

USER MANUAL
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WAVE USER MANUAL



FD260, FD440 & FD470

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Table of Contents

Guarantee and liability	3
Understanding Freeze-Drying	3
History of Freeze-Drying	4
Phases of Freeze-Drying	5
Advantages of Freeze-Drying	6
Applications of Freeze-Drying	7
Technical Drawings for FD440	13
Specifications for FD440	17
Technical Drawings for FD260	18
Specifications for FD260	20
Machine Operation	21
First Machine Run	22
Defrosting Process	24
Cleaning and Waste Water Management	24
Cooling System Operation	25
Vacuum Pump Operation	26
PLC / Remote Maintenance Guidelines	26
Heating System Functions	27
Surface Maintenance	27
Menu Navigation	27
Menu item "Settings"	28
Menu item "Statistics"	29
Menu item "Recipes"	30
Menu item "Control"	31
Menu item "Production"	32
Lower Button Bar Function	34
Safety and Responsibility	35
Risks during Transport, Mounting, Commissioning and Operation	36
Maintenance & Cleaning	41
Vacuum Pump	41
Cooling System	41
Quick Guide - 10 Steps	42
Electrical System Diagram and Wiring for FD440	43
Electrical System Diagram and Wiring for FD260	58
Chamber Simulation of the WAVE FD440	65
(same applies to the FD260 chamber)	65
Recommended Vacuum Oil for Oil Pumps	76
Links for Replacement Relais	76
Wave recipes for various materials	77
Alarms, Warnings & Troubleshooting	80

Tutorial Videos on Youtube	88
Machine Handbook	89
<i>Ensure that anyone operating the machine has thoroughly read and comprehended the entire operating manual.</i>	

Introduction - Purpose of the Machine

The freeze dryer is specifically engineered for extracting solid and liquid substances that do not release toxic or explosive gases or liquids. It is not intended for drying wastewater or sewage, as

this could damage the surface cables and vacuum pump in a short period. Please refrain from introducing solvents. The primary application of the freeze dryer is for drying food and plants, with a particular emphasis on water extraction.

Guarantee and liability

Please refer to the delivery conditions for information regarding our guarantee and liability, which were provided prior to your purchase.

Please note that our guarantee and liability will not apply under the following circumstances:

1. Incorrect usage of the machine.
2. Failure to adhere to the instructions in the operating manual.
3. Incorrect installation, use, or maintenance.

We do not assume any liability or provide a guarantee for the machine's performance. The outcome of the freeze-drying process is typically determined by the specific material being processed, as it is often a natural substance influenced by various factors. Therefore, several tests are necessary before achieving a satisfactory result.

For precise details about the guarantee and service level, please consult the sales contract and/or the invoice you received upon purchasing the machine.

Understanding Freeze-Drying

The primary components of the freeze dryer comprise the vacuum chamber, vacuum pump, and cooling system.

The freeze-drying procedure involves several key steps, starting with a cooling phase during which the materials are chilled to approximately 10°C below the solidification point of the specific goods (which varies depending on the product). We recommend pre-freezing your materials in a separate freezing device, such as a standard freezer or a shock freezer. While freezing within the freeze dryer is possible, it is not energy-efficient and takes longer than using a regular freezer.

Once your material has reached the desired temperature, the vacuum pump is activated, creating a vacuum within the chamber containing the materials to be dried. If you've pre-frozen your materials separately, we advise freezing them directly on the machine's trays, promptly loading them into the freeze dryer, and initiating the vacuum. At this point, you can select your program and start the process.

The sublimation process commences with the application of heat through heating mats located beneath the drawers. This heat transforms the water within the materials into water vapor. Since the walls of the vacuum chamber are colder, the water vapor migrates there and freezes on the wall. As needed, you can perform multiple drying phases. The duration of the drying cycle is heavily dependent on the material to be dried and the vacuum level.

Freeze-drying, also known as lyophilization, is a promising preservation method. It begins by freezing the product, then reducing the pressure to remove the ice through sublimation, the process of transitioning from a solid to a gaseous state without first becoming a liquid. Unlike other preservation methods that evaporate water through heat, freeze-drying eliminates water in the form of ice.

It's crucial to ensure throughout the process that only the ice transforms into vapor, and not the water. Otherwise, your material could become overcooked, significantly altering its taste and appearance.

The low temperatures involved result in a higher-quality end product. Not only does the product maintain its original shape, but the process is also gentle on vitamins. This is why freeze-drying finds extensive use in biomedicine and food processing, where nutrients and active ingredients are particularly well-preserved.

History of Freeze-Drying

The Pioneering Stages

The genesis of freeze-drying unfolded independently in the early communities of the Americas, East Asia, and Northern Europe. In the heart of the Andes Mountains, Peruvian tribes were already experimenting with freezing tubers and potatoes amidst the frigid peaks. They ingeniously harnessed the power of the sun to thaw these frozen provisions, allowing the ice to transform into vapor. This ingenious process yielded a traditional staple food that laid the foundation for a diverse array of meals. Consequently, indigenous peoples could ensure a year-round supply of preserved and delectable sustenance. The Peruvians, with their mastery of potatoes, the Japanese monks and their expertise in freeze-drying tofu, and the resourceful Vikings who applied this knowledge to cod preservation all reaped the benefits of freeze-drying.

Historical Landmarks

In a significant leap forward, 1890 marked the first instance where tissues were freeze-dried to perfection in a laboratory and subsequently rehydrated. Over the ensuing decades, freeze-drying underwent comprehensive research and was successfully scaled up. During the crucible of the Second World War, freeze-drying played a pivotal role in safely preserving and transporting vital resources, such as blood plasma. In subsequent years, this innovative technique was also harnessed for the secure transportation of vaccines. Notably, nearly all the food supplies for NASA's Apollo missions were effectively preserved through freeze-drying techniques, marking a milestone in space exploration.

Phases of Freeze-Drying

Freezing: A Vital Step

To prepare the product for freeze-drying, various freezing methods are possible. You can choose to employ a cold bath with liquid nitrogen, a shock freezer, a standard household freezer, or simply place the product on a shelf inside the freeze dryer. Ensuring the material is cooled below its eutectic temperature is crucial to prevent thawing and promote sublimation, preserving the product's original shape. Typically, most materials perform well when frozen below -22°C.

It's noteworthy that large ice crystals formed during slow freezing are the most conducive for the freeze dryer's drying process. Nevertheless, excessively large crystals can disrupt the cell structure of the product, leading to a lower-quality final product. To circumvent this, the freezing process should be expedited.

The Phases of Freeze-Drying

The second phase of freeze-drying, known as primary drying or sublimation, involves creating a vacuum by lowering the pressure and applying heat to the product, allowing the water to sublime. The vacuum encourages sublimation, while the condenser serves as a surface for the water vapor to solidify into ice. In the case of WAVE freeze dryers, the vacuum chamber wall functions as the condenser, safeguarding the vacuum pump from water vapor. It's important to add heat gradually to prevent structural and shape alterations in the material, as excess heat can cause the ice to melt and compromise the product's integrity.

This is succeeded by further phases of freeze-drying, referred to as secondary drying or adsorption, where water molecules that are ionically bonded are removed. By incrementally increasing the temperature compared to the primary drying phase, the bonds between the material and water molecules are broken. These drying stages can be adjusted flexibly, typically in 5°C to 10°C intervals, using the Siemens control system in WAVE freeze dryers. The resulting freeze-dried materials retain a porous structure. After the completion of the freeze-drying process, the vacuum can be released, and the material can be sealed airtight. Thanks to this meticulous process, most materials can achieve a residual moisture content of 1-5%.

Advantages of Freeze-Drying

- Treated products retain their original shape and structure.
- Aromas are better preserved than with other drying processes.
- Better taste and consistency for food.
- A gentle process that retains vitamins, nutrients, and active ingredients well.
- Less weight despite maintaining the original structure.
- Products can be rehydrated.
- Reduced risk of mold during the drying process.
- Very fast drying process.
- Freeze drying effectively eliminates nearly all germs and bacteria during the process.
- The material can be stored for up to 20 years.

Applications of Freeze-Drying

Freeze-drying is predominantly employed in pharmaceutical science to enhance the longevity of vital items, including vaccines and injectables. By eliminating water content and sealing the product in vials, it becomes conveniently storable, transportable, and easily reconstituted to its original state for injection.

In the realm of food preservation, freeze-drying plays a transformative role by rendering products lightweight while preserving their quality. Its ascent to popularity was further catalyzed when freeze-dried ice cream was developed as a snack for NASA astronauts. More recently, as the cost of freeze-drying has diminished, a diverse array of innovative products has emerged.

This innovative process breathes new life into items that may have been challenging to market otherwise, such as misshapen asparagus, which can be repurposed into innovative creations like asparagus powder for the food industry. Farmers seize the opportunity to process surplus vegetables and fruits, offering freeze-dried strawberries or apricots, among other delights. Confectioners also elevate their confections with the inclusion of freeze-dried ingredients.

In essence, freeze-drying opens doors to a multitude of creative possibilities, enriching the spectrum of products and experiences available to us.



The original freeze-dried ice cream created by Whirlpool Corporation for NASA, though it never had the chance to journey to space.

Time, Energy Consumption and Interesting Facts

The freeze-drying duration is a critical factor in making the most of a freeze dryer. Nonetheless, this time frame can significantly differ across various materials due to variations in water content, which stands as the primary influencing factor. Beyond this, there are other contributing factors to consider. For instance, fruits like oranges and tangerines are equipped with exceptionally water-resistant skins that store moisture efficiently. In such cases, the technique of cutting the fruit into smaller pieces becomes pivotal, as it expedites the freeze-drying process. Berries with thicker skins, like blueberries, are similarly adept at retaining water. On the other hand, strawberries prove to be notably easy to freeze dry.

The table below outlines the drying times for medium-sized pieces, approximately 10 mm in size, at final temperatures of 25°C, 40°C, and 60°C. It's worth noting that higher temperatures accelerate the drying process, but this may come at the expense of diminished vitamin retention and structural integrity. Therefore, it's imperative to customize temperature and drying cycles individually to achieve the desired quality of the end product. This adaptability is made possible through the user-friendly interface of the Wave freeze dryers.

Figure 1 below provides a visual representation of freeze-drying times in hours at various maximum heating temperatures.

Freeze-drying time in hours at different maximum heating temperatures

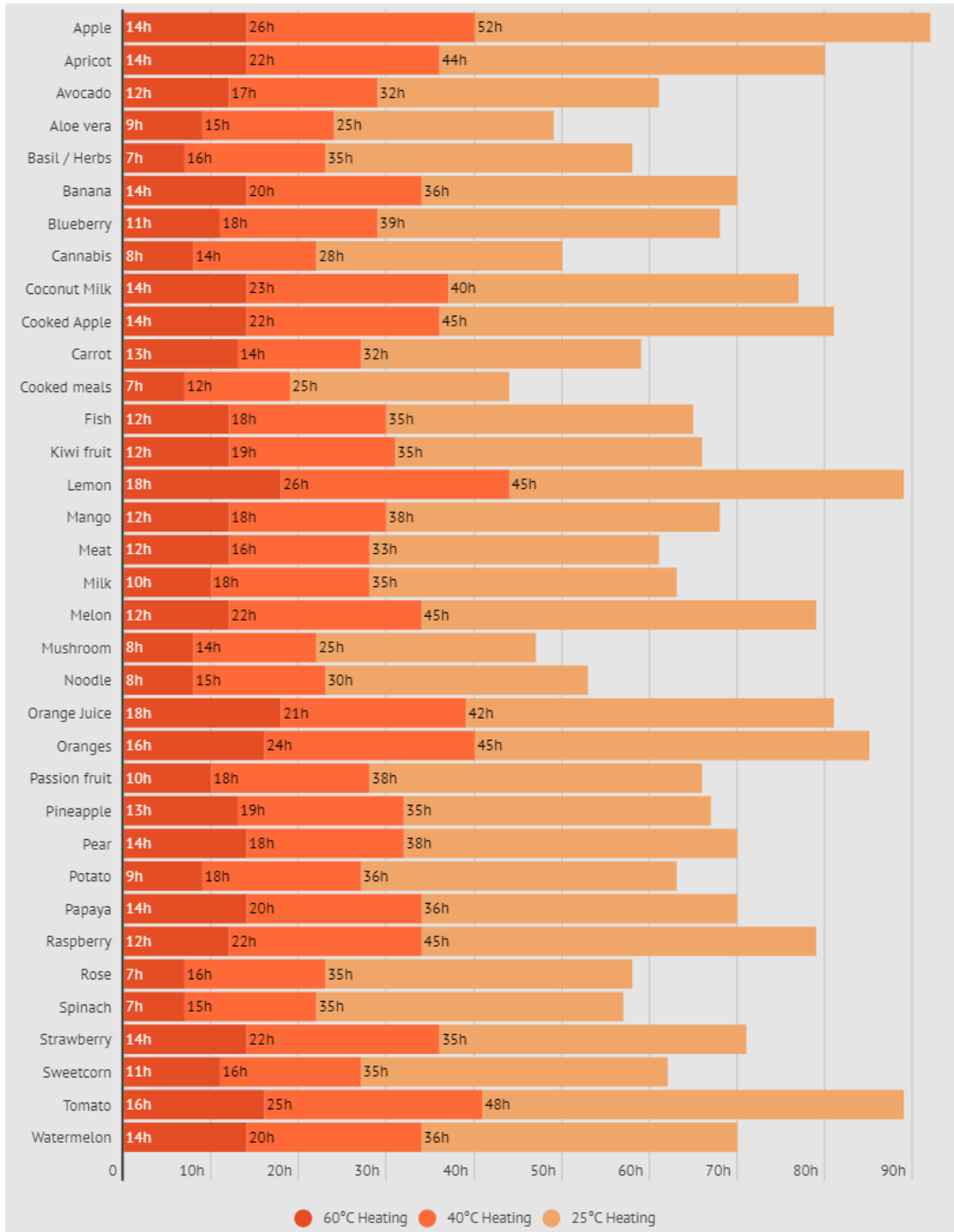
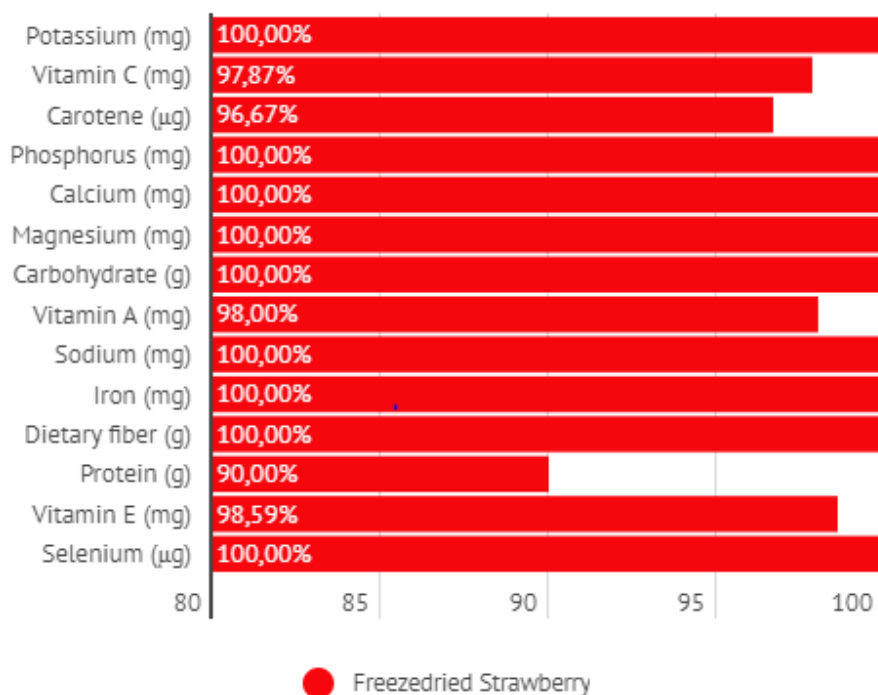


Figure 1; Source: <https://wave.cc/know-how>

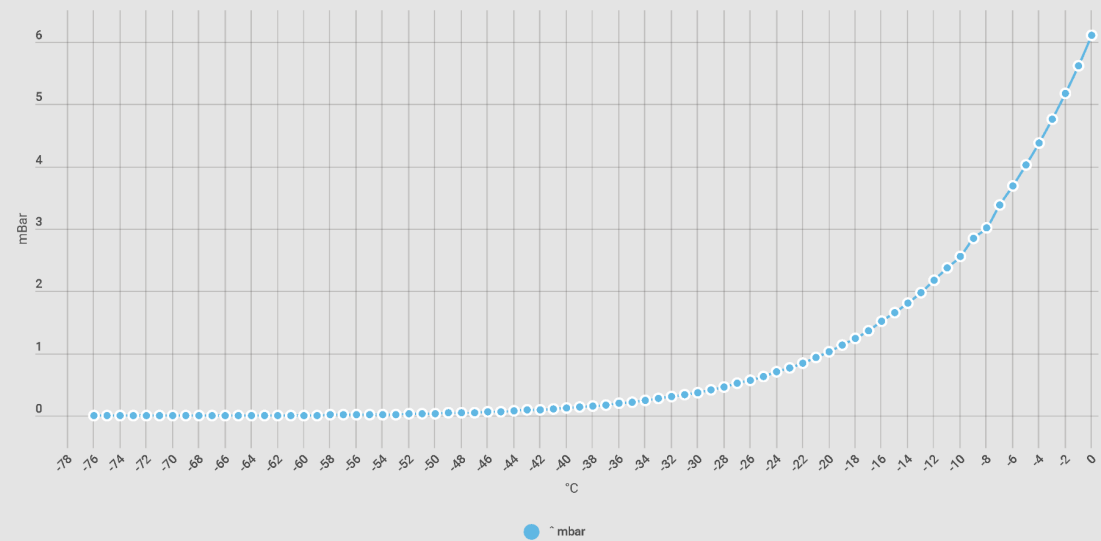
Nutrients before and after freeze-drying



Nutrient Name	Fresh Strawberry	Freeze-dried Strawberry	in %
Potassium (mg)	131,00	131,00	100,00%
Vitamin C (mg)	47,00	46,00	97,87%
Carotene (µg)	30,00	29,00	96,67%
Phosphorus (mg)	27,00	27,00	100,00%
Calcium (mg)	18,00	18,00	100,00%
Magnesium (mg)	12,00	12,00	100,00%
Carbohydrate (g)	7,10	7,10	100,00%
Vitamin A (mg)	5,00	4,90	98,00%
Sodium (mg)	4,20	4,20	100,00%
Iron (mg)	1,80	1,80	100,00%
Dietary fiber (g)	1,10	1,10	100,00%
Protein (g)	1,00	0,90	90,00%
Vitamin E (mg)	0,71	0,70	98,59%
Selenium (µg)	0,70	0,70	100,00%

Figure 2; Source: <https://wave.cc/know-how>

Ice Pressure - Curve (evaporation temperature)



[Download data](#)

Made with **Infogram**

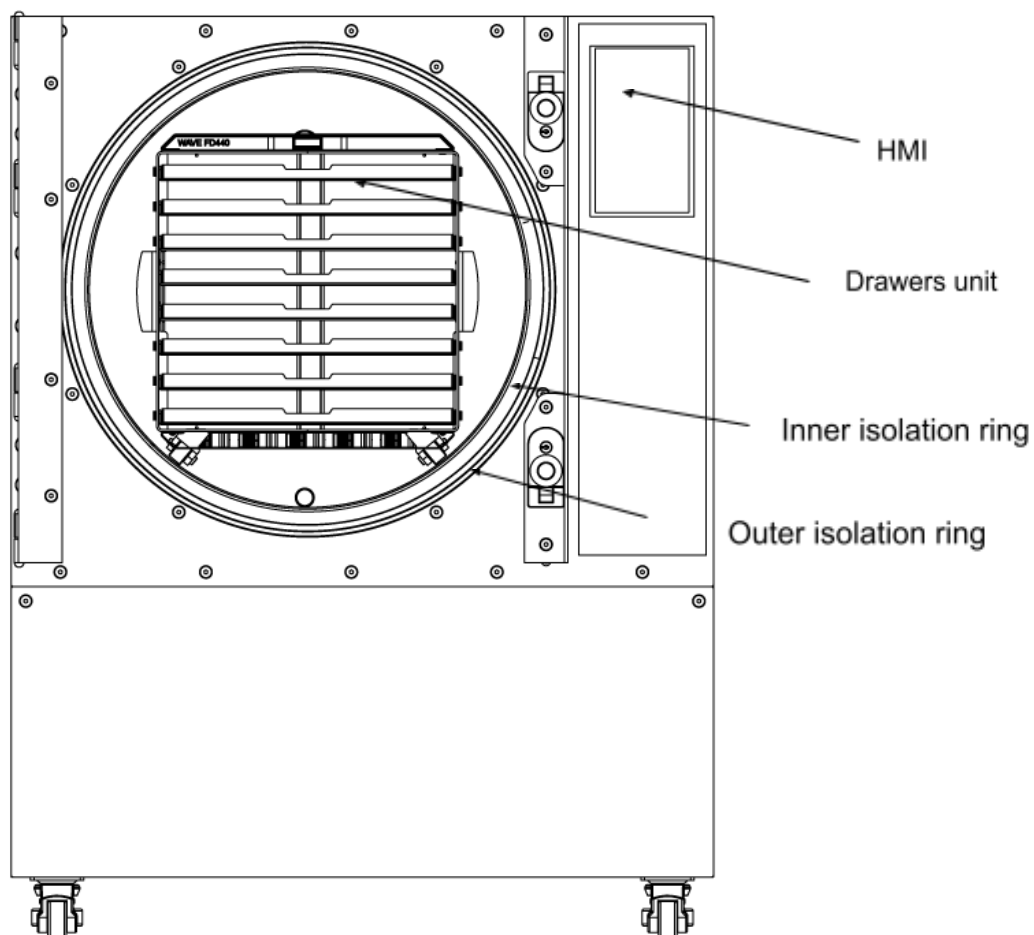
The ice pressure curve serves as a vital reference point for discerning the temperature at which water will transition into vapor under a designated pressure. This knowledge is instrumental in comprehending the intricate nuances of the drying process and in crafting a tailored drying program that aligns seamlessly with your specific material.

Ice pressure curve as a table

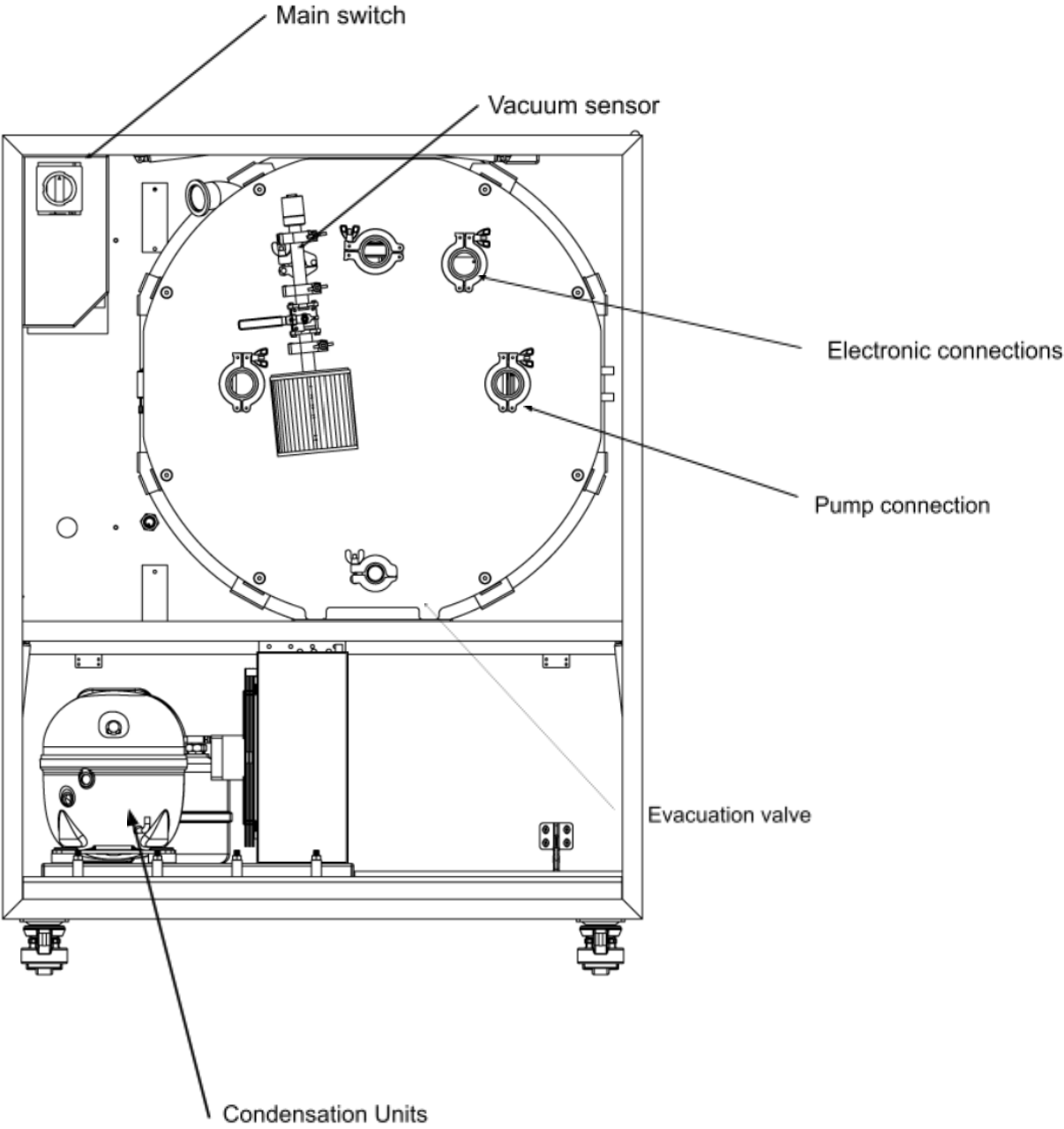
°C	mBar	mTorr		°C	mBar	mTorr		°C	mBar	mTorr
-76,00	1	0,8		-48,00	50	37,6		-20,00	1,030	774,4
-75,00	1	0,9		-47,00	55	41,4		-19,00	1,140	857,1
-74,00	1	1,1		-46,00	60	45,1		-18,00	1,250	939,8
-73,00	2	1,3		-45,00	70	52,6		-17,00	1,370	1030,1
-72,00	2	1,4		-44,00	80	60,2		-16,00	1,510	1135,3
-71,00	2	1,7		-43,00	90	67,7		-15,00	1,650	1240,6
-70,00	3	2,0		-42,00	100	75,2		-14,00	1,810	1360,9
-69,00	3	2,3		-41,00	110	82,7		-13,00	1,980	1488,7
-68,00	4	2,6		-40,00	120	90,2		-12,00	2,170	1631,6
-67,00	4	3,1		-39,00	140	105,3		-11,00	2,180	1639,1
-66,00	5	3,5		-38,00	160	120,3		-10,00	2,560	1924,8
-65,00	5	4,1		-37,00	180	135,3		-9,00	2,840	2135,3
-64,00	6	4,5		-36,00	200	150,4		-8,00	3,010	2263,2
-63,00	7	5,3		-35,00	220	165,4		-7,00	3,380	2541,4
-62,00	8	6,0		-34,00	250	188,0		-6,00	3,690	2774,4
-61,00	9	6,8		-33,00	280	210,5		-5,00	4,020	3022,6
-60,00	11	8,3		-32,00	310	233,1		-4,00	4,370	3285,7
-59,00	12	9,0		-31,00	340	255,6		-3,00	4,760	3578,9
-58,00	14	10,5		-30,00	370	278,2		-2,00	5,170	3887,2
-57,00	16	12,0		-29,00	420	315,8		-1,00	5,620	4225,6
-56,00	18	13,5		-28,00	470	353,4		0,00	6,110	4594,0
-55,00	21	15,8		-27,00	520	391,0				
-54,00	24	18,0		-26,00	570	428,6				
-53,00	25	18,8		-25,00	630	473,7				
-52,00	30	22,6		-24,00	700	526,3				
-51,00	35	26,3		-23,00	770	578,9				
-50,00	40	30,1		-22,00	850	639,1				
-49,00	45	33,8		-21,00	940	706,8				

Technical Drawings for FD440

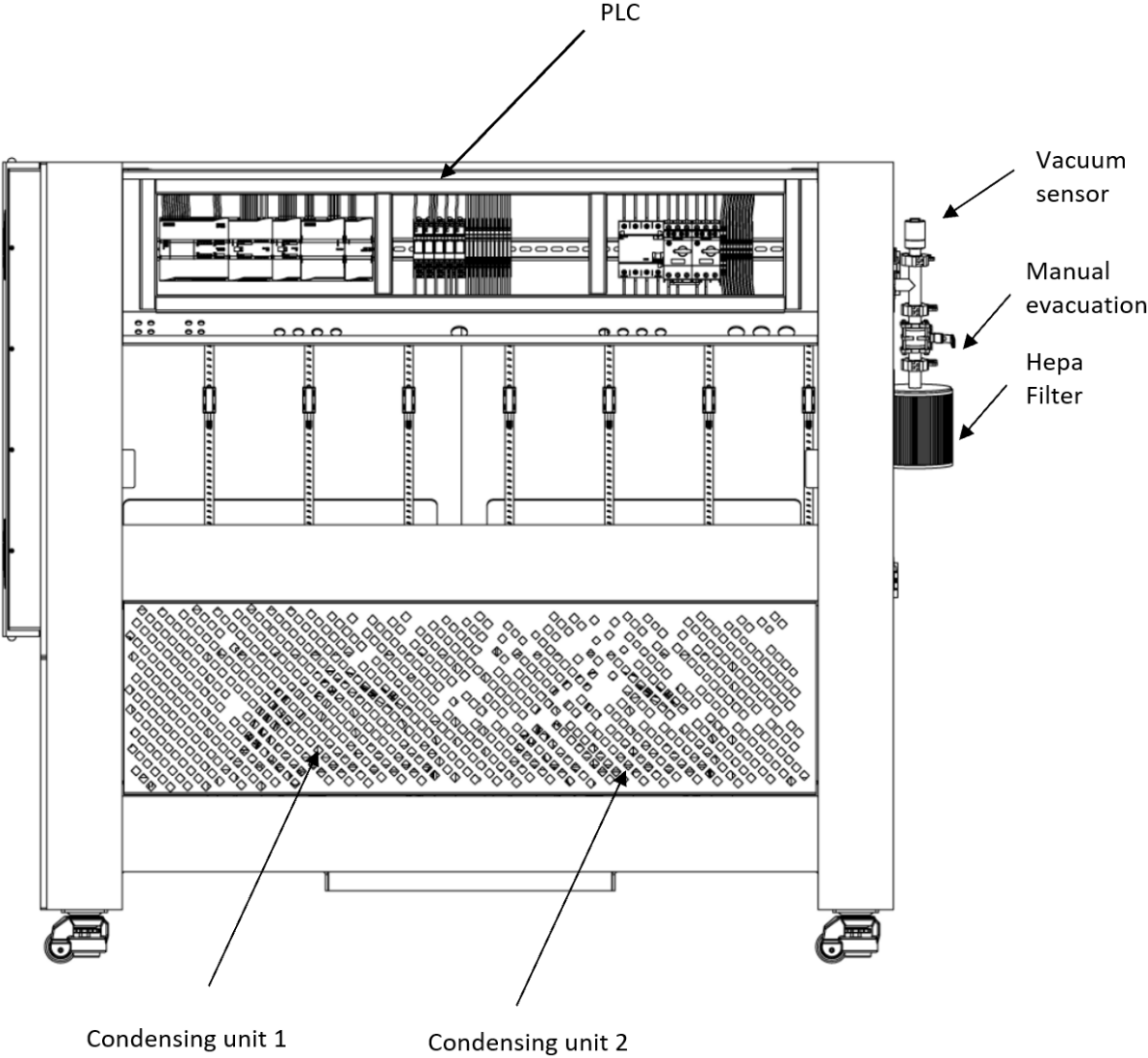
Front view



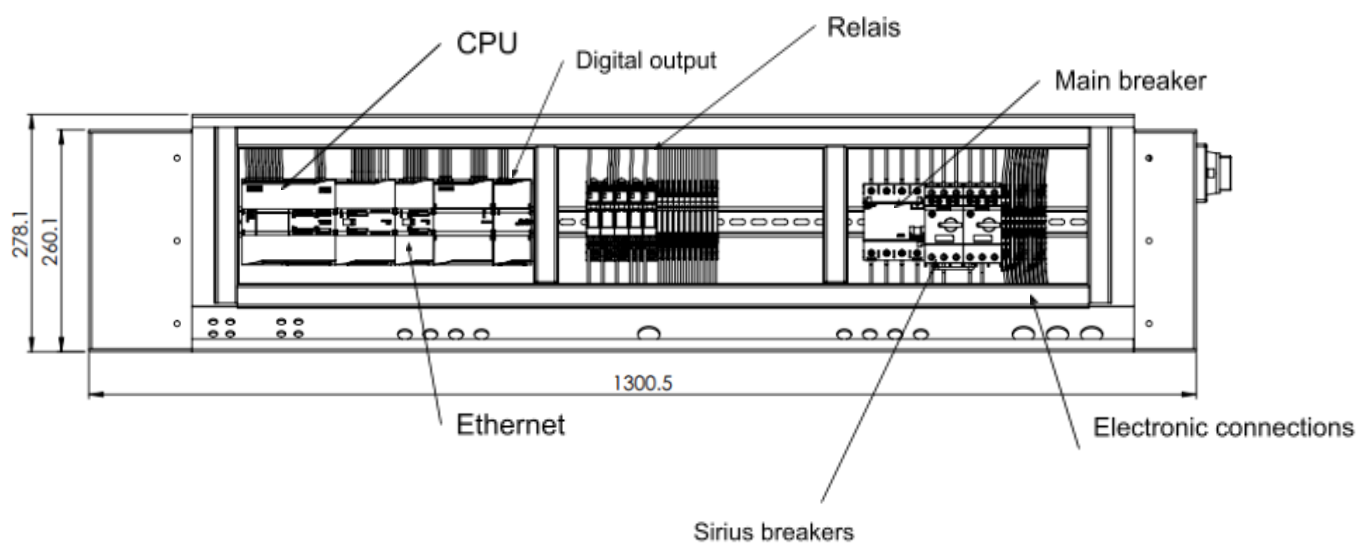
Back view



Side view



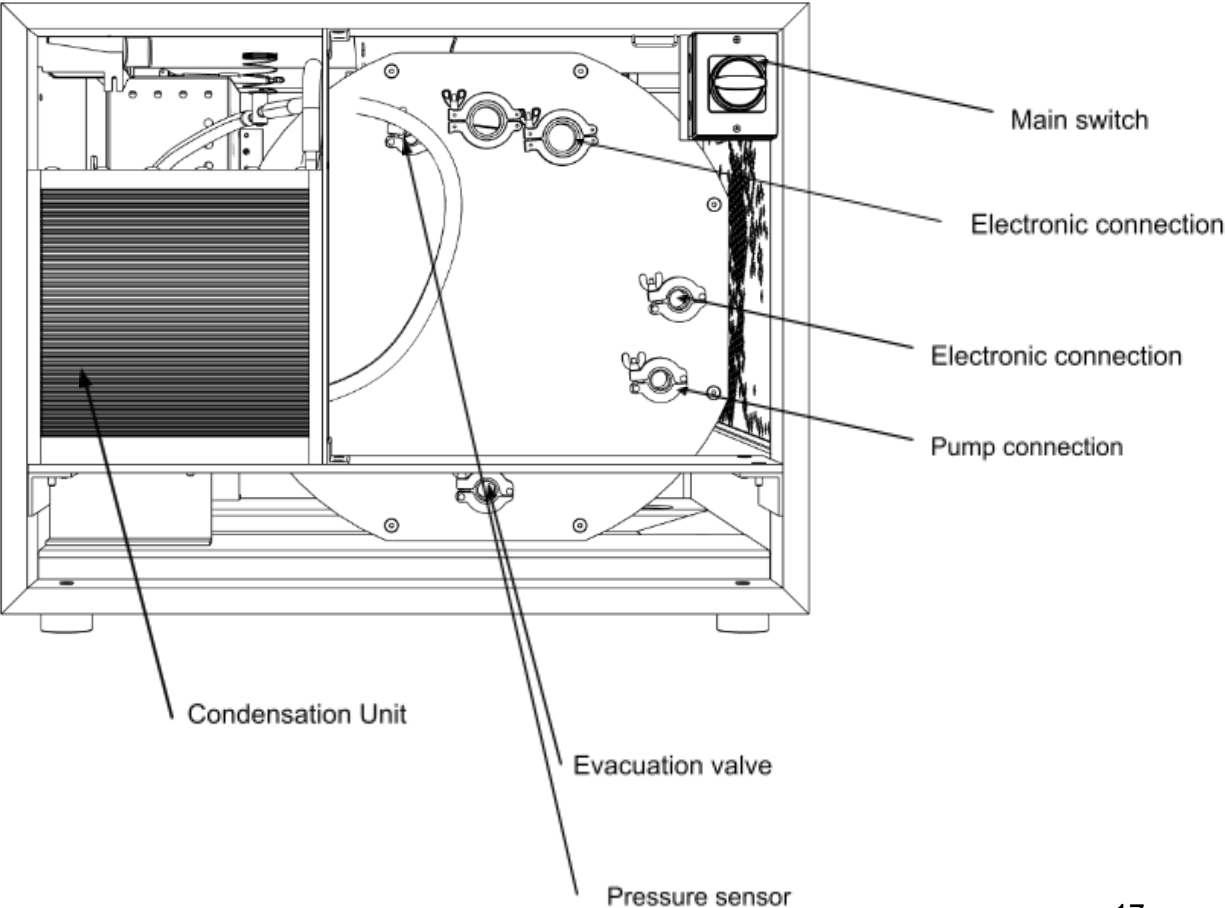
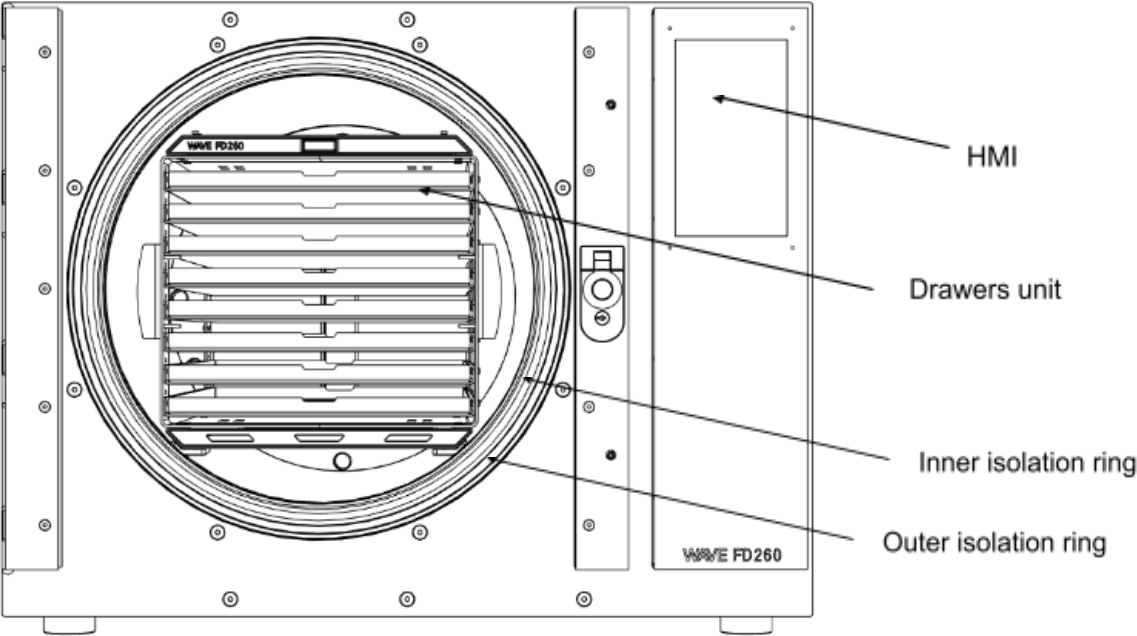
PLC

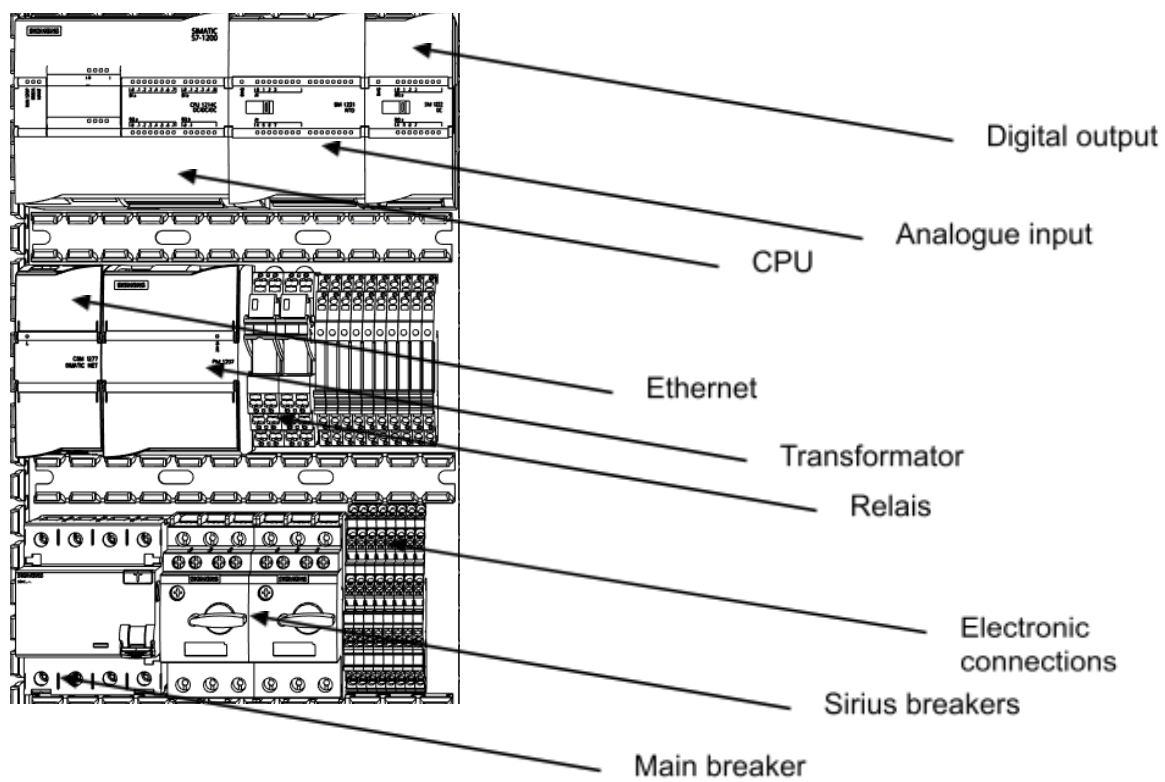
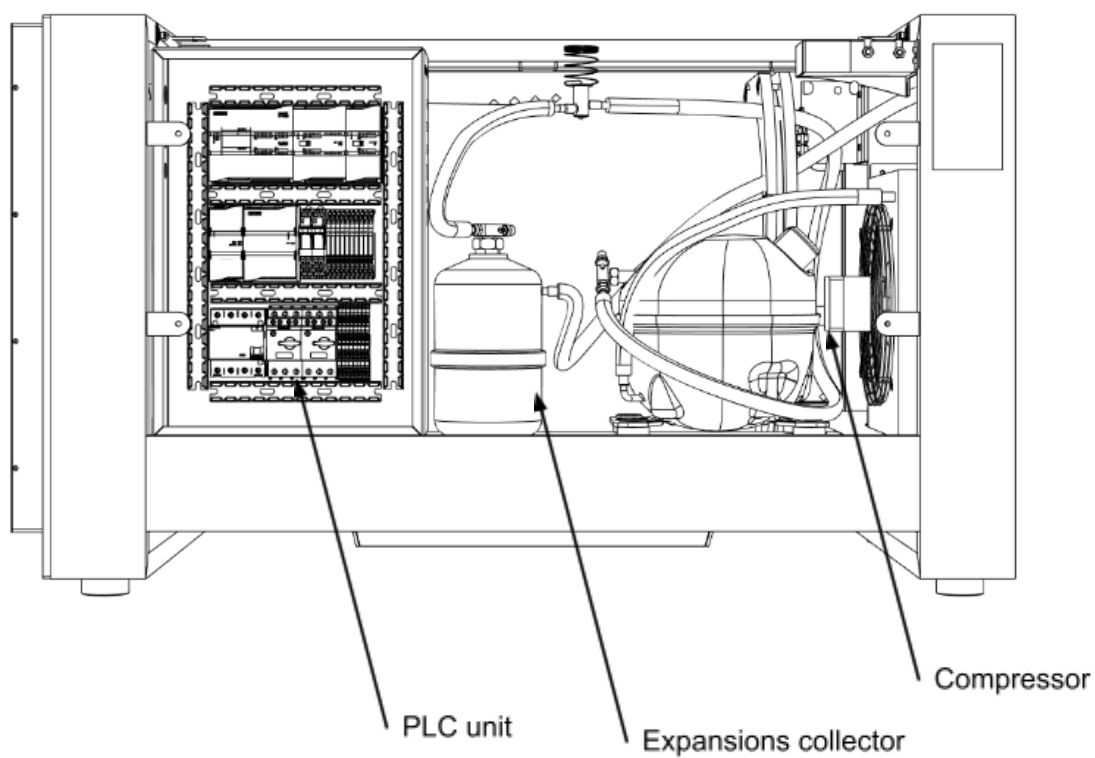


Specifications for FD440

Feature	Value
Extraction capacity	60 kg
Drawer loading volume	192 liters
Surface Area (8 drawers)	3.85m ²
Compartments	1-12
Tray material	Choice of Anodized Aluminum or Stainless Steel
Cooling capacity	3 kW
Heating capacity	Up to 400 watts / drawer
Current load	max. 9 kW
Condensation temperature	-40 C °
Maximum vacuum	50 mTorr
Time to Reach Maximum Vacuum	Approximately 20 minutes
Pump	Edwards 28 or a stronger model
Evacuation methods	Electromagnetic and manual
Door closing mechanism	Mechanical
De-icing	Electric
De-icing time	Approx. 20 minutes
Monitor	10 "HMI color touchscreen
Connectivity	Ethernet via CAT6
Control system	PLC Siemens simatic
Door material	40 mm acrylic
Vacuum chamber material	7mm Extruded Aluminium
Vacuum chamber surface	Powder-Coated
Total weight	430 kg
Electrical connection (US) (can be adapted)	3x 16A 230 V (3x 20A 110V)
Dimensions 440 (L x W x H)	140 cm x 93 cm x 130 cm

Technical Drawings for FD260





Specifications for FD260

Feature	Value
Extraction capacity	25 kg
Drawer loading volume	115 liters
Surface	2.8 m ²
Compartments	1-12
Tray Material	Aluminum anodized or stainless steel
Cooling capacity	1.5 kW
Heating capacity load	Up to 400 watts / drawer
Current load	Max 6.5 kW
Condensation temperature	-40 C °
Maximum vacuum	50 mTorr
Reaching the maximum vacuum	approx. 30 minutes
Pump	Edwards V12 or a stronger model
Evacuation	Electromagnetic
Door closing mechanism	Mechanical
De-icing	Electric
De-icing time	approx. 30 minutes
Monitor	10 "HMI
Connectivity	Ethernet via CAT6
Control	PLC Siemens simatic
Door	40 mm acrylic
Vacuum chamber material	Extruded aluminum 7mm
Vacuum chamber surface	Powder-coated
Front panel	Powder-coated
Total weight	310 kg
Dimension (LxWxH)	127,5 cm x 93,5 cm x 71 cm

Machine Operation

Machine Setup and Operation

Operating the machine is a straightforward process. Follow these steps to ensure proper operation:

1. **Placement:** Position the machine in a stable, vibration-free location with temperatures below 22°C for optimal performance. Please make sure the machine is placed on even ground and use a spirit level to verify its horizontal alignment. Note that ambient temperatures, especially during hot months, can affect drying times.
2. **Activate Brakes:** If the device is equipped with castors, engage all brakes once it's in its final position.
3. **Safety Checks:** Examine the machine for transport-related issues, particularly checking for leaks in the cooling system. Refer to the operating instructions for your specific cooling system (Embraco, Tecumseh, or Blitzer) and adhere to national regulations concerning cooling systems. Confirm that the door is correctly positioned and never place weight on it to avoid potential injuries.
4. **Power Connection:** Connect the machine to the appropriate power source. In Europe, machines are typically three-phase units rated at 400 V, with three phases, each at 230 V, along with one neutral and one ground. In the United States, machines are designed to work with 240 V on a single phase to neutral, but can also be operated with 2×120 V. Turn on the FI switch in the fuse box, then switch on the device using the main switch at the rear. The PLC (Programmable Logic Controller) will indicate readiness with a beep, and the display on the front-right of the machine should illuminate.
5. **Vacuum Pump Setup:** Ensure that the vacuum pump is placed on a level, dry, and well-ventilated surface, with sufficient clearance for safety. Connect the pump to the vacuum chamber using clamps. The connection may vary if you are using a pump other than the Edwards 18, so refer to your pump's specific manual, which was provided. Be sure to read and adhere to the safety instructions. Confirm that the pump operates at the voltage indicated on the machine's nameplate. The pump should be connected to a KF-25 (or 40 KF) based on pump size and model. Use a manual valve between the pump and the chamber to isolate the pump when needed (e.g., for oil changes) and to prevent air from being drawn into the chamber after a cycle.
6. **Language and Settings:** Access the "Menu Settings" to choose your preferred language and configure the time and date.
7. **Component Functionality Check:** Proceed to the "Control" section to verify the functionality of all machine components before initiating a cycle. This includes checking the heating mats, cooling system, vacuum pump, and more.

Following these steps will ensure a smooth and safe operation of the machine.

First Machine Run

It is essential to work with gloves and appropriate protective clothing.

1. **Recipe Selection:** Under the "Recipes" menu, choose the appropriate recipe for your drying cycle. If a suitable recipe isn't available, select a similar material's recipe and modify it for your specific drying needs. Alternatively, create a new recipe and save it for future use.

2. **Compressor Warm-Up:** Before the first run, it's advisable to warm up the compressor to around 20°C. This helps extend the lifespan of the condensing unit. You can achieve this by using a heat gun or a similar tool. If the room temperature is below 15°C, avoid starting the machine, as it may result in permanent compressor damage.

3. **Loading Material:** Load the machine with the material to be dried. Place silicone mats or baking sheets on the trays to facilitate easy removal of the material after the drying process. Ensure there are no large chunks of material, as those are more challenging to dry (ideally below 20 mm in thickness). When extracting liquids, it's recommended to use a small pump to transfer them to the designated drying drawer or pour them carefully into the nearly closed drawer. Also, ensure that the drawer unit is level before introducing liquids. If the machine is not fully loaded, prioritize loading the rear trays before the front ones to ensure accurate temperature readings, as the sensor is positioned in the rear.

You can introduce the drying material either frozen or unfrozen.

4. **Process Initiation:** Close the machine's door and commence the drying process. Ensure that all components in the "Control" section are set to "Auto," allowing the program to manage items such as the vacuum pump and heating mats. Confirm that the evacuation valve is closed before freezing to establish a tight seal for subsequent high vacuum during drying. If your material is pre-frozen to at least -22°C, no further cooling is necessary; ideally, precool the machine for 10 to 30 minutes before starting. Be cautious, as some parts of the cooling system can become extremely cold and might develop heat on certain pipes. Keep an eye on the sight glass of the cooling system to check for the formation of bubbles after initiating the cooling system. If no bubbles form, switch off the system; there may be a leak, and the coolant must be sealed and refilled by an HVAC technician. The freezing process induces a slight vacuum in the chamber, so we recommend closing the evacuation valve before freezing to facilitate the creation of this vacuum, which ensures a secure connection for subsequent high-vacuum drying.

5. **Vacuum Building:** After freezing, the machine initiates the vacuum-building phase, typically taking around 20-40 minutes, depending on the vacuum pump type used. The target is to achieve the required vacuum, typically averaging 600 mTorr, to commence the drying process. Be cautious when starting the vacuum pump, ensuring no body parts are near the openings to avoid injuries. If the target vacuum is not reached, consider the following potential issues:

- Verify the snug fit of the inner and outer silicone rings on the door, especially pressing the inner ring firmly through the door.
- Ensure the manual evacuation valve is completely closed.
- The inside of the door should be clean and dry or frozen.

- Check the quality of the vacuum oil in the pump; replace it if it appears whitish, indicating contamination with water.

- Allow your pump some time to reach its operating temperature.

- Ensure that the automated evacuation/drain valve is closed.

- Check for any debris in the evacuation valve at the bottom of the vacuum chamber at the rear of the machine.

6. **Drying Process:** When the target vacuum is reached, the drying process initiates automatically and proceeds through various drying stages set by the recipe or as adjusted manually. If the vacuum pump becomes noticeably hot ($> 80^{\circ}\text{C}$) or you detect a burnt smell, immediately switch it off. You have the flexibility to intervene at any point in the drying process to modify parameters or cancel it prematurely.

7. **Post-Drying:** Once the drying process is completed, the device awaits manual evacuation and defrosting. Follow this recommended sequence to conclude the process:

- Close the valve at the pump.

- Stop the pump from the "Control" menu.

- Stop the cooling system from the control menu.

- Open the evacuation valve OR, if you have a dedicated evacuation valve, open it.

- Open the door and inspect the material. If it's dry, promptly pack it; if not, close the door, restart the cooling system, initiate the pump, open the valve, and continue drying (see also points 7 and 8). Exercise caution near the valves, as they pose a significant danger (see safety instructions). Ensure that any evacuation hose doesn't reach into a water-filled basin, as it may draw in water.

- If the evacuation valve doesn't close as desired, it's possible that the capacitors inside have been deeply discharged. To resolve this, switch the valve to "ON," i.e., open, and allow it to charge for about 30 minutes.

8. **Quality Check:** Verify whether the goods have reached the desired drying state. If not, you can add an additional drying level and run the process again. Handle the drawer or device only with gloves, as it can be extremely hot or cold (see safety instructions).

9. **Packaging:** Once the goods are dry, promptly remove and seal them airtight, ideally using a vacuum packing machine to prevent further moisture absorption.

We recommend using the 10-step start and stop guide provided with each machine, which can also be found in this manual.

Defrosting Process

10) If your machine is equipped with a hot gas bypass valve feature, you have the "Rapid Defrost" option at your disposal. Once the drying process is complete and you've removed the material from the machine, you can choose to either leave the cooling system running or restart it. Next, activate the "Rapid Defrost" function, which will run for a duration of up to 30 minutes or until the temperature reaches 12°C.

- **Function:** During the "Rapid Defrost," the compressor shifts from cooling to heating. After this process, there's a cooldown period where the function cannot be used for several hours to avoid overloading the compressor. Once the "Rapid Defrost" concludes, the machine will automatically switch to the regular defrost mode. This mode utilizes electrical heating mats within the chamber unit to defrost the ice plates. The defrost continues until the ice plates are ready to be safely removed with gloves, or until the ice is completely melted (the latter option will take longer).

If your machine does not feature a hot gas bypass valve, you can use the standard defrost function. Activate this function manually by pressing the defrost button for an extended duration. This process heats the vacuum chamber using heating mats positioned around it. The duration of this process varies based on the machine's extraction capacity.

Once the defrosting is complete, and if you've met all the prerequisites listed in point 4), you can refill the machine and start a new cycle after ensuring it's been properly cleaned. You can adjust the maximum defrost temperature under the "Settings" menu.

Recommended Temperatures:

- For defrosting and water removal, set the temperature to approximately 50°C.
- If you intend to loosen the ice sheets, a temperature of 30°C is sufficient. In this case, wait until the vacuum chamber reaches the desired temperature, then gently pull the drawer forward to release the ice plates, which can then be carefully removed.

Ensure that the maximum defrost temperature in the "Settings" does not exceed 70°C. This will help maintain the integrity of the machine and ensure safe and efficient defrosting.

Cleaning and Waste Water Management

Proper cleaning and maintenance of the machine are essential for its longevity and the quality of the products it processes. Follow these guidelines:

1. **Post-Cycle Cleaning:** After each drying cycle, it's crucial to clean the trays. If you've processed materials containing toxic substances, perform an exceptionally thorough cleaning to eliminate any residues from the vacuum chamber, trays, or anywhere in the drying room. (Refer to safety instructions for additional guidance).

2. **Product Switch Cleaning:** When transitioning from one dry product to another, especially if the new material has strong aromas or involves animal or dairy products, we recommend a meticulous cleaning of the machine.

3. **Door Cleaning:** Wipe the inside of the door with a soft, damp cloth. This action not only maintains cleanliness but also aids in creating a proper vacuum. Use only soft cloths to prevent scratches on the door's surface. If the door does become scratched, it can be restored using a suitable acrylic polishing cream.

4. **Drawer and Vacuum Chamber Cleaning:** In addition to cleaning the trays, ensure the body of the drawer and the vacuum chamber are thoroughly cleaned. To clean the body, detach it from the tube. Be cautious while sliding it out, as the body of the drawer is permanently wired to the tube (unless you have the plug option) and has a 2.5-meter cable. To slide it back, align it at a 45° angle at the beginning of the chamber. You can clean the body of the drawer using water and/or water with detergent (rinse off any detergent thoroughly). Due to the presence of silicone mats, avoid using caustic cleaning agents.

- **Caution:** When cleaning the inner chamber, ensure no liquid enters the vacuum ports located at the center and top of the chamber, as this could damage the pump.

5. **Chemical Caution:** Never employ acetone, bleach, chlorine, nitro, or harsh chemicals/solvents to clean any internal or external parts of the machine.

6. **Toxic Substance Disposal:** If you're drying materials from which toxins are extracted with water, make sure the extracted liquid is disposed of properly, following safety instructions.

7. **Manual Cleaning and MULE:** For preparation, removal of the drawer unit, material compatibility and documented release, see "Cleaning, disinfection and MULE" (supplement C1-C3; PDF pages 94-96). Follow the instructions for the supplied configuration.

By following these cleaning and maintenance guidelines, you can ensure the longevity and effectiveness of your machine.

Cooling System Operation

Do not start the compressor in cold conditions. Ensure that the ambient temperature is at least 20°Celsius. If the environment is colder, you can warm up the compressor using a standard fan. Be certain that the entire compressor is adequately warmed, which typically takes about 30 minutes. Once it's running, a lower ambient temperature is acceptable.

The cooling system comprises several key components, including the compressor, condenser, bubble glass, filter, vessel, and the T XV valve.

If you encounter performance issues with the compressor, check the bubble glass for any bubbles. The presence of bubbles indicates a refrigerant leak, and it's essential to have an HVAC technician inspect and repair the unit.

For detailed guidance on your specific cooling system (Embraco, Tecumseh, or Bitzer), please refer to the operating instructions provided in the manual sent to you. Additionally, adhere to national regulations concerning the handling of cooling systems.

Be aware that regular service intervals may vary by region. Consult your local requirements to determine the recommended maintenance schedules for your cooling system.

By following these guidelines, you can maintain the optimal performance of your compressor and cooling system while ensuring its longevity and efficiency.

Vacuum Pump Operation

The vacuum pump may vary depending on the specific machine, so it's essential to reference the provided operating instructions for your specific model. Proper maintenance is crucial, including regular oil changes if your pump is not oil-free. The user manual will offer detailed guidance on installation and pump connection.

Maintaining the pump's performance requires that the ballast on the pump remains fully open.

Both oil pumps and drive pumps feature a ballast button to regulate air intake, crucial for removing water from within the pump.

When installing the pump, ensure it's placed in a suitable environment: a straight, dry, and cool location with adequate ventilation and safety clearance.

For machines equipped with an oil vacuum pump, avoid starting the pump until the internal chamber temperature is below freezing. Operating the pump in a warm chamber can quickly lead to contamination of the pump's oil, necessitating immediate replacement.

Please note that only specific oils are compatible with the vacuum pumps we supply:

- Edwards Ultrade 19 Vacuum Oil

- Petro Canada Super Vac 19 Vacuum Pump Fluid

Following these instructions will help ensure the efficient and safe operation of your vacuum pump, prolonging its lifespan and optimizing its performance.

PLC / Remote Maintenance Guidelines

The Wave FD is furnished with a Siemens Simatic PLC, characterized by its modular structure that allows for future expansions, modernization, and upgrades to the latest generation of machine control. This Simatic system is managed through the HMI and is inherently maintenance-free.

Remote maintenance is a seamless option, requiring Ethernet access from the PLC to a network-connected PC. This connection is established through the Ethernet port on the switch box using a CAT6 cable, granting access to the Wave FD440 from external locations, such as via Teamviewer. This facilitates the retrieval of system data and the verification of functions through remote monitoring.

Additionally, located on the back of the HMI, there's a USB stick where all process drying profiles are stored and can be extracted in the form of an Excel table. To save these drying profiles to the USB stick, please activate the feature under the "Statistics" tab.

For machines equipped with the "Wave" router, data exchange and brokering with other systems can be achieved using MQTT. The Wave router empowers the machine to connect directly and be accessible by the Wave team through various means, including Ethernet, Wi-Fi, or a dedicated SIM

card. However, it's crucial to enable data transfer out and allow firmware upgrades or any other remote operations conducted by the Wave team. Please note that no production can occur during planned firmware upgrades or when remote access is granted to the Wave team. Nevertheless, you have the flexibility to enable remote access to your in-house systems as needed.

Heating System Functions

Typically, the Wave FD is outfitted with a set of 6 to 12 heating mats. Each of these mats is meticulously adjusted to reach the precise temperature required for achieving a consistent and uniform drying outcome. With each mat boasting 660 watts of heating power, this power is effectively distributed across the three phases for optimal performance.

The quantity of heating mats can be customized within the "Settings" menu, ensuring flexibility to meet specific drying needs. It's worth noting that the number of drawers is preconfigured accurately at the factory for your convenience.

Surface Maintenance

The surfaces of the drawers, the drawer body, and the vacuum tube are hard anodized, with a thickness of 25 micrometers (25um), making them certified as food-safe surfaces. These surfaces can be effectively cleaned using a gentle cleaning agent.

Menu Navigation

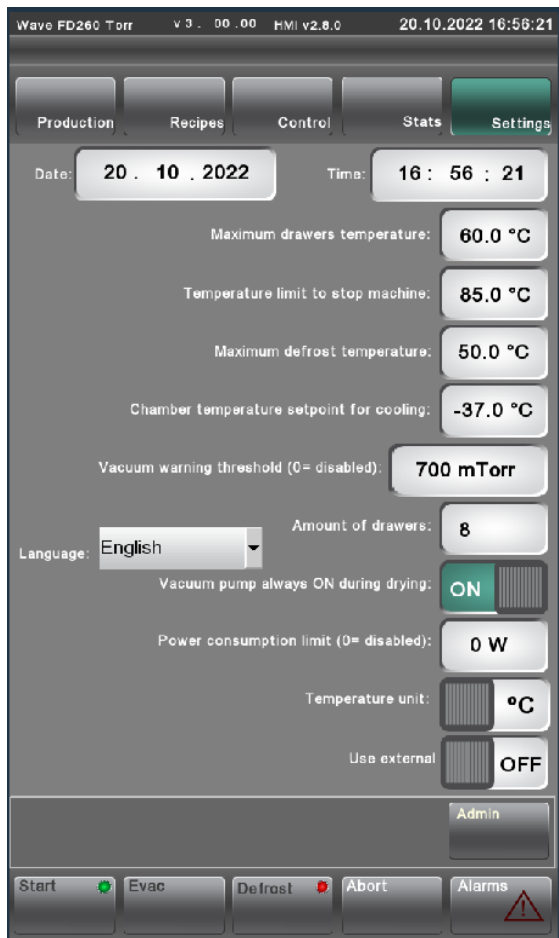
The freeze dryer features a user-friendly touch screen interface. Each button press triggers a specific function, ranging from opening dialog boxes to adjusting values or confirming actions. This intuitive design allows for flexible and precise control of all machine components to handle goods effectively.

However, please ensure that your fingers are clean when interacting with the screen. Dirty or oily hands can interfere with the screen's responsiveness and lead to malfunctions. It's crucial to avoid using solvents for cleaning the monitor. Also, refrain from using any hard objects like metal, screwdrivers, or wood to interact with the screen to prevent damage.

Menu item “Settings”

Within this menu, you can configure various settings, select your preferred language, and set the date and time. Additionally, you have the option to specify values for different functions, including:

1. **Maximum Drawer Temperature:** This defines the upper limit for the drawer temperature, which is typically set at 60°C by default.
2. **Temperature to Halt the Machine:** If any sensor on the machine reaches the threshold set here, the machine will stop its operation.
3. **Maximum Defrost Temperature:** This specifies the highest temperature the vacuum chamber can reach during the defrosting process, with an inherent limit of 70°C to ensure effective de-icing.
4. **Chamber Cooling Setpoint:** The maximum allowable output temperature of the refrigeration system is -40°C, and it should not surpass this value. The default shutdown temperature is set at -37°C.
5. **Vacuum Warning Setpoint:** This represents the minimum vacuum level that the machine must attain to initiate a drying process, with a default value of 600 mTorr.
6. **Vacuum Pump Operation (Always On/Off):** You can choose whether to keep the vacuum pump running continuously or turn it off as needed.
7. **Power Consumption Limit:** This value, measured in watts (W), determines the maximum power usage by the machine. Reducing this value can mitigate the risk of a power outage, but it may slightly prolong the drying process.
8. **Temperature Unit:** You can switch between temperature measurements in degrees Celsius and Fahrenheit as per your preference.



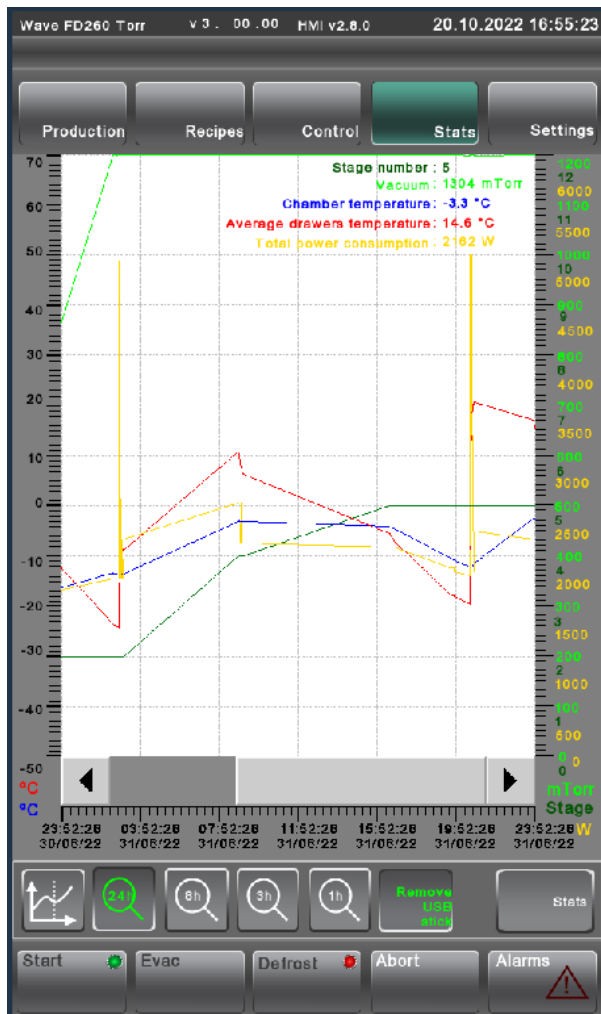
Menu item “Statistics”

In the "Statistics" section, you can discover the machine's type number and the total number of freeze-drying runs it has undergone. Additionally, the latest drying profiles are accessible here, serving as crucial tools for achieving the best drying outcomes and early detection of potential technical issues. While in the midst of the drying process, the live drying profiles can be observed, aiding significantly in optimizing the process concerning time and energy efficiency.

To retrieve this data, simply insert a USB stick into the HMI, located at the rear of the monitor. Interpretation of the drying profiles may necessitate some experience with the machine and the drying process. Key patterns to observe are:

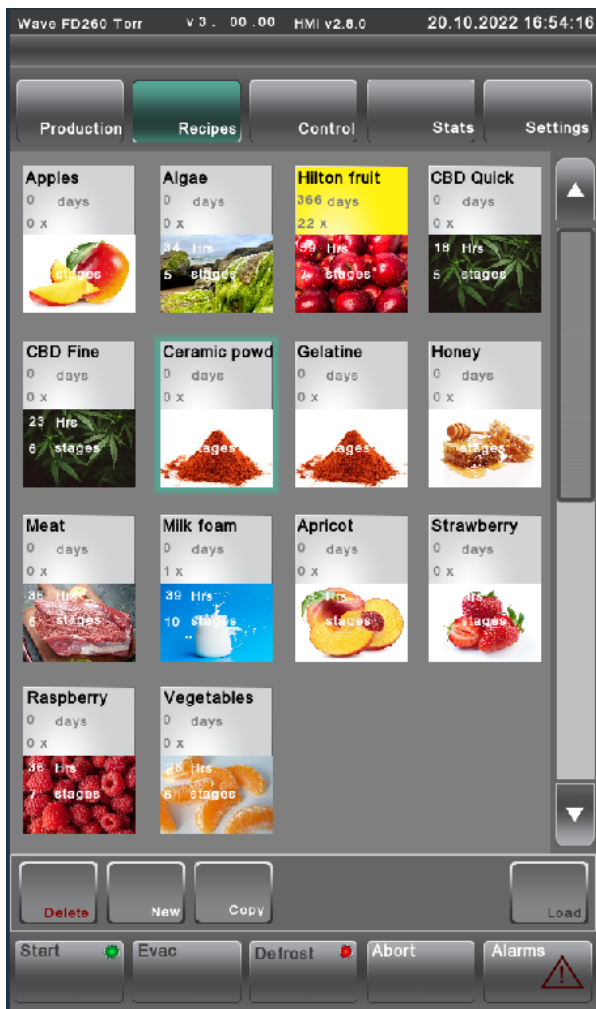
- Notable temperature fluctuations, which are typically normal but may signify that the chosen temperature is excessively high or that the pump output is insufficient.
- Phases featuring consistent temperature and stable vacuum, which denote productive periods during which extraction performance aligns with the pump's capabilities.

- Phases characterized by a sustained temperature and escalating pressure, suggesting unproductive drying intervals with minimal to no extraction occurring at the designated temperature. By understanding and analyzing these patterns, you can fine-tune your drying process for optimal results.



Menu item "Recipes"

Here you can see a selection of saved recipes. You can load these with the command "load", so that this recipe is ready to be processed. It is now in the "Production" displayed area. If you want to change an existing recipe, click on the "Recipe" and change all the desired parameters. You can delete recipes with "delete", copy with "copy" or create a new one with "New", into which, e.g., a recipe can be copied.



Menu item “Control”

In this section, you have the ability to individually access and control each component of the machine. You can switch the vacuum pump, cooling system, and evacuation valve on or off separately. To adjust their operation, follow these steps:

1. By selecting "Go to auto" in the respective field and then pressing "Apply changes" at the bottom left, you align the element's control with the recipe or the production settings.
2. If you choose "Go to on" and press "apply changes," the respective element will be activated or indicated as "Go to off."

To restore automatic control over all elements, simply press the button labeled "Reset all to auto" in the lower right corner. This action will reestablish production settings as the governing parameters for all elements.



Menu item "Production"

In this section, you can load a recipe, which consists of both cooling and drying stages. The cooling stages freeze the goods, while the drying stages freeze-dry them under vacuum by cyclically heating the mats while simultaneously cooling the goods.

Each stage is represented by a color code. A green level indicates an active stage, while you can deactivate it by pressing the green level, turning it red, like the other non-active stages. You can manipulate the stages in the following ways:

- To add a new stage, either press "+ stage below" to insert a stage directly below the selected one or use "+ dry / cool stage" to add a stage at the end of the cycle. You can delete a stage by pressing "delete" for the respective stage.

Cooling Stage:

- If you've selected "Freeze by temperature," you can cool the goods down to a specific temperature. Adjust the temperature by pressing the temperature display and altering the value. The system then cools the goods until the desired temperature is reached in the vacuum chamber.

- Alternatively, you can set the cooling stage duration by selecting "Freeze by time" and adjusting the time as needed.

- If available, you can activate or deactivate the Quickfreeze option using the "O / I" button. This feature activates fans during the freezing process to ensure faster and more even cooling. Information displayed in green indicates the current machine status while it's running.

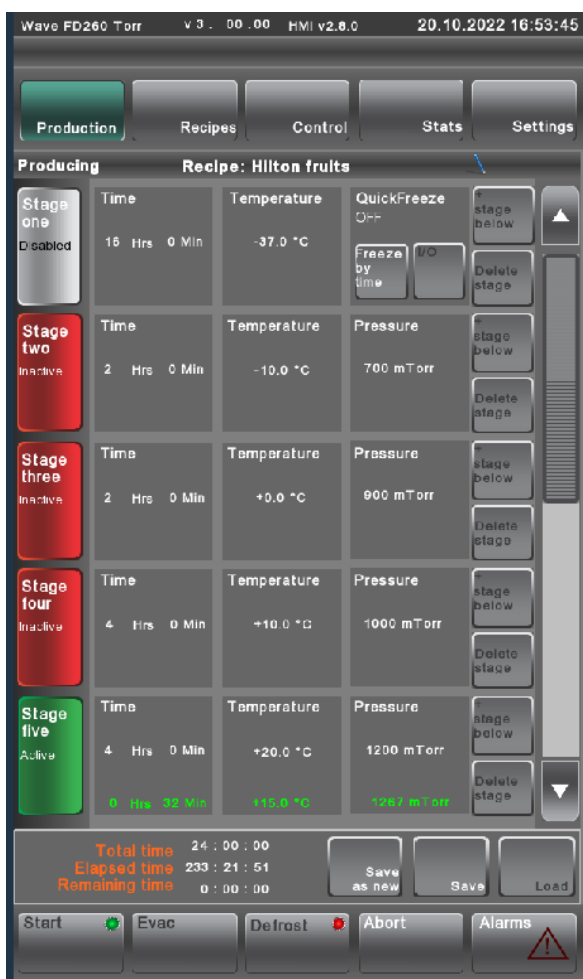
To add a cooling stage, press "+ Cool stage," located at the bottom of the screen after all other stages. It's generally not recommended to freeze items inside the vacuum chamber, as it's not energy-efficient, and other devices can perform freezing more economically and quickly.

Drying Level:

- In a drying level, you can set the duration, temperature of the heating mats, and pressure (in mT). Adjust these settings by interacting with the relevant information, such as pressing and adjusting the temperature to 5°C.
- Green information indicates the current machine status during operation.

When you make changes to recipes during production, you can save them as new recipes using "save as new" or update existing recipes with "save." When creating a new recipe using "save as new," you can name it, and it will appear under "Recipes."

You can add a drying stage by pressing "+ Dry stage," located at the bottom of the screen after all other stages.



Lower Button Bar Function

Start

A freeze-drying cycle can be started with Start.

Evac

Most of our machines are equipped with a manual evacuation valve, which is used for the actual evacuation, while the automatic valve is employed to drain water from the machine. To initiate the evacuation, press and hold the "Evac" button. After all cooling and drying stages are completed, a message will indicate that the machine is ready for evacuation. The machine continues to cool the goods, a necessary step to prevent any damage. Consequently, manual evacuation of the machine is required. During production, if you intend to change the recipe, the machine must first undergo the evacuation process to load the new recipe. However, parameters can be manually adjusted during production as specified in the desired recipe.

It's advisable to promptly remove the goods, ideally when they are warm, and package them in an airtight manner.

Defrost

Pressing the "Defrost" button activates the defrosting process in the machine. It's essential to remove the goods from the machine in advance and store or package them appropriately.

TIP1: There are two distinct methods for defrosting the machine. The first method involves allowing the machine to warm up after goods removal or using the defrost function to facilitate ice melting and removal.

The second method utilizes the defrost function to warm the chamber. By removing the inner compartment and detaching the ice from the chamber wall, this process typically takes just 20 minutes, enabling a swift loading of a new batch.

TIP2: In cases where you need to dry batches with a substantial water content, such as liquids, and the total volume exceeds the machine's capacity, you can apply the method described above. It entails aborting the drying process using the manual function to evacuate the cooling system, deactivating the defrosting function, detaching the ice, and resuming the program. With this approach, significantly larger batches can be processed, and the interruption caused by heating and cooling lasts approximately 90 minutes.

Abort

Selecting "Abort" will halt the production process, but the system will continue to cool the goods until it's ready for evacuation.

Alarms

When the machine generates an alarm message, the "Alarms" button at the bottom right flashes. By clicking on it, you can access the alarm messages, which you can

acknowledge using the "ack all alarms" option. This action marks them as read and accepted.

TIP: The machine features a relatively sensitive alarm system, indicating various levels of urgency with both normal and bold alarm messages. Frequent alarms often pertain to issues with vacuum or chamber temperature. In response, consider degassing or changing the vacuum pump's oil, or lowering the ambient temperature to address these alarms.

Ack

You can acknowledge incoming alarms by pressing this button.

Safety and Responsibility

Safety Guidelines & Operator Responsibility

The operator holds a crucial role in ensuring the safe operation of the machine, and specific responsibilities are outlined below:

1. **Age Restriction:** The operator must ensure that only individuals aged 18 or older operate the machine.
2. **Proper Training:** The operator must guarantee that machine operators have received appropriate training. They should be familiar with the machine's functions, aware of potential operational hazards, and have thoroughly read the provided operating instructions.
3. **First Aid Competency:** Operators must be capable of administering first aid measures in the event of an accident while operating the machine.
4. **Protective Gear:** All personnel operating the machine must be equipped with suitable protective clothing. Gloves, in particular, should be worn at all times during machine operation.
5. **Safety Assessment:** The working environment must be regularly assessed to identify potential accidents related to the freeze dryer's presence.
6. **Timely Maintenance:** Any components of the freeze dryer found to be in less than perfect condition should be replaced without delay to maintain safe and efficient operation.
7. **Accessible Instructions:** It's essential to keep the operating instructions in close proximity to the freeze dryer, ensuring quick access for reference.

By adhering to these safety guidelines and fulfilling the responsibilities outlined, the operator contributes significantly to maintaining a secure operational environment.

The danger stickers on the machine must be visible at all times and replaced if necessary.

Risks during Transport, Mounting, Commissioning and Operation



Dangers can arise during transport

Transportation can pose risks if the machine or its components are inadequately fastened or secured, potentially leading to movement or falling. For comprehensive guidance on this subject, please refer to the 'Transport and Storage' chapter.



Dangers can be caused by incorrect positioning

Ensure the machine is positioned for easy access to all its areas, while maintaining a minimum safety clearance of at least 30 cm, ensuring ample space around the machine.



Caution Regarding the Door

Avoid applying any force or weight to the machine's door, such as leaning on it, opening it abruptly, or slamming it shut. Always ensure that the door remains clear of contact with your feet or any other part of your body.

It's essential to be cautious around the plexiglass door, as it features sharp edges and corners that could potentially cause injuries or cuts.



Drawer Unit Handling

When removing the drawer unit, it's advisable to take it out of the machine in an upright position. The unit can be placed both upright and flat, but please exercise caution with the cables at the back of the unit – avoid pulling on these cables.

	Dangers from the fan of the compressor Make sure not to touch the fan of the compressor unit, positioned behind the condensator.
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	Dangers can be created by incorrect connection to the power source Failure to correctly connect electronic components may result in injuries. Ensure that no liquids enter the electronic area of the machine. Any work on the power supply system should be performed exclusively by licensed professionals. Regularly inspect the electronic system for functionality, and promptly replace any loose or burnt cables.
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	Ensure a precise alignment between the local voltage and the nominal voltage, as indicated on the type plate.
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	Ensure a consistent and stable electrical supply with minimal voltage fluctuations in the machine's operating area. If the current is not steady, consider implementing external current stabilizers for all phases compatible with the machine's power requirements. Be aware of the potential risk of electric shock when handling live components. In case of an electric shock, seek immediate medical attention and consult a doctor without delay.
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Danger from the cooling system

Frostbite risk exists when handling the cooling system. Always wear protective gloves, and refrain from touching the cooling system before, during, or after a freeze-dry cycle of the machine.



Danger from the refrigerant

Be aware of the potential risk of refrigerant poisoning when the air's concentration reaches unsafe levels. Only individuals with specialized training in coolant handling should perform any work on the cooling system. Additionally, exercise caution to prevent any movement or damage to the cooling system during machine operations, such as moving, opening, or closing. Furthermore, ensure that the room housing the machine is adequately ventilated to maintain a safe environment.



Danger from dangerous dry goods

Take precautions against potential poisoning or infections that may result from hazardous or toxic substances leaking from the dry goods. Shield yourself and your personnel from any contact with such substances while unloading and cleaning the machine, and adhere to necessary decontamination protocols.

Avoid the use of solvents containing explosive gaseous mixtures or acids to prevent the risk of injury.

Furthermore, be mindful that certain chemicals have the potential to etch or cause severe damage to various materials in the machine or vacuum pump, such as metals, acrylic, PTFE, viton, nitrile, rubber, silicone, and gaskets. It's advisable to have a trained chemist evaluate the risk of damage and determine the appropriate program based on the boiling point under vacuum for each enclosed chemical before operating the machine.

When working with chemicals, be alert to the possibility of vapors entering the vacuum pump and being released into the same room.

	There is a risk of toxic extraction water. Ensure that it is disposed of in an environmentally friendly manner and cannot become a hazard to the operating personnel.
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	Danger due to hot surfaces Be cautious of the elevated surface temperatures of the machine after the drying stage, which can lead to burns if touched. This includes the drawers within the machine, the exposed pipes of the cooling system, certain components of the compressor, and even the surface of the vacuum pump, all of which may become very hot.
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	Danger from cold surfaces Beware of the risk of extreme cold on the machine's surfaces during and after operation, as it can lead to frostbite if touched. Notably, the vacuum chamber, drawers, components at the rear of the machine (such as connectors), and the cooling system's piping may become extremely cold.
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	Danger due to a vacuum that has built up or is building up Severe injuries may result from contact with openings during vacuum buildup or when a vacuum has already been established. These openings can create suction forces due to temperature differences. Be especially cautious around the front door and any openings where body parts could become entangled. Avoid proximity to valves with limbs, such as the evacuation valve, which can open and close automatically, presenting a significant danger. In case of uncertainty about injury management, promptly call for an ambulance. Additionally, remember to replace the front machine seal (blue seal ring) annually.
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**General safety rules**

Refrain from leaning on or attempting to move the machine while it's in operation. If you encounter any malfunctions or detect unusual odors like burning materials or suspicious sounds, cease the machine's operation promptly.

Under no circumstances should you operate the machine if there is any damage to the plexiglas door, including cracks or dents, as this poses a risk of implosion.

To disconnect the power connection, ensure the machine's power connection control switch is set to the "0" or "Off" position.

Maintenance & Cleaning

The manufacturer cannot be held responsible for damages resulting from improper use or maintenance.

When transitioning to a different product, ensure thorough cleaning of the freeze dryer using soap or mild detergents, and make sure to clean it only when it is switched off.

For disinfection of the inner chamber, you may use diluted ethanol, isopropyl alcohol, or diluted hydrogen peroxide. Never employ aggressive chemicals like acetone, bleach, nitro, carbon tetrachloride, chlorine, petrol, or similar substances.

It's vital to avoid contact between alcohol and ethanol (in liquid or vapor form) with the acrylic door, as this can cause permanent damage, reduce transparency, and create small cracks that serve as breeding grounds for bacteria.

Regularly inspect the freeze dryer's general condition to promptly identify and address any potential issues, including:

- Leaks
- Corrosion
- Bent, dented, or cracked materials
- Loose or exposed cables
- Accumulated dirt
- Open components

Vacuum Pump

For comprehensive maintenance and safety guidelines pertaining to the operation of the pump, we recommend consulting the pump instruction manual.

When the oil becomes visibly contaminated, consider changing it promptly. In specific cases, this may be necessary after each drying cycle for certain products. It's advisable to perform the oil change while the pump is still warm for optimal results.

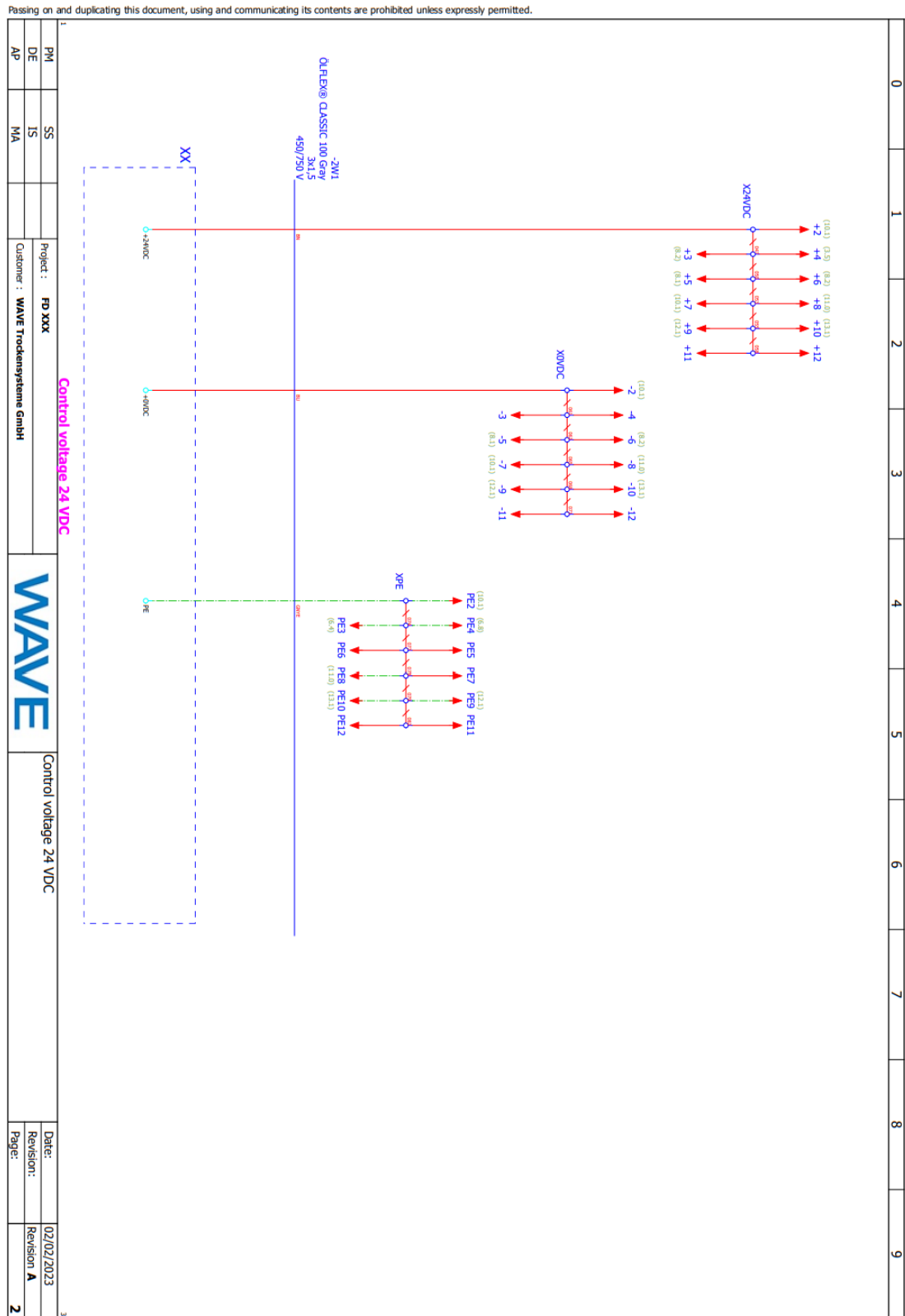
Cooling System

For in-depth maintenance insights and safety guidelines during operation, kindly review the pump's operating instructions. Additionally, please ensure compliance with national regulations governing the handling of cooling systems.

Quick Guide - 10 Steps

Check if the chamber is dry and defrosted	1	Check the pressure on statistics, if it below 300 mTorr and not moving for 3 to 4 hrs, you are good
Start the cooling system (control/ cooling system/manual on)	2	Make sure the material is at least at room temperature, if not heat to +25°C and continue then
Check the pump, check if oil is clean, close the valve on the pump	3	Close the valve at the pump
Check the manual and/or electric evacuation valves(s) / close them	4	Stop the cooling system
Check the door and ring for dirt - make sure its clean	5	Stop the pump
After about 15 minutes load the machine with your prefrozen material	6	Open the evacuation valve
Close the door	7	When the door plops, open the chamber and start packing one tray at a time
Start the pump, open the valve on the pump	8	Make sure the evacuation valve/drain valve is open to remove the water
Check if vacuum builds - if pressure reaches 700 m bar you are good	9	When the machine is empty, start the defrost or leave machine to defrost by itself
Start the production software	10	When the chamber is dry or you have removed the ice stop the defrost

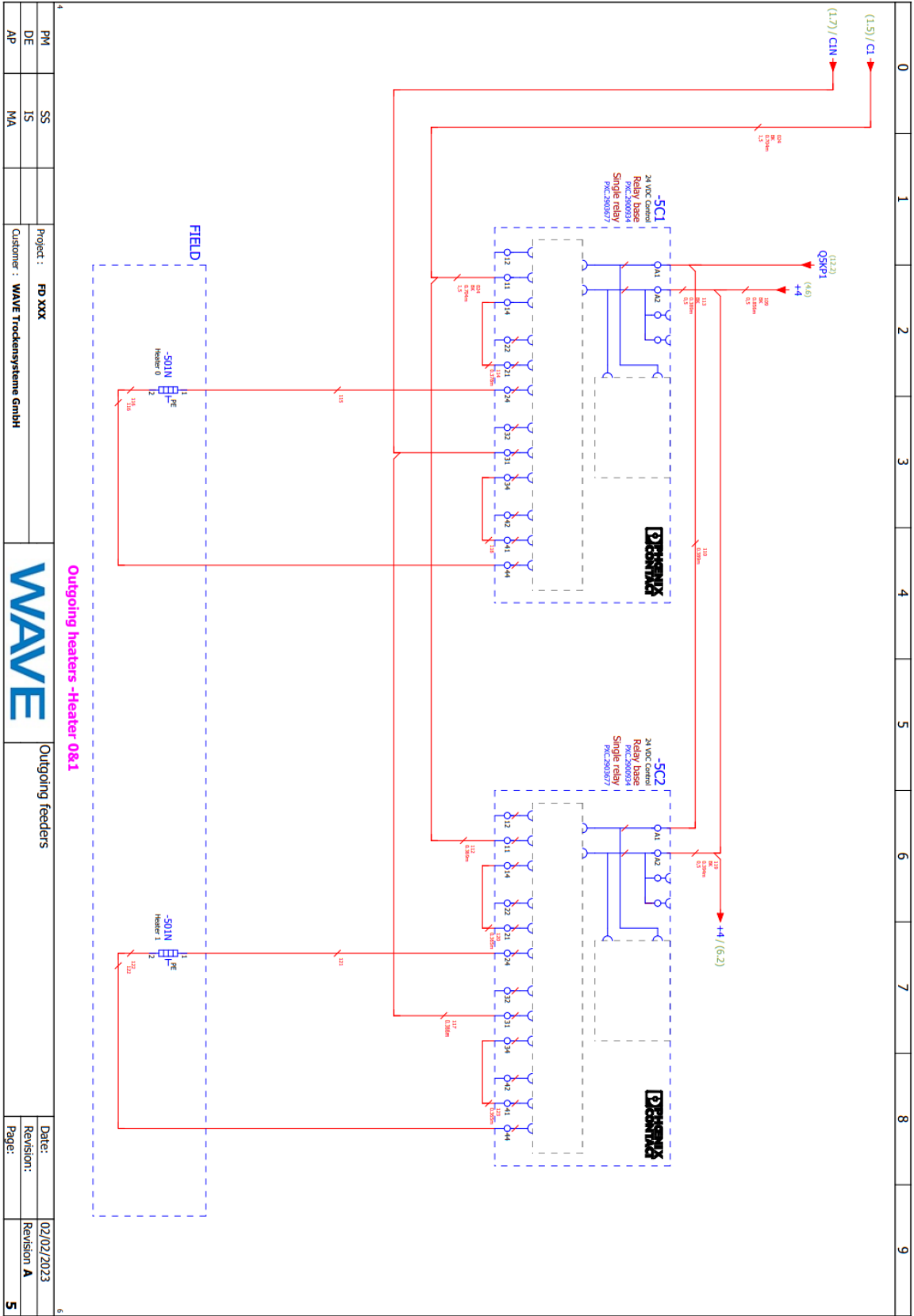
(The wiring may vary depending on the machine configuration)

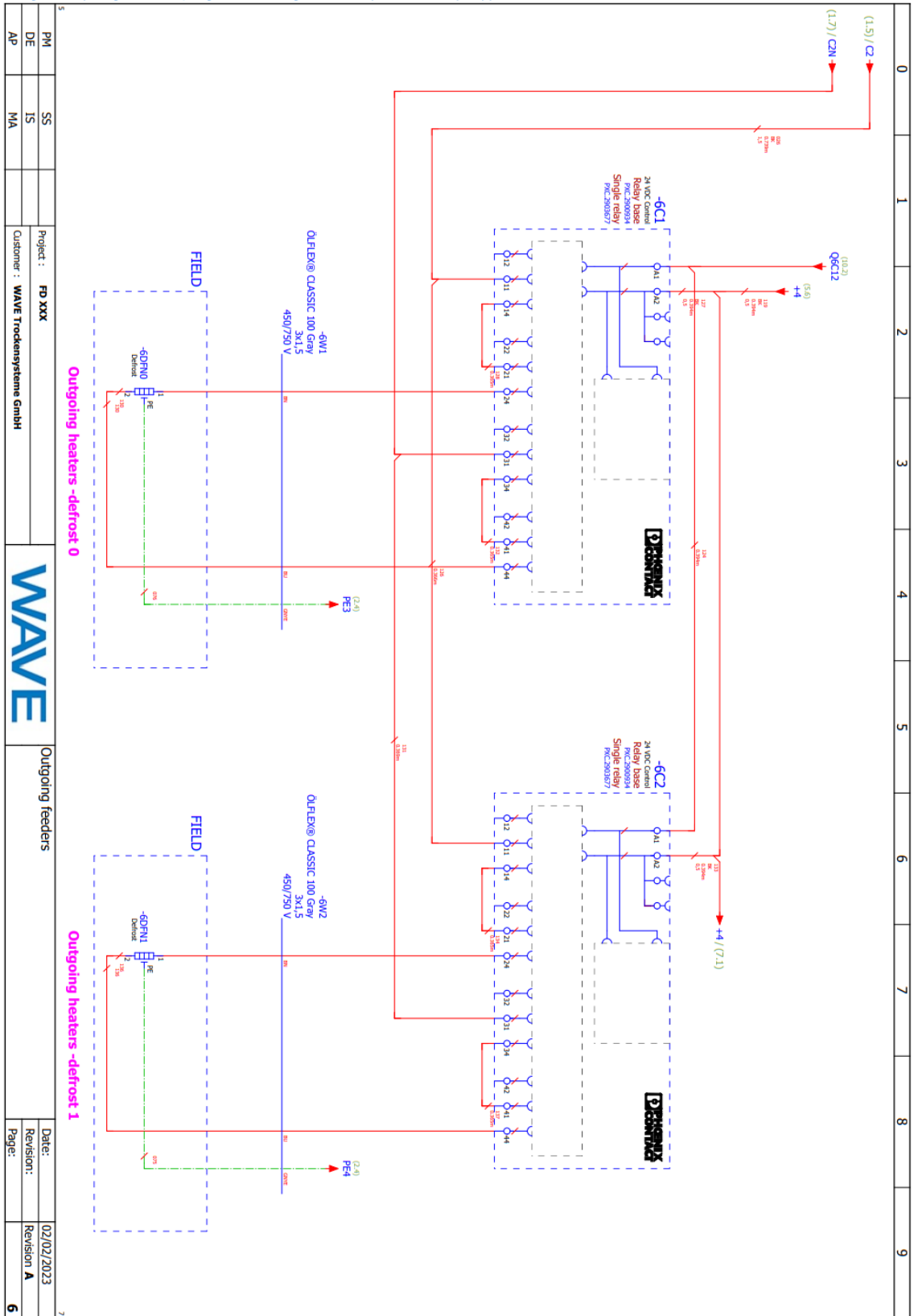




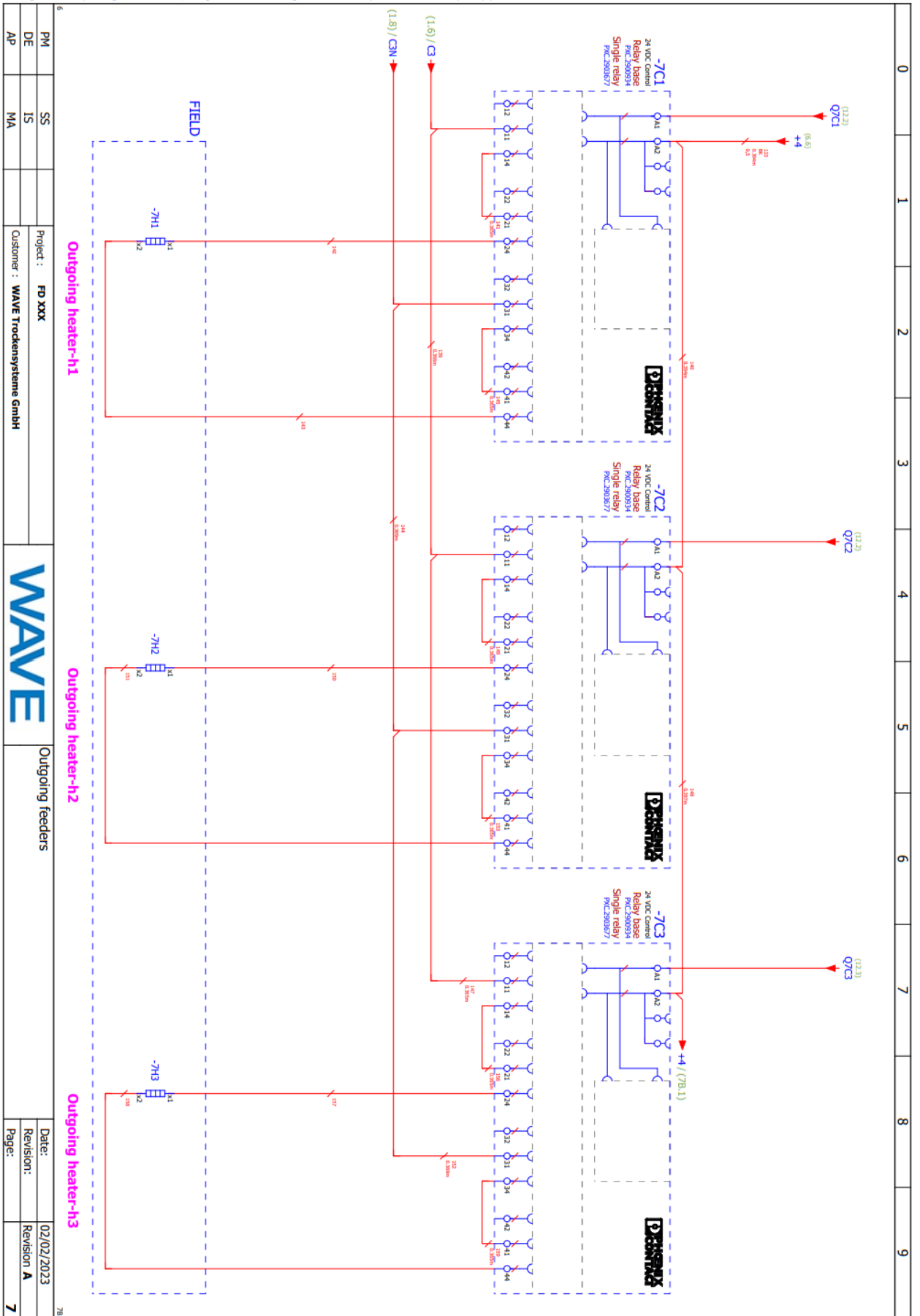


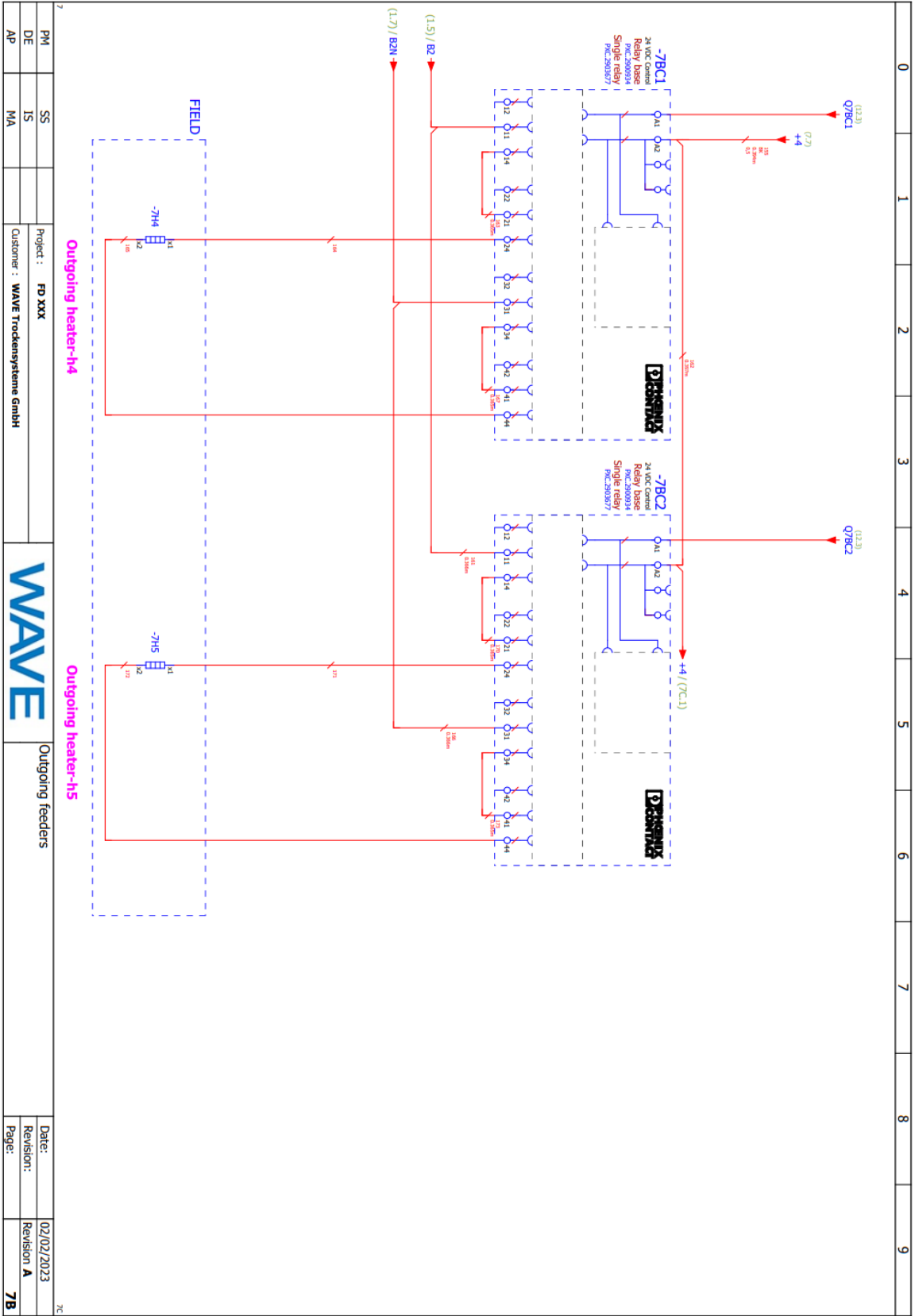


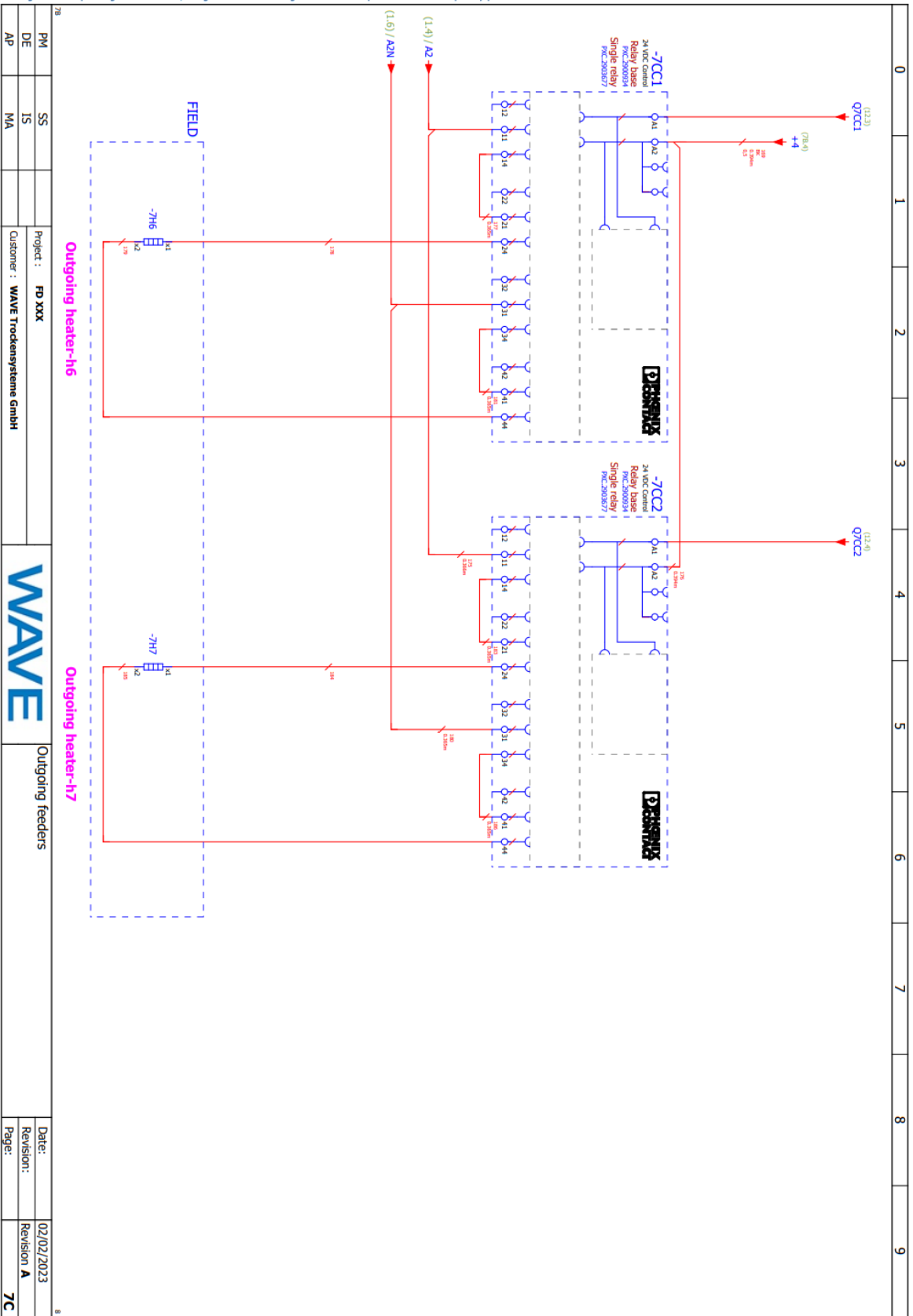


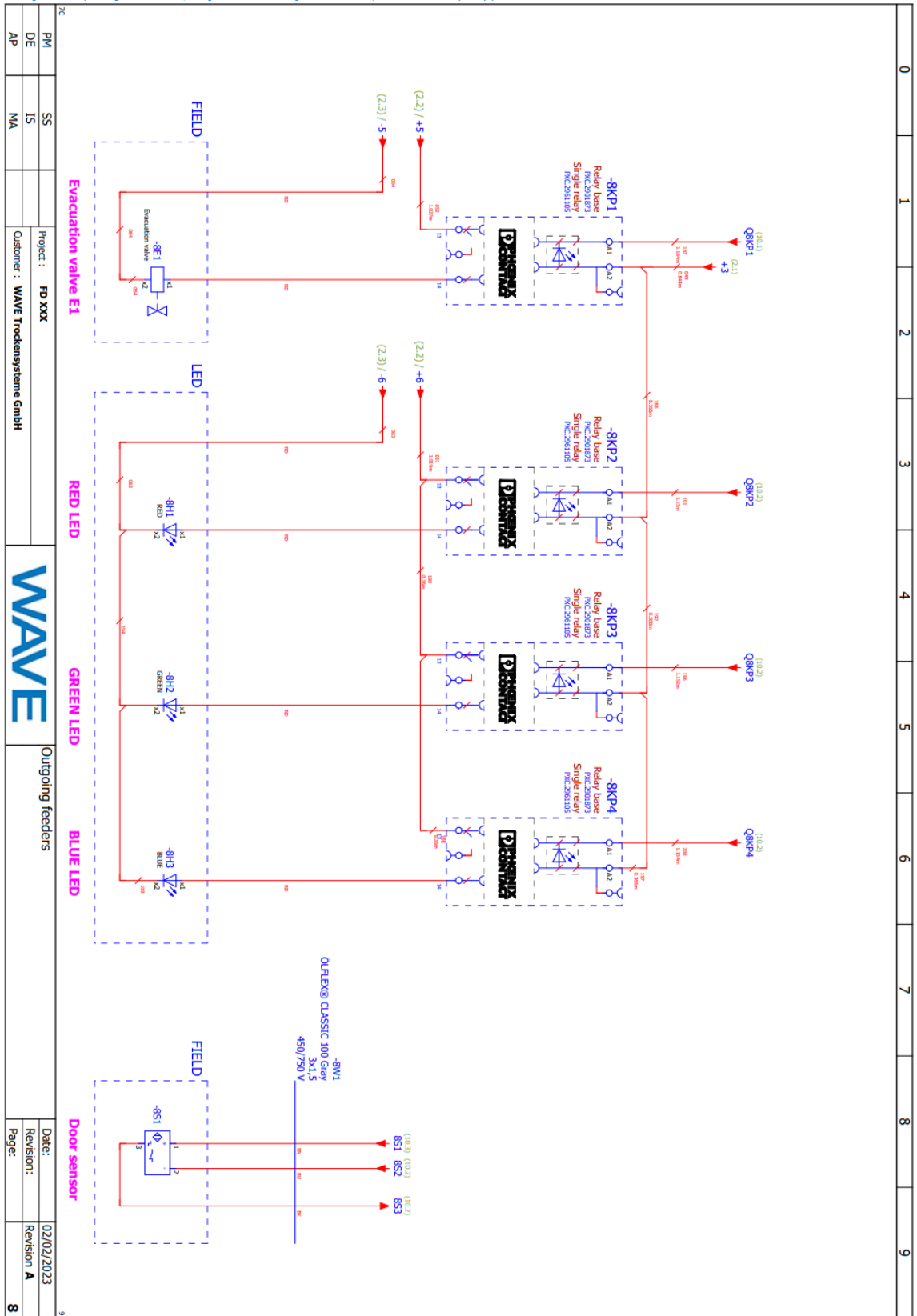


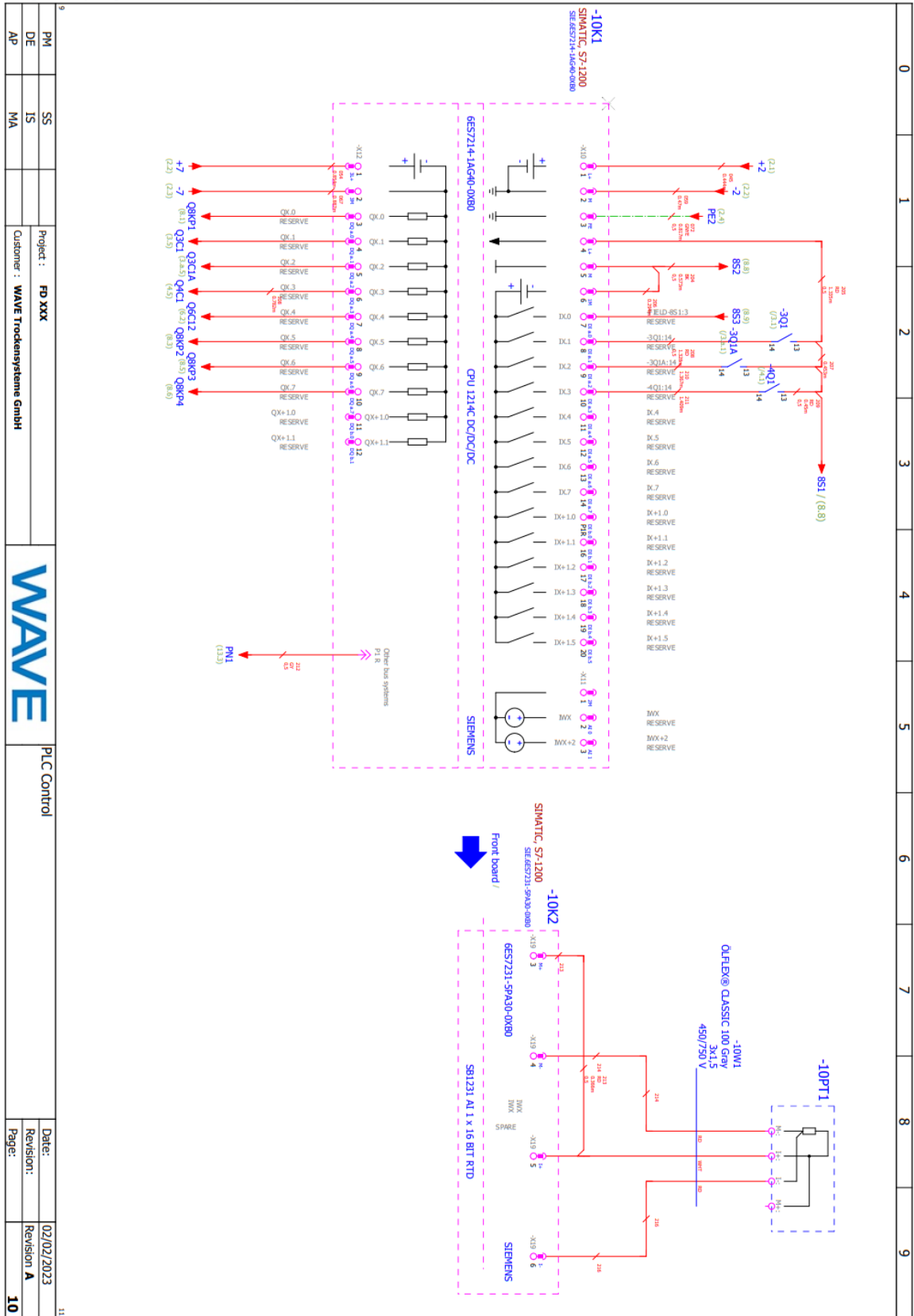














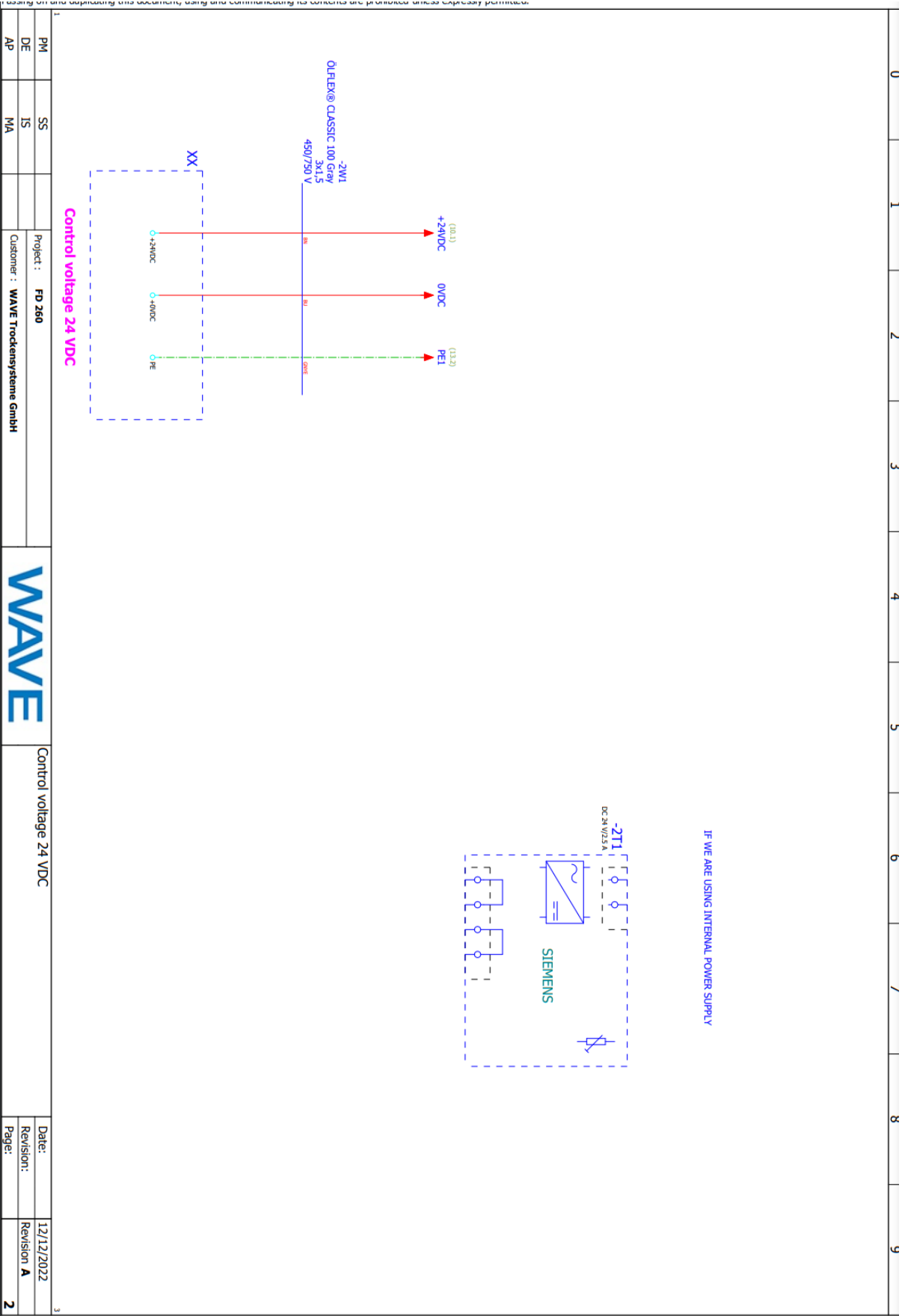


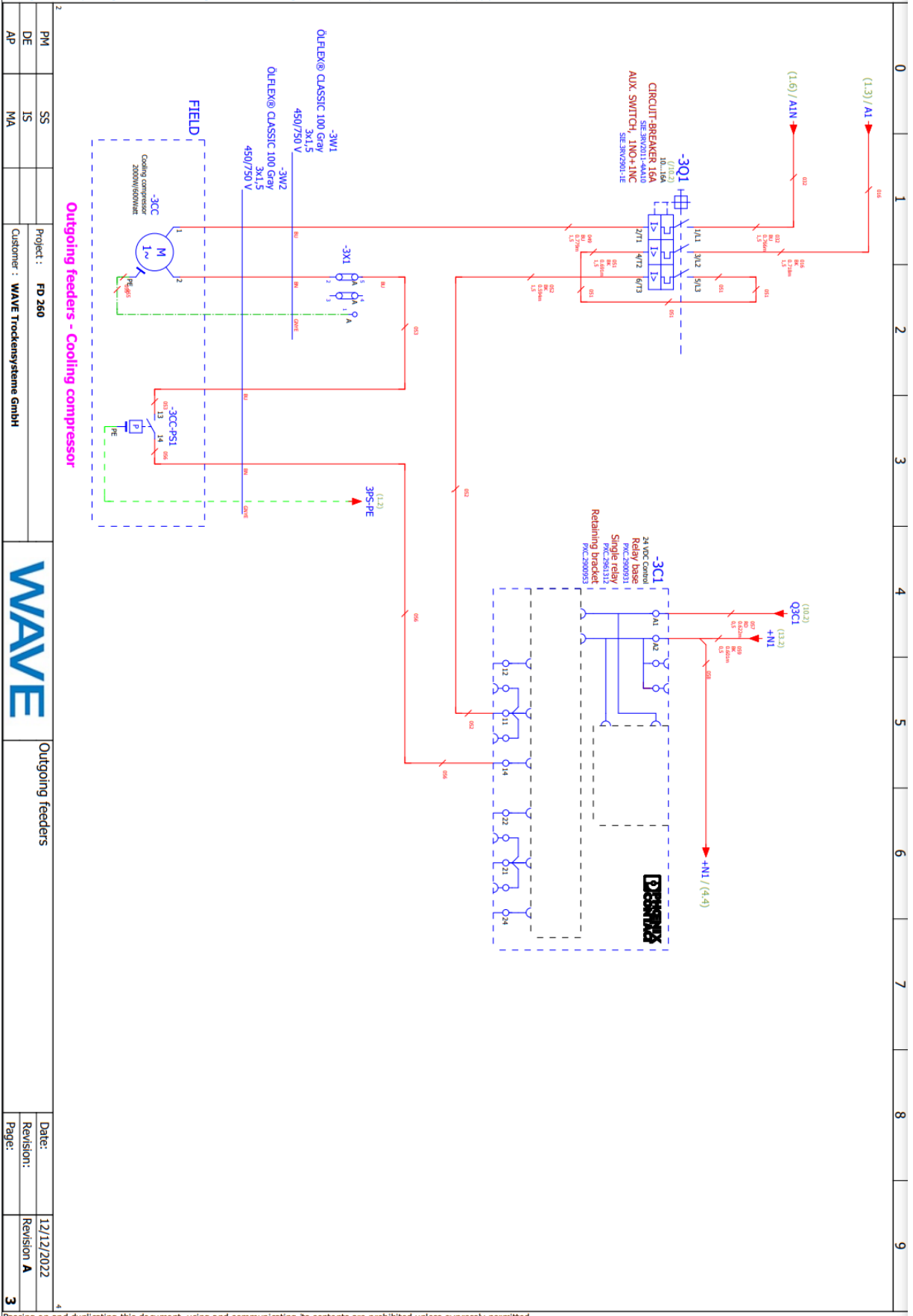
Passing on and duplicating this document, using and communicating its contents are prohibited unless expressly permitted.

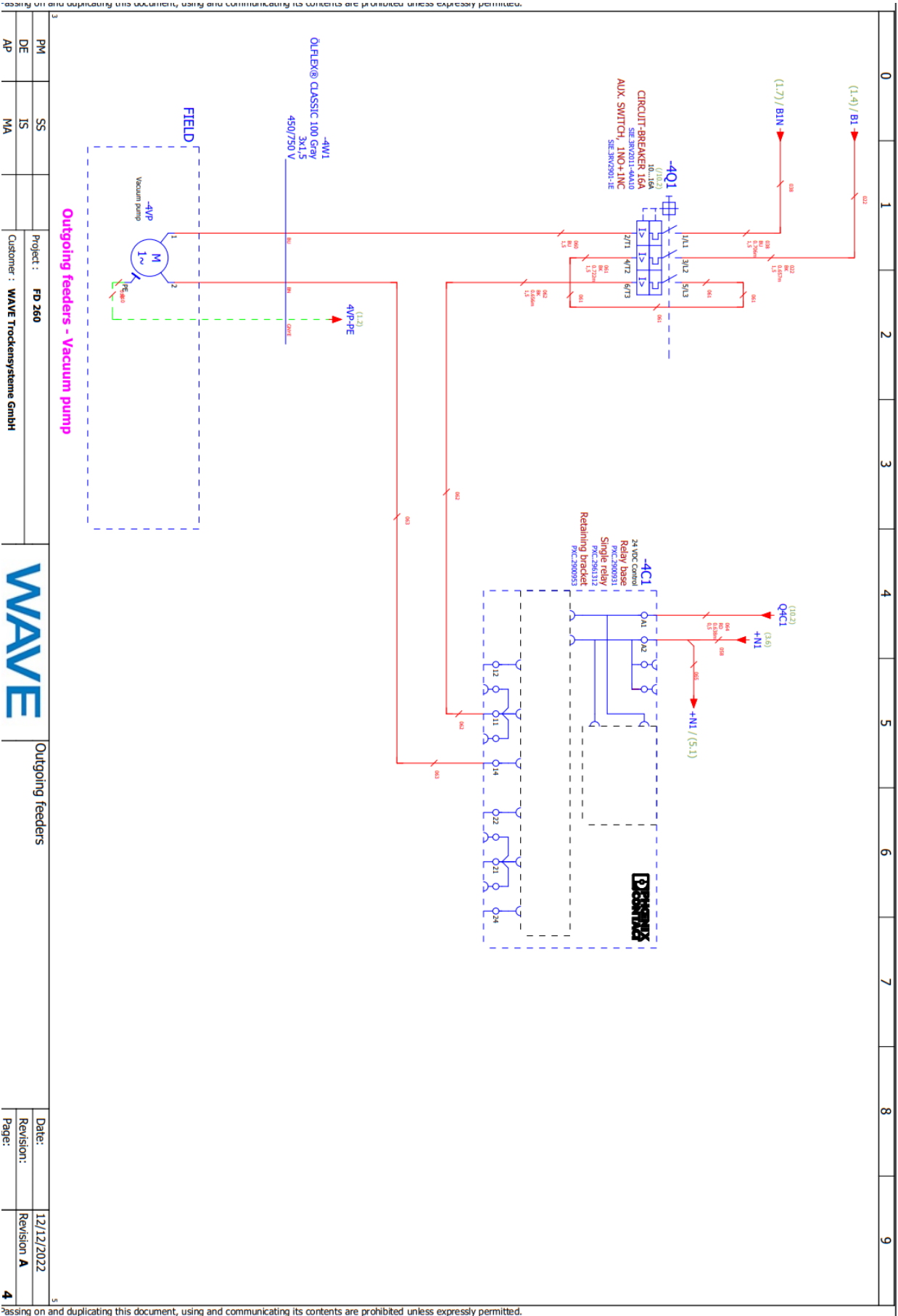
The diagram illustrates the internal wiring of a Siemens compact switch module. It shows the main power supply (L, N, PE) and the output lines (P1, P2, P3, P4). The module is connected to a 24V DC power source (2.5V / RE10) and a 24V AC source (2.3V / -10). The output lines are connected to a 24V AC source (2.2V / +10). The module is labeled '6ES7 317-1EX00-0AB0' and 'SIEMENS'.

57

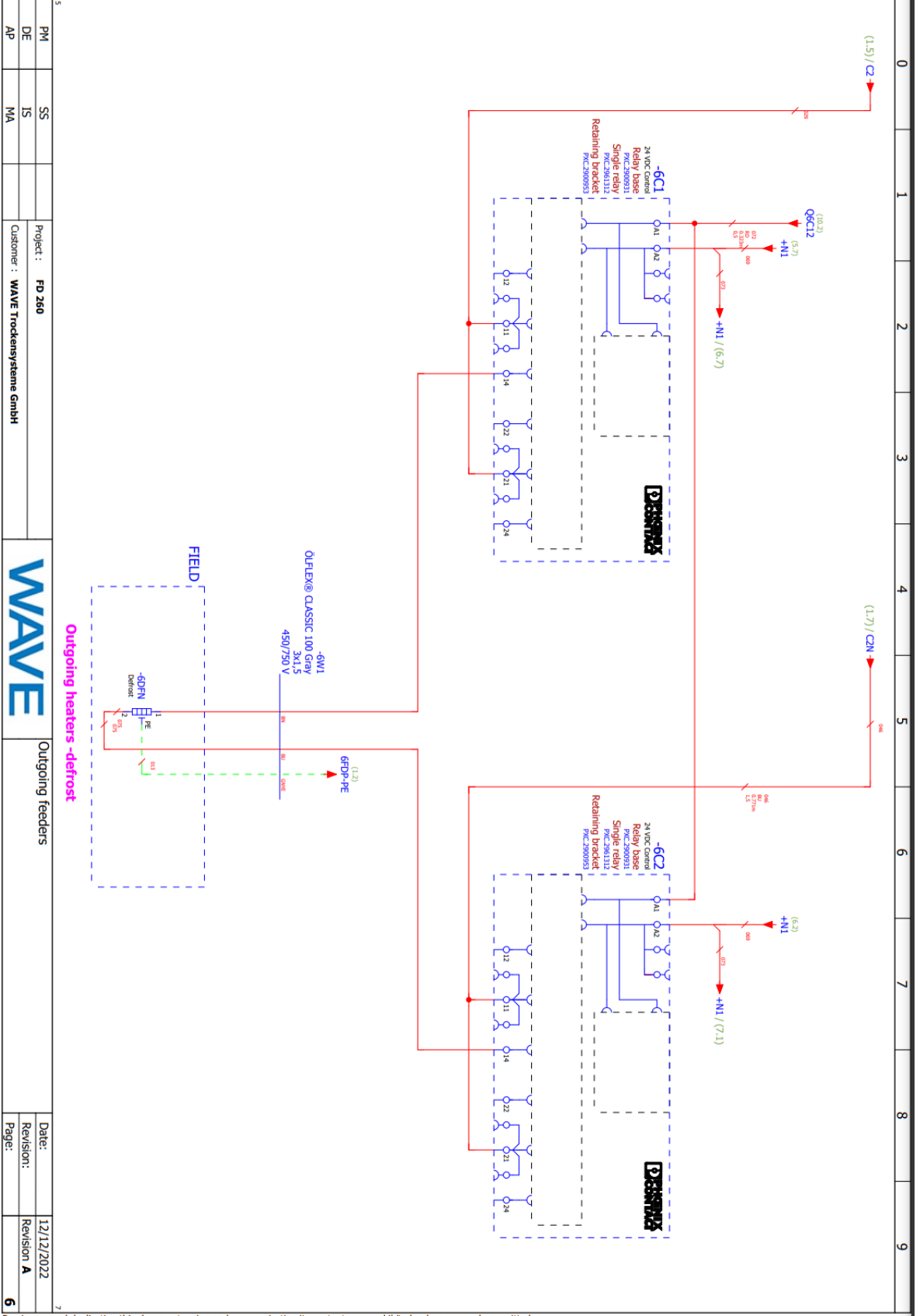






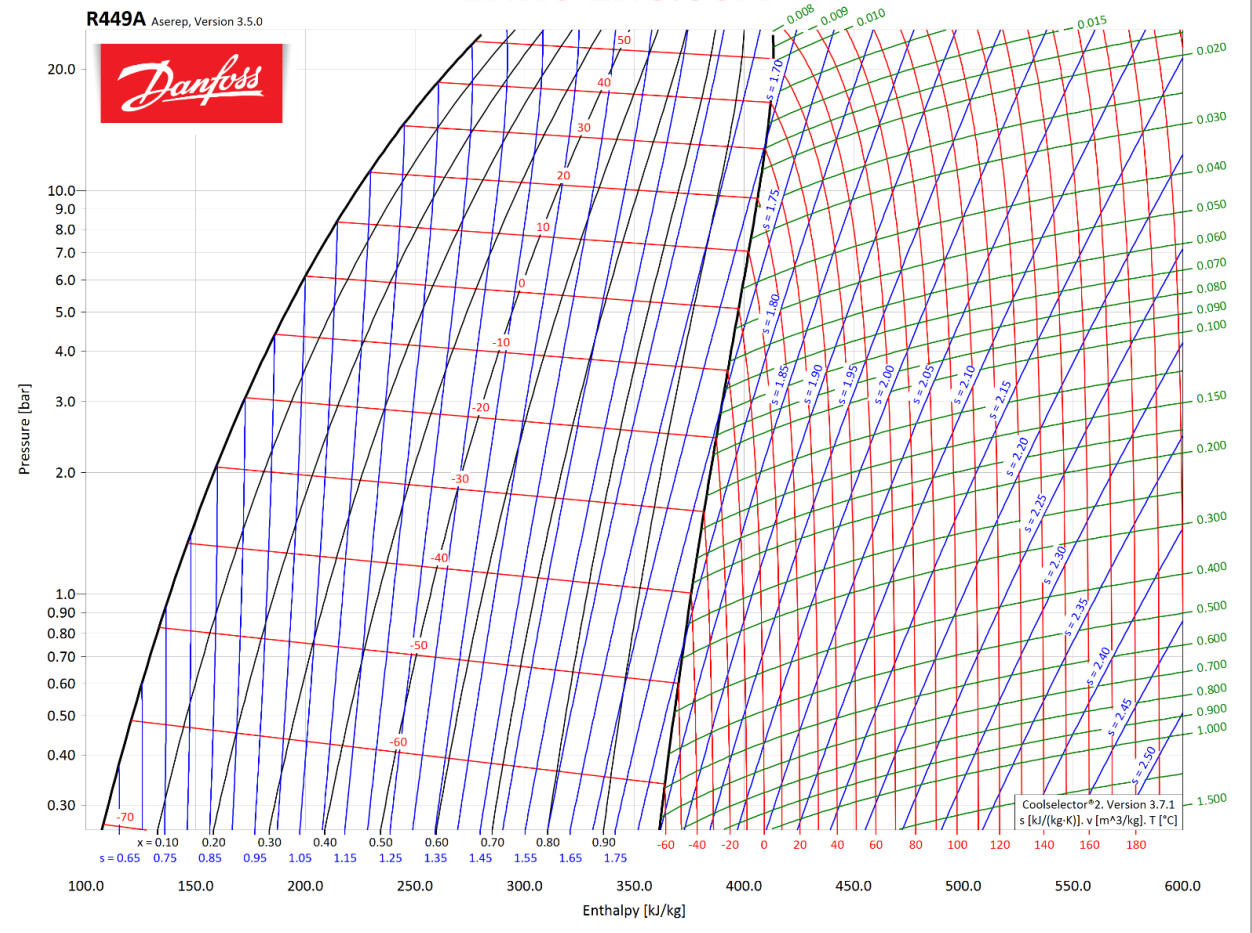






ENTHALPY CURVE FOR THE EMBRACO COMPRESSOR

HVAC-ENG.COM



Chamber Simulation of the WAVE FD440

(same applies to the FD260 chamber)

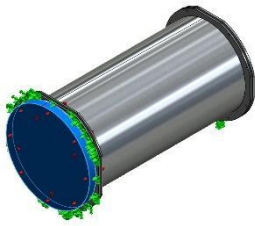
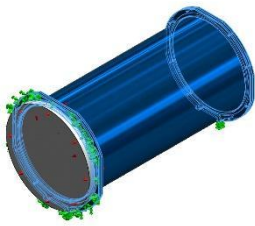
Study Properties

Study name	Static 1
Analysis type	Static
Mesh type	Solid Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SOLIDWORKS Flow Simulation	Off
Solver type	FFEPlus
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Friction	Off
Use Adaptive Method:	Off

Units

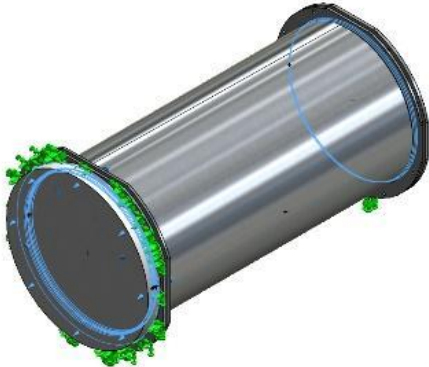
Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m ²

Material Properties

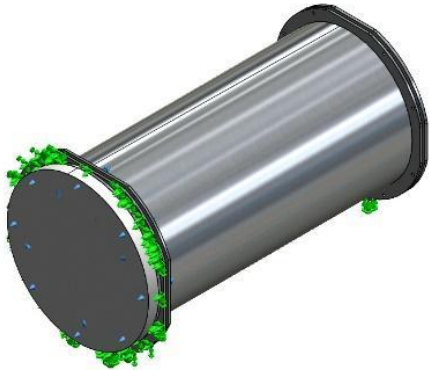
Model Reference	Properties	Components
	Name: PMMA Model type: Linear Elastic Isotropic Default failure criterion: Unknown Tensile strength: $6.1 \times 10^7 \text{ N/m}^2$ Compressive strength: $1.05 \times 10^8 \text{ N/m}^2$ Elastic modulus: $2.77 \times 10^9 \text{ N/m}^2$ Mass density: $1,190 \text{ kg/m}^3$	SolidBody 1 (Boss-Extrude1) (FD440_Chamber)
Curve Data:N/A		
	Name: 6061-T6 (SS) Model type: Linear Elastic Isotropic Default failure criterion: Max von Mises Stress Yield strength: $2.75 \times 10^8 \text{ N/m}^2$ Tensile strength: $3.1 \times 10^8 \text{ N/m}^2$ Elastic modulus: $6.9 \times 10^{10} \text{ N/m}^2$ Poisson's ratio: 0.33 Mass density: $2,700 \text{ kg/m}^3$ Shear modulus: $2.6 \times 10^{10} \text{ N/m}^2$ Thermal expansion coefficient: $2.4 \times 10^{-5} / \text{Kelvin}$	SolidBody 2 (Combine1) (FD440_Chamber)
Curve Data:N/A		

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details		
Fixed-1		Entities: Type: 10 face(s) Fixed Geometry		
Resultant Forces				
Components	X	Y	Z	Resultant
Reaction force(N)	-0.0654321	0.0910505	6,918.63	6,918.63
Reaction Moment(N.m)	0	0	0	0

Load name	Load Image	Load Details
Pressure-1		Entities: 13 face(s) Type: Normal to selected face Value: -101,324 Units: N/m² Phase Angle: 0 Units: deg

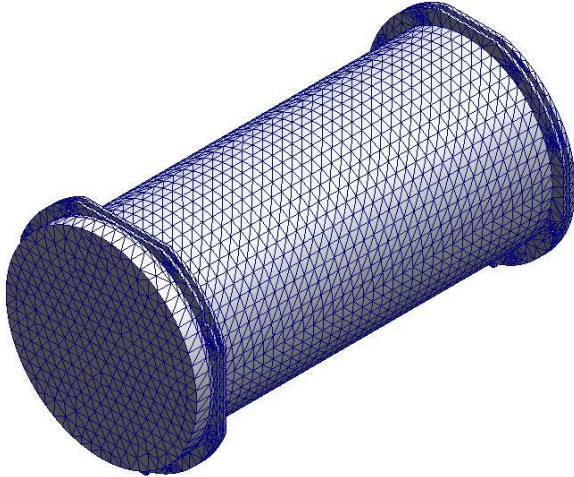
Contact Information

Contact	Contact Image	Contact Properties
Global Contact		Type: Components: Options: Bonded 1 component(s) Incompatible mesh

Mesh information

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points for High quality mesh	16 Points
Element Size	36.0283 mm
Tolerance	1.80141 mm
Mesh Quality	High

Mesh information - Details

Total Nodes	51625
Total Elements	26211
Maximum Aspect Ratio	29.125
% of elements with Aspect Ratio < 3	37
Percentage of elements with Aspect Ratio > 10	0.595
Percentage of distorted elements	0
	

Reaction forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	-0.0654321	0.0910505	6,918.63	6,918.63

Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	0	0	0	0

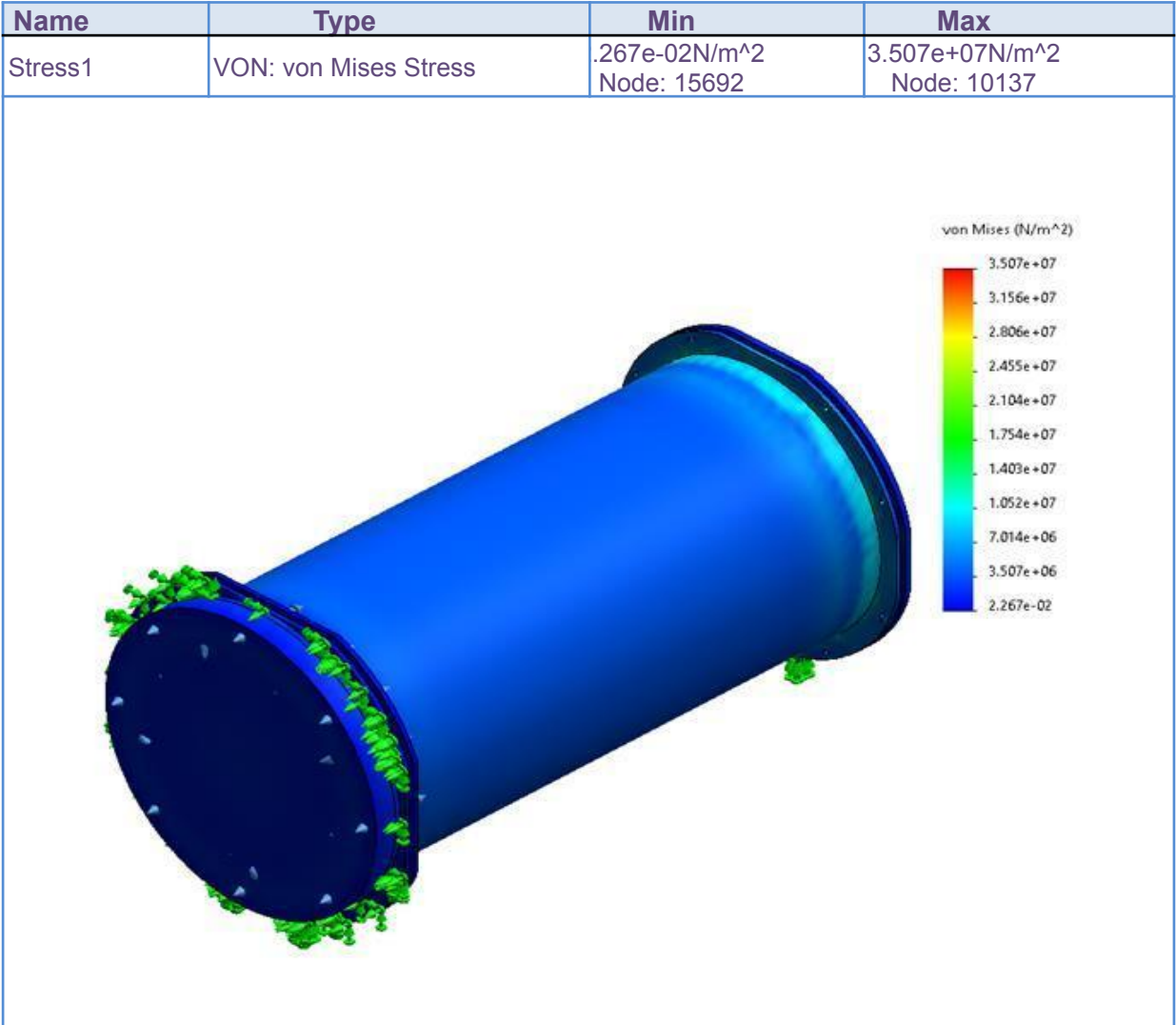
Free body forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	-62.3245	-46.683	17.8777	79.8953

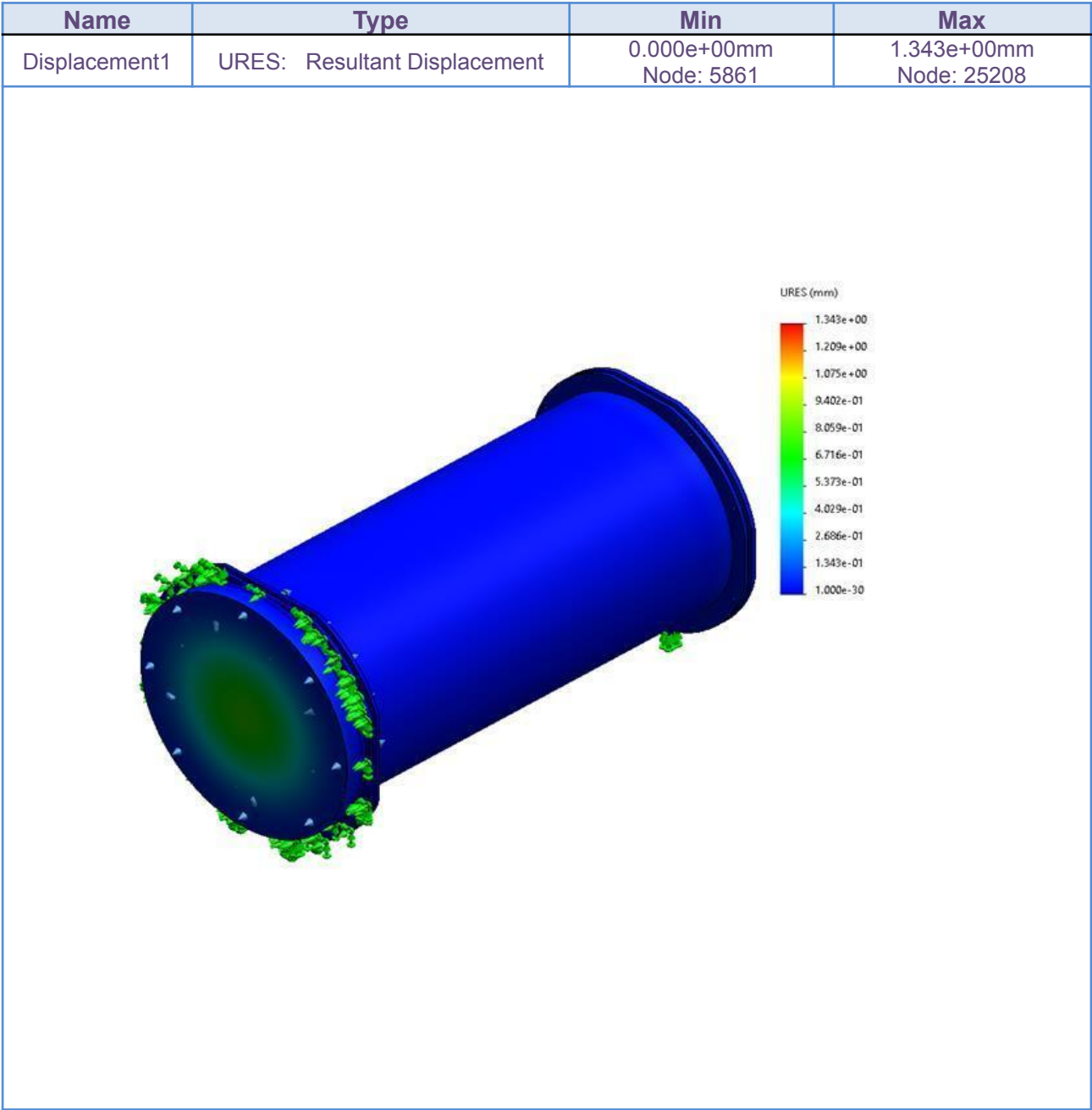
Free body moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	0	0	0	1e-33

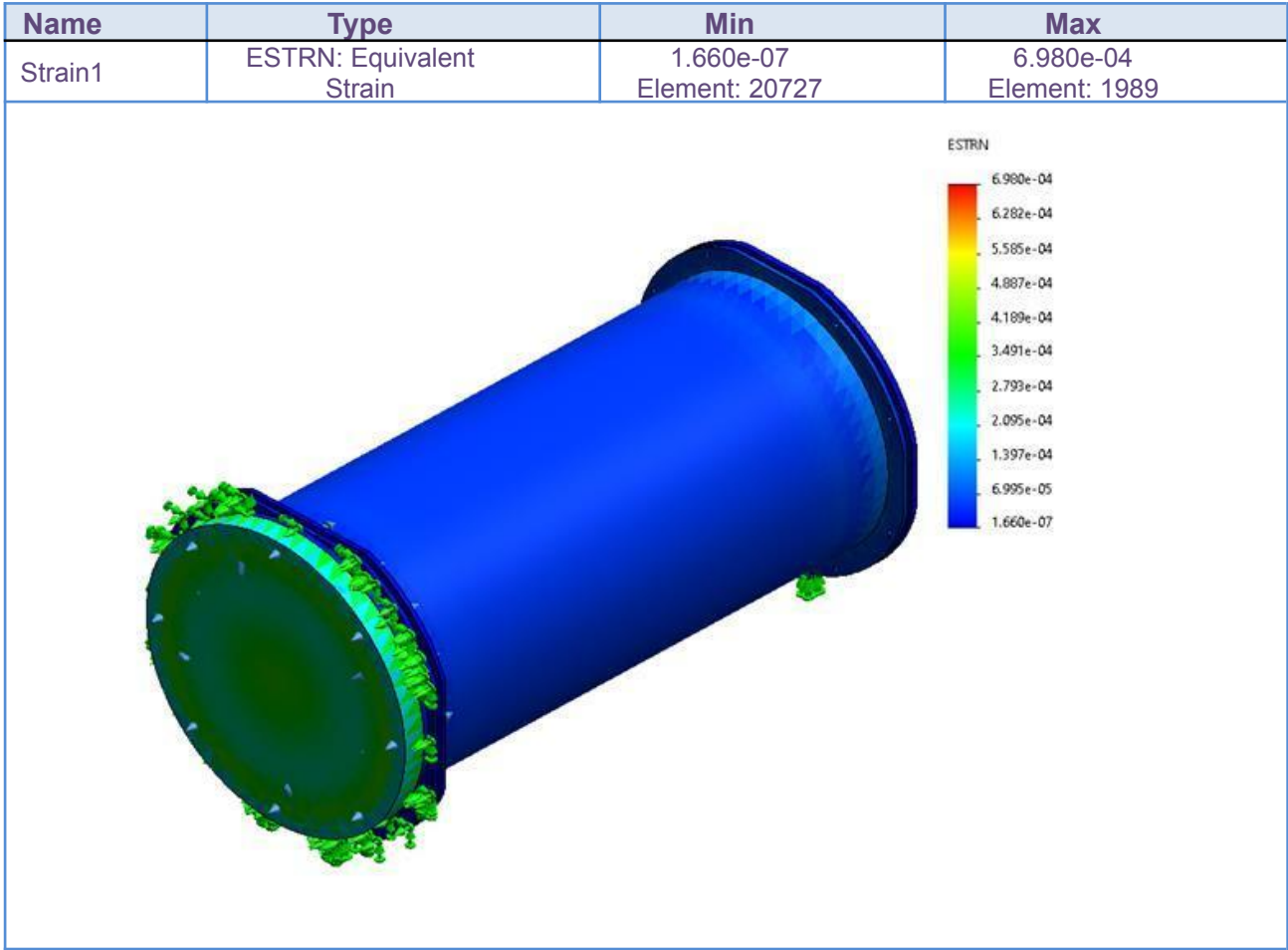
Study Results



FD440 Chamber-Static 1-Displacement-Displacement1

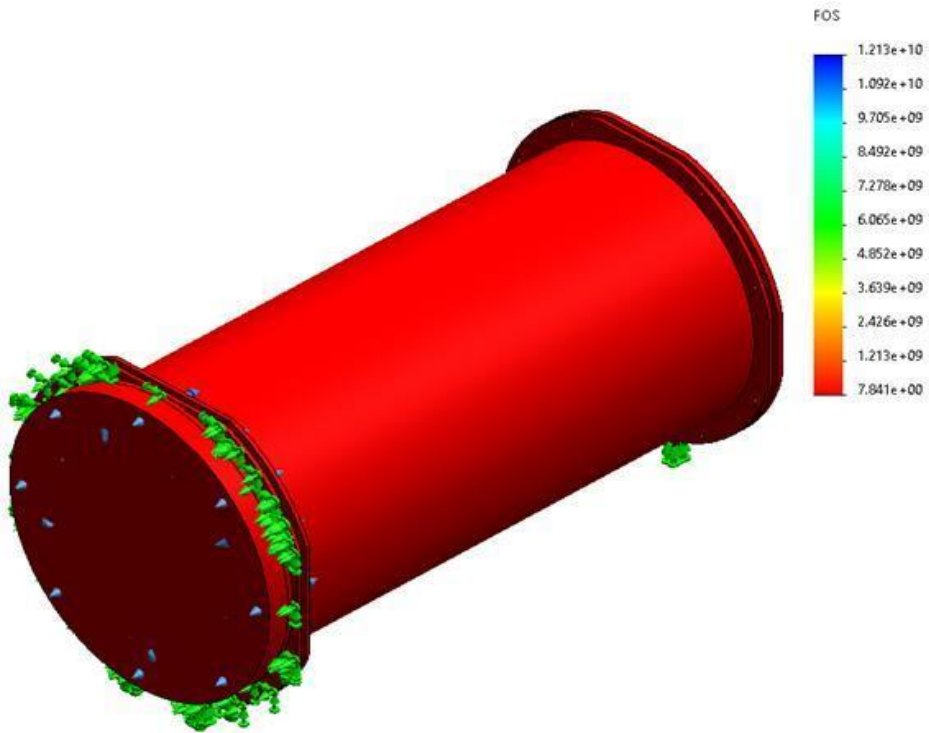


FD440 Chamber-Static 1-Strain-Strain1



FD440 Chamber-Static 1-Factor of Safety-Factor of Safety1

Name	Type	Min	Max
Factor of Safety1	Automatic	7.841e+00 Node: 10137	1.213e+10 Node: 15692

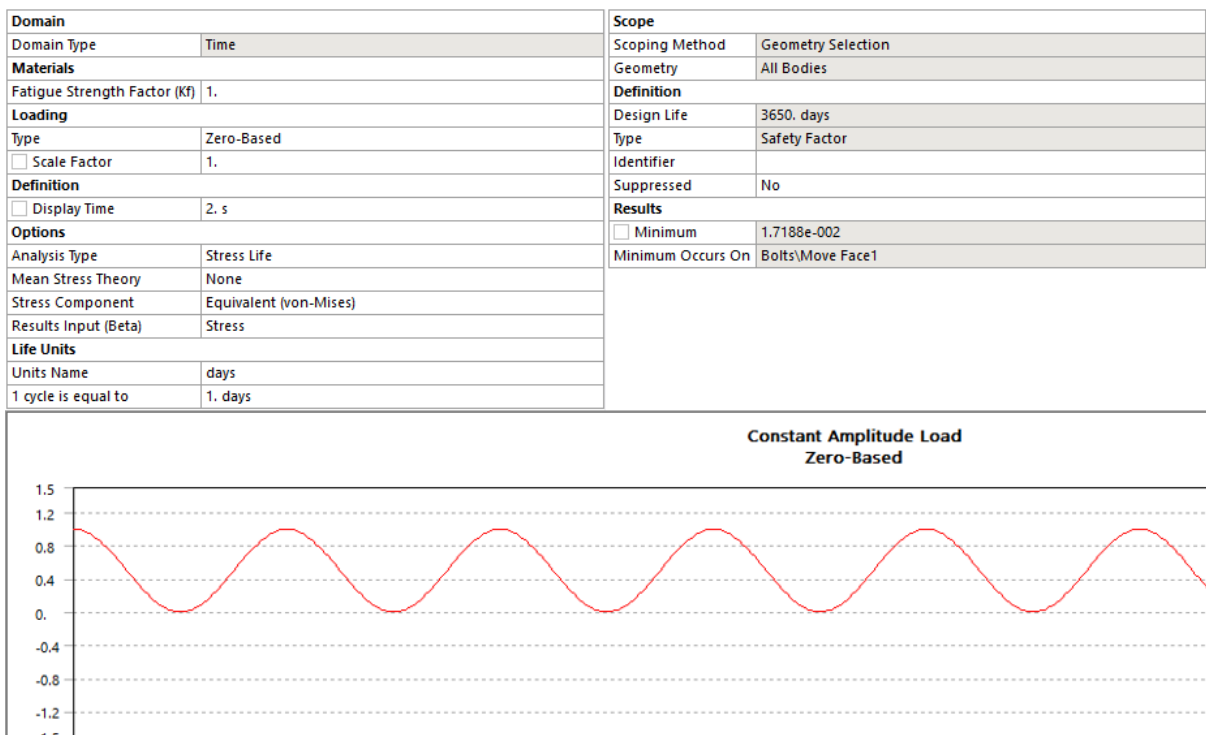


Conclusion: Ok

Fatigue Assessment of the chambers:

Introduction

The chamber's fatigue assessment involves a rigorous testing regimen. The chamber undergoes cyclic transitions, starting from 1 bar down to 0.01 mBar, along with temperature fluctuations from 20°C to -40°C. After a 24-hour period, it returns to ambient conditions and ascends to 60°C, before reverting to 20°C, and this cyclic process repeats. Notably, the most significant stress and deformation occur during the second step when the temperature reaches -40°C, and the pressure drops to 0.01 mBar. The fatigue assessment encompasses a ten-year evaluation, equivalent to 3,650 cycles of this rigorous testing procedure.

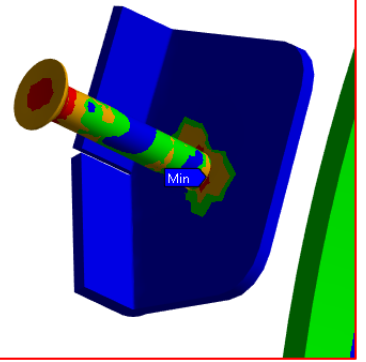
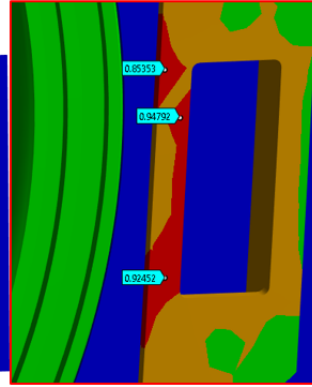
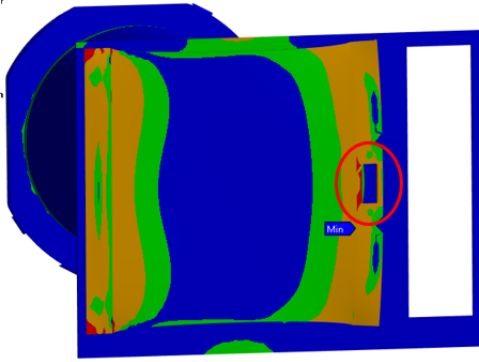


Fatigue findings

The safety reserve factor falls below one, particularly evident in regions near the door supports and bolt holes. These critical areas experience heightened stress, primarily due to the extreme temperature of -40°C. For comprehensive insights into the stress and fatigue evaluation, please refer to the accompanying presentation for further details.

Safety Factor
Type: Safety Factor
18.04.2023 1:02

15 Max
10
5
1
0.021476 Min
0



Recommended Vacuum Oil for Oil Pumps



EDWARDS **ULTRAGRADE 19** (best option)
EDWARDS **ULTRAGRADE 20**



PETRO CANADA **SUPER VAC Fluid 19** (best option)
PETRO CANADA **SUPER VAC Fluid 20**

Links for Replacement Relais

FOR MACHINES EQUIPPED WITH PHOENIX RELAIS



Wave recipes for various materials

GENERAL FRUITS

Strawberry, Mango, Raspberry, Kiwi, Dragonfruit

IN PCS TO MAX 6mm thick (prefreeze to -25°C)

Stage 1	3 hrs	-10°C	800 mTorr
Stage 2	3 hrs	0°C	800 mTorr
Stage 3	3 hrs	+10°C	800 mTorr
Stage 4	3 hrs	+20°C	800 mTorr
Stage 5	30 hrs	+40°C	600 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

Pineapple: cut vertical pieces from top to bottom in order to cut through the fibers.

Blueberry: difficult to dry, we recommend to cut them or pinch them or alternatively make a smoothie, freeze and dry the smoothie to get a fruitcake.

GENERAL FRUITS

Strawberry, Mango, Raspberry, Kiwi, Dragonfruit

IN PCS TO MAX 30 mm thick (prefreeze to -25°C)

Stage 1	5 hrs	-10°C	800 mTorr
Stage 2	5 hrs	0°C	800 mTorr
Stage 3	5 hrs	+10°C	800 mTorr
Stage 4	5 hrs	+20°C	800 mTorr
Stage 5	60 hrs	+40°C	500 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

RASPBERRY HIGH QUALITY (prefreeze to -25°C)

Stage 1	6 hrs	-10°C	800 mTorr
Stage 2	4 hrs	0°C	800 mTorr
Stage 3	4 hrs	+10°C	800 mTorr
Stage 4	4 hrs	+20°C	800 mTorr
Stage 5	30 hrs	+40°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

ALGEE (prefreeze to -25°C)

Stage 1	3 hrs	-10°C	800 mTorr
Stage 2	3 hrs	0°C	800 mTorr
Stage 3	3 hrs	+10°C	800 mTorr
Stage 4	3 hrs	+20°C	800 mTorr
Stage 5	30 hrs	+40°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

CANDY no prefreezing necessary

Stage 1	4 hrs	+70°C	600mTorr
----------------	-------	-------	----------

Material is done when pressure is steady for 2 Hrs below 200mTorr

Make sure to place baking paper below and on top material to avoid it to stick to the machine.

CANNABIS (prefreeze to -25°C)

Stage 1	3 hrs	-10°C	1200 mTorr
Stage 2	3 hrs	0°C	1200 mTorr
Stage 3	3 hrs	+10°C	1200 mTorr
Stage 4	3 hrs	+20°C	1200 mTorr
Stage 5	30 hrs	+25°C	1200 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

CANNABIS (fresh/ unfrozen)

Stage 1	3 hrs	+ 10°C	1200 mTorr
Stage 2	3 hrs	+ 15°C	1200 mTorr
Stage 3	3 hrs	+ 20°C	1200 mTorr
Stage 4	3 hrs	+ 25°C	1200 mTorr
Stage 5	8 hrs	+ 35°C	1200 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

COFFEE (prefreeze to -25°C)

Stage 1	5 hrs	+10°C	800 mTorr
Stage 2	5 hrs	+20°C	800 mTorr
Stage 3	30 hrs	+60°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

We recommend to use a maximal thickness of 15 mm per tray.

FISH, SHRIMP

IN PCS TO MAX 20 mm thick (prefreeze to -25°C)

Stage 1	3 hrs	-10°C	800 mTorr
Stage 2	3 hrs	0°C	800 mTorr
Stage 3	3 hrs	+10°C	800 mTorr
Stage 4	3 hrs	+20°C	800 mTorr
Stage 5	30 hrs	+40°C	600 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

HERBS, BASIL etc. (preefreeze or fresh)

Stage 1	3 hrs	+ 10°C	1200 mTorr
Stage 2	3 hrs	+ 15°C	1200 mTorr
Stage 3	3 hrs	+ 20°C	1200 mTorr
Stage 4	3 hrs	+ 25°C	1200 mTorr
Stage 5	8 hrs	+ 35°C	1200 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

Herbs can also be dried without prefreezing, just using fresh plants.

HONEY Mix with water first: 10% honey/ 90% water (prefreeze to -30°C)

Stage 1	10 hrs	-10°C	1500 mTorr
Stage 2	10 hrs	0°C	1500 mTorr
Stage 3	10 hrs	+10°C	1500 mTorr
Stage 4	10 hrs	+20°C	1500 mTorr
Stage 5	30 hrs	+30°C	1500 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

Difficult to dry, times may be much longer than indicated.

Make sure to place baking paper below and on top material to avoid it to stick to the machine.

MEALS (prefreeze to -25°C)

Stage 1	5 hrs	+10°C	800 mTorr
Stage 2	5 hrs	+20°C	800 mTorr
Stage 3	30 hrs	+40 to 50°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

We recommend to use a maximal thickness of 30 mm per tray.

Try to use as little fat as possible, ideally below 10%.

MILK, JUICES, (prefreeze to -25°C)

Stage 3	7 hrs	+10°C	800 mTorr
Stage 4	7 hrs	+20°C	800 mTorr
Stage 5	30 hrs	+40°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

We recommend to use a maximal thickness of 15mm per tray.

MUSHROOMS (fresh/ unfrozen)

Stage 1	3 hrs	+10°C	800 mTorr
Stage 2	3 hrs	+20°C	800 mTorr
Stage 3	10 hrs	+40°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

Alternatively it can also be dried without prefreezing, just using fresh mushrooms.

POTATO (fresh/ unfrozen)

Stage 1	3 hrs	+10°C	800 mTorr
Stage 2	3 hrs	+20°C	800 mTorr
Stage 3	20hrs	+40°C	800 mTorr

Material is done when pressure is steady for 2 Hrs below 200mTorr

Alarms, Warnings & Troubleshooting

ALARM 1:

The CPU or PLC module is faulted

Check 1: Examine all cables on the CPU module (located on the top-left of the PLC) to ensure they are correctly attached and secure.

Check 2: Verify that all Simatic units remain firmly connected to each other, especially checking the horizontal connections between modules. If you notice any gaps between modules, gently press them together to establish a secure connection.

Check 3: Ensure that the sensors are properly connected, inspect for any loose cables, and be on the lookout for red indicator lights next to the sensors, as they signal potential issues with the sensor connections.

ALARM 4:

CPU execution time fault

Requires intervention by the Wave service team

ALARM 5:

Chamber temperature sensor fault

Check 1 if the sensor on the CPU is attached correctly

Check 2 if the sensor cable is connected properly inside the analog Siemens Simatic module

Check 3 if the cable itself is damaged inside the chamber or outside the chamber leading to the PLC box

ALARM 6 to 17

Temperature sensor fault in drawers 1 to 12

Check 1: Examine the sensor connections to the PLC, which are located on the analog module (the second module from the left on the highest level).

Check 2: Inspect the cables leading to the feedthrough at the chamber for any signs of damage.

Check 3: Within the chamber, assess the cable from the feedthrough to the drawer-unit for any damage.

Check 4: Evaluate the sensors inside the mats, looking for any visible damage, such as tears or openings in the mats.

ALARM 18:

Vacuum sensor fault

Check 1: Inspect the connections of the cables leading from the sensor at the PLC. (These cables are located on the upper left level, above the CPU.)

Check 2: Ensure that the cable is correctly and securely attached to the sensor, including proper screw connections.

Check 3: Be aware that extremely low sensor temperatures may trigger an alarm. Check for the absence of condensation or ice on the sensor and confirm that it remains connected.

Check 4: Remove the sensor to check for any dirt or contaminants.

Check 5: If needed, clean the sensor by removing it and using 99.99% alcohol for cleaning. Fill the sensor completely with alcohol, empty it, and repeat this process up to three times. Allow the sensor to dry for several hours before attempting to obtain accurate readings.

Check 6: If your unit is equipped with a Thyracont sensor, follow this procedure: power on the machine, remove the two rubber closures on top of the sensor, and press the "ADJ" button for approximately 10 seconds to calibrate the sensor to atmospheric pressure.

(For powder drying, we recommend utilizing a manual slow evacuation module to prevent sensor contamination.)

ALARM 19:

Compressor motor fault

Check 1: Restart the compressor manually via the control board.

Check 2: Reset the motor breaker in the PLC by first turning it fully to the left, then to the right, and finally, switch it back to the "on" position.

Check 3: Halt the machine's operation and then restart it.

Check 4: Pause the machine and replace the compressor relay.

Check 5: If your machine features a pressostat, the compressor may fail without triggering the motor breaker. In such cases, please get in touch with the Wave team for assistance.

ALARM 20:

Vacuum pump fault

Check 1: Manually restart the pump from the control menu.

Check 2: Reset the motor breaker in the PLC by turning it all the way to the left, then to the right, and switch it back to the "on" position.

Check 3: Verify if the pump is set to manual "off" in the control section on the touch screen.

Check 4: Confirm the pump's connection to the machine's electricity supply.

Check 5: Halt the machine's operation and then restart it.

Check 6: Pause the machine and replace the pump relay.

Check 7: Ensure that the manual button on the pump itself is set to "on."

ALARM 21:

Vacuum pump stopped due to inability to create a vacuum.

TROUBLESHOOT 21:

The Machine fails to achieve a high vacuum.

Check 0: The chamber must always be at least at -20°C when trying to achieve a vacuum; otherwise, water will enter the pump and prevent proper vacuum achievement.

Check 1: Whether the evacuation valve is closed in the manual option in the control menu.

Check 2: Whether the evacuation valve is closed properly and is not clogged with dirt.

Check 3: Whether the pump is connected correctly, and all connections are closed.

Check 4: Whether the oil level is sufficient; it should be at least at the lower level of the oil gauge of the pump.

Check 5: Whether the oil is clear and clean. If not, change the oil and replace it with fresh oil, using only Edwards 19 or compatible oil to Edwards "19."

Check 6: Whether the door is properly closed, and both rings are free of dirt.

Check 7: Whether the vacuum sucks the door to the outer ring when the vacuum is started. Otherwise, adjust the door screws using rings to bring the door closer to the 2 blue rings. This is done by removing either the special steel part on the right side bar of the acrylic door from the special steel part on the left side

and then placing steel washers between the special steel and the acrylic glass door.

Check 8: The load in the chamber. If the maximum capacity of 25 kg for FD260 or 60 kg for FD440 is exceeded, it will be difficult to achieve a vacuum, especially with porous, powdery, or large-surface material.

Check 9: The temperature of the material in the chamber; the initial temperature should not exceed -20°C. Make sure your material is completely frozen and has not melted during the loading process.

Check 10: Whether the ballast on the pump is open; let it run for at least one hour after opening; if there is moisture in the chamber, this will correct the problem.

(To check if the vacuum problem is in the chamber or a problem with the pump, run the pump for about 30 minutes, then close the valve on the pump and stop the pump. After 10 minutes, an empty chamber at -20°C should not lose more than 700 mTorr of pressure or 1 mBar.)

Check 11: Perform a vacuum test for your pump. Unmount the vacuum sensor from the machine and use a reduction from KF25 to KF16 to place the sensor directly to the intake of the pump. Put your machine on, then put the pump to manual on, the pump should reach at least 30 mTorr.

WARNING 33:
Overtemperature of the chamber mat

WARNING 34 to 45:
Overtemperature of the heating mats 1 - 12

Check 1 Replace the chamber mat defrosting relay

Check 1: If the issue is present with multiple mats, pinpoint the mat with the highest temperature. Turn off the machine and replace the relay for this specific mat.

Check 2: If the problem is isolated to a single mat, turn off the machine and replace the relay for that mat.

WARNING 46:
Close door before production

WARNING 48:
Door not closed

WARNING 47:
Machine cannot reach high vacuum

WARNING 50:
Machine cannot reach vacuum setpoint

WARNING 49:
Machine cannot reach cooling setpoint

TROUBLESHOOT 49:
Machine does not reach low temperature

Check 1: Confirm if the door is securely closed.

Check 2: Test the sensor's responsiveness to a metal object (try with any metal); if the sensor changes its state, either behind the front plate or on its own, proceed to unlock the threads of the sensors and move it forward, closer to the door.

Check 3: If the sensor does not react, inspect if there is a light at the sensor. If not, verify if the sensor is properly connected to the cable, which should be securely screwed onto the sensor.

Note: The sensor can be manually overridden by selecting "manual on" in the control board menu.

This pertains to the setpoint located in the "Settings" menu. If the setpoint cannot be achieved within 20 minutes, it serves as a warning. You may need to adjust the setting or consult the troubleshooting guide for ALARM 21 for further assistance.

This pertains to the setpoint in the "Settings" menu, serving as a warning if the setpoint cannot be reached within 20 minutes. To address this, consider the following checks:

Check 1: Inspect the bubble glass of the compressor. If bubbles appear after hours of operation or regularly, this may indicate refrigerant loss and a potential leak. In this case, contact WAVE support or reach out to an HVAC technician to assess the cooling system.

Check 2: Ensure that the ambient temperature does not exceed 23°C for FD260 and 25°C for FD440 to achieve lower temperatures. Operating the machine at higher temperatures is possible but will significantly extend drying times. However, at 30°C or higher, it may become too hot to operate the machine effectively.

Check 3: Examine areas for significant condensation buildup. Accumulation of large blocks of ice due to condensation can lead to temperature variations and reduced performance over time.

Check 4: Check the condensing unit on the back (FD260) or the lower side of the machine (FD440) for

obstructions caused by material or dirt that hinder airflow.

Check 5: In the settings, verify that the low setpoint is adjusted appropriately for the system to perform effectively. The system requires a minimum temperature difference of 20°C between the chamber temperature and the lowest heating temperature of the drawer.

Check 6: Engage an HVAC technician to recalibrate the TXV valve for optimal performance.

WARNING 51:
Machine cannot heat the drawers

Check 1: If the drawers are configured to "manual off," it is typical to receive this alarm, as the drawers are intentionally not in the heating mode.

Check 2: To assess the functionality of the relays, switch them to manual operation in the control menu while listening for any operational changes. If necessary, replace the relays to ensure proper functioning.

TROUBLESHOOT 1:
Breakers of energy supply went off

Check 1: If this is the first time you've connected the machine to your power supply, it's advisable to contact the Wave support team for guidance.

Check 2: If the issue arises after the machine was running smoothly, investigate whether any other machines in your facility started operating at the time of the power interruption or if any machine was scheduled to start, as the combined power usage might have overloaded the circuit.

Check 3: Unplug the machine and inspect the plug for any melted points or signs of overheating.

Check 4: Examine whether any of the Sirius breakers have tripped and inspect the connected machines, compressor, and vacuum pump for signs of heat, damage, or the smell of melted metal or plastics.

Check 5: If Check 2 yields results or no other issues are evident, navigate to the settings page and reduce the maximum energy draw of the machine (0W denotes the maximum, any other value will adjust the maximum power consumption accordingly).

Check 6: If these steps do not resolve the problem or if you remain uncertain, it is recommended to contact the Wave support team for further assistance.

TROUBLESHOOT 2:
Breakers at the machine went off

Check 1 contact the Wave support team

TROUBLESHOOT 4:
Condensation on the machine

Check 1: If you notice condensation on the door while freezing, this is considered normal. The machine is not intended for prolonged freezing use.

Check 2: In the event of condensation occurring at the front of the machine, ensure that the insulation is intact within the inner ring. You can inspect this from inside the machine while looking toward the front plate.

Check 3: If condensation is present at the back of the machine, verify that the insulation around the pipes of the cooling system and their connections is in good condition.

TROUBLESHOOT 5:
Collapsed material

Check 1: Ensure that the material was stored at -25°C or lower before placing it in the machine.

Check 2: Make sure to initiate the vacuum or allow the machine to run until the drawers reach -20°C before commencing the drying process.

Check 3: Confirm that the drying steps are not too abrupt. Begin at -10°C and attempt the initial steps at 5°C. If this is ineffective, start at -15°C.

Check 4: Verify that the pieces intended for drying do not exceed 20mm in diameter or thickness.

Check 5: Ensure that the material is prepared correctly. For fibrous fruits like pineapple or citrus fruits, cut them to minimize fiber length. For pineapple, cut pieces along the stem rather than slicing through the core. For citrus fruits, cut north along the natural slices and through them to open as many cells as possible.

For fruits or berries with skins, cut or pre-treat them to reduce the water-retaining characteristics of the skin. For example, blueberries are best frozen at 0 to 3°C, cut in half, refrozen to -25°C, and then dried.

As honey has a very low freezing temperature, it is typically mixed with water to raise its freezing point.

TROUBLESHOOT 6:
Wet material

Check 1: When drying, consider raising the end-temperature and extending the drying time. Ensure that the vacuum level is at least 250 mTorr and has remained stable for at least 2 hours (when running a full machine) before concluding the drying cycle. Note that predicting this can be more challenging when the machine is not full.

TROUBLESHOOT 7:
Very long drying times

Check 1: If your final drying temperature is below +40°C, be aware that drying times can increase significantly, potentially up to a week. Consider using a higher end-temperature, and ensure you achieve a vacuum of at least 1 mbar with a full machine.

Check 2: Ensure that your material is thoroughly frozen when placed into the machine.

Check 3: Verify the pump's performance and check if the ballast is open.

Check 4: Examine the compressor's performance. If the chamber temperature is higher than -25°C, the compressor's efficiency will substantially decrease. This could be due to high ambient temperature or compressor performance issues.

TROUBLESHOOT 8:
Uneven drying over drawers

Check 1: Ensure even distribution of materials in the drawers, especially if drawers (or shelves with more than one drawer) are primarily filled in the front of the machine. Proper functioning requires balanced loading as the sensors for the drawers are located at the back of the machine. To prevent this issue, always load the tree in the back.

TROUBLESHOOT 9:
Evacuation valve not working

Check 1: Inspect the evacuation valve for any debris or obstructions that might hinder proper closure.

Check 2: Over time, the valve may undergo deep discharge. To address this, switch the valve to "manual on" in the control menu and allow it to charge in this mode for 10 minutes.

TROUBLESHOOT 10:
Powder is contaminating the machine

Check 1: Employ an additional manual valve to gradually evacuate the chamber, preventing the dispersion of powder throughout the chamber.

Workaround: After drying, open one of the clamps in the back of the machine that leads from the chamber to the pump until air is drawn inside.

TROUBLESHOOT 11:
Water flowing from the machine in the front

Check 1: Adjust the front height of the machine to a higher position so that the water naturally flows toward the back of the machine, preventing it from spilling in the front.

Tutorial Videos on Youtube



Machine Handbook

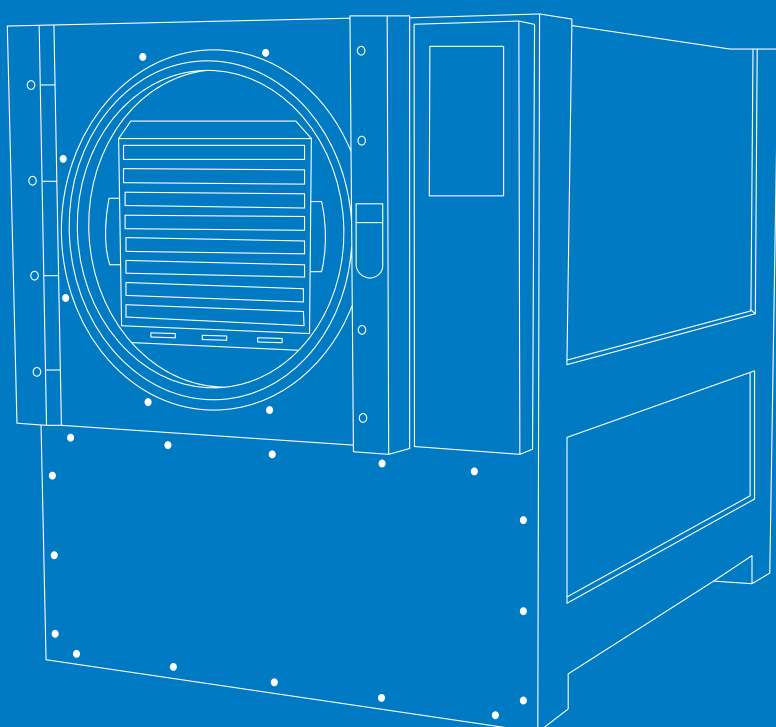
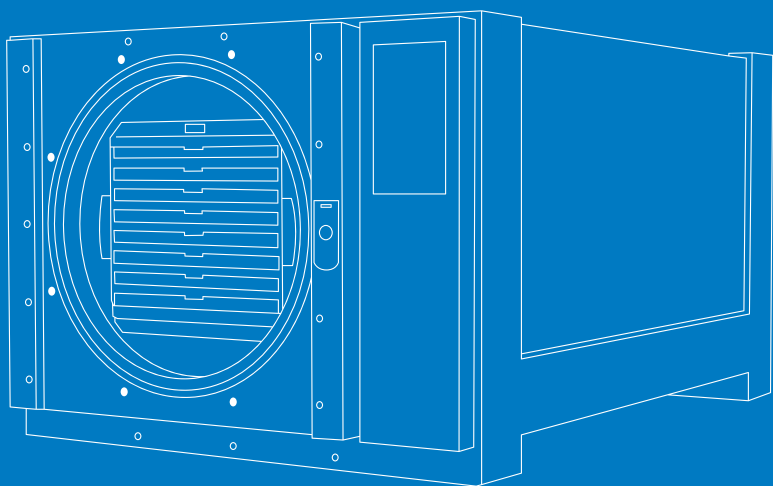
Machine serial number	
Year of manufacture	
Machine model	
Version	
Max warm vacuum	
Max temperature	
Modifications	

Manufacturer's Signature	
Date & Location	

[illegible]

USER MANUAL 5.0
2026

WAVE FD260 WAVE FD440



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1060 Vienna
Austria
+43 699 15852848
www.wave.cc
mike@wave.cc

Cleaning, disinfection and MULE

1. Prepare the machine and cleaning area

Finish or stop the cycle using the normal operating procedure. Vent the chamber fully before opening it. Complete defrosting and allow parts to reach a safe handling temperature. Then switch off and isolate the equipment as described in the safety instructions. Prevent unintended restart during cleaning.

Remove the product and trays. Handle remaining product, condensate and cleaning waste according to the site procedure. Use the protective equipment specified for the product and cleaning agents. Keep dirty parts separate from cleaned parts.

2. Remove the drawer unit with the WAVE MULE

Where fitted, use the model-compatible WAVE MULE to support and remove the complete drawer/loading unit. The unit can then be cleaned on the MULE, and the empty chamber becomes accessible. Follow the handling instructions for the supplied machine and MULE; secure the trolley and load against movement or tipping.

Protect the cables and connections at the rear of the unit. Never pull on them. Only disconnect connections designed for operator disconnection, following the model instructions. With permanently wired units, respect the available cable reach and keep the MULE beside the machine; do not move the unit to a remote wash area while it remains attached.

3. Clean the trays, loading unit and chamber

Clean trays after each cycle. Clean the drawer unit, chamber and accessible condensate/drain areas at the intervals in the site cleaning plan, and after spills or product changes as required. Remove residues with suitable non-abrasive tools. Use water and a mild detergent compatible with the actual surfaces, seals and heating mats. Remove detergent residues thoroughly with suitable-quality water.

Keep liquid out of the central/top vacuum connections, pump line, electrical parts, connectors and sensors. Do not flood or immerse the assembled drawer unit, or use pressure washing or steam cleaning unless that method is expressly approved for the supplied configuration. Clean the MULE supports and contact surfaces as part of the procedure.

Do not use caustic or abrasive cleaners on the drawer unit or silicone heating mats. A cleaner suitable for stainless steel is not automatically suitable for aluminium, coatings, acrylic, seals or electrical components.

Material compatibility and return to service

4. Acrylic door: protect against chemical damage

Do not use alcohol-containing cleaners or disinfectants on the acrylic door. Avoid contact with their vapours as well.

Acrylic can develop fine stress cracks or be weakened by incompatible chemicals. Do not assume that a general recommendation for acrylic sheet also applies to this vacuum-loaded door.

For routine door cleaning, use a soft, lint-free cloth moistened with lukewarm water and a mild cleaning agent approved for the door. Do not rub the surface dry or use abrasive pads, scouring powders or unsuitable glass cleaners. Inspect the door and seal for damage. If cracks, crazing or other damage are visible, keep the machine out of service and contact WAVE.

Any alternative door disinfection method requires specific compatibility confirmation for the actual door, including the formulation, concentration, temperature, contact time and repeated exposure. A spot test or a general chemical-resistance table is not sufficient.

5. Disinfection, where the process requires it

Clean first; disinfection does not replace removal of residues. The site procedure must identify the agent, concentration, application method, temperature and contact time, together with any rinsing and drying requirements. Use only conditions compatible with every exposed component. The actual delivered materials govern, including any aluminium, coating, elastomer or acrylic surface.

Earlier references in this manual to diluted ethanol, isopropanol or hydrogen peroxide for chamber disinfection are not a universal recipe or approval for all parts. An applicable procedure must prevent exposure of the acrylic door, including vapour exposure, and protect the pump, electrical parts and seals. Do not use such a procedure unless its compatibility and safe execution have been established.

6. Dry, inspect, reassemble and release

Remove cleaning and disinfectant residues as required by the approved procedure. Allow cleaned parts and protected connections to dry fully. Inspect accessible surfaces, seals, the door, drains and the loading unit. Reinstall the drawer unit and connections according to the model instructions, without trapping cables or damaging the seal.

Record the cleaning and complete the checks required by the site before releasing the machine for the next batch. If residues, damage or an unresolved deviation remain, do not release the machine. Cleaning, disinfection and sterilisation are different processes; this chapter does not establish a sterilisation procedure.

Site cleaning plan and GMP responsibility

7. The operator determines suitability for the intended use

The operator is responsible for deciding whether the delivered machine can be integrated into the intended manufacturing process and quality system. Where GMP applies, the operator must define the user requirements, assess suitability, arrange the necessary equipment qualification and process/cleaning validation, and approve the operating procedures and release criteria before use.

This manual, a CE declaration or individual component certificates do not establish GMP compliance of a production process. The scope of technical information, qualification support and additional documentation provided by WAVE must be agreed for the specific configuration. The operator's responsibilities do not change the manufacturer's obligations for the equipment supplied.

8. Define and document the cleaning procedure

Set the frequency and sequence according to the product, contamination risk and site requirements. Include hard-to-reach areas, product changes, relevant allergens, dirty/clean holding times, and the handling of the MULE and removable parts. Train the personnel who carry out and check the procedure.

For GMP use, manual cleaning requires a justified validation approach and periodic confirmation of effectiveness. Visual cleanliness is a useful check but normally is not sufficient on its own. The responsible quality unit defines appropriate residue limits, sampling locations and methods, microbiological checks where relevant, and the response to deviations.

Cleaning record: minimum entries

Identification	Machine / serial number, procedure and revision, product and batch, reason for cleaning.
Execution	Date and times, operator, cleaned areas, MULE use and removed/reinstalled parts.
Agents and parameters	Agent identity and batch, prepared concentration, temperature, contact time, water quality, rinsing and drying.
Verification	Visual findings and any required samples/results; condition of door, seal, cables and connections.
Release	Deviations and actions, completed reassembly, responsible reviewer, release decision and date/time.

Reference: EU GMP Annex 15, section 10 (Cleaning Validation), including 10.15 for manual cleaning. Apply the requirements relevant to the intended activity and jurisdiction. [Official Annex 15](#).

Component documents

Reference annex

WAVE FD260 / FD440 / FD470 - Manual 5.0 / 2026

Original manual pages 1-93 retain their layout; the obsolete program paragraph on page 26 has been replaced. The cleaning supplement is on PDF pages 94-96. This appendix collects original component documents from the IC570 manual and two official Embraco manufacturer declarations. Original layouts, signatures, restrictions and printed page numbers are preserved.

YELLOW - EQUIPMENT MATCH TO BE CONFIRMED.

The IC570 reference copies apply only to the components and variants they name. Matching the actual FD260/FD440/FD470 equipment, suffixes and ratings has not yet been confirmed. These documents do not declare conformity of a complete WAVE machine.

Embraco UNJ2212GK

Embraco's installation instructions identify UNJ2212GK within the UNJ condensing-unit series (PDF page 47 / printed page 45). The attached declarations of 15 March 2021 include UNJ. Confirm the actual nameplate and configuration, including the stated manufacturer Embraco Slovakia. The incorporation declaration also requires conformity of the final machine before use.

Official documents: [CE declaration](#) | [Declaration of incorporation](#) | [Model-to-series identification](#)

RED - HISTORICAL DOCUMENTS WITH PRINTED EXPIRY DATES.

ABB / ABS source pages 112 and 113 expired on 13 and 14 August 2024 respectively; source pages 120 and 121 expired on 15 October 2025. They are retained as historical references, not as current approval evidence.

How to use the register

The register separates CE-related material from UL/CSA, ABS, CB and VDE documents. No current registry status is inferred where no expiry date is printed. Model-list addenda and approval conditions remain attached. No Bitzer documents or IC570-specific wiring diagrams are included. The page references in the next two pages refer to physical PDF pages in this expanded manual.

Document register 1/2

All component matches remain to be confirmed. Original source pages follow this register.

Ref. / Source	PDF page	Component / document	Issued / status
R01 IC570 108-109	100-101	PHOENIX CONTACT GmbH & Co. KG UNO2-PS/1AC/24DC/960W switching power supply UL Certificate of Compliance - Canada (NMTR7) UL-CA-2217226-3	2022-06-09 No expiry printed Registry not checked
R02 IC570 110-111	102-103	PHOENIX CONTACT GmbH & Co. KG UNO2-PS/1AC/24DC/960W switching power supply UL Certificate of Compliance - USA (NMTR) UL-US-2217786-2	2022-06-09 No expiry printed Registry not checked
R03 IC570 112	104	ABB STOTZ KONTAKT GMBH ESB16/20/25/40/63/100-xxN and EH04-xxN electrical contactors ABS Product Design Assessment 19-HG1879891-PDA	2019-08-14 EXPIRED 2024-08-13 Historical only
R04 IC570 113	105	ABB BULGARIA EOOD - RAKOVSKI BRANCH ESB16/20/25/40/63/100-xxN and EH04-xxN electrical contactors ABS Product Design Assessment 19-HG1879891-PDA-DUP	2019-08-14 EXPIRED 2024-08-14 Historical only
R05 IC570 114-115	106-107	PHOENIX CONTACT GmbH & Co. KG UNO2-PS/1AC/24DC/960W switching power supply UL Certificate of Compliance - hazardous locations (USL/CNL) E199827	2022-06-20 No expiry printed Registry not checked
R06 IC570 116-117	108-109	ABB Stotz-Kontakt GmbH ESB16/20/24/25/40/63/100 magnetic motor controllers; EH04 accessories, exact suffixes on source page 117 UL Certificate of Compliance - USA (NLDX) UL-US-L191658-112-10306991-5	2024-08-01 No expiry printed Registry not checked
R07 IC570 118-119	110-111	ABB Stotz-Kontakt GmbH ESB16/20/24/25/40/63/100 magnetic motor controllers; EH04 accessories, exact suffixes on source page 119 UL Certificate of Compliance - Canada (NLDX7) UL-CA-L191658-412-10306991-5	2024-08-01 No expiry printed Registry not checked
R08 IC570 120	112	ABB STOTZ KONTAKT GMBH MS116-xxx motor protection circuit breaker ABS Product Design Assessment 20-2040577-PDA	2020-10-16 EXPIRED 2025-10-15 Historical only

Document register 2/2

All component matches remain to be confirmed. Original source pages follow this register.

Ref. / Source	PDF page	Component / document	Issued / status
R09 IC570 121	113	ABB XINHUI LOW VOLTAGE SWITCHGEAR COMPANY LTD MS116-xxx motor protection circuit breaker ABS Product Design Assessment 20-2040577-PDA-DUP	2020-10-16 EXPIRED 2025-10-15 Historical only
R10 IC570 122-123	114-115	ABB Stotz-Kontakt GmbH MS116-0.16 through MS116-32.0, MBS32NG and listed auxiliary contacts/trips/accessories UL Certificate of Compliance - USA (NLRV) UL-US-L137861-33721-81210002-2	2023-05-24 No expiry printed Registry not checked
R11 IC570 124-125	116-117	ABB Stotz-Kontakt GmbH MS116-0.16 through MS116-32.0, MBS32NG and listed auxiliary contacts/trips/accessories UL Certificate of Compliance - Canada (NLRV7) UL-CA-L137861-33751-81210002-2	2023-05-24 No expiry printed Registry not checked
R12 IC570 126	118	ZHEJIANG ETEK Electrical Technology CO., LTD. EKL1-63B Type B RCCB, 1P+N / 3P+N, 16-63 A listed variants BV LCIE China attestation of conformity with European Directives 2466AS03ASCQ53832	2024-03-21 No expiry printed Registry not checked
R13 IC570 127-128	119-120	ZHEJIANG ETEK Electrical Technology CO., LTD. EKL1-63B Type B RCCB, 1P+N / 3P+N, listed current and residual-current variants IECEE CB Test Certificate (VDE) DE1-65823	2021-12-09 No expiry printed Registry not checked
R14 IC570 129-132	121-124	ZHEJIANG ETEK Electrical Technology CO., LTD. EKL1-63B Type B RCCB, manufacturing site 30026643 VDE Marks Approval with model sheet, factory supplement and conditions 40054469	2021-12-09 No expiry printed Registry not checked
R15 Embraco 1	125	Embraco Slovakia s.r.o. Condensing units, including UNJ series CE declaration of conformity UNJ family declaration	2021-03-15 Manufacturer declaration Nameplate match pending
R16 Embraco 1	126	Embraco Slovakia s.r.o. Condensing units, including UNJ series Declaration of incorporation UNJ family declaration	2021-03-15 Manufacturer declaration Nameplate match pending

Source notes: ETEK CB pages carry a 2021-12-09 signature date and a separate 2018-06-05 form footer; both remain unchanged. VDE approval conditions and named manufacturing sites remain part of the original document. UL hazardous-location evidence concerns the listed power supply and does not certify the WAVE machine for hazardous locations.

CERTIFICATE OF COMPLIANCE

Certificate Number UL-CA-2217226-3
Report Reference E123528-20220427
Date 9-Jun-2022

Issued to: PHOENIX CONTACT GmbH & Co. KG
Flachsmarktstrasse 8 Blomberg 32825
Germany

This is to certify that
representative samples of

NMTR7 - Power Circuit and Motor-mounted Apparatus
Certified for Canada
See Addendum Page for Product Designation(s).

Have been investigated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety: CSA C22.2 NO. 61010-1, 3rd Ed., Issue Date: 2012-05-11,
Revision Date: 2018-11-01, CSA C22.2 NO. 61010-2-
201:18, 2nd Ed., Issue Date: 2018-02-01

Additional Information: See the UL Online Certifications Directory at
<https://iq.ulprospector.com> for additional information

This Certificate of Compliance does not provide authorization to apply the UL Mark. Only the UL Follow-Up Services Procedure provides authorization to apply the UL Mark.

Only those products bearing the UL Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Certification Mark on the product.



Bruce Mahrenholz, Director North American Certification Program

UL LLC

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CERTIFICATE OF COMPLIANCE

Certificate Number UL-CA-2217226-3
Report Reference E123528-20220427
Date 9-Jun-2022

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

Model	Category Description
UNO2-PS/1AC/24DC/960W, may be followed by a suffix of one or more alphanumeric or special characters including " - / , . _ " or semicolon or blank, for internal references only, not safety relevant.	Switching power supplies



Bruce Mahrenholz, Director North American Certification Program

UL LLC



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CERTIFICATE OF COMPLIANCE

Certificate Number UL-US-2217786-2
Report Reference E123528-20220427
Date 9-Jun-2022

Issued to: PHOENIX CONTACT GmbH & Co. KG
Flachsmarktstrasse 8 Blomberg 32825
Germany

This is to certify that
representative samples of NMTR - Power Circuit and Motor-mounted Apparatus
See Addendum Page for Product Designation(s).

Have been investigated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety: UL 61010-1, 3rd Ed., Issue Date: 2012-05-11, Revision
Date: 2019-07-19, UL 61010-2-201, 2nd Ed., Issue Date:
2018-05-14

Additional Information: See the UL Online Certifications Directory at
<https://iq.ulprospector.com> for additional information

This Certificate of Compliance does not provide authorization to apply the UL Mark. Only the UL Follow-Up
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contact a local UL Customer Service Representative at <http://ul.com/aboutul/locations/>

CERTIFICATE OF COMPLIANCE

Certificate Number UL-US-2217786-2
Report Reference E123528-20220427
Date 9-Jun-2022

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

Model	Category Description
UNO2-PS/1AC/24DC/960W, may be followed by a suffix of one or more alphanumeric or special characters including " - / , . _ " or semicolon or blank, for internal references only, not safety relevant.	Switching power supplies



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CERTIFICATE NUMBER 19- HG1879891-PDA

EFFECTIVE DATE 14-Aug-2019

EXPIRATION DATE 13-Aug-2024

ABS TECHNICAL OFFICE

Hamburg Engineering Department

CERTIFICATE OF Product Design Assessment

This is to certify that a representative of this Bureau did, at the request of

ABB STOTZ KONTAKT GMBH

located at

**EPPELHEIMER STR. 82,
D-69123 HEIDELBERG, GERMANY**

assess design plans and data for the below listed product. This assessment is a representation by the Bureau as to the degree of compliance the design exhibits with applicable sections of the Rules. This assessment does not waive unit certification or classification procedures required by ABS Rules for products to be installed in ABS classed vessels or facilities. This certificate, by itself, does not reflect that the product is Type Approved. The scope and limitations of this assessment are detailed on the pages attached to this certificate.

Product Contactor, Electrical

Model ESB16-xxN, ESB20-xxN, ESB25-xxN, ESB40-xxN, ESB63-xxN, ESB100-xxN, EH04-xxN

This Product Design Assessment (PDA) Certificate remains valid until 13-Aug-2024 or until the Rules and/or Standards used in the assessment are revised or until there is a design modification warranting design reassessment (whichever occurs first).

Acceptance of product is limited to the "Intended Service" details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or previous to the effective date of the ABS Rules and standards applied at the time of PDA issuance. Use of the Product for non-ABS units is subject to agreement between the manufacturer and intended client.

American Bureau of Shipping

Efstratios Maliatsos
Engineer/Consultant

NOTE: This certificate evidences compliance with one or more of the Rules, Guides, standards or other criteria of ABS or a statutory, industrial or manufacturer's standards. It is issued solely for the use of ABS, its committees, its clients or other authorized entities. Any significant changes to the aforementioned product without approval from ABS will result in this certificate becoming null and void. This certificate is governed by ABS Rules 1-1-A3/5.9 Terms and Conditions of the Request for Product Type Approval and Agreement (2010)



CERTIFICATE NUMBER 19- HG1879891-PDA-DUP

EFFECTIVE DATE 14-August-2019

EXPIRATION DATE 14-August-2024

ABS TECHNICAL OFFICE

Hamburg Engineering Department

CERTIFICATE OF

Product Design Assessment

This is to certify that a representative of this Bureau did, at the request of

ABB BULGARIA EOOD- RAKOVSKI BRANCH

located at

**14, INDUSTRIALEN PUT 1, STRYAMA
BULGARIA 4142**

assess design plans and data for the below listed product. This assessment is a representation by the Bureau as to the degree of compliance the design exhibits with applicable sections of the Rules. This assessment does not waive unit certification or classification procedures required by ABS Rules for products to be installed in ABS classed vessels or facilities. This certificate, by itself, does not reflect that the product is Type Approved. The scope and limitations of this assessment are detailed on the pages attached to this certificate.

Product Contactor, Electrical

Model ESB16-xxN, ESB20-xxN, ESB25-xxN, ESB40-xxN, ESB63-xxN, ESB100-xxN, EH04-xxN

This Product Design Assessment (PDA) Certificate remains valid until 14-August-2024 or until the Rules and/or Standards used in the assessment are revised or until there is a design modification warranting design reassessment (whichever occurs first).

Acceptance of product is limited to the "Intended Service" details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or previous to the effective date of the ABS Rules and standards applied at the time of PDA issuance. Use of the Product for non-ABS units is subject to agreement between the manufacturer and intended client.

American Bureau of Shipping

Efstratios Maliatsos
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NOTE: This certificate evidences compliance with one or more of the Rules, Guides, standards or other criteria of ABS or a statutory, industrial or manufacturer's standards. It is issued solely for the use of ABS, its committees, its clients or other authorized entities. Any significant changes to the aforementioned product without approval from ABS will result in this certificate becoming null and void. This certificate is governed by ABS Rules 1-1-A3/5.9 Terms and Conditions of the Request for Product Type Approval and Agreement (2010)

CERTIFICATE OF COMPLIANCE

Certificate Number E199827
Report Reference E199827-2022-05-26
Date 2022-June-20

Issued to: PHOENIX CONTACT GmbH & Co. KG
Flachsmarktstrasse 8
Blomberg 32825 DE

This is to certify that
representative samples of

PROCESS CONTROL EQUIPMENT FOR USE IN
HAZARDOUS LOCATIONS

See Addendum Page for Product Designation(s).

Have been evaluated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety: See Addendum Page for Standard(s) for Safety

Additional Information: See the UL Online Certifications Directory at
<https://iq.ulprospector.com> for additional information

This Certificate of Compliance indicates that representative samples of the product described in the certification report have met the requirements for UL certification. It does not provide authorization to apply the UL Mark. Only the Authorization Page that references the Follow-Up Services Procedure for ongoing surveillance provides authorization to apply the UL Mark.

Only those products bearing the UL Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Certification Mark on the product.



Bruce Mahrenholz, Director North American Certification Program

UL LLC

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CERTIFICATE OF COMPLIANCE

Certificate Number E199827
Report Reference E199827-2022-05-26
Date 2022-June-20

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

USL, CNL – Power Supply for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations.

Model: UNO2-PS/1AC/24DC/960W

All model/catalogue number(s) may be followed by a suffix of one or more alphanumeric or special characters including " - / , . _ " or semicolon or blank, for internal references only, not safety relevant.

Standard(s) for Safety

UL61010-1 Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements

UL61010-2-201 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-201: Particular Requirements for Control Equipment

CAN/CSA-C22.2 No. 61010-1:12 Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements

CAN/CSA-C22.2 No. 61010-2-201:18 Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-201: Particular requirements for control equipment



Bruce Mahrenholz, Director North American Certification Program

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Certificate of Compliance

Certificate Number:

UL-US-L191658-112-
10306991-5

Report Reference:

E191658-19960301

Issue Date:

2024-08-01

Issued to:

**ABB Stotz-Kontakt GmbH
Eppelheimer Str 82 Heidelberg 69123
Germany**

This certificate confirms that representative samples of:

NLDX - Motor Controllers, Magnetic

See Addendum Page for Product Designation(s).

Have been evaluated by UL in accordance with the Standard(s) indicated on this Certificate.

**UL 60947-4-1, 3rd Ed., Issue Date: 2014-04-04, Revision Date:
2017-10-17, UL 60947-1, 5th Ed., Issue Date: 2013-07-31,
Revision Date: 2019-05-06**

Additional Information:

See UL Product iQ® at <https://iq.ulprospector.com> for additional information.

This Certificate of Compliance indicates that representative samples of the product described in the certification report have met the requirements for UL certification. It does not provide authorization to apply the UL Mark. Only the Authorization Page that references the Follow-Up Services Procedure for ongoing surveillance provides authorization to apply the UL Mark.

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David Piecuch
UL Mark Certification Program Manager



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CERTIFICATE OF COMPLIANCE

Certificate number UL-US-L191658-112-10306991-5
Report reference E191658-19960301
Date 2024-08-01

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Model	Product Description
EH04-11, may be followed by N	Accessory Open type
EH04-20, may be followed by N	Accessory Open type
ESB100, followed by -40 or -20, followed by N	Open type, Motor controllers
ESB16, followed by -11, -20 or -02, followed by N.	Open type, Motor controllers
ESB20, followed by -11, -20 or -02, followed by N	Open type, Motor controllers
ESB24, followed by -0, 1, 2, 3 or 4, followed by 0, 1, 2, 3 or 4.	Open type, Motor controllers
ESB25, followed by -0, -1, -2, -3, or -4, followed by 0, 1, 2, 3, or 4 followed by N	Open type, Motor controllers
ESB40, followed by -0, 1, 2, 3 or 4, followed by 0, 1 or 2, may be followed by N, may be followed by -DC-B or E.	Open type, Motor controllers
ESB63, followed by -0, 1, 2, 3 or 4, followed by 0, 1 or 2, may be followed by N, may be followed by -DC-B or E.	Open type, Motor controllers



David Piecuch
UL Mark Certification Program Manager

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Certificate of Compliance

Certificate Number:

UL-CA-L191658-412-
10306991-5

Report Reference:

E191658-19960301

Issue Date:

2024-08-01

Issued to:

**ABB Stotz-Kontakt GmbH
Eppelheimer Str 82 Heidelberg 69123
Germany**

This certificate confirms that representative samples of:

NLDX7 - Motor Controllers, Magnetic Certified for Canada

See Addendum Page for Product Designation(s).

Have been evaluated by UL in accordance with the Standard(s) indicated on this Certificate.

**CSA C22.2 NO. 60947-4-1, 2nd Ed., Issue Date: 2014-04-04,
Revised 2018-05, CSA C22.2 No. 60947-1, 2nd Ed., Issue Date:
2013-07-01**

Additional Information:

See UL Product iQ® at <https://iq.ulprospector.com> for additional information.

This Certificate of Compliance indicates that representative samples of the product described in the certification report have met the requirements for UL certification. It does not provide authorization to apply the UL Mark. Only the Authorization Page that references the Follow-Up Services Procedure for ongoing surveillance provides authorization to apply the UL Mark.

Only those products bearing the UL Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Certification Mark on the product.



David Piecuch
UL Mark Certification Program Manager



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CERTIFICATE OF COMPLIANCE

Certificate number UL-CA-L191658-412-10306991-5
Report reference E191658-19960301
Date 2024-08-01

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Model	Product Description
EH04-11, may be followed by N	Accessory Open type
EH04-20, may be followed by N	Accessory Open type
ESB100, followed by -40 or -20, followed by N	Open type, Motor controllers
ESB16, followed by -11, -20 or -02, followed by N.	Open type, Motor controllers
ESB20, followed by -11, -20 or -02, followed by N	Open type, Motor controllers
ESB24, followed by -0, 1, 2, 3 or 4, followed by 0, 1, 2, 3 or 4.	Open type, Motor controllers
ESB25, followed by -0, -1, -2, -3, or -4, followed by 0, 1, 2, 3, or 4 followed by N	Open type, Motor controllers
ESB40, followed by -0, 1, 2, 3 or 4, followed by 0, 1 or 2, may be followed by N, may be followed by -DC-B or E.	Open type, Motor controllers
ESB63, followed by -0, 1, 2, 3 or 4, followed by 0, 1 or 2, may be followed by N, may be followed by -DC-B or E.	Open type, Motor controllers



David Piecuch
UL Mark Certification Program Manager

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CERTIFICATE NUMBER	20-2040577-PDA
EFFECTIVE DATE	16-Oct-2020
EXPIRY DATE	15-Oct-2025
ABS TECHNICAL OFFICE	Hamburg Engineering Department

CERTIFICATE OF Product Design Assessment

This is to certify that a representative of this Bureau did, at the request of

ABB STOTZ KONTAKT GMBH

located at

EPPELHEIMER STR. 82, HEIDELBERG, Germany, D-69123

assess design plans and data for the below listed product. This assessment is a representation by the Bureau as to the degree of compliance the design exhibits with applicable sections of the Rules. This assessment does not waive unit certification or classification procedures required by ABS Rules for products to be installed in ABS classed vessels or facilities. This certificate, by itself, does not reflect that the product is Type Approved. The scope and limitations of this assessment are detailed on the pages attached to this certificate.

Product Motor Protection Circuit Breaker

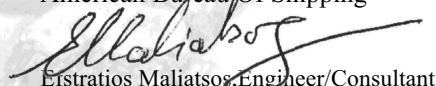
Model MS116-xxx

This Product Design Assessment (PDA) Certificate remains valid until 15/Oct/2025 or until the Rules and/or Standards used in the assessment are revised or until there is a design modification warranting design reassessment (whichever occurs first).

Acceptance of product is limited to the "Intended Service" details prescribed in the certificate and as per applicable Rules and Standards.

This Certificate is valid for installation of the listed product on ABS units which exist or are under contract for construction on or previous to the effective date of the ABS Rules and standards applied at the time of PDA issuance. Use of the Product for non-ABS units is subject to agreement between the manufacturer and intended client.

American Bureau Of Shipping


Eustratios Maliatsos, Engineer/Consultant

NOTE: This certificate evidences compliance with one or more of the Rules, Guides, standards or other criteria of ABS or a statutory, industrial or manufacturer's standards. It is issued solely for the use of ABS, its committees, its clients or other authorized entities. Any significant changes to the aforementioned product without approval from ABS will result in this certificate becoming null and void. This certificate is governed by ABS Rules 1-1-A3/5.9 Terms and Conditions of the Request for Product Type Approval and Agreement (2010)



CERTIFICATE NUMBER
EFFECTIVE DATE
EXPIRY DATE
ABS TECHNICAL OFFICE

20-2040577-PDA-DUP
16-Oct-2020
15-Oct-2025
Hamburg Engineering Department

CERTIFICATE OF Product Design Assessment

This is to certify that a representative of this Bureau did, at the request of

ABB XINHUI LOW VOLTAGE SWITCHGEAR COMPANY LTD

located at

**NO. 9, NORTH SANHE ROAD, XINHUI DISTRICT, JIANGMEN CITY,
China, 529100**

assess design plans and data for the below listed product. This assessment is a representation by the Bureau as to the degree of compliance the design exhibits with applicable sections of the Rules. This assessment does not waive unit certification or classification procedures required by ABS Rules for products to be installed in ABS classed vessels or facilities. This certificate, by itself, does not reflect that the product is Type Approved. The scope and limitations of this assessment are detailed on the pages attached to this certificate.

Product Motor Protection Circuit Breaker

Model MS116-xxx

This Product Design Assessment (PDA) Certificate remains valid until 15/Oct/2025 or until the Rules and/or Standards used in the assessment are revised or until there is a design modification warranting design reassessment (whichever occurs first).

Acceptance of product is limited to the "Intended Service" details prescribed in the certificate and as per applicable Rules and Standards.

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American Bureau Of Shipping

Efstratios Maliatsos, Engineer/Consultant

NOTE: This certificate evidences compliance with one or more of the Rules, Guides, standards or other criteria of ABS or a statutory, industrial or manufacturer's standards. It is issued solely for the use of ABS, its committees, its clients or other authorized entities. Any significant changes to the aforementioned product without approval from ABS will result in this certificate becoming null and void. This certificate is governed by ABS Rules 1-1-A3/5.9 Terms and Conditions of the Request for Product Type Approval and Agreement (2010)

CERTIFICATE OF COMPLIANCE

Certificate Number UL-US-L137861-33721-81210002-2
Report Reference E137861-20001218
Date 24-May-2023

Issued to: ABB Stotz-Kontakt GmbH
Eppelheimer Str 82
Heidelberg, Baden-Wurttemberg 69123
Germany

This is to certify that NLRV - Motor Controllers, Manual
representative samples of See Addendum Page for Product Designation(s).

Have been evaluated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety: UL 60947-1, 5th Ed., Issue Date: 2013-7-31, Revision Date:
2019-5-6, UL 60947-4-1, 3rd Ed., Issue Date: 2014-04-04,
Revision Date: 2017-10-17

Additional Information: See the UL Online Certifications Directory at
<https://iq.ulprospector.com> for additional information

This Certificate of Compliance indicates that representative samples of the product described in the certification report have met the requirements for UL certification. It does not provide authorization to apply the UL Mark. Only the Authorization Page that references the Follow-Up Services Procedure for ongoing surveillance provides authorization to apply the UL Mark.

Only those products bearing the UL Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Certification Mark on the product.



Deborah Jennings-Conner, VP Regulatory Services

UL LLC

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please contact a local UL Customer Service Representative at <http://ul.com/aboutul/locations/>

CERTIFICATE OF COMPLIANCE

Certificate Number UL-US-L137861-33721-81210002-2
Report Reference E137861-20001218
Date 24-May-2023

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

Model	Category Description
Accessory, Auxiliary Contacts , CK1, HKF1, and HK1, followed by -02, -11, -20, -01, -10 may be followed by L, may be followed by K, may be followed by A, may be followed by B.	Motor Controllers - Manual
Accessory, Auxiliary Contacts , MAHN, followed by -02, -11, -20, -01, -10, followed by FB, LL or LR.	Motor Controllers - Manual
Accessory, Undervoltage Trip , MARNLLA, Shunt Trip MAANLLA, followed by -20, -24, -48, -60, -110, -208, -230, -400, -415 or -575.	Motor Controllers - Manual
Accessory, Padlock Kit , MAS1	Motor Controllers - Manual
MBS32NG,, followed by -002, -003, -004, -006, -010, -016, -025, -040, -063, -100, -120, -160, -200, -250 or -320.	Motor Controllers - Manual
MS116-0.16,, -0.25, -0.40, -0.63, -1.00, -1.60, -2.5, -4.00, -6.3, -10.0, -12.0, -16.00, -20.0, -25.0 or -32.0.	Motor Controllers - Manual
Accessory, Padlock Kit , SA1, SA3, SA10.	Motor Controllers - Manual
Accessory, Auxiliary Contacts , SK1, followed by -02, -11, -20, -01, -10,, may be followed by AR, may be followed by K, may be followed by A, may be followed by B.	Motor Controllers - Manual
Accessory, Undervoltage Trip , UA1, Shunt Trip AA1, – followed by -20, -24, -48, -60, -110, -208, -230, -400, -415 or -575.	Motor Controllers - Manual



Deborah Jennings-Conner, VP Regulatory Services

UL LLC

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CERTIFICATE OF COMPLIANCE

Certificate Number UL-CA-L137861-33751-81210002-2
Report Reference E137861-20001218
Date 24-May-2023

Issued to: ABB Stotz-Kontakt GmbH
Eppelheimer Str 82
Heidelberg, Baden-Wurttemberg 69123
Germany

This is to certify that NLRV7 - Motor Controllers, Manual Certified for Canada
representative samples of See Addendum Page for Product Designation(s).

Have been evaluated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety: CSA C22.2 No. 60947-1, 2nd Ed., Issue Date: 2013-07-01,
CSA C22.2 NO. 60947-4-1, 2nd Ed., Issue Date: 2014-04-
04, Revised 2018-05

Additional Information: See the UL Online Certifications Directory at
<https://iq.ulprospector.com> for additional information

This Certificate of Compliance indicates that representative samples of the product described in the certification report have met the requirements for UL certification. It does not provide authorization to apply the UL Mark. Only the Authorization Page that references the Follow-Up Services Procedure for ongoing surveillance provides authorization to apply the UL Mark.

Only those products bearing the UL Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Certification Mark on the product.



Deborah Jennings-Conner, VP Regulatory Services

UL LLC

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CERTIFICATE OF COMPLIANCE

Certificate Number UL-CA-L137861-33751-81210002-2
Report Reference E137861-20001218
Date 24-May-2023

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

Model	Category Description
Accessory, Auxiliary Contacts , CK1, HKF1, and HK1, followed by -02, -11, -20, -01, -10 may be followed by L, may be followed by K, may be followed by A, may be followed by B.	Motor Controllers - Manual
Accessory, Auxiliary Contacts , MAHN, followed by -02, -11, -20, -01, -10, followed by FB, LL or LR.	Motor Controllers - Manual
Accessory, Undervoltage Trip , MARNLLA, Shunt Trip MAANLLA, followed by -20, -24, -48, -60, -110, -208, -230, -400, -415 or -575.	Motor Controllers - Manual
Accessory, Padlock Kit , MAS1	Motor Controllers - Manual
MBS32NG,, followed by -002, -003, -004, -006, -010, -016, -025, -040, -063, -100, -120, -160, -200, -250 or -320.	Motor Controllers - Manual
MS116-0.16,, -0.25, -0.40, -0.63, -1.00, -1.60, -2.5, -4.00, -6.3, -10.0, -12.0, -16.00, -20.0, -25.0 or -32.0.	Motor Controllers - Manual
Accessory, Padlock Kit , SA1, SA3, SA10.	Motor Controllers - Manual
Accessory, Auxiliary Contacts , SK1, followed by -02, -11, -20, -01, -10,, may be followed by AR, may be followed by K, may be followed by A, may be followed by B.	Motor Controllers - Manual
Accessory, Undervoltage Trip , UA1, Shunt Trip AA1, – followed by -20, -24, -48, -60, -110, -208, -230, -400, -415 or -575.	Motor Controllers - Manual



Deborah Jennings-Conner, VP Regulatory Services

UL LLC

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please contact a local UL Customer Service Representative at <http://ul.com/aboutul/locations/>



BV LCIE
CHINA
Number

N° 2466AS03ASCQ53832

ATTESTATION of conformity with European Directives

Product: Type B RCCB
Reference: EKL1-63B
Issued to: ZHEJIANG ETEK Electrical Technology CO.,LTD.
Address: NO.288, Wei 17th Road; Yueqing Economic Development Zone; 325600
Yueqing, Wenzhou; Zhejiang China
Manufacturer: ZHEJIANG ETEK Electrical Technology CO.,LTD.
1P+N and 3P+N(neutral on right)
Ue=230/240V~ for 1P+N, 400/415V~ for 3P+N; 50/60Hz
In= 16A,20A,25A,32A,40A,63A
Inc=IΔc=10kA
Technical characteristics: Im=IΔm=500 A (In = 16,20,25,32,40 A); 630 A (In = 63 A)
IΔn=30mA; 100mA; 300mA; Grid distance = 50mm
Ui= 415V; Uimp=4kV
Material group=IIa
Screw diameter=4,9mm

The submitted sample of the above equipment has been tested for **CE** marking according to following European Directive and following standards:

Low Voltage Directive 2014/35/EU

Standards	Report number	Report date
EN 62423:2012 used in conjunction with EN 61008-1:2012+A1:2014+A2:2014+A11:2015, EN 61008-2-1:1994 + A11:1998	ASCQ-ESH-P24020665	03/18/2024

The referred test report(s) show that the product complies with standard(s) recognized as giving presumption of compliance with the essential requirements in the specified European Directive

This verification does not imply assessment of the production of the product

The **CE** marking may be affixed if all relevant and effective European Directives with **CE** are applicable

Shanghai (P.R. China), Mar. 21st, 2024.

Charlie CHEN
Product Line Manager



This document shall not be reproduced, except in full, without the written approval of BV LCIE China.
Information given in this document, are related to the tested specimen of the described electrical sample.

IEC SYSTEM FOR MUTUAL RECOGNITION OF TEST CERTIFICATES FOR ELECTRICAL EQUIPMENT
(IECEE) CB SCHEME

CB TEST CERTIFICATE

Product

RCCB, residual current operated circuit-breaker without integral overcurrent protection, functionally independent of line voltage

Name and address of the applicant

ZHEJIANG ETEK Electrical Technology CO.,LTD.
NO.288, Wei 17th Road, Yueqing Economic Development Zone, 325600 Yueqing, Wenzhou, Zhejiang
CHINA

Name and address of the manufacturer

ZHEJIANG ETEK Electrical Technology CO.,LTD.
NO.288, Wei 17th Road, Yueqing Economic Development Zone, 325600 Yueqing, Wenzhou, Zhejiang
CHINA

Name and address of the factory

ZHEJIANG ETEK Electrical Technology CO.,LTD.
NO.288, Wei 17th Road, Yueqing Economic Development Zone, 325600 Yueqing, Wenzhou, Zhejiang
CHINA

Note: When more than one factory, please report on page 2

☐ Additional Information on page 2

Ratings and principal characteristics

Ue : AC 230 V / 240 V (1P+N)
AC 400 V / 415 V (3P+N)

Trademark (if any)



Customer's Testing Facility (CTF) Stage used

Model / Type Ref.

EKL1-63B

Additional information (if necessary may also be reported on page 2)

see further ratings on page 2

☒ Additional Information on page 2

A sample of the product was tested and found to be in conformity with

IEC 61008-1:2010
IEC 61008-1:2010/AMD1:2012
IEC 61008-1:2010/AMD2:2013
IEC 61008-2-1:1990
IEC 62423:2009

As shown in the Test Report Ref. No. which forms part of this Certificate

286311-TL3-1

This CB Test Certificate is issued by the National Certification Body

VDE Prüf- und Zertifizierungsinstitut GmbH

VDE Testing and Certification Institute

Zertifizierungsstelle und internat. Angelegenheiten

Certification Body and internat. Affairs

Date: 2021-12-09

Signature:



R. Nickel

Additional information (if necessary)

Further ratings and principal characteristics:

50/60 Hz

In: 16 A; 20 A; 25 A; 32 A; 40 A; 63 A

I Δ n: 30 mA; 100 mA; 300 mA

Behaviour in presence of d.c. components: Type B

Inc: 10 kA

I Δ m: 500 A (In = 16,20,25,32,40 A); 630 A (In = 63 A)

VDE Prüf- und Zertifizierungsinstitut GmbH
VDE Testing and Certification Institute
 Zertifizierungsstelle und internat. Angelegenheiten
 Certification Body and internat. Affairs

Date: 2021-12-09

Signature:


 R. Nickel

ZEICHENGENEHMIGUNG MARKS APPROVAL

ZHEJIANG ETEK Electrical
Technology CO.,LTD.
NO.288, Wei 17th Road
Yueqing Economic Development Zone
325600 Yueqing, Wenzhou
Zhejiang China

ist berechtigt, für ihr Produkt /
is authorized to use for their product

**Fehlerstromschutzschalter ohne eingebauten
Überstromschutz,netzspannungsunabhängig (RCCB)**
***RCCB, residual current operated circuit-breaker without integral
overcurrent protection, functionally independent of line voltage***

die hier abgebildeten markenrechtlich geschützten Zeichen
für die ab Blatt 2 aufgeführten Typen zu benutzen /
the legally protected Marks as shown below for the types referred to on page 2 ff.



Geprüft und zertifiziert nach /
Tested and certified according to

DIN EN 61008-1 (VDE 0664-10):2018-03; EN 61008-1:2012+A1+A2+A11+A1/AC:2016+A12:2017
DIN EN 61008-2-1 (VDE 0664 Teil 11):1999-12; EN 61008-2-1:1994+A11:1998
DIN EN 62423 (VDE 0664-40):2013-08; EN 62423:2012



Aktenzeichen: 5027864-1720-0001 / 286311

File ref.:

Ausweis-Nr. 40054469

Certificate No.

Weitere Bedingungen siehe Rückseite und Folgeblätter /
further conditions see overleaf and following pages

Offenbach, 2021-12-09

Blatt 1

Page

VDE Prüf- und Zertifizierungsinstitut GmbH
VDE Testing and Certification Institute
Zertifizierungsstelle / Certification

R. Nickel

VDE Zertifikate sind nur gültig bei Veröffentlichung unter:
VDE certificates are valid only when published on:

<http://www.vde.com/zertifikat>
<http://www.vde.com/certificate>

Name und Sitz des Genehmigungs-Inhabers / Name and registered seat of the Certificate holder

ZHEJIANG ETEK Electrical Technology CO.,LTD., NO.288, Wei 17th Road, Yueqing Economic Development Zone, 325600 YUEQING, WENZHOU, Zhejiang, CHINA

Aktenzeichen / File ref.

5027864-1720-0001 / 286311 / TL3 / KOH

Datum / Date

2021-12-09

Dieses Blatt gilt nur in Verbindung mit Blatt 1 des Zeichengenehmigungsausweises Nr. 40054469.

This supplement is only valid in conjunction with page 1 of the Certificate No. 40054469.

Fehlerstromschutzschalter ohne eingebauten Überstromschutz,netzspannungsunabhängig (RCCB) RCCB, residual current operated circuit-breaker without integral overcurrent protection, functionally independent of line voltage

Typ(en) / Type(s)

EKL1-63B

Bemessungsspannung <i>Rated voltage</i>	AC 230/240 V (1P+N) AC 400/415 V (3P+N)
Bemessungsstrom <i>Rated current</i>	16 A; 20 A; 25 A; 32 A; 40 A; 63 A
Nennfrequenz <i>Rated frequency</i>	50/60 Hz
Anzahl der Pole <i>Number of poles</i>	1P+N; 3P+N
Bemessungsfehlerstrom <i>Rated residual operating current</i>	30 mA; 100 mA; 300 mA
Bemessungsschaltvermögen <i>Rated making and breaking capacity</i>	630 A (In = 63 A) 500 A (In = 16 A, 20 A, 25 A, 32A,40 A)
Bedingter Bemessungskurzschlussstrom <i>Rated conditional short-circuit current</i>	10 kA
Vorsicherung / Kurzschlusschutzeinricht <i>Fuse / Short-circuit protection device</i>	Silberdraht <i>silver wire</i>
Verhalten bei Gleichstromanteilen <i>Behaviour in presence of d.c. components</i>	Typ B <i>Type B</i>
Umgebungstemperatur <i>Ambient temperature</i>	-25°/+40°C
Anbringungsart <i>Attachment type</i>	Tragschienenmontage <i>DIN rail mounting</i>
Anschlussart <i>Type of termination</i>	Schraubklemmen <i>screw-type terminals</i>

Name und Sitz des Genehmigungs-Inhabers / *Name and registered seat of the Certificate holder*

ZHEJIANG ETEK Electrical Technology CO.,LTD., NO.288, Wei 17th Road, Yueqing Economic Development Zone, 325600 YUEQING, WENZHOU, Zhejiang, CHINA

Aktenzeichen / *File ref.*

5027864-1720-0001 / 286311 / TL3 / KOH

Datum / *Date*

2021-12-09

Dieses Beiblatt ist Bestandteil des Zeichengenehmigungsausweises Nr. 40054469.

This supplement is part of the Certificate No. 40054469.

**Fehlerstromschutzschalter ohne eingebauten
Überstromschutz,netzspannungsunabhängig (RCCB)**
***RCCB, residual current operated circuit-breaker without integral
overcurrent protection, functionally independent of line voltage***

Fertigungsstätte(n)

Place(s) of manufacture

Referenz/*Reference*

30026643

ZHEJIANG ETEK Electrical
Technology CO.,LTD.
NO.288, Wei 17th Road
Yueqing Economic Development Zone
325600 YUEQING, WENZHOU
Zhejiang
CHINA

Name und Sitz des Genehmigungs-Inhabers / Name and registered seat of the Certificate holder

ZHEJIANG ETEK Electrical Technology CO.,LTD., NO.288, Wei 17th Road, Yueqing Economic Development Zone, 325600 YUEQING, WENZHOU, Zhejiang, CHINA

Aktenzeichen / File ref.

5027864-1720-0001 / 286311 / TL3 / KOH

Datum / Date

2021-12-09

Dieses Blatt gilt nur in Verbindung mit Blatt 1 des Zeichengenehmigungsausweises Nr. 40054469.

This supplement is only valid in conjunction with page 1 of the Certificate No. 40054469.

Genehmigung zum Benutzen des auf Seite 1 abgebildeten markenrechtlich geschützten Zeichens des VDE:

Grundlage für die Benutzung sind die Allgemeinen Geschäftsbedingungen (AGB) der VDE Prüf- und Zertifizierungsinstitut GmbH (www.vde.com\AGB-Institut). Das Recht zur Benutzung erstreckt sich nur auf die bezeichnete Firma mit den genannten Fertigungsstätten und die oben aufgeführten Produkte mit den zugeordneten Bezeichnungen. Die Fertigungsstätte muss so eingerichtet sein, dass eine gleichmäßige Herstellung der geprüften und zertifizierten Ausführung gewährleistet ist.

Die Genehmigung ist so lange gültig wie die VDE-Bestimmungen gelten, die der Zertifizierung zugrunde gelegen haben, sofern sie nicht auf Grund anderer Bedingungen aus der VDE Prüf- und Zertifizierungsordnung (PM102) zurückgezogen werden muss.

Der Gültigkeitszeitraum einer VDE-GS-Zeichengenehmigung kann auf Antrag verlängert werden. Bei gesetzlichen und / oder normativen Änderungen kann die VDE-GS-Zeichengenehmigung ihre Gültigkeit zu einem früheren als dem angegebenen Datum verlieren.

Produkte, die das Biozid Dimethylfumarat (DMF) enthalten, dürfen gemäß der Kommissionsentscheidung 2009/251/EG nicht mehr in den Verkehr gebracht oder auf dem Markt bereitgestellt werden.

Der VDE-Zeichengenehmigungsausweis wird ausschließlich auf der ersten Seite unterzeichnet.

Approval to use the legally protected Mark of the VDE as shown on the first page:

Basis for the use are the general terms and conditions of the VDE Testing and Certification Institute (www.vde.com\terms-institute). The right to use the mark is granted only to the mentioned company with the named places of manufacture and the listed products with the related type references. The place of manufacture shall be equipped in a way that a constant manufacturing of the certified construction is assured.

The approval is valid as long as the VDE specifications are in force, on which the certification is based on, unless it is withdrawn according to the VDE Testing and Certification Procedure (PM102E).

The validity period of a VDE-GS-Mark Approval may be prolonged on request. In case of changes in legal and / or normative requirements, the validity period of a VDE-GS-Mark Approval may be shortened.

Products containing the biocide dimethylfumarate (DMF) may not be marketed or made available on the EC market according to the Commission Decision 2009/251/EC.

The approval is solely signed on the first page.



Declaration of conformity

Manufacturer : Embraco Slovakia s.r.o.

Odorínska cesta 2, 052 01 Spišská Nová Ves, Slovakia
tel. +421 53 4172 110, 111

We hereby declare as manufacturer that the following products:

Embraco Condensing Units series (including electrical parts)

UGT, UGNT, UGNJ, UCNJ, UCNT, UNE, UNEK, UNEU, UNEX, UVNEK, UVNEU, UT, UNT, UNTX, USE, UJ, UNJ, UNJX, UEMC, UEMT, UEMX, UHNJ, UGHNJ, UHNT, UGHNT, ULEMT, ULNE, ULNEK, ULNEU, ULNT, ULNJ, USEMT, USNE, USNEK, USNEU, USNT, USNJ, U2NT, U2NJ, U3NT, U3NJ, UDH, UDL, UH, UL, USVNEK, ULVNEU, ULVNEK

are in conformity with the following Directive(s):

2014/35/EU Low Voltage Directive (LVD)

2011/65/EU RoHS II Directive

2015/863/EU RoHS III Commission Delegated Directive

2009/125/EC Ecodesign Directive

following standards were applied:

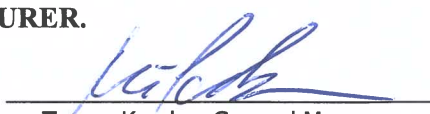
EN 60335-1	Safety of household and similar electrical appliances – Part-1- General
EN 60335-2-34	Safety of household and similar electrical appliance – Part 2-34- Particular requirements for motor compressors.
EN 50581	Technical documentation for the assessment of electrical and electronic equipment with respect to the restriction of hazardous substances.
EN 13771-2	Compressors and condensing units for refrigeration – part-2- Performance testing and test methods. Condensing units.

However, it is not allowed to put our product into operation until the machine into which it is to be incorporated or of which it is to be a part has been found and declared to be in conformity with the provisions of legislation, i.e. as a whole, including the products subject of this declaration.

THIS DECLARATION OF CONFORMITY IS ISSUED UNDER THE SOLE RESPONSIBILITY OF MANUFACTURER.

In Spišská Nová Ves

On March 15th, 2021


Tomas Kandra, General Manager

Embraco Slovakia s.r.o., Odorínska cesta 2, 052 01 Spišská Nová Ves, Slovakia, Tel: +421 53 41 72 110

ID No.: 35 734 132, VAT ID No.: SK2020269295, IBAN: SK21 1111 0000 0066 1168 9000, SWIFT: UNCRSKBX
Company is registered in the Commercial Register of District Court Košice I, part Sro, insertion No. 10327/V

Declaration of incorporation

Manufacturer : Embraco Slovakia s.r.o.
Odorínska cesta 2, 052 01 Spišská Nová Ves, Slovakia
tel. +421 53 4172 110, 111

We hereby declare as manufacturer that the following products:

Embraco Condensing Units series (including electrical parts)

UGT, UGNT, UGNJ, UCNJ, UCNT, UNE, UNEK, UNEU, UNEX, UVNEK, UVNEU, UT, UNT, UNTX, USE, UJ, UNJ, UNJX, UEMC, UEMT, UEMX, UHNJ, UGHNJ, UHNT, UGHNT, ULEMT, ULNE, ULNEK, ULNEU, ULNT, ULNJ, USEMT, USNE, USNEK, USNEU, USNT, USNJ, U2NT, U2NJ, U3NT, U3NJ, UDH, UDL, UH, UL, USVNEK, ULVNEU, ULVNEK

is in conformity with the following Directive:

2006/42/EU Machinery Directive

following standards were applied:

EN 378-2 Refrigerating systems and heat pumps. Safety and environmental requirements. Design, construction, testing, marking and documentation.

Compliance with the Machinery Directive **2006/42/EU** as **partly completed machinery**.

We confirm that following special technical documents are prepared before placing the products above on the market:

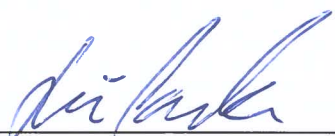
- a. relevant technical documentation which is compiled in accordance with part B of Annex VII
- b. assembly instructions in accordance with Annex VI

The relevant documentation to the products mentioned above is available on the request within a reasonable time.

Embraco condensing unit shall not be put into operation until the final machinery into which it is incorporated is declared to be in accordance with the provisions of Machinery Directive 2006/42/EC.

In Spišská Nová Ves

On March 15th, 2021


Tomas Kandra, General Manager