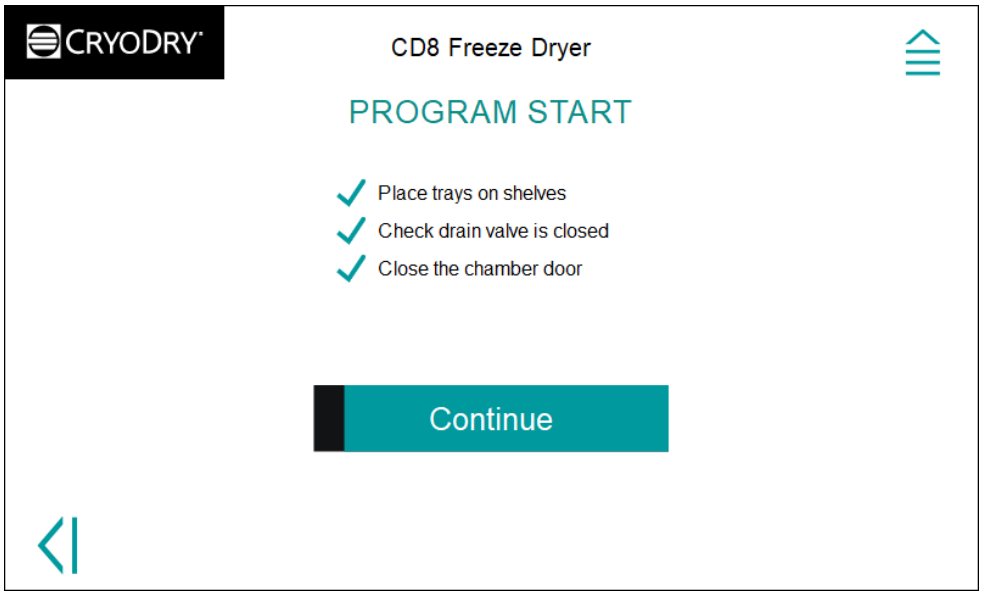


Figure 25

When attempting to start a program while Manual mode is active, the following error message will appear in Figure 26. Please go back to the Manual Control page and disable Manual Mode.

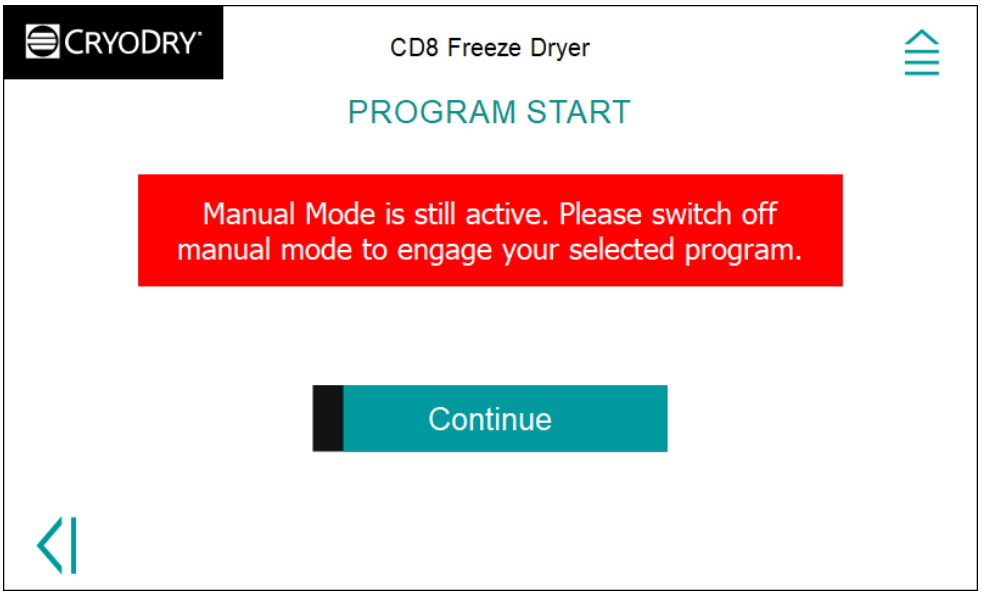


Figure 26

Verify the program is running by the sound of the compressor starting and the "Program Progress" screen appearing (Figure 27).

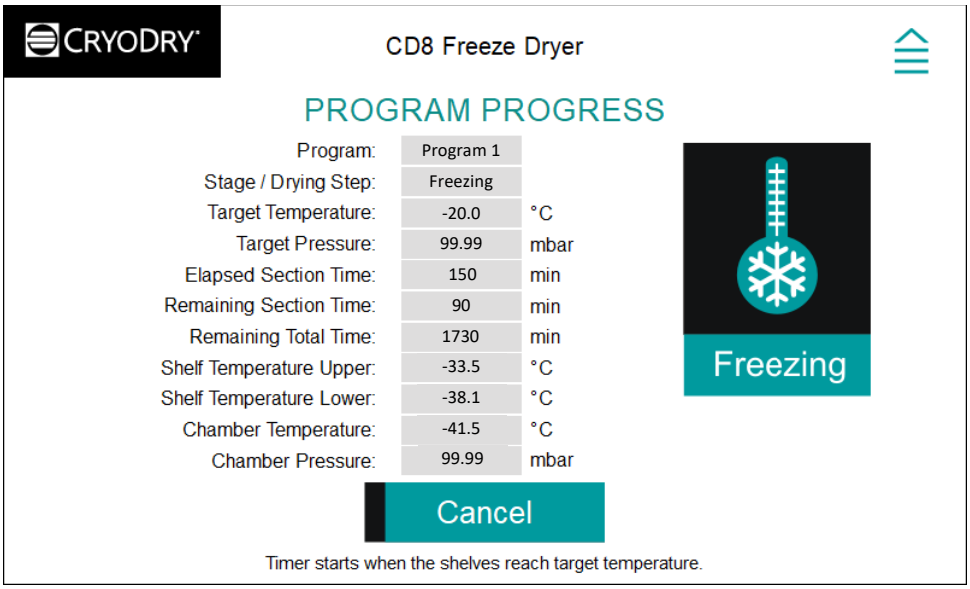


Figure 27

The "Program Progress" screen displays real-time values of the operation of the current program (Figure 27). Some of the readings are as follows:

Elapsed Section Time: The timer of the current stage / drying step.

Remaining Section Time: The timer for how much time is left on the current stage / drying step.

Remaining Total Time: The accumulative total of all the times from each stage and drying steps. This is not the estimated remaining time, but rather the remaining timer time.

Note: The timers don't start unless the preconditions are met (incl. ramp time checked, or temp / pressure setpoint reached).

The “Program Progress” screen also displays the current processing step. As mentioned in earlier sections, there are four stages in a Program, and they are “Freezing” (Figure 27), “Evacuating” (Figure 28), “Drying” (Figure 29) and “Storage” (Figure 30).

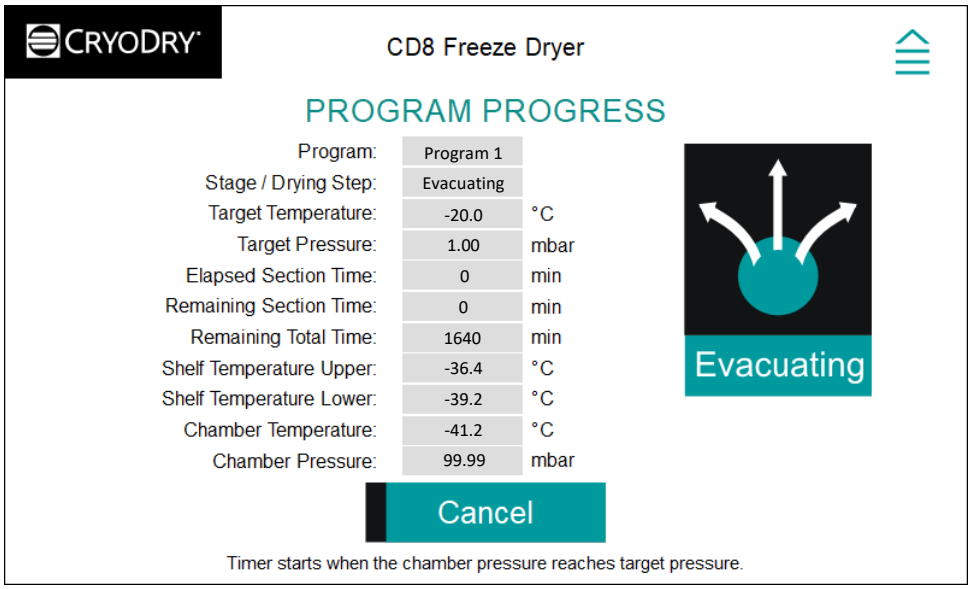


Figure 28

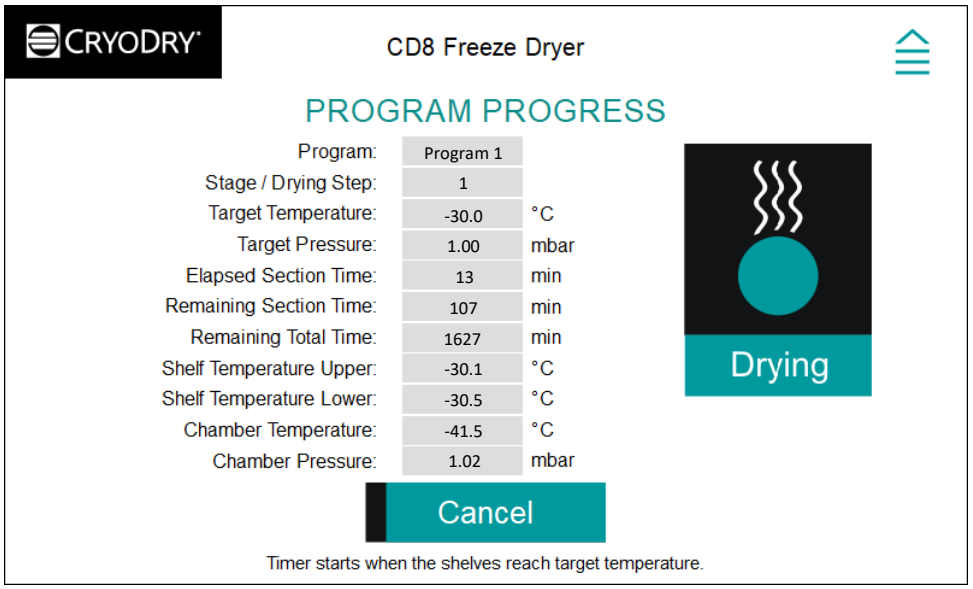


Figure 29

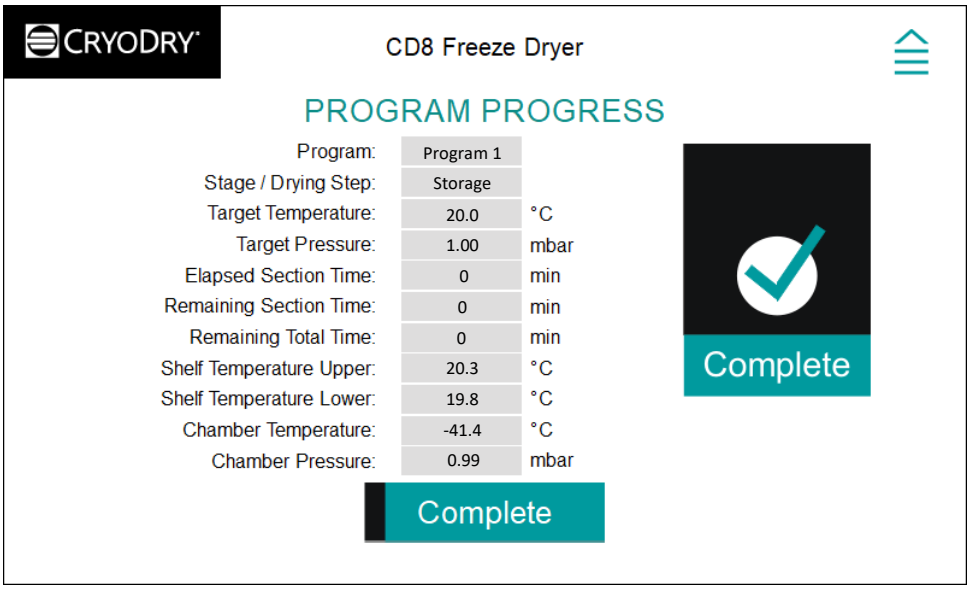


Figure 30

When the "Stage / Drying step" displays "Storage" (Figure 30), the Program is finished, and it will maintain temps and pressure based on the storage parameters. Tap on "Complete" to stop the Program. A popup will appear to confirm the stoppage of the program (Figure 31).

Tap on "Confirm" to stop the Program. Open the drain valve and wait for the chamber pressure to return to normal before opening the chamber door to retrieve the product.

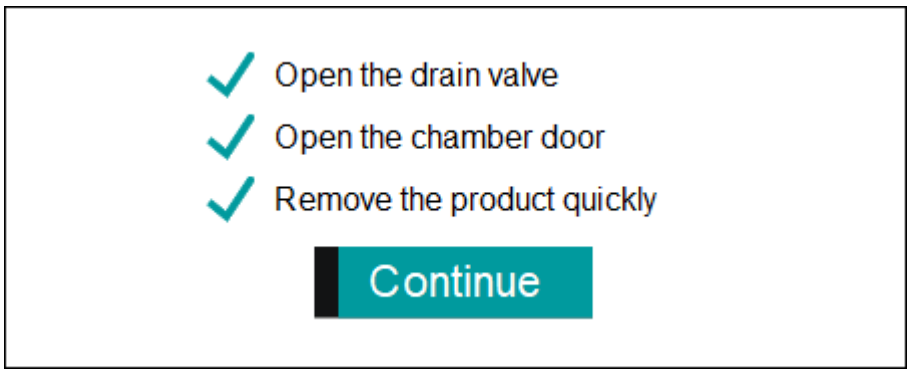


Figure 31

During a program run, the run can be stopped by tapping "Cancel Run". A confirmation box will appear to confirm the action (Figure 32).

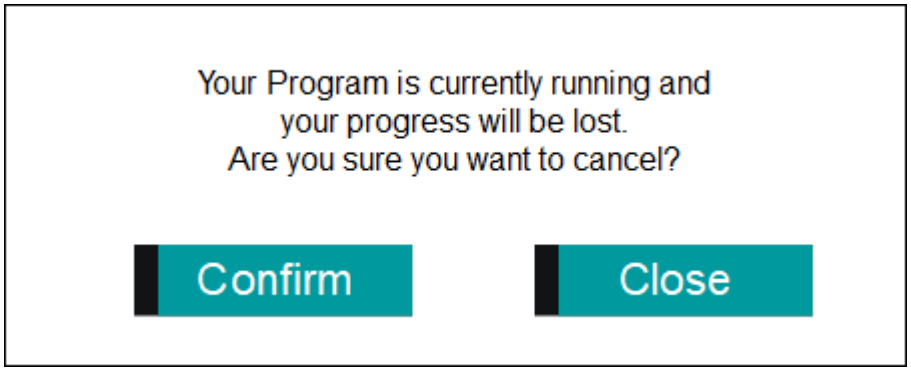


Figure 32

9.3. SafeDry Program

SafeDry, which is available in Program 4, provides a generalized program that will safely dry a wide range of products (Figure 33). There is nothing special about this program, as it will run the same as any other program. This feature simply fills the parameters in Program 4 and is a good starting point.

If a large amount of product is present, then additional drying time will be required. Please ensure when using the SafeDry program, the product is thinly sliced for the best results.

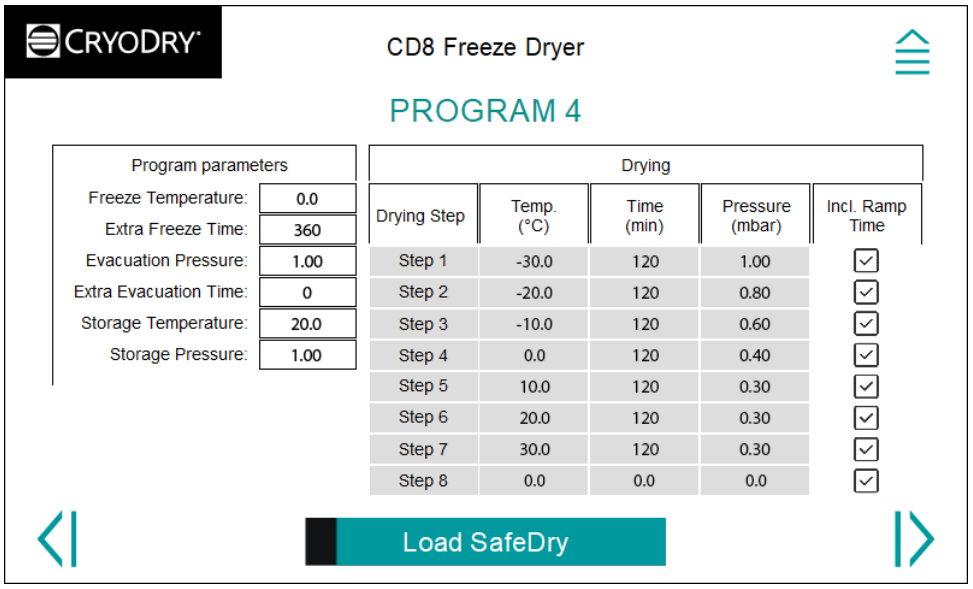


Figure 33

Note: This is currently only available for Program 4. There is no way to load SafeDry onto other programs.

To load SafeDry onto Program 4, tap on “Load SafeDry” (Figure 34).

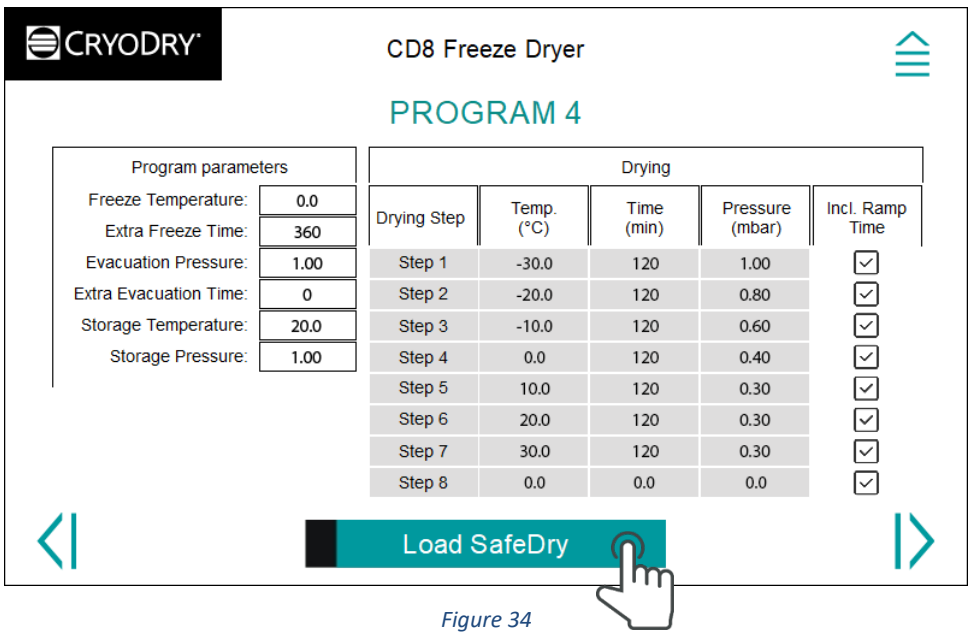


Figure 34

This will pop up a message prompting the user to confirm that they want to load a SafeDry program (Figure 35). Tapping on “Load” will overwrite the existing parameters on Program 4.

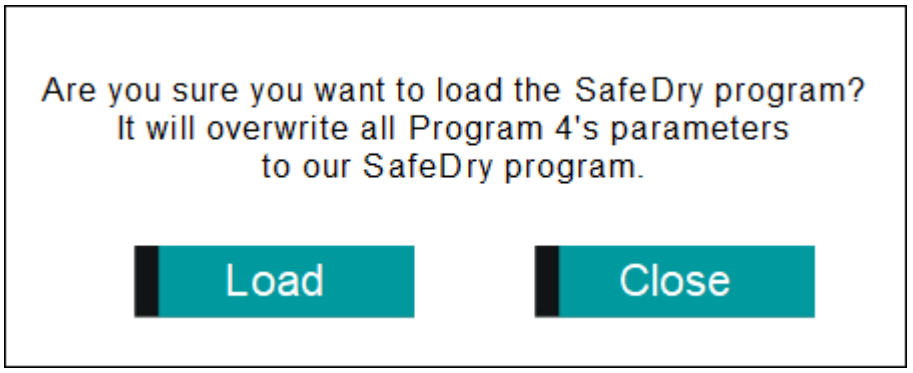


Figure 35

After tapping on “Load”, the popup will confirm that the SafeDry program was successfully loaded (Figure 36). Tap on “Close” to hide the pop up.

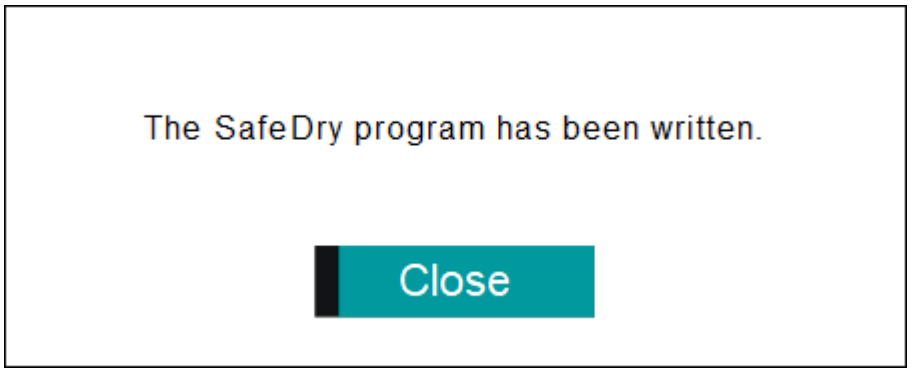


Figure 36

9.4. Defrost Mode

When no program is running, and Manual mode is turned off, tap on “Defrost” from the home screen to enter the Defrost screen (Figure 37).

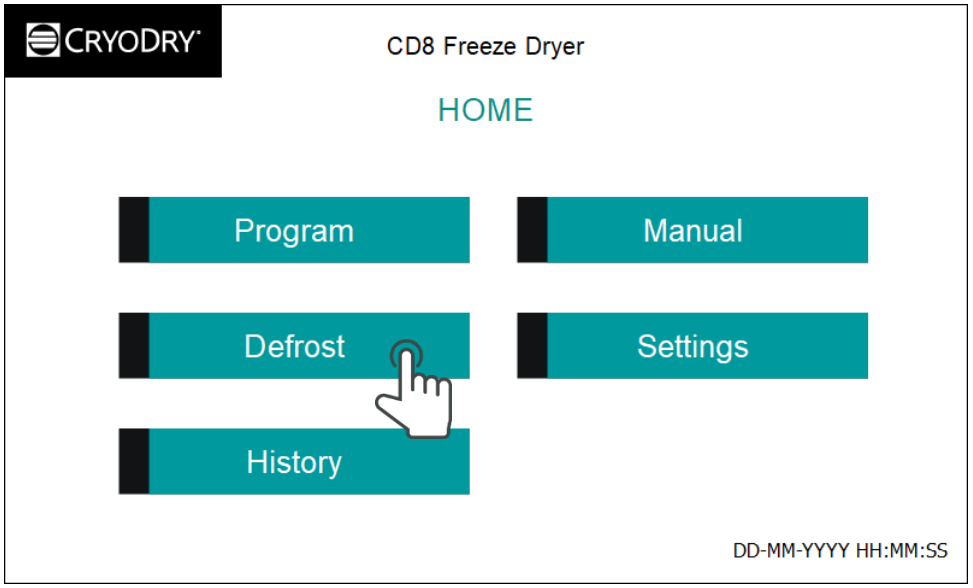


Figure 37

Figure 38 Is the Defrost screen prior to Starting.

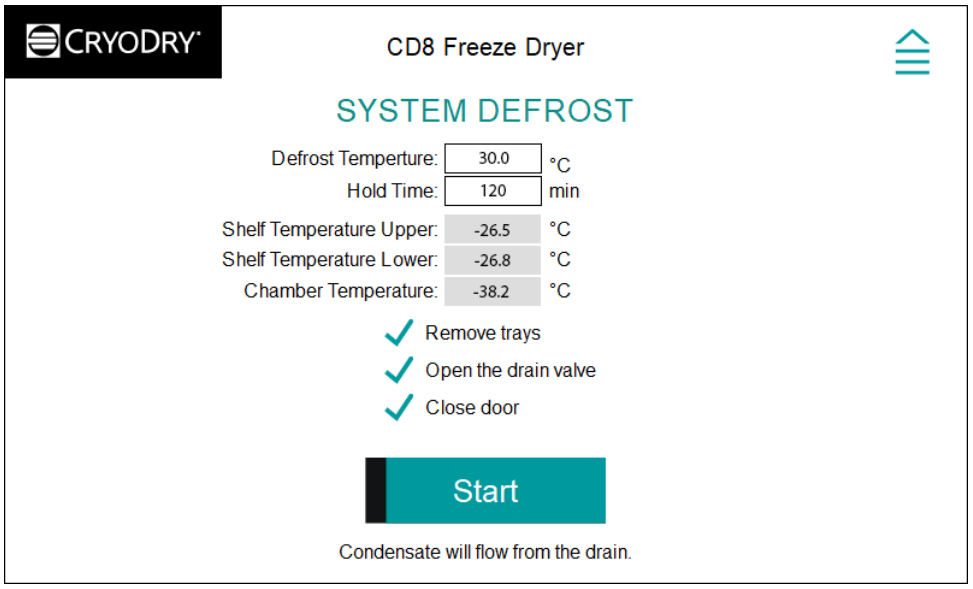


Figure 38

The main difference between the Manual screen and Defrost screen, is that in the Defrost screen, a timer is available for the shelves. Once the shelves reach the “Defrost Temperature”, the shelves will hold that temperature specified in the “Hold Time” before turning off.

Before starting the Defrost process, please confirm:

- Product has been taken out.
- Drain valve is open.
- Chamber door is closed.

Set the defrost temperature and defrost time as desired (Figure 39). For most users, 50°C defrost temperature and 2 hours hold time are adequate.

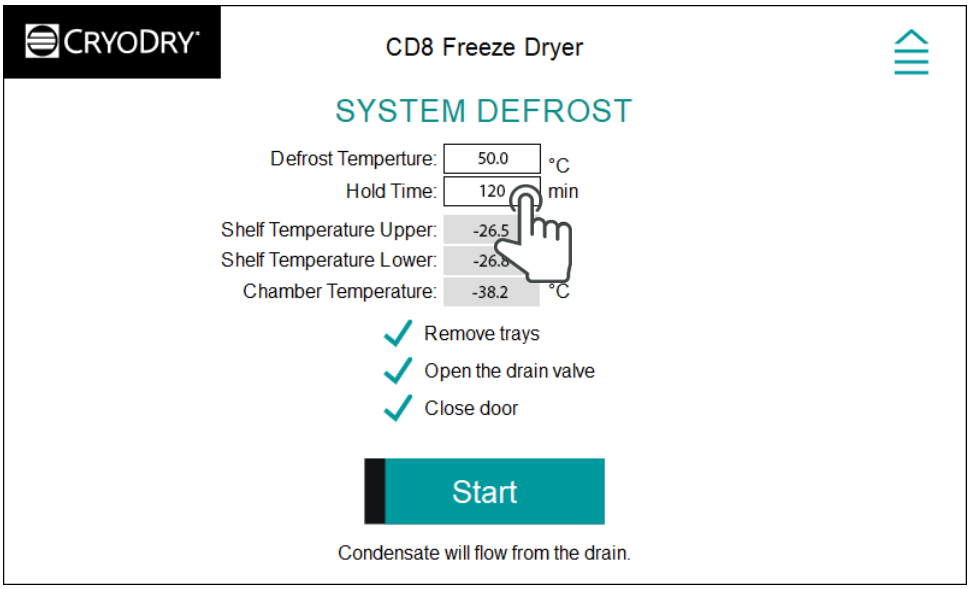


Figure 39

When it's time to begin defrosting, tap on start (Figure 40).

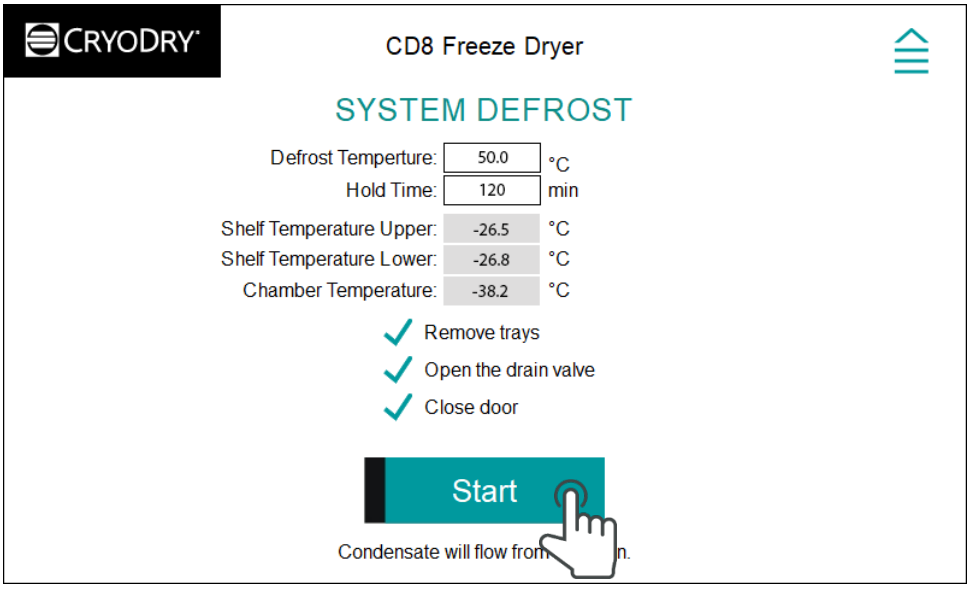


Figure 40

To confirm that defrosting has started, the “Defrosting” icon will appear (Figure 41).

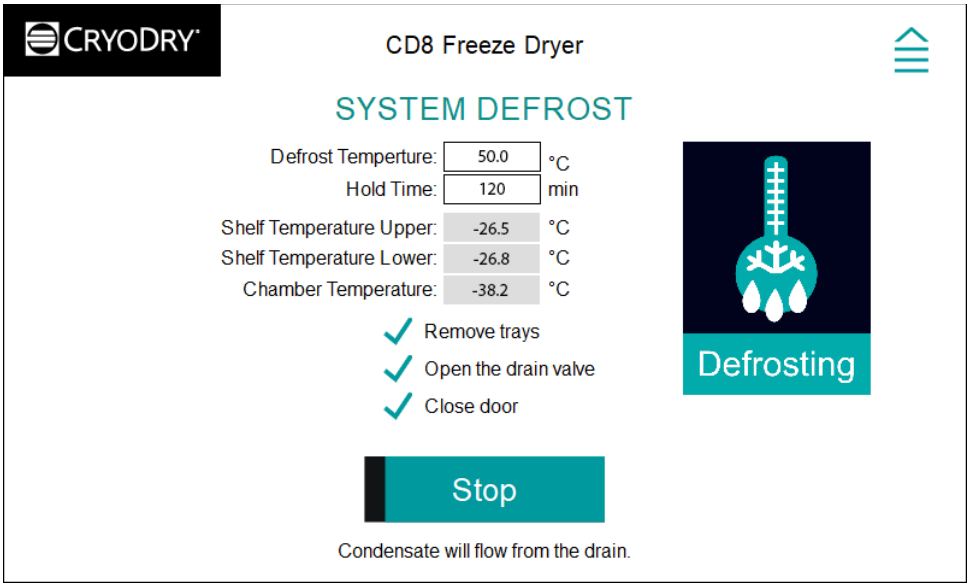


Figure 41

This “System Defrost” screen will display the real-time values of the temperature for the lower and upper shelf temperature, and chamber temperature.

Once started, tap “Stop” to stop the defrosting process (Figure 42).

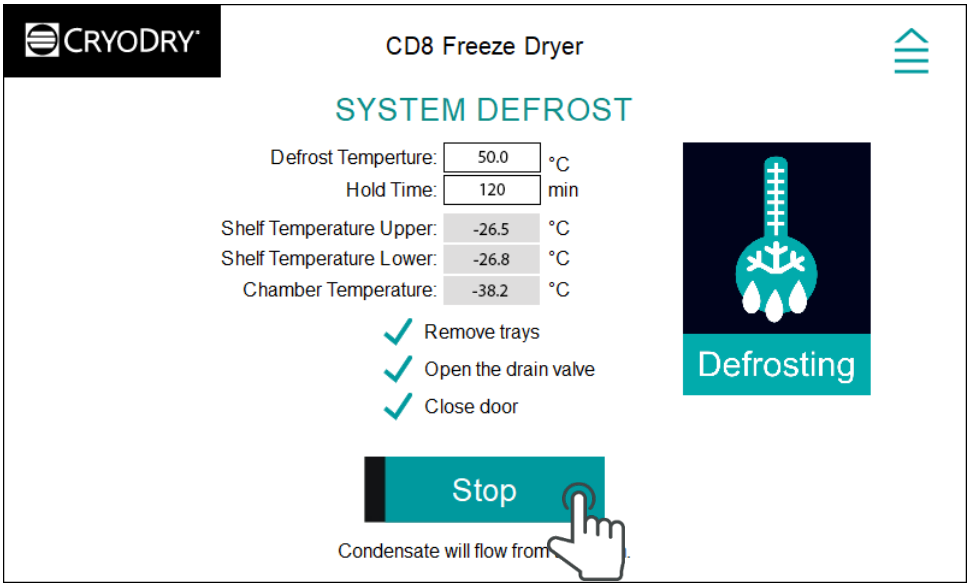


Figure 42

9.5. System Settings

Tap “Settings” on the home screen (Figure 43).

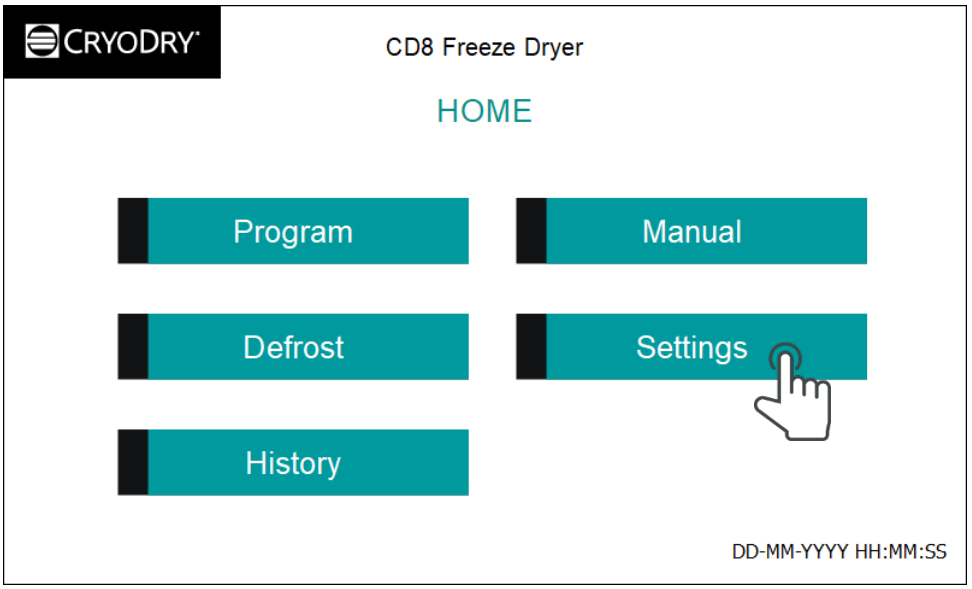


Figure 43

The settings screen displays information like the current version of the software (Figure 44). Adjust the screen timeout, time, brightness, and reboot the display from this screen (Rebooting doesn’t affect the running program, relays, and any other running state). Note, this doesn’t restart the machine. After updating, perform a power cycle using either the main power switch located under the display, or from the wall.

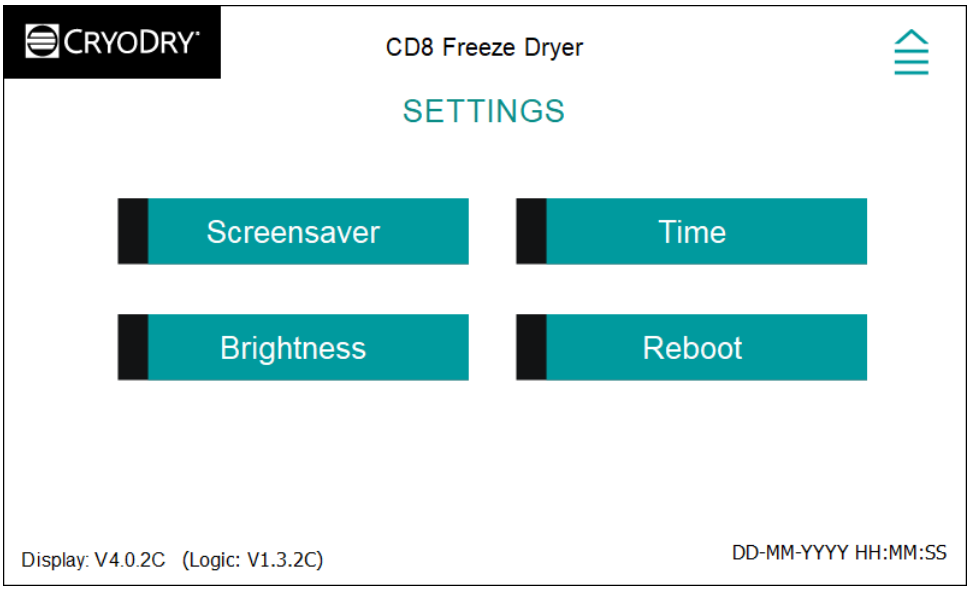


Figure 44

The screen timeout specifies the time it takes to display the “System State” since the last touch interaction. Setting it to 0 minutes will disable it. The System state screen (Figure 45) shows a general overview of the current state of the instrument.

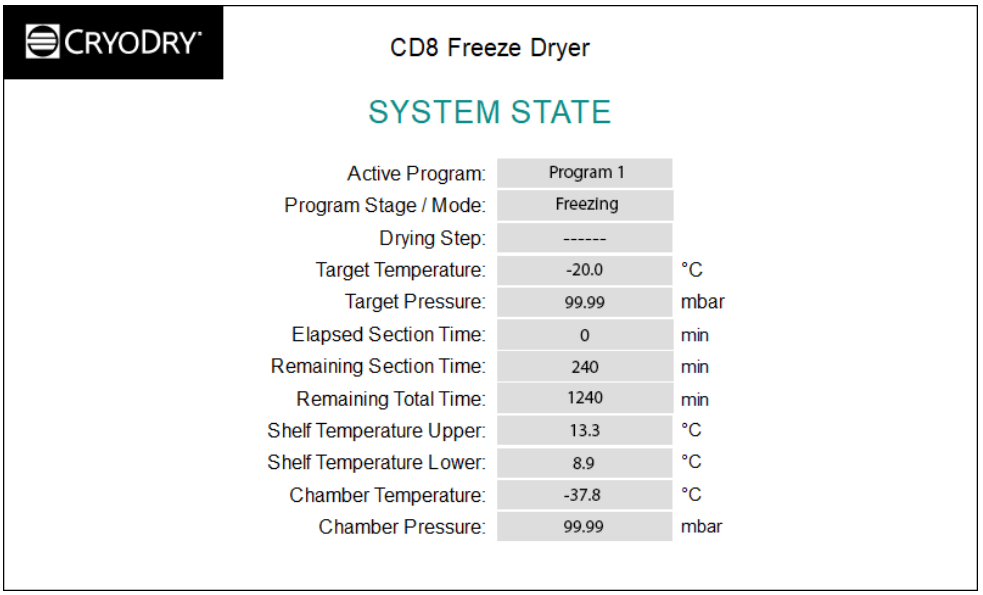


Figure 45

9.6. History Screen

The History screen shows data from the instrument over time, in 15 second intervals. To access this screen, tap on “History” from the Home screen (Figure 46).

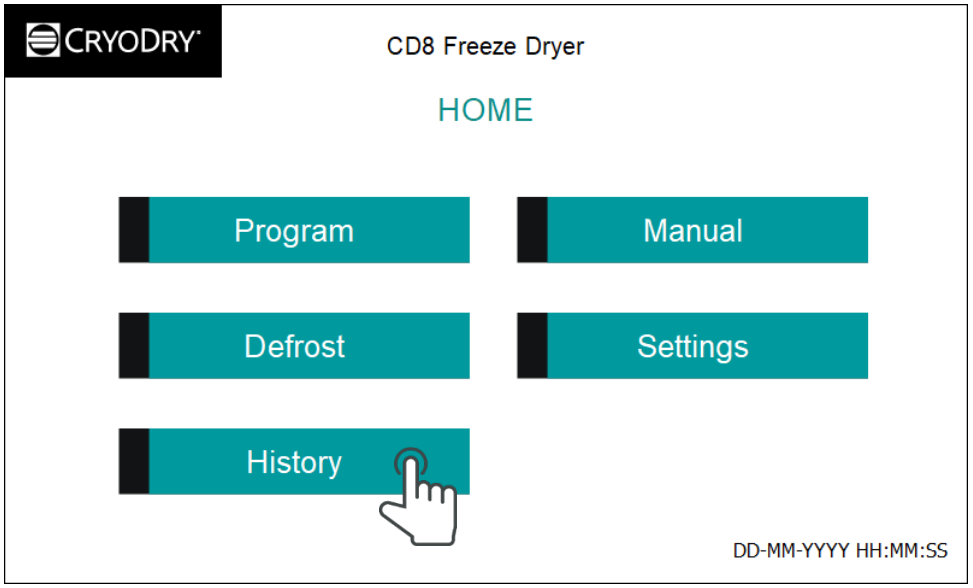
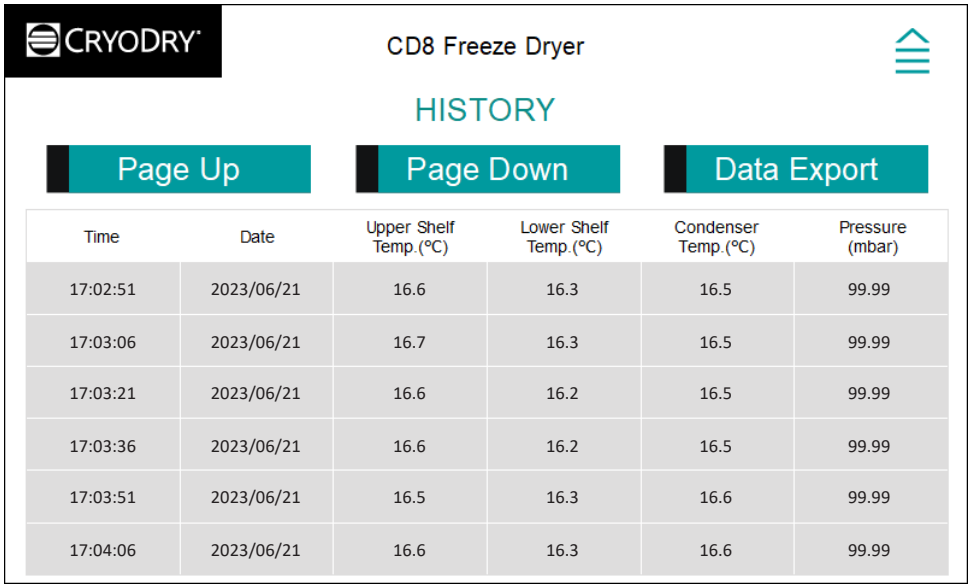


Figure 46

Figure 47 is the History screen. Tap on “Page Up” and “Page Down” to navigate through the history of the temperature / pressure sensors with the associated time stamps.



Time	Date	Upper Shelf Temp.(°C)	Lower Shelf Temp.(°C)	Condenser Temp.(°C)	Pressure (mbar)
17:02:51	2023/06/21	16.6	16.3	16.5	99.99
17:03:06	2023/06/21	16.7	16.3	16.5	99.99
17:03:21	2023/06/21	16.6	16.2	16.5	99.99
17:03:36	2023/06/21	16.6	16.2	16.5	99.99
17:03:51	2023/06/21	16.5	16.3	16.6	99.99
17:04:06	2023/06/21	16.6	16.3	16.6	99.99

Figure 47

9.6.1. History Export

To export the History of the instrument, insert a USB formatted as FAT32 into the USB-A port of the instrument.

After inserting the USB, navigate to the History page and tap on “Data Export” (Figure 48).

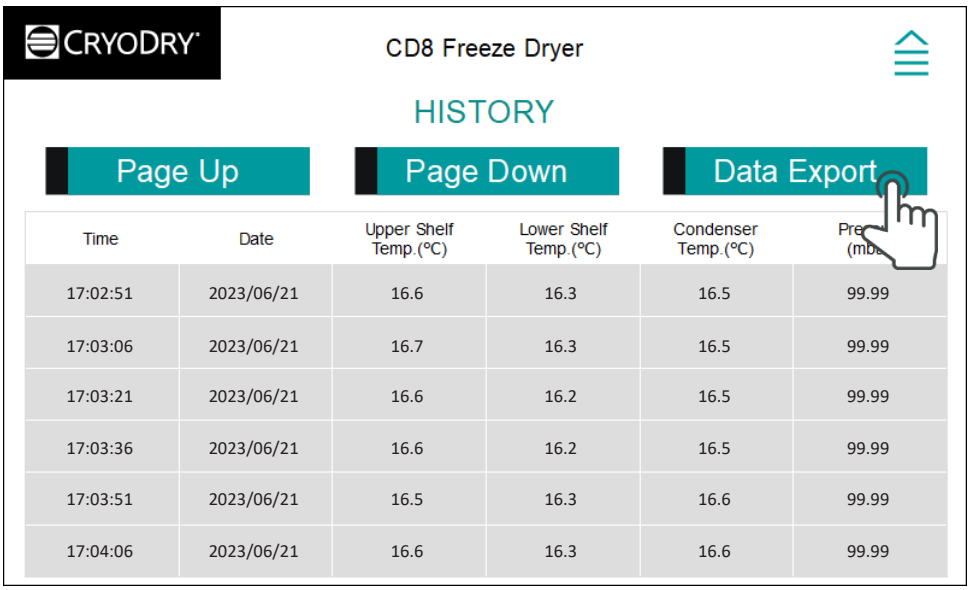


Figure 48

After tapping on “Data Export”, a dialog box will appear showing “Exporting Data...”. Wait until “Exporting Complete” is shown, followed by disappearing. After that, remove the USB.

The exported file will be called “History-YYYY-MM-DD-HH-mm-SS.xls”, where the filename specifies the timestamp of when the history was exported.

10. Fault Diagnosis

Before conducting a diagnosis, verify that the chamber is clean, dry, and empty of product.

Error	Solutions
Ultimate Vacuum of 1.5 x 10-1 mbar not reached	Check that the vacuum pump is correctly connected to the main unit with the clamp (tightly)
	Check that the drain valve is closed
	Check that the vacuum hose and rings are installed correctly. Verify that there's no damage on the rubber rings and is clear from particles
	Check that the vacuum pump functions correctly, and the vacuum pump oil is clear (if oil sealed vacuum pumps are used)
	If the error remains, contact support
The chamber temperature is not cooling to specification	Verify that no strange sounds are coming from the compressor. The instrument should operate quietly. Contact support if the instrument makes strange noises
	Check that "Defrost" is not running
	Make sure the compressor is running by listening for it
	If compressor is "ON" but the temperature inside the chamber is still high. check the housing vents for blockage and dust. Remove blocking items and clean as required. If substantial dust is visible on the condenser inside the housing contact support
	Ensure that there is enough clearance around the vents and that ambient temperature of the room is below 25°C
The unit is making a strange sound	Turn off the machine and contact support immediately

11. Cleaning and Maintenance

11.1. Cleaning

- Water from the product will collect inside of the chamber during drying. Please be sure to defrost after each run and clean the inside of the chamber periodically by wiping down the chamber walls with washing detergent.
- Clean the trays after every freeze-drying process with mild non-corrosive detergent. Wipe dry afterwards.
- Periodically check the chamber door seal ring and contact surface is clean from contaminants to ensure performant evacuation.

11.2. Maintenance

- Check the chamber door seal ring regularly to make sure it is not damaged or worn.
- If an oil vacuum pump is used, check the vacuum oil after every 100 hours of operation and replace the vacuum pump oil if the level is low or if the oil is dirty.
- If a dry pump is used, please refer to its own user's manual.
- Clean instrument vents regularly to prevent dust build up.

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