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Functional Design Specification

LOWENCO -80°C Temperature Freezers

Customer: Client

Project: Client

Units: LSSU -80°C Freezer

Table of Contents

1 Introduction

This document describes the functionality of the control for the -80°C freezer equipment delivered to Client by LOWENCO A/S. The freezer is designed for storing 3.200 kg. at -80°C.

The system consists of two independent refrigeration plants, each capable of keeping temperature at the desired setpoint inside the freezer during normal running conditions. The systems can be controlled from two common HMI´s, one located outside the anteroom and one in the technical space on top of the freezers. The HMI´s communicate internally via ethernet modbus TCP/IP connection. Both refrigeration systems have their own control board based on a Siemens S7-1500 series PLC.

The compressor plants are of cascade type, which means that each plant has two separate cooling systems. The LT system is operating with R508B and is connected to the evaporator inside the duct system of the LSSU. The HT system is operating with R449A and this circuit is only located on the compressor skid and connected to the LT system with a cascade heat exchanger (HEX703).

The HT system is acting as a condenser for the LT system, therefore the LT compressor (COM101) force starts the HT compressor (COM401) to keep the condensing pressure down on the LT circuit.

The condenser for the HT system is a water-cooled circuit with Propylene glycol (30%) as cooling medium and is connected to the drycooler (DC501), placed outside on the roof.

2 References

The control system consists of three control panels as listed:

Panel +A1	Main Control Panel – System 1
Panel +B1	Main Control Panel – System 2
Panel +C1	Room Control Panel – Common for system 1 and 2

3 Automated components

Section 3.1 contains a list of automated components within the system including a description of the abbreviations used in this Functional Design Specification.

3.1 Automated components System 1 / System 2

Tag:	Description:
-COM101	LT compressor
-COM401	HT compressor
-DC501	Drycooler fan
-DT001	Drain tracing
-EEV001	Electronic expansion valve
-EF001	Evaporator fan
-EFH001 heating	Evaporator fan heating
-MHH001 (MHC001 + MHF001)	Maintenance hatch heating
-MV101 (Normally Closed)	LT compressor oil return solenoid valve
-MV102 (Normally Open)	LT compressor discharge line shut off solenoid valve
-MV103 (Normally Closed)	LT hot gas defrost solenoid valve
-MV201 (Normally Open)	Liquid line pressure control solenoid valve to expansion tank
-MV202 (Normally Closed)	Suction line startup solenoid valve from expansion tank
-MV203 (Normally Open)	Suction line pressure control solenoid valve to expansion tank
-MV204 (Normally Closed)	Oil return solenoid valve from expansion tank
-MV401 (Normally Closed)	HT liquid line solenoid valve
-PUM502	Circulation pump, glycol circuit
-Room Tracing	Door heating + Pressure relief valve heating
-VS501	Motorized 3-Way valve

3.2 Security access levels

To adjust the set points, and control the system, the user needs to log in. Below are the different access levels and their permissions.

Function	Operator	Supervisor	Administrator	LOWENCO
Navigate the HMI	X	X	X	X
Acknowledge Alarms	X	X	X	X
Reset Failure	-	X	X	X
Start and Stop	-	X	X	X
View Setpoints	X	X	X	X
View and export Audit Trail	-	X	X	X
Manual Lead/Lag switch	-	X	X	X
Force start/stop Defrost	-	X	X	X
Trend Config	-	-	X	X
Change Setpoints	-	-	X	X
Administration	-	-	X	X
Restart settings after a power loss	-	-	-	X

Table of security access levels X = allowed

4 Power failure and recovery

This section describes the system's behavior during partial or total loss of power, including both main supply and UPS failure scenarios. The functionality is designed in accordance with GAMP5 guidelines and supports GMP-compliant operation with full traceability and fail-safe recovery. Validation of this functionality is referenced in FAT protocol.

4.1 Main Power Supply Failure

Redundant Supply Configuration:

Each freezer is supplied with two separate cooling systems. The two cooling systems are supplied from two different transformer lines.
System 1 is supplied from transformer line 1.
System 2 is supplied from transformer line 2.
In the event of failure on one supply line, the second system will automatically take over without interrupting operation.

Fail-safe Activation:

If both main supplies are lost, the system transitions to a defined fail-safe state. All outputs are de-energized, preventing unintended reactivation upon unstable power return.

System Recovery upon Power Resumption:

Depending on the configured restart mode, the system behaves as follows:

Manual Restart:

The operator must log in via the HMI (access level ≥ Supervisor), acknowledge the power failure alarm and manually initiate system restart. All actions are logged with user ID and timestamp in the audit trail.

Automatic Restart:

The system automatically detects stable power restoration, clears the relevant alarm, and reinitializes the system, provided all safety and process interlocks are in a healthy state.

Lead Priority Behavior:

If both power sources have been unavailable, the unit that first receives restored power will automatically assume the Lead role and trigger master startup sequence.

4.2 UPS Failure

Immediate Shutdown of Control System:

Loss of UPS power results in immediate shutdown of the PLC and control logic. Volatile memory (RAM) is lost, and all active processes are halted.

Fail-safe State Enforcement:

The system enters a predefined fail-safe state, where all outputs are deactivated to prevent hazardous or unintentional actions.

Non-volatile Program Storage:

All control programs, configuration files, and parameters are stored on the PLC's SD memory card. This ensures data integrity. The SD card is validated and protected against unauthorized modifications.

Automated Recovery:

Upon restoration of UPS power, the PLC automatically reloads the program and configuration from the SD card. The system reinitializes, contingent on all safety interlocks being in a validated state. The recovery event is logged in the audit trail, including timestamp and system status.

4.3 Data Logging and Retention

All process data, alarm history, and event logs are stored redundantly on local HMI hard drives. Data is retained for a minimum of 12 months in accordance with GMP requirements and can be reviewed or exported for audit purposes.

4.4 Fail-Safe State Overview

A detailed overview of device-level fail-safe states is provided on the table 4.1 below.

Table 4.1 – Fail-Safe Conditions

Item	Fail-Safe Condition	Default State (NO/NC)	Mechanical Fail Position	Reference / Tag ID
LT Compressor	Compressor will stop.	N/A	Stop	COM101
HT Compressor	Compressor will stop.	N/A	Stop	COM401
Circulation Pump	Pump will stop	N/A	Stop	PUM502
Drycooler fan	Drycooler fan will stop.	N/A	Stop	DC501
Evaporator fan	Evaporator fan will stop.	N/A	Stop	EF001
Evaporator fan heater	Evaporator fan heater will stop.	N/A	Stop	EFH001
Maintenance hatch heating	Maintenance hatch heating will stop.	N/A	Stop	MHH001
Motorized valve	Valve will stop and retain last position or go to fail-safe.	N/A	Last pos. / fail pos.	VS501
Room heating	Room heating will stop.	N/A	Stop	RH901
LT compressor oil return solenoid valve	Valve will de-energize and assume default position.	NC	Normally Closed	MV101
LT compressor discharge line shut off solenoid valve	Valve will de-energize and assume default position.	NO	Normally Open	MV102
LT hot gas defrost solenoid valve	Valve will de-energize and assume default position.	NC	Normally Closed	MV103
Liquid line pressure control solenoid valve to expansion tank	Valve will de-energize and assume default position.	NO	Normally Open	MV201
Suction line startup solenoid valve from expansion tank	Valve will de-energize and assume default position.	NC	Normally Closed	MV202
Suction line pressure control solenoid valve to expansion tank	Valve will de-energize and assume default position.	NO	Normally Open	MV203
Oil return solenoid valve from expansion tank	Valve will de-energize and assume default position.	NC	Normally Closed	MV204
HT liquid line solenoid valve	Valve will de-energize and assume default position.	NO	Normally Open	MV401

5 Communication HMI/PLC

Each HMI panel is equipped with an IPC 677E for handling communication with main control panel CPU's.

RM3136_HMI_01-TS connects primarily with storage freezers System 1.
RM3136_HMI_02-AR connects primarily with storage freezers System 2.

All storage freezers, the corridor and the anteroom have active communication between the two systems.

If communication between system 1 and system 2 fails, both systems will go into lead mode.

6 Running condition (Cooling sequence)

6.1 Cooling sequence – Setpoint operation

When the room temperature reaches a level above the main set-point (ST1) + main difference (P1), the system, which is in lead, will start the normal cooling sequence (Fig.01).

- The HT compressor (COM401) start signal is trigged and the startup sequence is activated. The (EEV001) will open at a fixed opening % and the LT compressor (COM101) startup sequence is activated. LT compressor is not capable of starting, if the HT compressor is not running.
- Under normal running conditions – Several PID controllers controlling the system to reach the setpoints.
- (TT001) are room temperature and used as control temperature. If there is a transmitter error on (TT001), (TT002) will take over as control temperature.
- When the room temperature reaches the main set-point (ST1), the electronic expansion valve (EEV001) de-energizes and the system will stop – When suction pressure for the LT compressor is reached

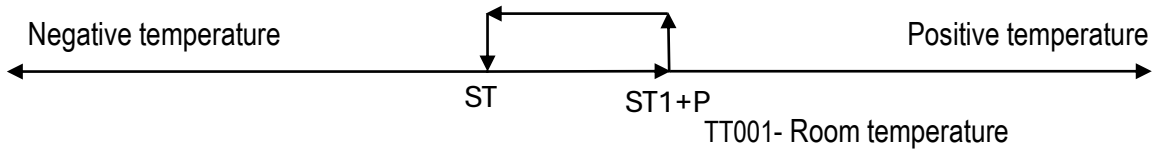
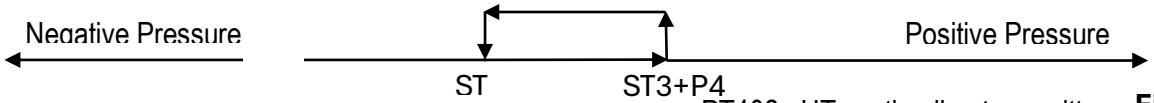


Fig.

6.2 Operating condition and startup sequence – HT compressor

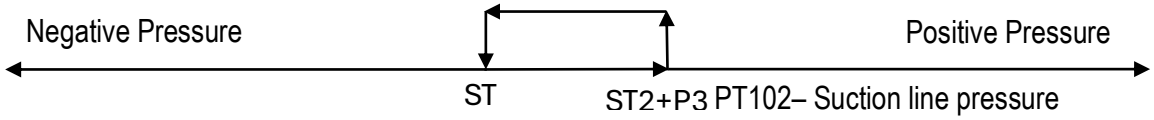
- When the cascade cooling sequence is activated, it triggers the start signal for the HT compressor (COM401).
- The (MV401) will open and when the suction pressure reaches a level above suction pressure setpoint (ST3) + pressure difference (P4)(Fig.02) the HT compressor will start, if the min. off time (CD2) has ended
- The frequency inverter of the HT compressor (COM401) operates the compressor at set point (ST3).
- When the "6.1 cooling sequence – Setpoint operation" and the HT compressor min. on time (CD1) have ended, the solenoid valve (MV401) will close, and the HT compressor will stop.
- (MV401) will always be active while COM101 is running.
- If the suction pressure (PT102) goes below -0,7 bar an alarm will occur after the delay (300s) .
- If the discharge pressure (PT101) goes above 25,2 bar on PSH101 will stop the compressor (COM101).



PT402– HT suction line transmitter **Fig.**

6.3 Operating condition and startup sequence – LT compressor

- When the HT system is running the LT compressor (COM101) start signal is triggered.
- The electronic expansion valve (EEV001) is energized and when the suction pressure (PT102) reaches a level above the LT compressor set-point (ST2) + LT compressor difference (P3)(Fig.03) and the 10 sec. delay after HT compressor start has ended, the LT compressor will start.
- After the LT compressor (COM101) min. off time (CD2) has ended, the compressor (COM101) starts
- If the superheat is below setpoint (ST6) at startup the Expansion valve (EEV001) preconditioning function will make an offset for a short period of time, forcing the valve to open.
- The electronic expansion valve (EEV001) will now control after superheat.
- To prevent high liquid pressure (PT201) at startup and pull down the pressure is controlled by opening (MV201) and (MV202) and moving refrigerant to the expansion tank (ET201).
- The frequency inverter of the LT compressor (COM101) operates the compressor at set point (ST2).
- After reaching setpoint (ST1) the electronic expansion valve (EEV001) is de-energized and the suction pressure (PT102) reaches a level below the LT compressor set-point (ST2)
- If the suction pressure (PT102) goes below -0,7 bar an alarm will occur.
- If the discharge pressure (PT101) goes above 27,9 bar on PSH101 will stop the compressor (COM101).
- If the suction pressure (PT102) reaches a level above 7 bar when system is in standby/Lag mode, the LT compressor start-up to perform a pump-down cycle.



PT102– Suction line pressure **Fig.**

6.4 Oil return LT compressor

The LT compressor has a passive oil system. The solenoid valve (MV101) will be active together with the compressor and when the oil level in the separator rises the oil will be returned to the compressor.

6.5 Compressor recommended start/stops per hour

The recommended maximum start/stops per hour is determined by the compressor manufacturer to 8 no. of start/stops per hour. This is a fixed parameter in the software. When the compressor have been started more than 8 times on an hour – An alarm will occur

6.6 Compressor minimum on/off time

LOWENCO recommends a min. on time (CD1) and a min. off time (CD2) when the compressor has been started/stopped.

- Min. on time (CD1) will keep the compressor running and if setpoint (ST1) is reached within the min. on time (CD1) cooling sequence will keep running and overruled (e.g., door opening).
- When the compressor is stopped the min. off time (CD2) will keep the system stopped until the min. off time (CD2) has ended. If the room temperature reaches a level above the main set-point (ST1) + main difference (P1) min. off time will be overruled

6.7 Door switch

All doors are equipped with door switches once closed enables the operation of electronic expansion valve (EEV001) and evaporator fan (EF001). Every door opening and time of door opening is logged in the room trend

7 Running condition – Assist cooling sequence

7.1 Running condition – setpoint operation – Assist cooling sequence

If the room temperature reaches a level above the main set-point (ST1) + main difference (P1) + assist difference (P2), the lag system will start the assist cooling sequence. The lead systems temperature transmitter (TT001) activates the assist cooling sequence (Fig.04).

- When the lead systems room temperature (TT001) reaches a level above main set-point (ST1) + main difference (P1) + assist difference (P2), the assist system starts the cooling sequence. When the electronic expansion valve (EEV001) is activated, the status will change from lag to assist.
- Both lead & assist systems will operate until the room temperature (TT001) for the lead system reaches (ST1), the PLC's then de-energizes the electronic expansion valve (EEV001) on both systems.

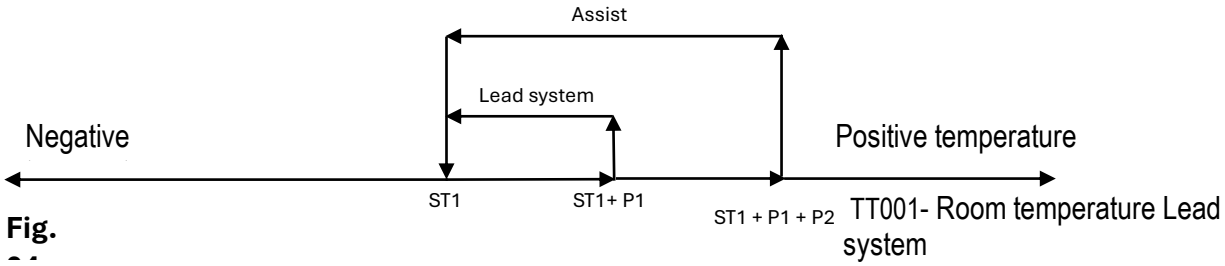


Fig.

8 Disable High/Hi Hi Alarm function

When a freezer is loaded with ambient products the room temperature will rise inside the freezer.

The temperature can reach the room Hi alarm (AH1) and room Hi Hi alarm (AH2) setpoints and activate the alarm.

The user can press the "Disable High/Hi Hi Alarm" button on the HMI after loading products.

Pressing the "Disable High/Hi Hi Alarm" button will suppress the room high (AH1) and room Hi Hi alarm (AH2), on the lead system, for a user with access to changing setpoints, determined period of AD5 hours. When the "Disable High/Hi Hi Alarm" button is pressed, a confirmation popup window will appear on the HMI where the user need to confirm that High/Hi Hi Alarm Disable is correctly selected. Once the "Disable High/Hi Hi Alarm" is pressed a countdown timer showing AD5 period will emerge on the HMI, and the "Disable High/Hi Hi Alarm" button will disappear so it cannot be pressed again and therefore it is not possible to reset the timer.

If the "Disable High/Hi Hi Alarm" is activated unintentionally, the "Enable High/Hi Hi Alarm" button can be pressed. A confirmation popup window will appear when "Enable High/Hi Hi Alarm" is pressed.

When the period AD5 hours runs out, the freezer continues in normal operation with adjustable parameter settings for room High (AH1) and room Hi Hi alarm (AH2).

The disabled High/Hi Hi alarm is a common function for both systems.

9 Lead/Lag mode

Normal operating conditions

Under normal operating conditions the two systems operate in lead/lag mode.

In this mode, the lag system is always in back-up for the lead system. If the lead system either fails or by some reason cannot keep the temperature inside the freezer, the lag system automatically goes in assist mode, to maintain the desired room temperature.

The alarms related to the room temperature probe (TT001) for the lag system is suppressed when the unit is in lag or in assist – That is due to in lag mode, the temperature in the duct system can be higher than the alarm limit.

Starting up from switched off condition

The system that is started first is dedicated as the lead system. When the second system is powered up, it will automatically be dedicated as the lag / assist system.

The lead/lag assignment will automatically change at every defrost session. This means that once the lead system goes to defrost mode, the lag system will automatically be dedicated as lead to maintain the desired temperature inside the freezer. The system that is defrosting is after ended defrost dedicated as the lag system and ready to assist the lead or take over in case of a malfunction of the lead.

Failure condition

If a failure occurs on the lead system, the lag system will be dedicated as lead system. In a situation where the fan release temperature (FT) for the new lead system is not achieved yet – it will when the (FT) has been reached on (TT003) see section - 10 Evaporator fan control

The lead/lag assignment can be changed manually from both HMI panels. The changeover can be performed by pressing the “Lead” or “Lag” button on the control page of the HMI on the preferred system.

10 Evaporator fan control

- In normal running condition the evaporator fan (EF001) of the lead compressor system is always on to keep the freezer well ventilated, ensuring a temperature as equal as possible in the entire room.
- In pull down the fan will start when the evaporator coil temperature (TT003) reaches the desired value, fan release temperature (FT).
- The evaporator fan (EF001) of the lag system is always off in normal running condition and will only switch on in case the assist cooling sequence, or lead/lag changeover is activated.
- The evaporator fan(s) (EF001) for both systems will stop when the door is opened, and if the emergency stop is activated.
- After a natural stop i.e., lead/lag switch over or door opening the fan will start when (FT) is reached.
- When the temperature increases to (ST1+P1+P2) and assist cooling is activated. The fan for the assist system will start when (FT) is reached. This is to ensure that the remaining heat in the coil and duct is removed before starting to ventilate the room.

11 Defrost sequence

The defrost sequence is triggered by timer (D1) or force start defrost.
When the defrost sequence is trigged the lead system switch to “Lead Preparing Defrost” and the lag system starts up in “Assist Preparing Defrost”, assisting the lead system to reach the room set point (ST1) - 0,5K. When the setpoint is reached the lead systems go to defrost and the lag system switch to lead and will continue to run during the defrost period.

- The defrosting of the evaporator is performed with hot gas defrost by running the LT compressors (COM101) hot gas directly into the evaporator coil. When the defrost sequence is activated the fan (EF001) will be off.
- The LT compressor discharge solenoid valve (MV102) will energize (normally open valve) and isolate the refrigerant flow to the defrost pipeline.
- Defrost solenoid valve (MV103) will energize and the hot gas will flow through the evaporator and back to the compressor.
- During defrost the temperature in the evaporator coil (TT003) is maintained at DC (defrost control temperature) When (TT003) reaches DC the compressor will ramp down to 30Hz. The compressor will be able to ramp up when defrost control temperature is below DC - P6 (defrost control difference) (Fig. 06)

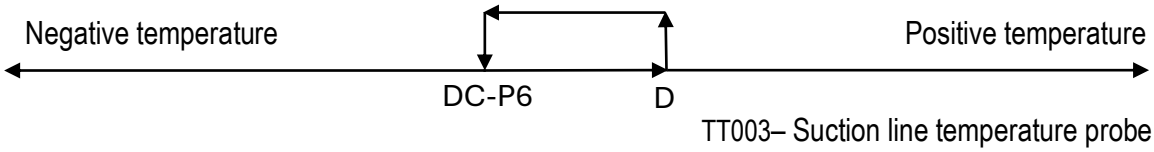


Fig.

- During hot gas defrost sequence, the compressor is limited by high temperature, monitored on the LT discharge temperature transmitter (TT101 = max.130 °C) and LT discharge pressure transmitter (PT101 = max 25 bar). If any of these limits are reached, the frequency inverter will automatically decrease the frequency to lower pressure or temperature.
- The defrost will continue until the defrost stop temperature set-point (DS) has been reached, or the defrost timeout (DT) timer has passed.

- Defrost stop temperature set-point (DS) is an adjustable parameter and can be adjusted. The stop control temperature TT001 and TT002 is measured in the duct system. If the defrost stop temperature set-point (DS) is not reached within the defrost timeout (DT) period, the defrost will stop.
- Defrost timeout (DT) period is an adjustable parameter.
- After end defrost, defrost drip time (DD) is activated for a desired period (min), after drip time the system will go in assist.
- To avoid increase in temperature inside the freezer the defrosted system will enter assist cooling and activate duct cooling. This function will release the evaporator fan only if both TT002 air supply and TT001 air return temperate sensors show values below -50°C and the lead system is in range and below -69.5C. This is to ensure that as much heat is removed before circulating air to the room

Defrost on timer (D1)

When the lead system has been running for a period of (D1) hours, the defrost sequence starts. The lag system starts up in assist mode, assisting the lead system to reach the room set point (ST1). Once the room set point has been reached on the lead and assist system, the lead system will go into defrost mode and the assist system becomes lead.

Force start defrost

The defrost sequence can be forced started manually by pressing the force start defrost button on the HMI on the control page. This action will override the defrost timer (D1) and start a normal defrost sequence. The lag system starts up in assist mode, assisting the lead system to reach the room set point (ST1).

Once the room set point has been reached on the lead and assist system, the lead system will go into defrost mode and the assist system becomes lead.

Instant defrost

The instant defrost sequence can only be started by a LOWENCO technician, by pressing the instant defrost button on the control page. Once initiated a defrost will start immediately on the desired system, with no regards for the temperature.

Force stop defrost

To abort the defrost session manually, press the force defrost stop button on the HMI.
A defrost sequence interrupted alarm will occur.
The system will go into drip time before returning to normal running conditions.

12 LT compressor Operation

12.1 LT Compressor Frequency Inverter

The system is operating with a frequency inverter on the LT compressor (COM101) to perform capacity regulation at various loads.
The frequency inverter also ensures that the discharge temperature (TT101) on the LT compressor (COM101) is maintained below 130°C to ensure good lubricant performance of the compressor oil.
The frequency inverter also limits the output if the discharge pressure (PT101) rises to 25 bar (fixed parameter) during operation.
The frequency inverter is limited to operate at frequencies between 30 and 70 Hz.

Fixed regulating parameters:

The compressor discharge temperature transmitter (TT101) and the LT discharge pressure transmitter (PT101) are used as reference to ensure the following:

- TT101 ≤ 120°C = The frequency inverter is allowed to increase the frequency until 70 Hz
- TT101 > 130°C = The frequency inverter automatically decreases the frequency
- PT101 ≤ 21 bar = The frequency inverter is allowed to increase the frequency until 70 Hz
- PT101 > 25 bar = The frequency inverter automatically decreases the frequency

The frequency inverter is allowed to increase the frequency until the nominal current level. 1A above the nominal current the inverter decreases the frequency.

12.2 LT Compressor limitations

LT compressor is protected from hazards by the PLC with below descriptions.

- If the suction pressure (PT102) goes below -0,7 bar (ST8) for more than 300 sec (AD7) the compressor will stop and a alarm occur.
- If the discharge pressure (PT101) goes above 27,9 bar – Pressure safety switch (PSH101) will stop the compressor (COM101).

13 HT compressor operation

13.1 HT Compressor Frequency Inverter

The system is operating with a frequency inverter on the HT compressor (COM401) to perform capacity regulation at various loads. The frequency inverter also ensures that the discharge temperature (TT401) on the HT compressor (COM101) is maintained below 130°C to ensure good lubricant performance of the compressor oil.

The frequency inverter also limits the output if the discharge pressure (PT401) rises to 21bar (fixed parameter) during operation.

The frequency inverter is limited to operate at frequencies between 30 and 70 Hz.

Fixed regulating parameters:

- The Discharge pressure transmitter (PT401) is used as a reference to ensure the following:
- TT401 ≤ 120°C = The frequency inverter is allowed to increase the frequency until 70 Hz
- TT401 > 130°C = The frequency inverter automatically decreases the frequency
- PT401 ≤ 19 bar = The frequency inverter is allowed to increase the frequency until 70 Hz
- PT401 > 21 bar = The frequency inverter automatically decreases the frequency
-

The frequency inverter is allowed to increase the frequency until the nominal current level. 1A above the nominal current the inverter decreases the frequency.

13.2 HT Compressor limitations

HT compressor is protected from hazards by the PLC with below descriptions.

- If the suction pressure (PT402) goes below -0,7 bar (ST10) for more than 300 sec (AD8) the compressor will stop and an alarm occurs.
- If the discharge pressure (PT401) goes above 25,2 bar – Pressure safety switch (PSH401) will stop the compressor (COM401).

14 Heating control

The system is fitted with the below listed heating devices. If a failure occurs on one of the heating elements and a reset is performed from the HMI, the heating will automatically turn on again, The heating elements is detected with a amperage surveillance relay – Upper and lower limits is set in the amperage surveillance relay – If the heating element performance changes and the upper and lower limits is breach, and alarm will occur.

- Drain tracing

  The drain tracing (DT001) is active during defrost sequence and drip time (DD) to ensure ice buildups in the drainpipes from the evaporators will melt during a defrost session. This allows water to flow freely through the drainpipes.

- Maintenance hatch tracing

  The maintenance hatch heating (MHC001) and (MHF001) is active when the system room temperature transmitter (TT001) is reading below -5°C (fixed), and is deactivated when the temperature increases and reaches 0°C.

- Evaporator fan motor heating

  The evaporator fan motor heating (EFH001) is active when system room temperature transmitter (TT001) is reading below -5°C (fixed), and is deactivated when the temperature increases and reaches 0°C.

- Door heating and pressure relief valve heating

  The door heating and pressure relief valve heating (RRH901) is active when the system room temperature transmitter (TT001) is reading below -5°C (fixed), and is deactivated when the temperature increases and reaches 0°C.

15 Expansion tank control

The normally open (NO) solenoid valves (MV201) and (MV203) control the refrigerant flow to the expansion tank (ET201). The valves de-energize (open) at fixed values as per below:

- MV201 LT Liquid line opening pressure (de-energize): 23 bar, closing pressure (energize): 20 bar.
- MV203 LT Suction Line opening pressure (de-energize): 11 bar, closing pressure (energize): 8 bar.

When the system is in lead or assist mode, the solenoid valves will remain energized (closed), unless the above pressure values are reached.

The solenoid valves will de-energize and open in the following scenarios:

- The system is stopped
- The system is in lag mode
- A failure occurs
- Power failure

The normally closed (NC) solenoid valve (MV204) controls the oil return from the expansion tank. (MV204) will open when there is a pressure difference of 4,0 bar between the expansion tank pressure (PT202) and suction pressure (PT102).
(MV204) will remain open for 30 seconds.

The normally closed (NC) solenoid valve (MV202) control the refrigerant return from the expansion tank through the crankcase pressure controller (CVP201). (MV202) will open when start up sequence is started. Crankcase pressure controller (CVP201) will maintain the suction pressure below 2,0 bar until all the refrigerants are returned to the main system.

16 Manual control

The following components can be operated in manual mode:

- The LT compressor (COM101) can be operated manually, only with LOWENCO user login
- The HT compressor (COM401) can be operated manually, only with LOWENCO user login
- The evaporator fans (EF001) can be operated manually, only with LOWENCO user login.
- The circulation pump (PUM502) can be operated manually, only with LOWENCO user login.
- The drycooler (DC501) can be operated manually, only with LOWENCO user login.
- The electronic expansion valves (EEV001) can be operated manually, only with LOWENCO user login.
- The oil return solenoid valve (MV101) can be operated manually, only with LOWENCO user login.
- The discharge line shut off solenoid valve (MV102) can be operated manually, only with LOWENCO user login.
- The LT hot gas defrost solenoid valve (MV103) can be operated manually, only with LOWENCO user login.
- The liquid line expansion tank solenoid valve (MV201) can be operated manually, only with LOWENCO user login.
- The suction line return expansion tank solenoid valve (MV202) can be operated manually, only with LOWENCO user login.
- The suction line supply expansion tank solenoid valve (MV203) can be operated manually, only with LOWENCO user login.
- The expansion tank oil return solenoid valve (MV204) can be operated manually, only with LOWENCO user login.
- The HT cascade liquid line solenoid valve (MV401) can be operated manually, only with LOWENCO user login.
- The 3-way control valve (VS501) can be operated manually, only with LOWENCO user login.
- The maintenance hatch heating (MHC001) (MHF001) can be operated manually, only with LOWENCO user login.
- The room tracing (RT901) can be operated manually, only with LOWENCO user login.
- The evaporator fan heating (EFH001) can be operated manually, but only with LOWENCO user login.
- The drain tracing (DT001) can be operated manually, but only with LOWENCO user login.

17 Adjustable Parameter List -72°C

Parameter List -72°C	P&ID tag	Parameter	Units	Min.	Max.	Default Value	Parameter Type	Password Level			
								Operator	Supervisor	Administrator	LOWENCO
Room setpoints											
Main setpoint	TT001	ST1	°C	-85	-40	-72	Parameter	-	-	x	x
Main difference		P1	°C	1	10	1,5	Parameter	-	-	x	x
Assist difference		P2	°C	1	10	1,5	Parameter	-	-	x	x
Temperature Alarm setpoints											
Room temperature High	TT001	AH1	°C	-90	40	-60	Alarm	-	-	x	x
Delay room temperature High		AD1	Min	0	60	30	Alarm	-	-	x	x
Room temperature Hi Hi	TT001	AH2	°C	-90	40	-55	Alarm	-	-	x	x
Delay room temperature Hi Hi		AD2	Min	0	60	30	Alarm	-	-	x	x
Room temperature Low	TT001	AL1	°C	-90	40	-75	Alarm	-	-	x	x
Delay room temperature Low		AD3	Min	0	60	5	Alarm	-	-	x	x
Room temperature Lo Lo	TT001	AL2	°C	-90	40	-80	Alarm	-	-	x	x
Delay room temperature Lo Lo		AD4	Min	0	60	5	Alarm	-	-	x	x
Delay High/Hi Hi alarm disable	TT001	AD5	Hour	1	99	48	Alarm	-	-	x	x
Door open temperature	TT001	DA	°C	-90	40	-51	Alarm	-	-	x	x
Evaporator setpoints											
Evaporator fan release temperature	TT003	FT	°C	-100	40	-60	Parameter	-	-	x	x
Evaporator superheat	TT003 - PT001	ST6	K	0	20	4	Parameter	-	-	x	x
Defrost setpoints											
Defrost time interval		D1	Hour	0	200	72	Parameter	-	-	x	x
Defrost control temperature	TT003	DC	°C	0	20	5	Parameter	-	-	x	x
Defrost control difference		P6	°C	0	10	3	Parameter	-	-	x	x
Drip time		DD	Min	0	30	15	Parameter	-	-	x	x
Defrost timeout		DT	Min	0	90	60	Parameter	-	-	x	x
Defrost stop temperature		DS	°C	0	20	3	Parameter	-	-	x	x
LT Compressor setpoints											
LT compressor pressure	PT102	ST2	Bar	-1	18	0,5	Parameter	-	-	x	x
LT compressor difference		P3	Bar	0,3	18	0,8	Parameter	-	-	x	x
HT compressor setpoints											
HT compressor pressure	PT402	ST3	Bar	-1	18	0,4	Parameter	-	-	x	x
HT compressor difference		P4	Bar	0,3	18	0,5	Parameter	-	-	x	x
Compressor setpoints											
Compressor min. on time		CD1	Sec	0	999	120	Parameter	-	-	x	x
Compressor min. off time		CD2	Sec	0	999	30	Parameter	-	-	x	x
Condenser setpoints											
HT condensing pressure	PT401	ST4	Bar	10	20	14	Parameter	-	-	x	x
Dry cooler outlet temperature	TT501	ST5	°C	20	35	25	Parameter	-	-	x	x

18 Parameters

18.1 Adjustable room regulation parameters

Main set-point:	(ST1) the main set-point is the value of the desired room temperature where the system (both lead and lag) stops
Main difference:	(P1) the main difference is the temperature deviation from the main set-point where the lead system starts.
Assist difference:	(P2) the assist difference is the temperature deviation from the main set-point + main difference where the lag system starts to assist the lead compressor. Once the lag compressor is activated for assist mode, both compressors will run until the main set-point is reached.
Room temperature. High:	(AH1) is the room temperature HI alarm set- point. The alarm is activated when the room temperature exceeds AH1 for a period of time determined by AD1. Sound & light are activated, but the system is still running.
Delay Room temperature. High:	(AD1) this is the time in minutes from when AH1 is exceeded and until the alarm is activated.
Room temperature. HI HI:	(AH2) is the room temperature HI HI alarm set- point. The alarm is activated when the room temperature exceeds AH2 for a period of time determined by AD2. Sound & light are activated, but the system is still running.
Delay Room temperature. HI HI:	(AD2) this is the time in minutes from when AH2 is exceeded and until the alarm is activated.
Room temperature. Low:	(AL1) is the room temperature LO alarm set- point. The alarm is activated when the room temperature exceeds AL1 for a period of time determined by AD3. Sound & light are activated.
Delay Room temperature. Low:	(AD3) this is the time in minutes from when AL1 is exceeded and until the alarm is activated.
Room temperature. Lo Lo:	(AL2) is the room temperature LO LO alarm set- point. The alarm is activated when the room temperature exceeds AL2 for a period of time determined by AD4. Sound & light are activated.
Delay Room temperature. Low:	(AD4) delay for disabling of Hi/HiHi alarms
Delay Hi/HiHi alarm disable:	(AD5) this is the time in minutes from when AL2 is exceeded and until the alarm is activated.
Door open temperature alarm:	(DA) is high temperature alarm activated if the room temperature exceeds DA when a door is open. Sound and light are activated. The alarm is reset by closing the door. Additionally, a door open alarm appears after 2 min. (not adjustable)
Fan release temperature:	(FT) the fan release temperature is the value of the evaporator temperature (TT003) where the evaporator fan starts.
Evaporator superheat:	(ST6) value is visible at the system page. Measured on (PT001) and (TT003).

Defrost time interval:	(D1) the defrost time Interval is the period in hours between defrost. After defrosting a time stamp will be made and after D1 hours a new defrost will start.
Defrost control temperature:	(DC) the defrost control temperature is used to determine when in a defrost sequence the compressor should begin deceleration to control the temperature of the evaporator coil. The value is measured by (TT003).
Defrost control temperature difference:	(P6) the defrost control temperature difference is used to increase or decrease LT compressor frequency under defrost.
Drip time:	(DD) the defrost drip time is the period in minutes, where the compressor and the evaporator fan is forced in off position. This is to make sure all water has cleared the evaporator before starting the system. Assist mode will not overrule the drip time.
Defrost time out:	(DT) the defrost time out is a time in minutes, counting from defrost start. Once the time is reached, the defrost will stop.
Defrost stop temperature:	(DS) the defrost stop temperature defined by (TT001) and (TT002) to ensure all ice build in evaporator duct system is gone.
LT compressor pressure set point:	(ST2) the pressure that the compressors will operate at and the pressure is measured by the suction pressure transmitter (PT101)
LT compressor difference:	(P3) the LT compressor difference to the deviation from ST2 where the LT compressor can start.
HT compressor pressure set point:	(ST3) the temperature that the compressor will operate at, and the temperature is measured by the suction pressure transmitter (PT402).
HT compressor difference:	(P4) the HT compressor difference is the pressure deviation from ST4 where the HT compressor can start.
Comp. min. on time:	(CD1) is the period in seconds where the compressor according to the compressor manufacture must keep running once it has started.
Comp. min. off time:	(CD2) is the period in seconds where the compressor according to the compressor manufacture must stand still once it has stopped.
Condenser pressure set point:	(ST4) value indicates the desired condensing pressure for the HT compressor. Measured on (PT4011).
Dry cooler outlet temperature	(ST5) is the drycooler outlet temperature

19 Visible values

Evaporator air in (room) temperature	(TT001) this value is visible & recorded as a temperature trend.
Evaporator air out temperature:	(TT002) this value is visible & recorded as a temperature trend.

Evaporator coil temperature: (TT003) this value is visible & recorded as a temperature trend.

LT Discharge line temperature: (TT101) this value is visible & recorded as a temperature trend.

LT liquid temperature: (TT201) this value is visible & recorded as a temperature trend.

HT compressor discharge temperature: (TT401) this value is visible & recorded as a temperature trend.

HT compressor suction temperature: (TT402) this value is visible & recorded as a temperature trend.

Glycol inlet temperature: (TT501) this value is visible & recorded as a temperature trend.

Evaporator pressure: (PT001) this value is visible & recorded as a pressure trend.

LT Compressor discharge pressure: (PT101) this value is visible & recorded as a pressure trend.

LT Compressor Suction pressure: (PT102) this value is visible & recorded as a pressure trend.

LT Liquid pressure: (PT201) this value is visible & recorded as a pressure trend.

LT Expansion tank pressure: (PT202) this value is visible & recorded as a pressure trend.

HT Compressor discharge pressure: (PT401) this value is visible & recorded as a pressure trend.

HT Compressor suction pressure: (PT402) this value is visible & recorded as a pressure trend.

Glycol pressure: (PT501) this value is visible & recorded as a pressure trend.

Door: (open/closed) (DS901) this indication is visible & recorded on the room trend.

Defrost status: (on/off) This indication is visible & recorded.

20 Safety devices

Emergency stop system: In front of the main control panel (A1/B1) there is an emergency stop if pressed will stop system one or system two and activate an alarm.

Emergency stop room contr. panel: In front of the common control panel (C1) there is an emergency stop if pressed will stop system one and system two and activate an alarm.

Emergency stop freezer front: In front of the freezer room there is a wire emergency stop that once pulled, will stop system one and system two and activate an alarm.

High pressure cut out: The system has high-pressure safety cut out`s switch with manuel reset, on both LT and HT compressors. This pressure safety switches stops the compressor and activates an alarm. This alarm must be attended and reset manually at the HMI.

21 Definition of a temperature probe failure

The Temperature probes used is PT100 probes connected to a 4-20mA transmitter.

1. If the probe itself is broken in a way where the electrical circuit is broken, the transmitter is sending out a 0mA signal and creates a probe fault for the specific probe.
2. If the electrical connection/circuit between the PLC and the transmitter is broken, the PLC will detect 0mA and creates a probe fault for the specific probe.
3. If the probe is damaged in a way that makes it go below the pre-programmed temperature range, the transmitter will send out less than 3,8mA, and create a probe fault for the specific probe.
4. If the probe is damaged in a way that makes it go over the pre-programmed temperature range, the transmitter will send out 20,5mA, and create a probe fault for the specific probe.

22 Functionality and safe operating conditions of temp. probes

TT001 Evaporator air in (room) temperature probe

The temperature probe is located in the evaporator duct inlet side, return air from the room. TT001 is the main temperature probe for measuring the room temperature inside the freezer.

If TT001 fails it will activate a probe fault alarm and the system with the damage probe will use TT002 as control probe.

TT002 Evaporator air out temperature probe

The temperature probe is located in the evaporator duct outlet side for measuring supply air into the room.

TT002 is used for monitoring the performance through the evaporator.

If TT002 fails it will activate a probe fault alarm, but the system will keep running in normal running mode.

If both TT001 and TT002 fails, the unit will go into stop mode.

TT003 Evaporator coil temperature probe

The temperature probe is located on the suction line pipe just after the evaporator coil. TT003 is used for controlling the defrost end temperature, stopping the defrost cycle and controlling the superheat.

A fault on this probe will activate a failure, and the system will stop.

TT101 LT Discharge line temperature probe

The temperature probe is located on the discharge line pipe for the LT compressor and is used for limiting the discharge line temperature by regulating the compressor speed with the frequency inverter.

If TT101 fails, it will activate a probe fault alarm. The system will remain as lead and the frequency inverter output is limited to 30 Hz.

TT201 LT Liquid temperature probe

The temperature probe is located on the LT liquid line pipe after the HT exchanger. TT201 is used for monitoring the liquid temperature of the LT refrigerant (R508B).

A fault on this probe will activate a probe fault alarm, but the system will keep running in normal running mode.

TT401 HT Discharge line temperature probe

The temperature probe is located on the discharge line pipe for the HT compressor and is used for limiting the discharge line temperature by regulating the compressor speed with the frequency inverter.
If TT401 fails, fails, it will activate a probe fault alarm. The system will remain as lead and the frequency inverter output is limited to 30 Hz.

TT402 HT Suction temperature transmitter

The temperature probe is located on the suction line pipe just after the evaporator coil. TT402 is used for measuring the suction gas temperature from the heat exchanger.
A fault on this probe will activate a probe fault alarm, but the system will keep running in normal running conditions.

TT501 Glycol temperature return from drycooler probe

The temperature probe is located on the inlet pipe to the compressor unit from the drycooler.
TT501 is used to measure the inlet temperature for the glycol and control the drycooler fan.
A fault on this probe will activate a probe fault alarm, but the system will keep running in normal running conditions.

23 Definition of a pressure probe failure

The pressure probes used are 4-20mA transmitters.

1. If the probe itself is broken in a way where the electrical circuit is broken, the transmitter is sending out a 0mA signal and creates a probe failure for the specific probe.
2. If the electrical connection/circuit between the PLC and the transmitter is broken, the PLC will detect 0mA and create a probe failure for the specific probe.
3. If the probe is damaged in a way that makes it go below the pre-programmed temperature range, the transmitter will send out less than 2mA and create a probe failure for the specific probe.
4. If the probe is damaged in a way that makes it go over the pre-programmed temperature range, the transmitter will send out 22,4mA, and create a probe failure for the specific probe.

24 Functionality and safe operating conditions pressure probes

PT001 Evaporator superheat pressure transmitter

The transmitter is connected directly to the evaporator suction pipe & is used for measuring the pressure to regulate the superheat from the evaporator.
A failure on this probe will activate a failure, and the system will stop.

PT101 LT compressor discharge pressure transmitter

The transmitter is connected directly to the discharge side of the LT compressor and is used to limit the speed of the LT compressor to control the high pressure at a required level. If PT101 fails, it will activate a probe fault alarm. The system will remain as lead and the frequency inverter output is limited to 30 Hz.

PT102 LT compressor suction pressure transmitter

The transmitter is connected directly to the suction side of the LT compressor. The transmitter controls the start/stop of the compressor during normal running conditions and is the process value for the regulation of the LT compressor frequency inverter.
A fault on this probe will activate a failure, and the system will stop.

PT201 LT liquid line pressure transmitter

The transmitter is located on the LT liquid line between the interstage exchanger and the LT receiver.
A fault on this probe will activate a failure, and the system will stop

PT202 Expansion tank pressure transmitter

The transmitter is connected directly to the expansion tank and is used to understand the performance of the system.
The expansion tank pressure transmitter is also used to ensure that oil is returned from the expansions tank to the suction side of the compressor. When the suction pressure and expansion tank pressure (during startup from stopped condition or lag mode) difference reaches 2 bar, the solenoid valve (MV204) will energize for 20 seconds.
A failure on this probe will activate a probe failure alarm, but the system will keep running in normal running mode

PT401 HT compressor discharge pressure transmitter

The transmitter is connected directly to the discharge side of the compressor and is used and is used to limit the speed of the HT compressor to control the high pressure at a required level. A failure on this probe will activate a probe failure alarm.

PT402 HT compressor suction pressure transmitter

The transmitter is connected directly to the suction side of the HT compressor. The transmitter controls the start/stop of the HT compressor during normal running conditions and is the process value for the regulation of the LT compressor frequency inverter.
A fault on this probe will activate a failure, and the system will stop.

PT501 Glycol pressure transmitter

The PT501 transmitter is connected directly to the glycol circuit on the pressure side of the circulation pump and is used as a pump dry running protection.
A fault on this probe will activate a probe failure alarm, but the system will keep running in normal running mode.

25 Main Page color indicators on the HMI

The HMI light indicators consist of one indicator around each compressor skid, on the main overview page.
These indicators change color depending on the state of the system as per below:

Green light	Indicates normal operating condition
Red light flashing	The unit is in failure mode
Red light	System is stopped, or a failure is acknowledged but not mechanically reset/system not restarted
Yellow light flashing	The system is in alarm mode
Yellow light	An alarm is acknowledged but still active (e.g., high temperature alarm)

Blue light flashing	The system is defrosting

26 Components colors on the HMI

The components on the HMIs have different colors depending on the operating condition:

Green steady	On in automatic mode.
Green flashing	Component is pending operation in automatic mode.
Grey steady	Off in automatic mode.
Blue steady	On in manual mode.
Blue flashing	Component is pending in manual mode.
Yellow steady	Off in manual mode.
Yellow flashing	Off in manual mode, pending operation.
Red steady	Failure/alarm.

27 Definition of signal lights in front of freezer – located in corridor

27.1 Common signal tower (1)

A common signal tower is mounted above each freezer door.
The signal tower includes two distinct signal lights — one blue and one red. The tower also includes a buzzer at the base of the tower to provide audible alarms when necessary.

Blue light flashing	One of the systems is defrosting.
Red light flashing & sound	The unit is in alarm mode and not acknowledged.
Red light	The unit is in alarm mode and has been acknowledged, but the alarm is still present.
No light	The unit is in fault free condition.

NOTE: All alarms have an audible indicator and will activate with the red light flashing.

This is a common alarm and will give the signal light when either system 1 or 2 is in alarm mode

27.2 Door open alarm/indicator (2)

A separate indicator light is mounted above the freezer doors to show whether the freezer is operating within the setpoint range. If the temperature of the freezer is in the range of (set by customer) the door can be opened. If the temperature of the freezer is out of range, the door cannot be opened.

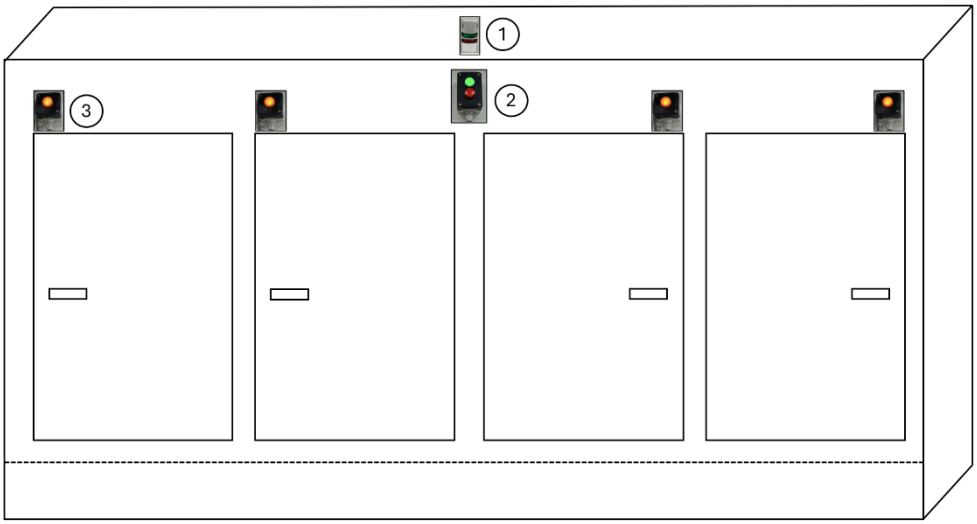
Red light	The freezer is out of the setpoint range.
Green light	The freezer is in the setpoint range.

27.3 Dedicated door open alarm/indicator (3)

Each door has its own dedicated light above the door showing either no light or amber light. This should indicate which of the doors are open in case the general door open alarm is triggered.

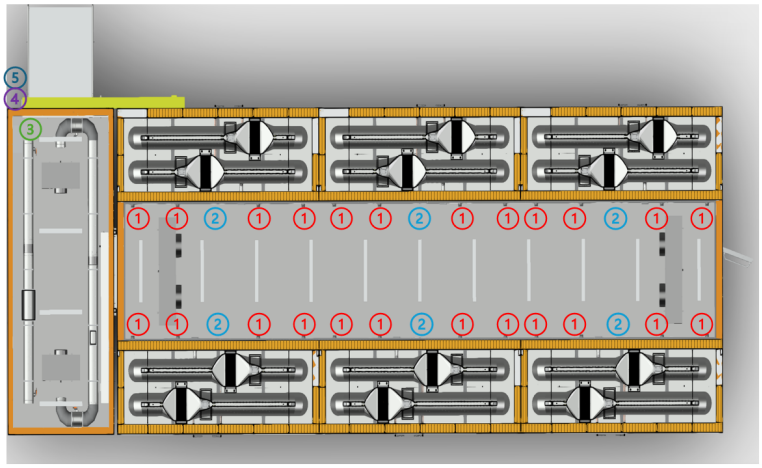
Amber light	The door is closed.
No light	The door is open.

The figure to the right shows an overview of the different alarms when seeing a freezer. A common door alarm/indicator is mounted in the anteroom. Common signal tower + mute button mounted at the entrance of the anteroom.



27.4 Alarm/indicator overview

Overview Of Indication Lamps		
1	**Door Open Indication Lamp** **Placement:** Above each freezer door	
2	**In/Out Temp. Indication Lamp** **Placement:** On the front of the freezer in the middle (to QBMS panel)	
3	**Common Door Open All Freezers Indication Lamp** **Placement:** On the wall leading outside of Anteroom	
4	**Alarm Buzzer Mute Button** **Placement:** At the inside to the anteroom, next To the push button for the sliding door	
5	**Common Alarm All Freezers Lamp** **Placement:** Above the buzzer mute button Over the door	



28 Definition of signal light for the compressor unit

Each compressor unit (System 1 and System 2) has its own dedicated alarm indicator located on the door of its electrical cabinet. This indicator consists of a single red flashing light with an audible alarm. If System 1 enters alarm mode, only the cabinet for System 1 will activate its alarm. The same applies to System 2.

This setup allows clear separation of alarms between the two systems, as the signal tower mounted above the freezer door provides only a shared (common) alarm indication.

Red light flashing & sound	The unit is in alarm mode and not acknowledged.
No light	The unit is in fault free condition or acknowledged.

NOTE: All alarms have an audible indicator and will activate with the red light flashing.

29 Acknowledge alarms/failures

If an alarm has been active, this alarm can be acknowledged by pressing the acknowledge button on the HMI. Acknowledging an alarm/failure will not reset the alarm but the buzzer will switch off and the HMI alarm flashing will stop. The signal lights in front of main control panel and freezer will be on until the alarm is no longer active. An acknowledged alarm will not need a second reset to disappear, the alarm will disappear when it is fixed. When a failure has been fixed it needs a reset to disappear in the failure page.

30 HMI general functionality

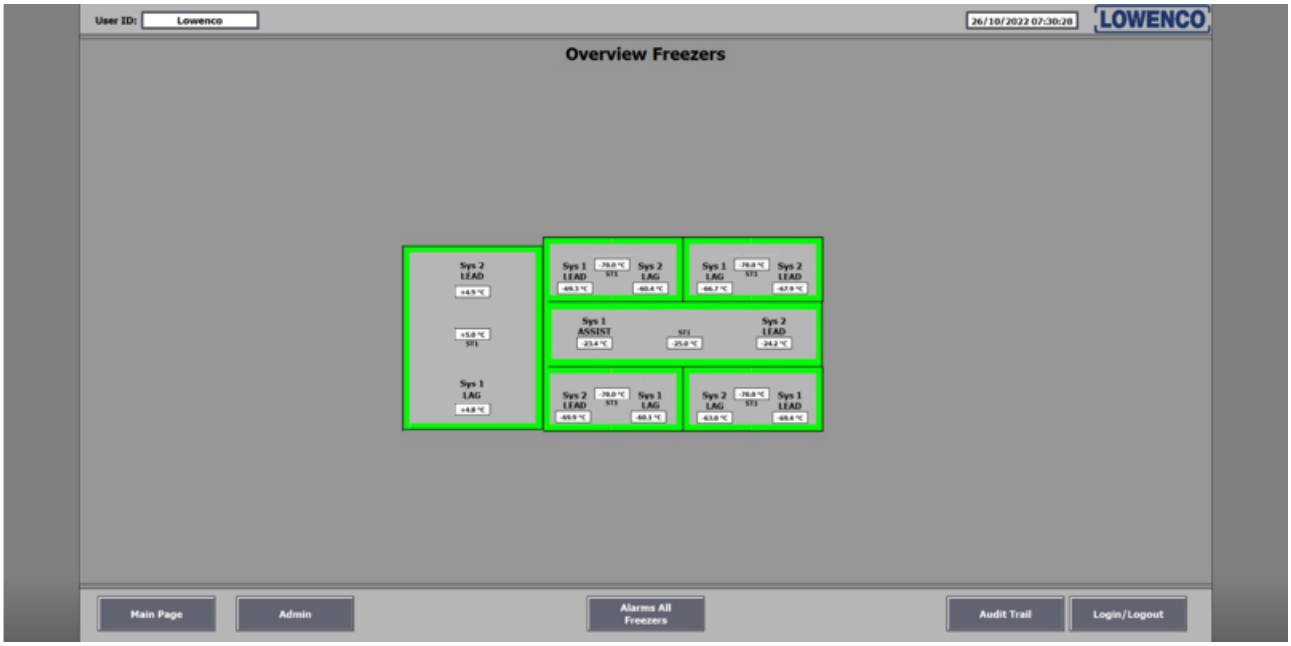
Access to the HMI requires a user authentication via electronic signature comprising two components. The two components are username and password. When the HMI are not used for 15 minutes, the user will be logged out. Historical process values will be retrievable for 365 days while historical alarm and audit trail will be retrievable for 730 days. All raw data will be located in project folder and maintained by MSSQL server 2019 and will not be editable by users. The data will have locally backup each 14 days.

The following sections are examples and will be updated and adjusted later in the process. This will be updated after SAT.

31 Operating the system

There are two HMI´s located in the tech space above the freezers and on the ground floor. The system is outlined to provide the user with a simple self-explaining structure, easy to understand and operate. It is possible for the user to navigate between the different screens to see the general status of the system i.e. set-points, temperatures, trend curves and alarm lists.

31.1 Main Page (Overview)



The main page's purpose is to provide the user with status and room temperatures for all systems.
The setpoint for all freezers are displayed next to ST1.

The current room temperature is displayed under the lead system.

Easy navigation to the system of preference etc. Freezer RM-3136_RIFRZ01can be performed by pressing the unit on screen.
The buttons featured on the main page:

Main Page: The main page button in the lower left corner shows the overview (this page) and is accessible from all pages.

Admin: The admin button allows the appropriate user to use the file explorer, choose the restart settings, stop wincc runtime (Close the HMI) and the remote access settings.

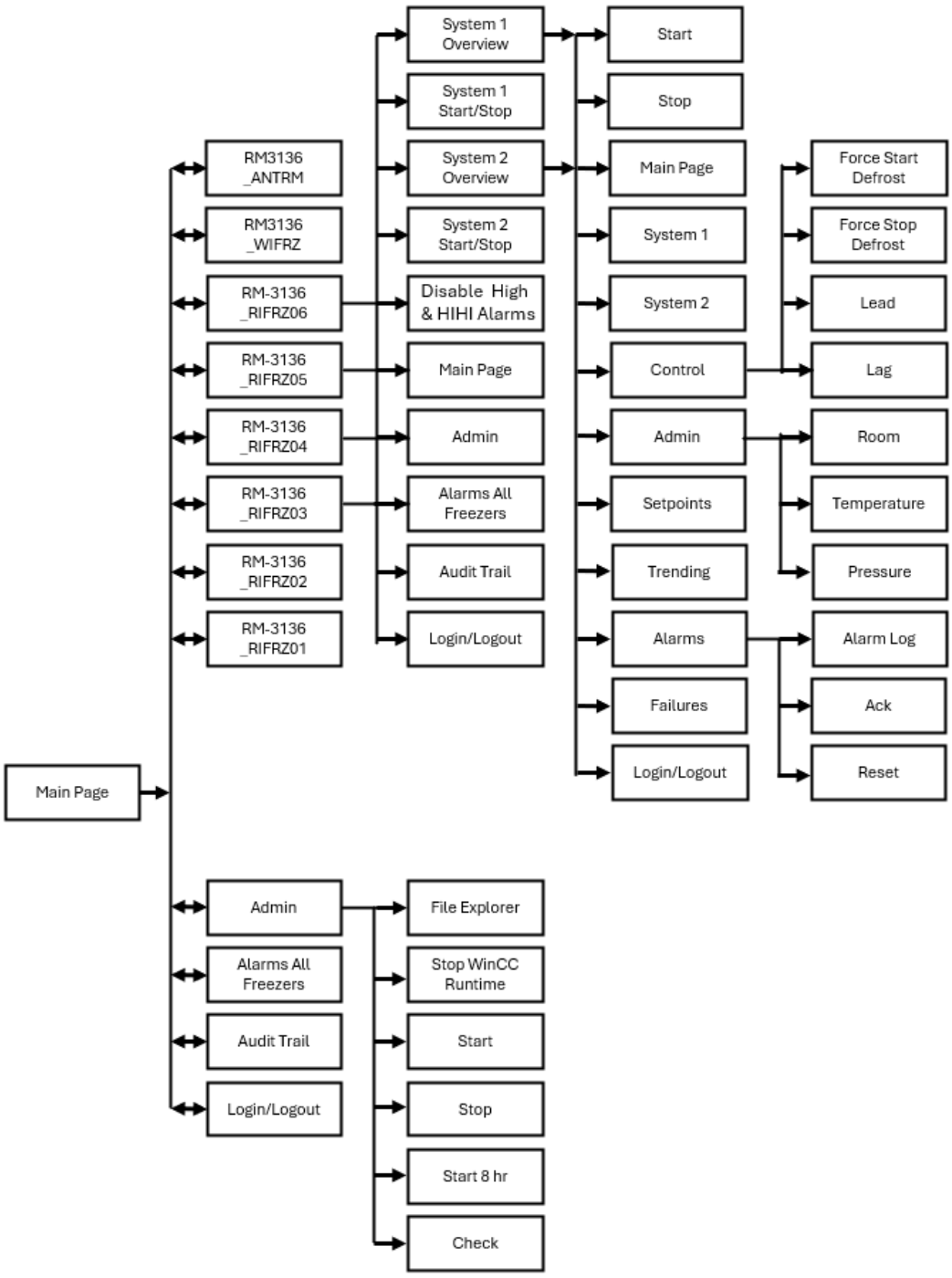
Alarms All Freezers: The alarm button in the middle lower section of the main page allows the operator to view active alarms on all freezers and export the alarm log.

Audit Trail: The audit trail button allows the user to view the registered changes on the systems and export the audit trail.

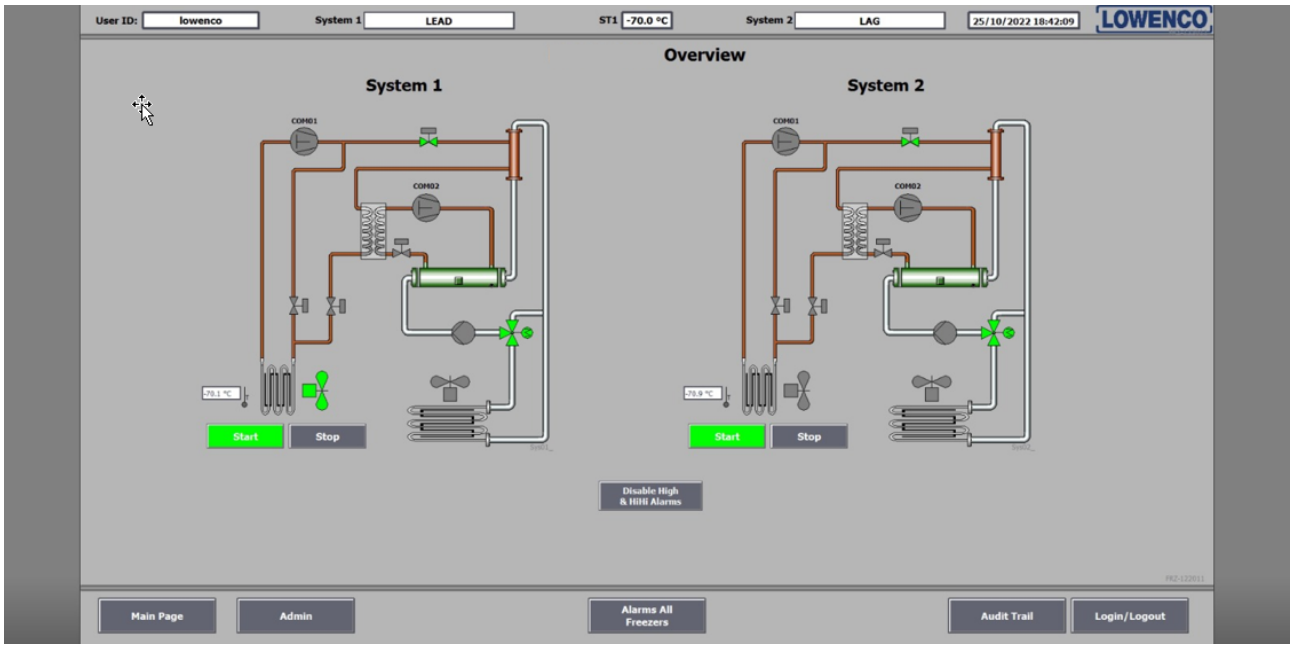
Login/Logout: The login/logout buttons allow the change of users on the HMI. automatic logout can be chosen in the administrator page.

31.2 HMI Overview

Access overview when logged in with Administrator:


Main Page
RM3136 _ANTRM
RM3136 _WIFRZ
RM-3136 _RIFRZ06
RM-3136 _RIFRZ05
RM-3136 _RIFRZ04
RM-3136 _RIFRZ03
RM-3136 _RIFRZ02
RM-3136 _RIFRZ01
System 1 Overview
System 1 Start/Stop
System 2 Overview
System 2 Start/Stop
Disable High & HIHI Alarms
Main Page
Admin
Alarms All Freezers
Audit Trail
Login/Logout
Start
Stop
Main Page
System 1
System 2
Control
Admin
Setpoints
Trending
Alarms
Failures
Login/Logout
Force Start Defrost
Force Stop Defrost
Lead
Lag
Room
Temperature
Pressure
Alarm Log
Ack
Reset
Admin
Alarms All Freezers
Audit Trail
Login/Logout
File Explorer
Stop WinCC Runtime
Start
Stop
Start 8 hr
Check

31.3 Freezer Overview



The main screen shows the actual status of system 1 and system 2 for a general overview of the entire freezer.

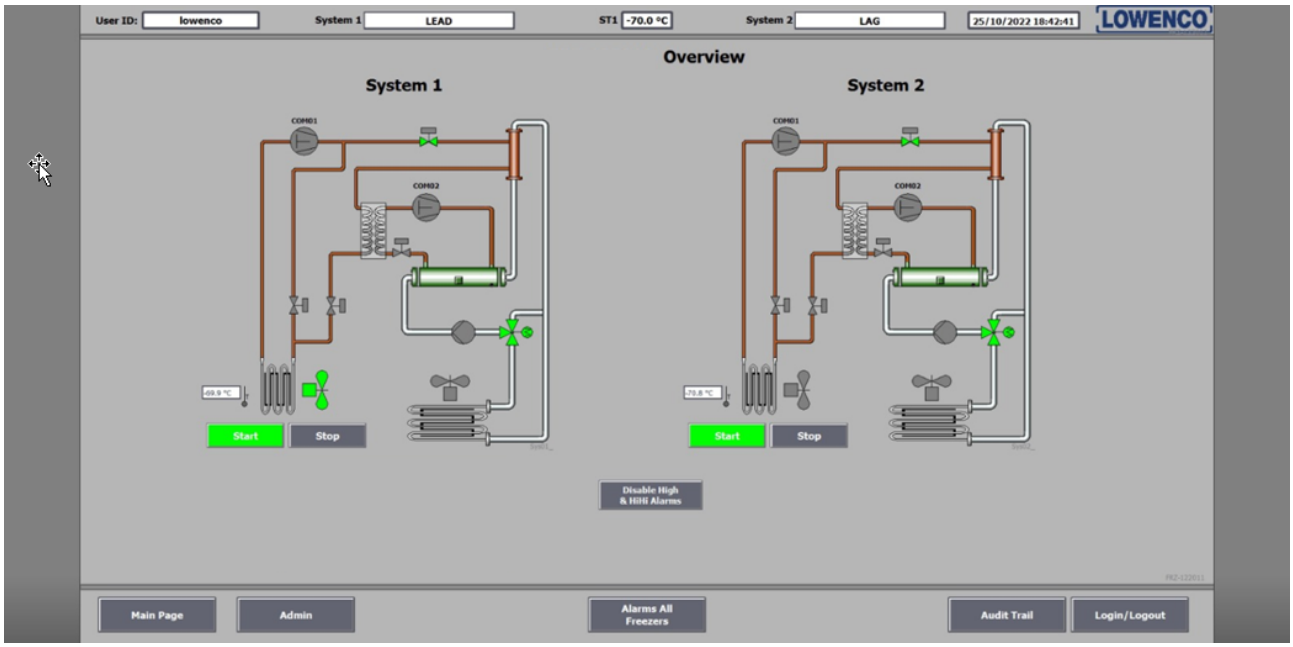
Status of the systems is visual in the top of the HMI.

The system status modes:

- Lead Cooling
- Lag
- Assist
- Preparing Defrost
- Defrost
- Drip time
- Stop

From this screen it is possible to start/stop the systems (depending on access levels), it is also possible to disable High & HiHi Alarms for a specified period (adjusted in the setpoint page) if warm products entering the freezer. (See System detailed overview.)

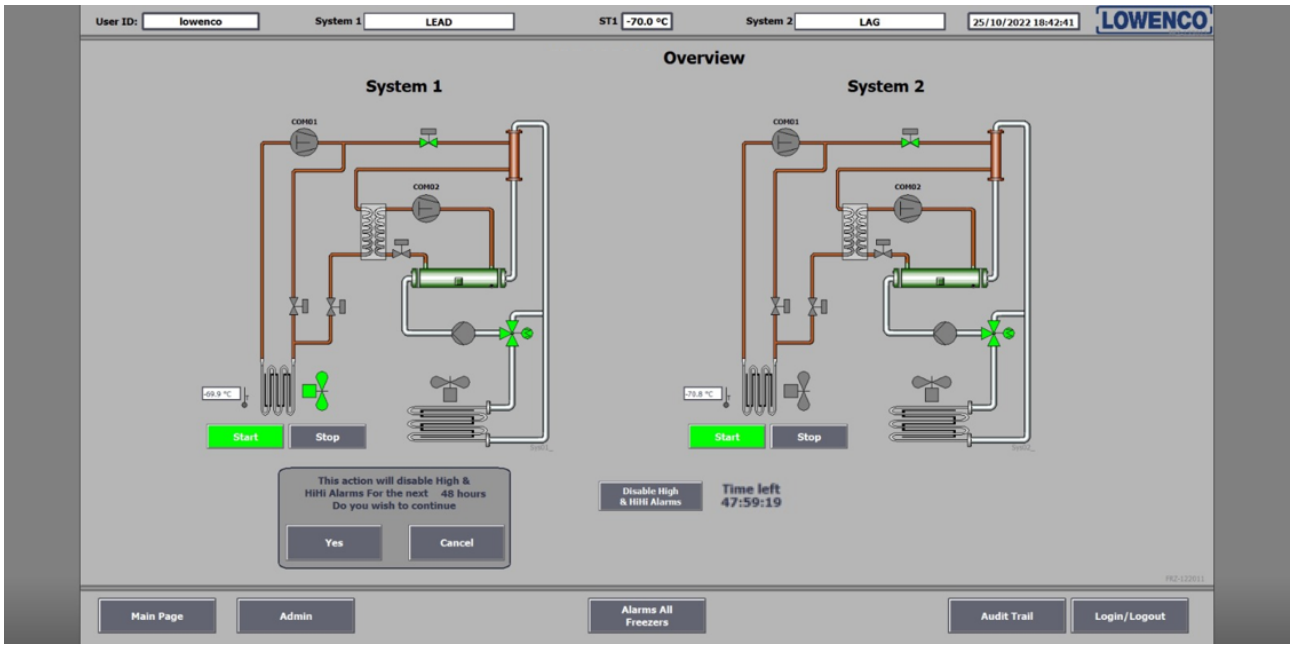
31.4 Disable High/HiHi alarms



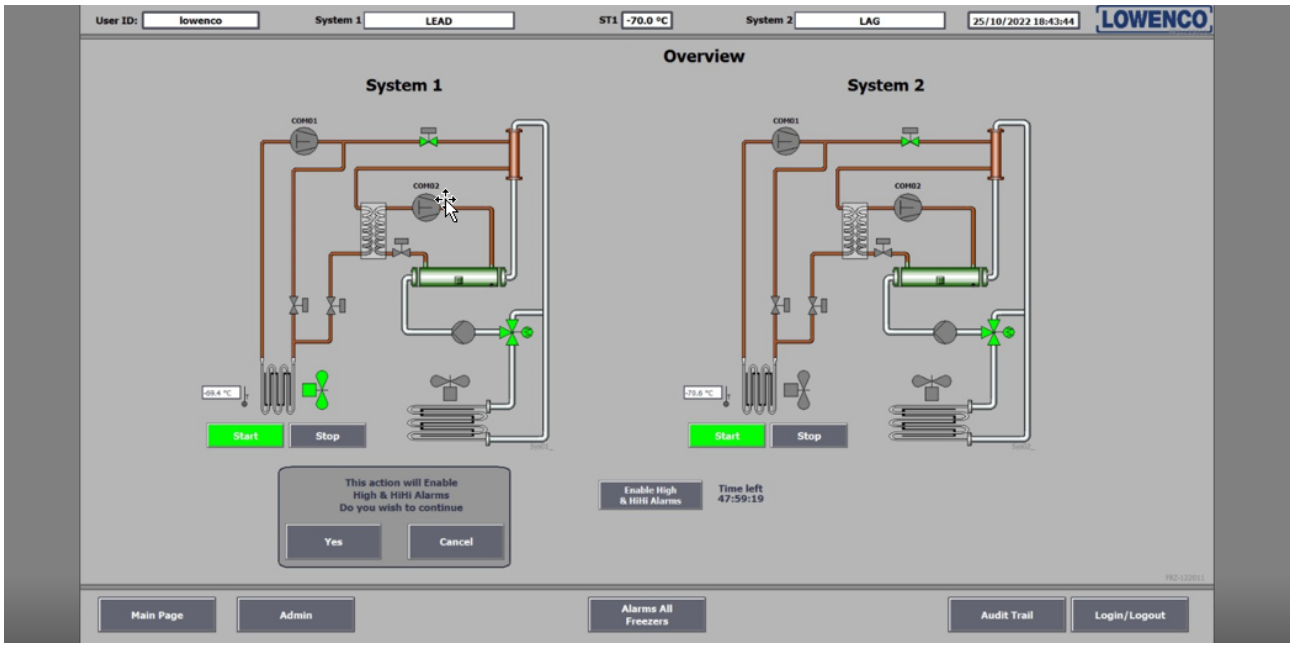
When loading fresh (ambient) products, the temperature alarms on the system can be suppressed with the “Disable High/HiHi alarms”.

By pressing the “Disable High/HiHi alarm” the operator can disable the room temp. High and HiHi alarms for an administrator determined period (AD5).

A popup confirmation window will appear when pressing the button, and a countdown timer will appear.



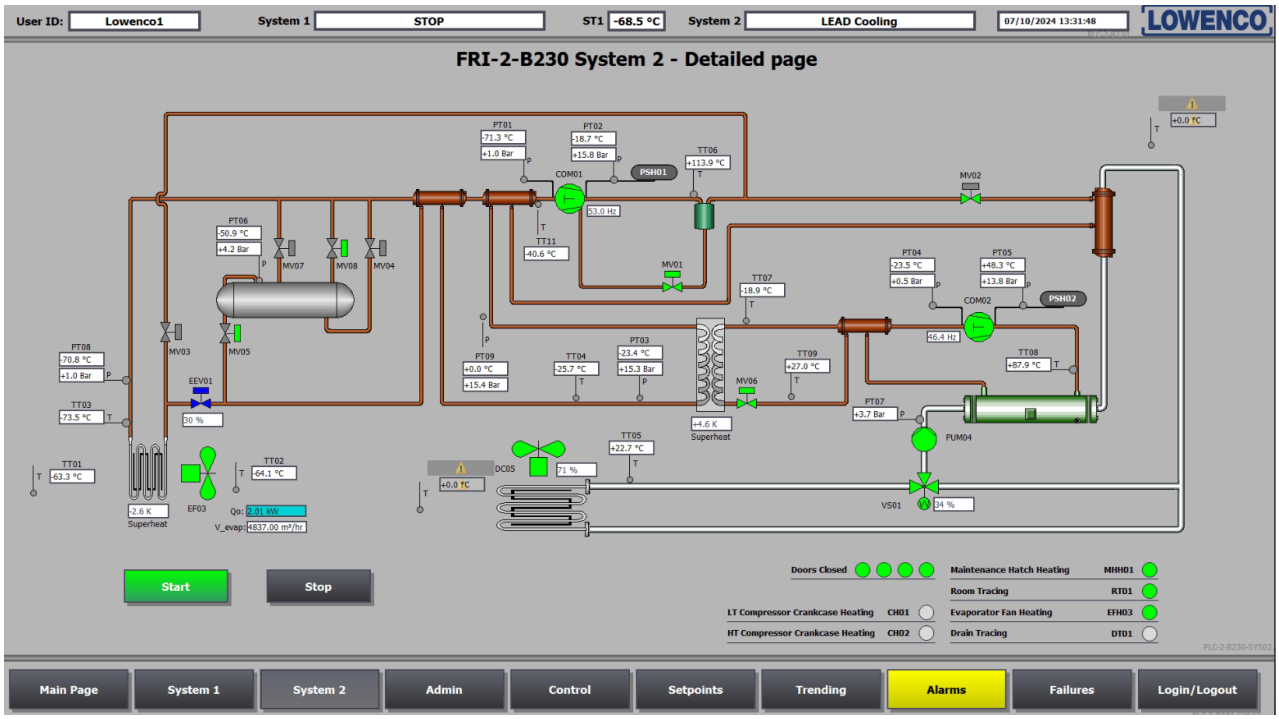
31.5 Enable High/HiHi alarms



Pressing “Enable High/HiHi alarm” will stop the disabled High/HiHi alarms suppression.

A popup confirmation window appears when pressing the button.

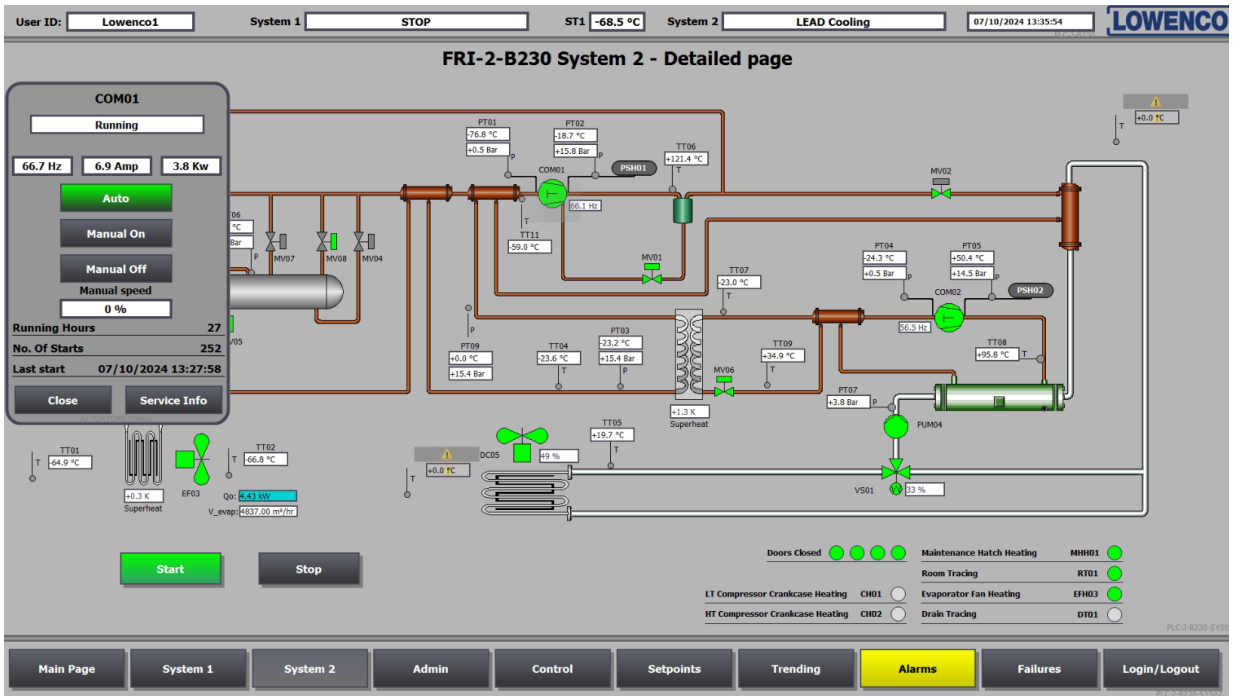
31.6 System detailed overview



All relevant pressures, temperatures and conditions of automated components are visible on the system detailed overview page. On the bottom of the page there is navigation buttons to the following pages:

- Main Page
- System 1
- System 2
- Admin
- Control
- Setpoints
- Trending
- Alarms
- Failures
- Login/Logout

31.7 Manual Control



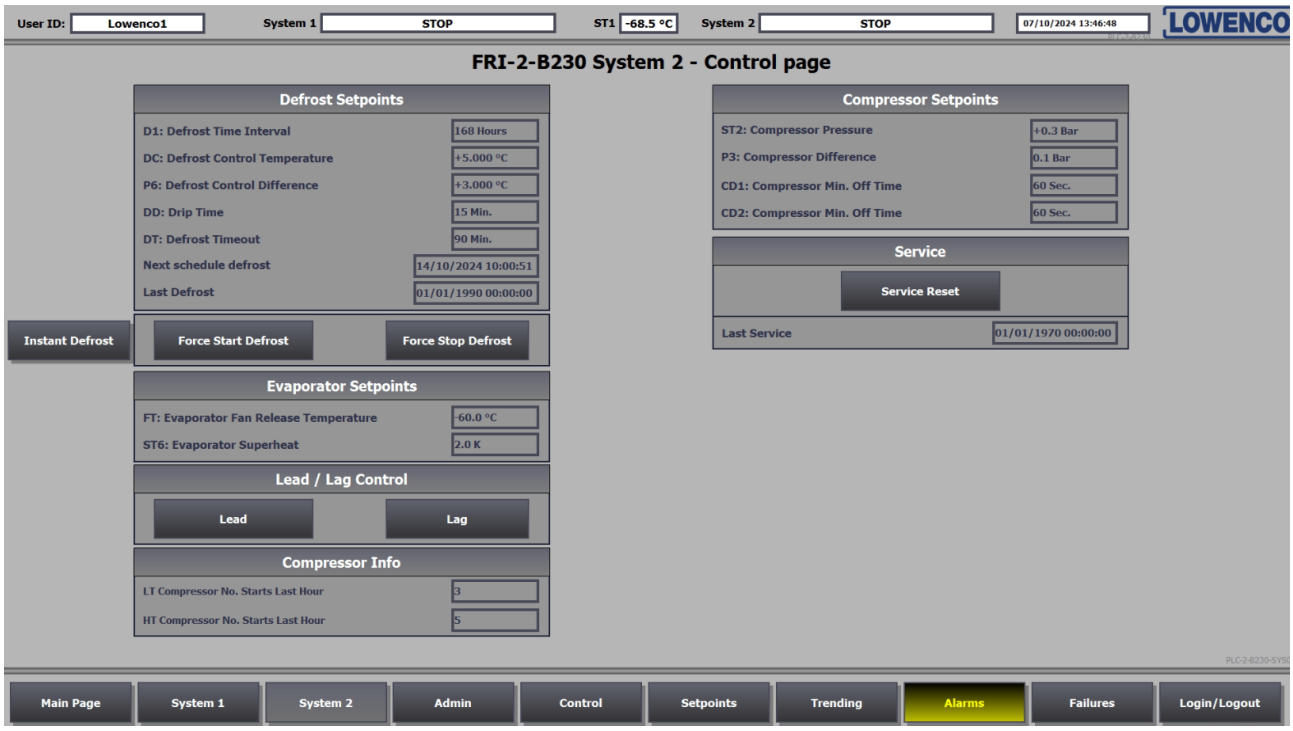
When pressing the individual automated components, a pop-up window with different possibilities of manual control will appear:

- Auto
- Manual on (Manual speed)
- Manual off

If the compressors start, all manual control will be terminated, and the components will return to auto.

The LT/HT compressors have detailed information on: Frequency, Amp consumption, Power consumption, Running Hours, starts per hour, last start, and service history.

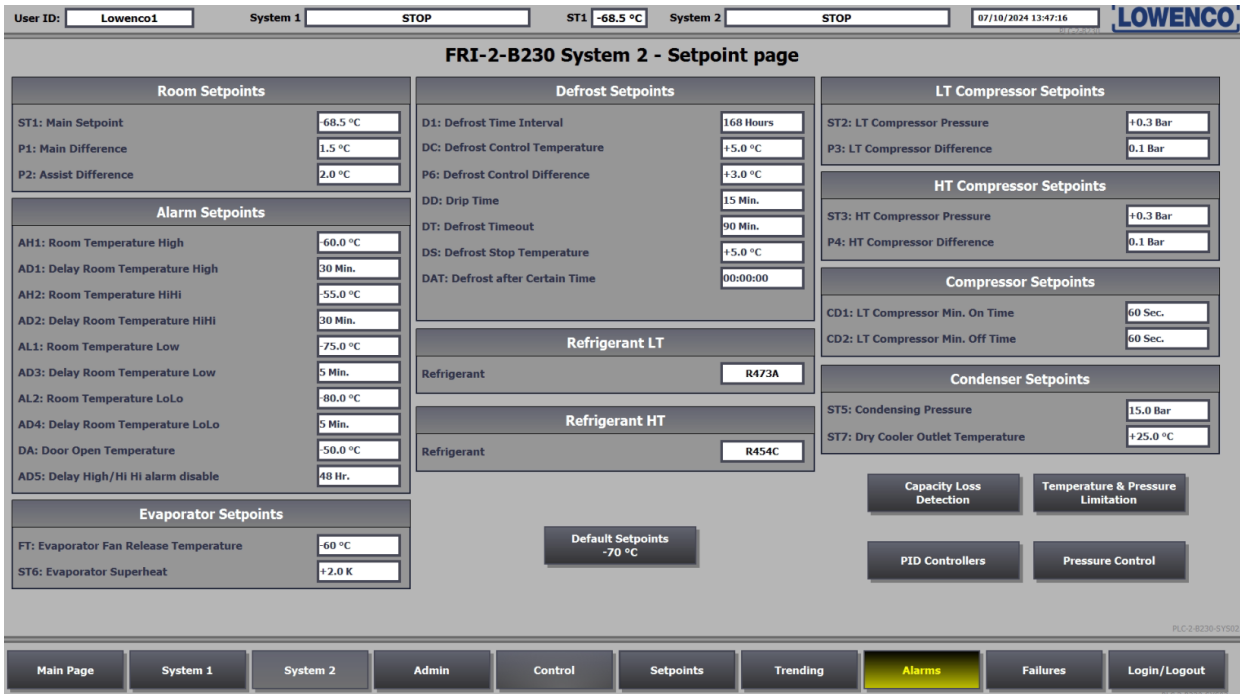
31.8 Control page



The control page provides the user with relevant system information such as: Current setpoints, force start/stop of defrosts, instant defrost[1], Lead/Lag changeover, service reset, and compressor starts per hour.

[1]Instant defrost is only possible with LOWENCO login.

31.9 Setpoint page



The setpoints page allows the user (depending on user access rights) to change setpoints of the system.

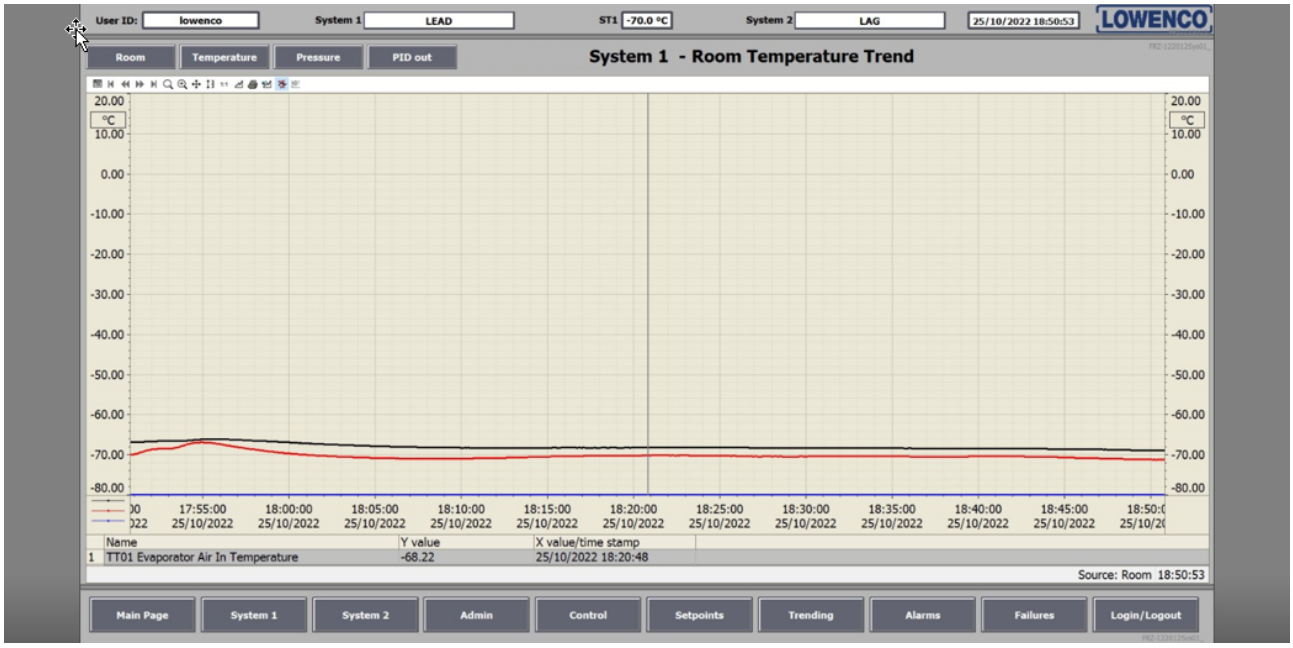
The page also contains a button to restore default -72°C setpoints.

The setpoints page are unique for each system, which allows for different settings on the two systems operating on the same freezer. The Default settings buttons will restore default settings on both systems if pressed.

31.10 Details on trended values:

The trending page allows the user to view system trend curves in pressure and temperature format. The curve identification color/name can be viewed in the bottom of the page.

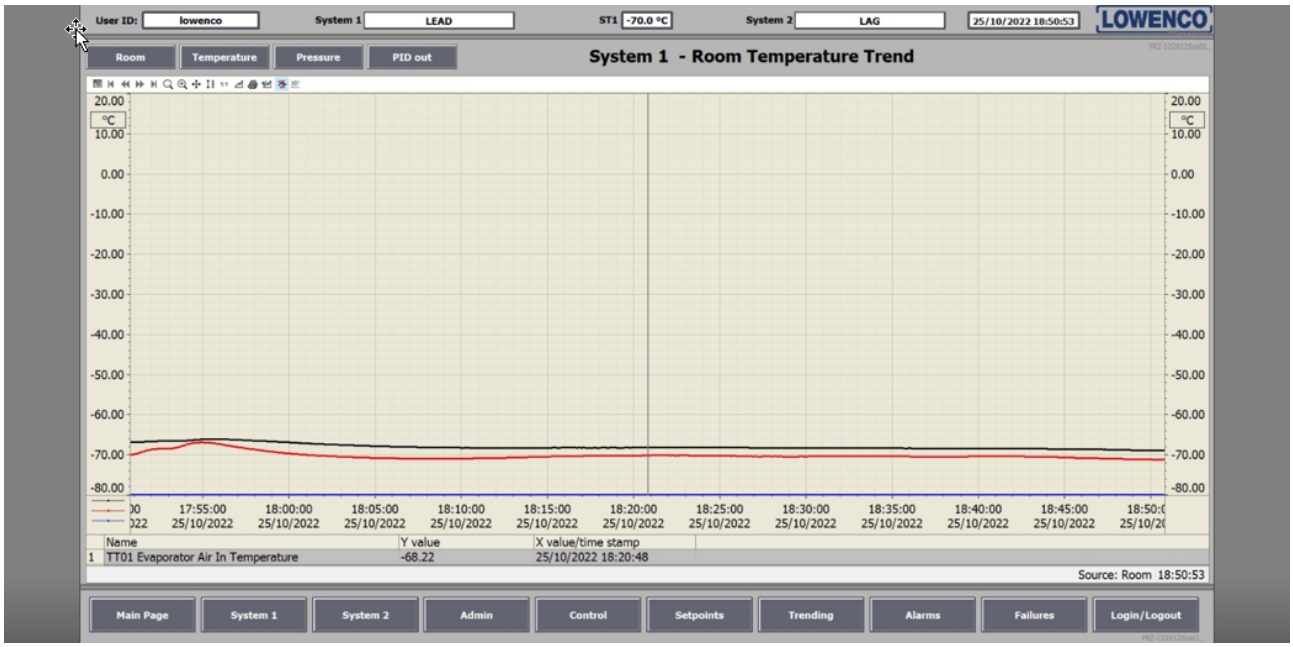
View change between temperature and pressure trends is performed in the top left corner by pressing "Room", "Temperature" or "Pressure".



Visible trends tags are listed below:

Temperature:	Pressure:
TT001 – Evaporator air in (room) temperature	PT001 – Evaporator superheat pressure
TT002 – Evaporator air out	PT101 – LT compressor discharge pressure
TT003 – Evaporator coil temperature	PT102 – LT compressor suction pressure
TT101 – LT Compressor discharge temperature	PT201 – Heat exchanger control pressure
TT201 – LT Liquid temperature	PT202 – Expansion tank pressure
TT401 – HT Compressor discharge temperature	PT401 – HT compressor discharge pressure
TT402 – HT Compressor suction temperature	PT402 – HT compressor suction pressure
TT501 – Glycol temperature return from Drycooler	
TT901 – Tech Space temperature	
TT902 – Outside Temperature at Drycooler	

31.11 Trending - Room temperature trend



In this screen, trends of TT001 and TT002 can be viewed.

Pressing the shown buttons under the curves allows the user to Navigate the temperature trend as preferred

31.12 Trending - Temperature trend

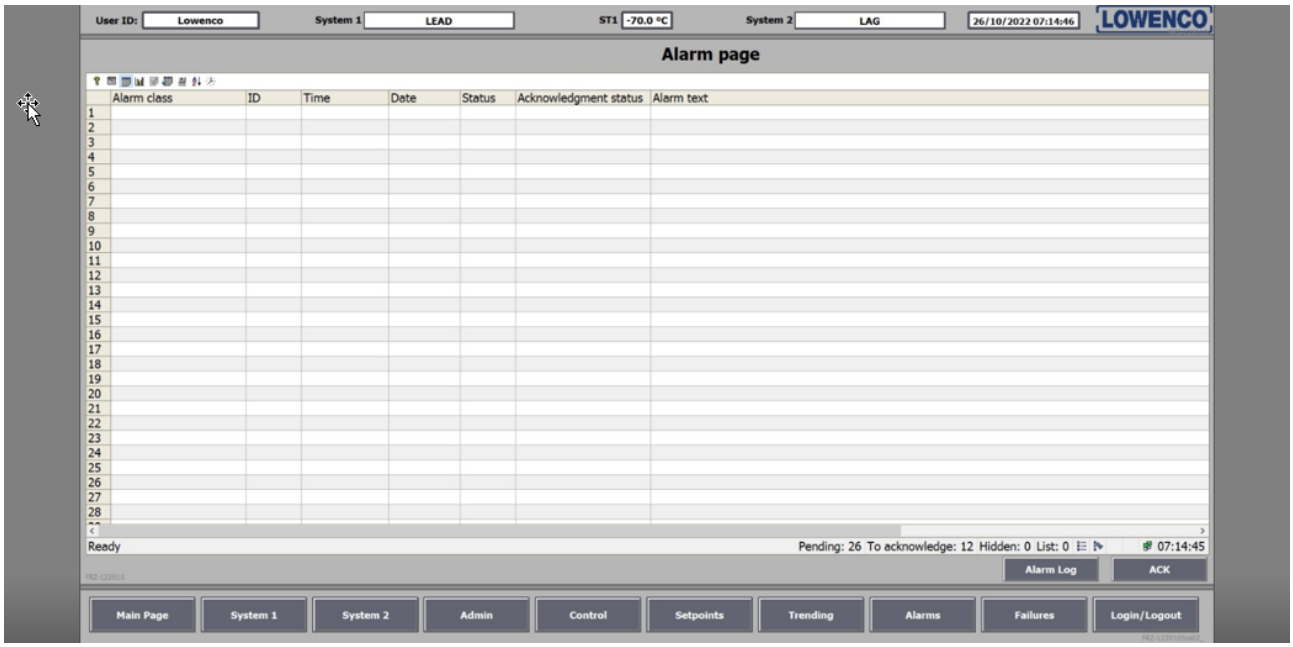
Detailed trended values on:TT001, TT002, TT003, TT201, TT101, TT401, TT402, TT901, TT501, and the evaporator superheat value.

Pressing the shown buttons under the curves allows the user to navigate the temperature trend as preferred.

31.13 Trending – Pressure trend

Detailed trended values on:PT101, PT201, PT001, PT202, PT102, PT401 and PT402.
Pressing the shown buttons under the curves allows the user to navigate the pressure trend as preferred.

31.14 Alarm



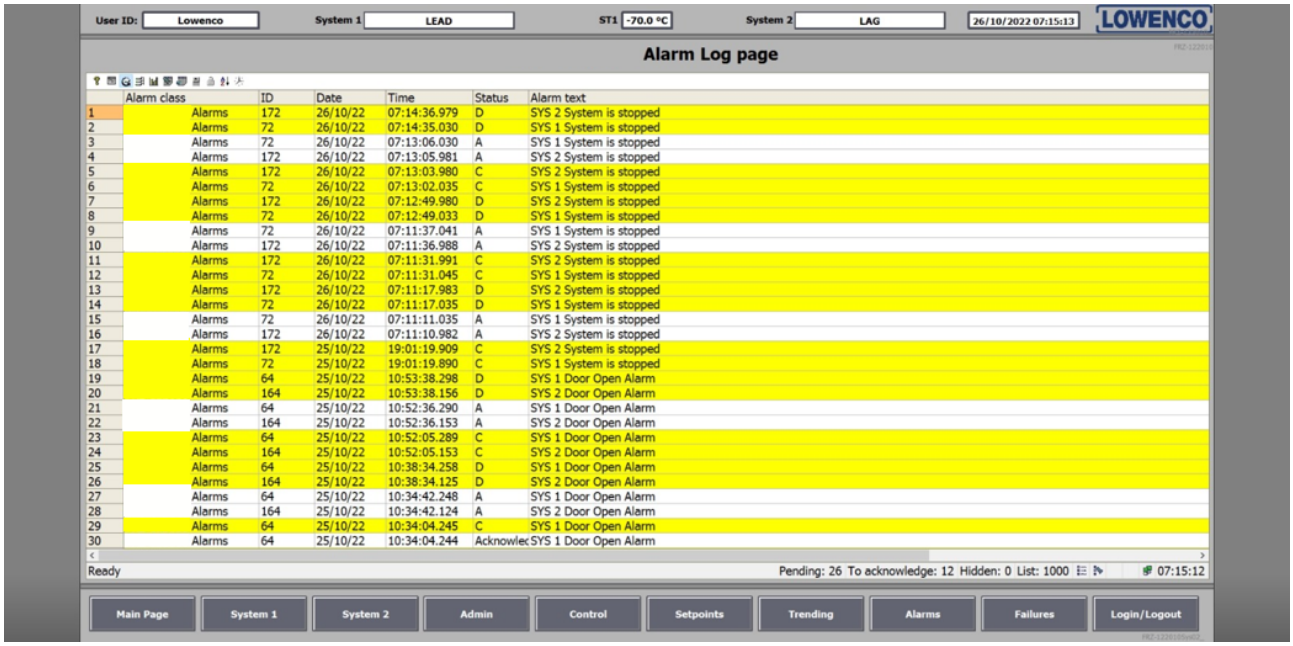
The alarm page can be accessed from the bottom of the system detailed overview page where it is possible to view the alarm log and acknowledge alarms.
The “Ack” button acknowledges active alarms.

The page contains:

- Alarm class indicates what freezer is in alarm.
- ID indicates the alarm number.
- Time indicates the time the alarm occurred.
- Date indicates the date the alarm occurred.
- Status indicates the status of the alarm:
    - C = Condition
    - A = Acknowledged
    - D = Deactivated
- Alarm text indicates a description of the alarm.

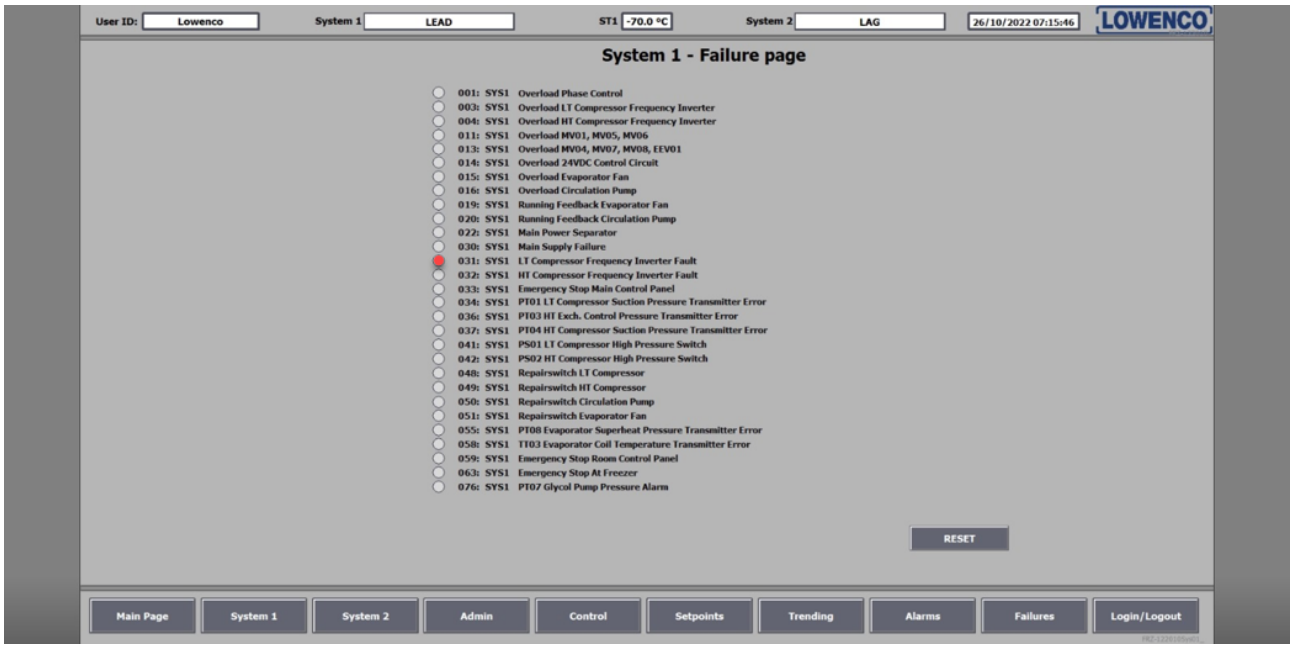
The Alarm Log page button is in the lower right corner of the page and contains all historic alarms and their status.

31.14.1 Alarm log



The Alarm Log page contains all historic alarms and their status.

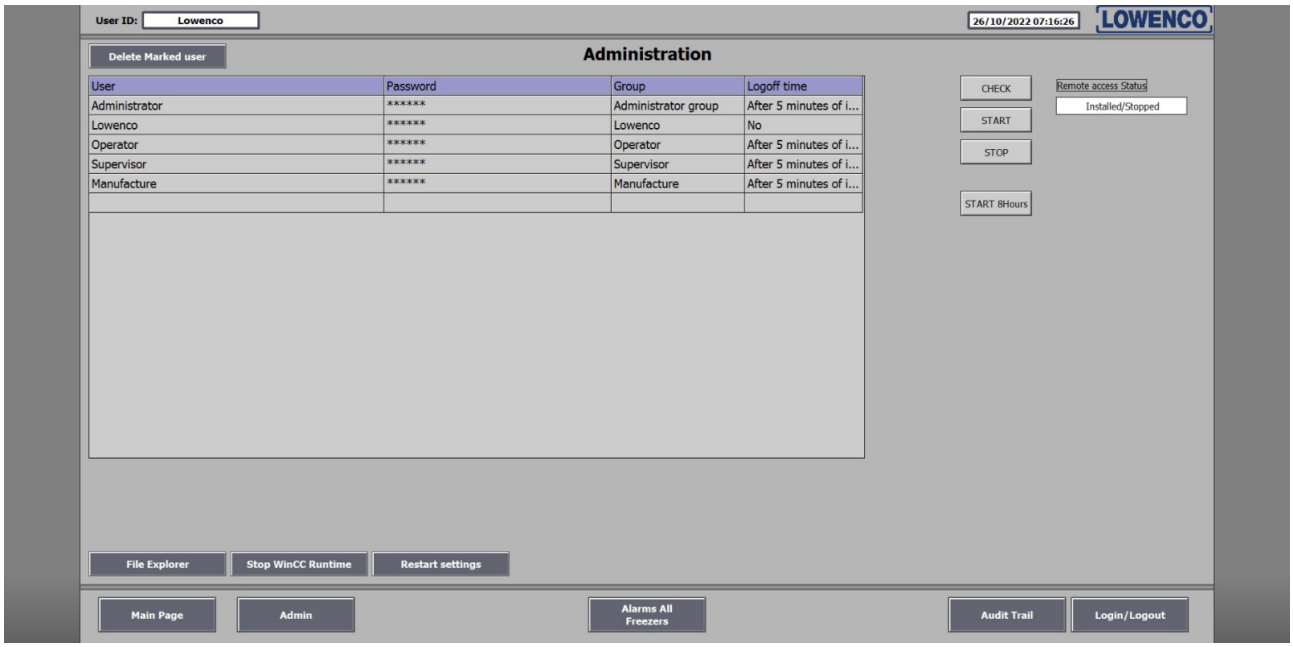
31.15 Failures



The failure page button is in the lower right corner of the page and contains critical system failures. All failures are indicated with red dots for easy identification.

Pressing the reset button will reset the failure (mechanical safety features such as Emergency stops, pressure switches etc. will have to be manually reset locally before a reset on the HMI is possible)

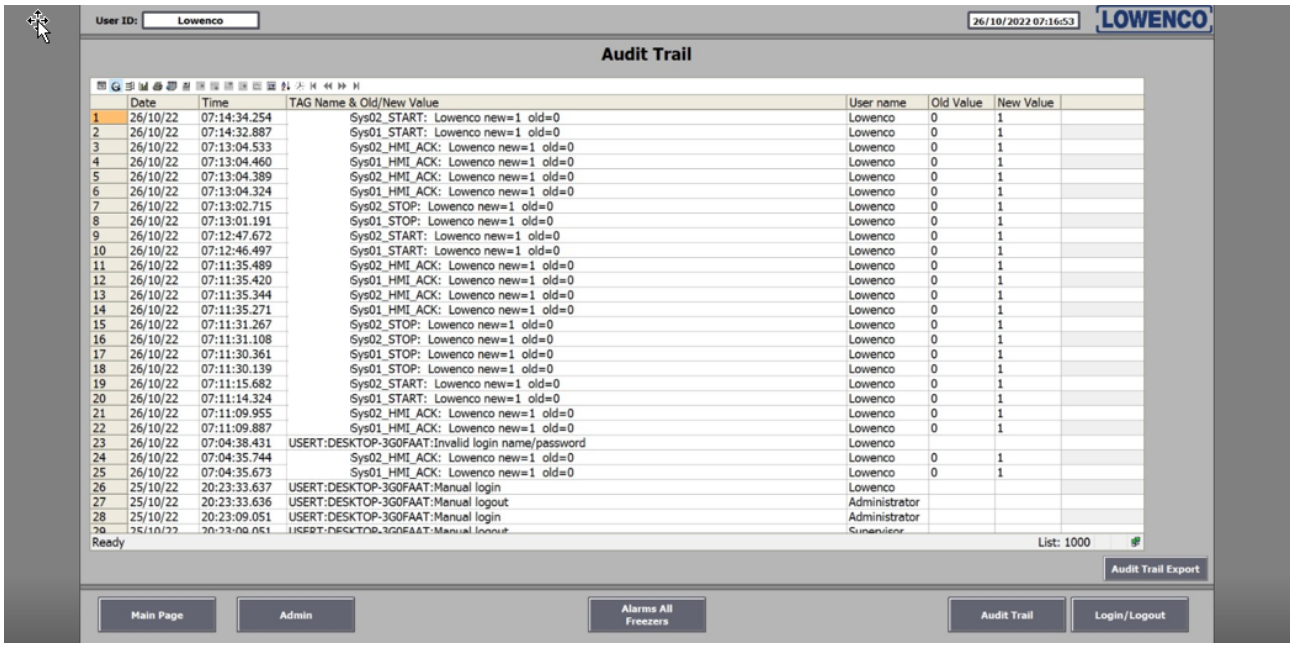
31.16 Administration



Pressing the “Admin” button enables the user to:

- Use the file explorer – to find etc. exported graphs or log
- Choose the restart the settings for the units
- Stop WinCC Runtime and enter desktop
- Add Users and give them the correct access levels
- View the automated logoff time status which is determined when the user is being created
- Enable/Disable Remote access (If a remote access has been installed at the freezers)
    - The options are:
        - Check if the remote access is active
        - Start the remote access on an infinite time
        - Stop the remote access
        - Start an 8-hour remote access session for LOWENCO to the system

31.17 Audit Trail



	Date	Time	TAG Name & Old/New Value	User name	Old Value	New Value
1	26/10/22	07:14:34.254	Sys02_START: Lowenco new=1 old=0	Lowenco	0	1
2	26/10/22	07:14:32.887	Sys01_START: Lowenco new=1 old=0	Lowenco	0	1
3	26/10/22	07:13:04.533	Sys02_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
4	26/10/22	07:13:04.460	Sys01_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
5	26/10/22	07:13:04.389	Sys02_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
6	26/10/22	07:13:04.324	Sys01_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
7	26/10/22	07:13:02.715	Sys02_STOP: Lowenco new=1 old=0	Lowenco	0	1
8	26/10/22	07:13:01.191	Sys01_STOP: Lowenco new=1 old=0	Lowenco	0	1
9	26/10/22	07:12:47.672	Sys02_START: Lowenco new=1 old=0	Lowenco	0	1
10	26/10/22	07:12:46.497	Sys01_START: Lowenco new=1 old=0	Lowenco	0	1
11	26/10/22	07:11:35.489	Sys02_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
12	26/10/22	07:11:35.420	Sys01_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
13	26/10/22	07:11:35.344	Sys02_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
14	26/10/22	07:11:35.271	Sys01_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
15	26/10/22	07:11:31.267	Sys02_STOP: Lowenco new=1 old=0	Lowenco	0	1
16	26/10/22	07:11:31.108	Sys02_STOP: Lowenco new=1 old=0	Lowenco	0	1
17	26/10/22	07:11:30.361	Sys01_STOP: Lowenco new=1 old=0	Lowenco	0	1
18	26/10/22	07:11:30.139	Sys01_STOP: Lowenco new=1 old=0	Lowenco	0	1
19	26/10/22	07:11:15.682	Sys02_START: Lowenco new=1 old=0	Lowenco	0	1
20	26/10/22	07:11:14.324	Sys01_START: Lowenco new=1 old=0	Lowenco	0	1
21	26/10/22	07:11:09.955	Sys02_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
22	26/10/22	07:11:09.887	Sys01_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
23	26/10/22	07:04:38.431	USERT:DESKTOP-3G0FAAT:Invalid login name/password	Lowenco		
24	26/10/22	07:04:35.744	Sys02_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
25	26/10/22	07:04:35.673	Sys01_HMI_ACK: Lowenco new=1 old=0	Lowenco	0	1
26	25/10/22	20:23:33.637	USERT:DESKTOP-3G0FAAT:Manual login	Lowenco		
27	25/10/22	20:23:33.636	USERT:DESKTOP-3G0FAAT:Manual logout	Administrator		
28	25/10/22	20:23:09.051	USERT:DESKTOP-3G0FAAT:Manual login	Administrator		
29	25/10/22	20:23:09.051	USERT:DESKTOP-3G0FAAT:Manual logout	Supervisor		

The LOWENCO audit trail is equipped on each HMI (Scada) system, and can easily be accessed from the main page, by pressing the “Audit Trail” button. The Audit trail logs the following changes

- Login/Logout
- Changes to setpoints
- Start/Stop of the systems
- Lead/Lag changeover
- Start Defrost / Force stop defrost
- Acknowledge Alarms and Failures
- Reset of failures.

Tag tables

Customer name	Client
Address	Bavnevej 10A, DK-6580 Vamdrup
Project no.	2026
Project name	LSSU -80°C
Pulldown time	36 Hours
PLC CPU type	Siemens S7-1500
LT refrigerant	R508B
HT refrigerant	R449A
Condensing Medium	Propylene glycol (30%)
FDS Name	FDS Template LSSU -80°C

	Freezer	Corridor	Anteroom
Name	FR-101	FR-202	CR-201
System 1	CM-101-001	CM-202-001	CM-201-001
System 2	CM-101-002	CM-202-002	-
Panel 1	CP-101-001+A1	CP-202-001+A1	CP-201-001+A1
Panel 2	CP-101-002+B1	CP-202-002+B1	-
Common Panel	CP-101-003+C1	CP-202-003+C1	CP-201-003+C1

	Freezer		
Name	FR-102		
System 1	CM-102-001		
System 2	CM-102-002		
Panel 1	CP-102-001+A1		
Panel 2	CP-102-002+B1		
Common Panel	CP-102-003+C1		

	Freezer		
Name	FR-103		
System 1	CM-103-001		
System 2	CM-103-002		
Panel 1	CP-103-001+A1		
Panel 2	CP-103-002+B1		
Common Panel	CP-103-003+C1		

	Freezer		
Name	FR-104		
System 1	CM-104-001		
System 2	CM-104-002		
Panel 1	CP-104-001+A1		
Panel 2	CP-104-002+B1		
Common Panel	CP-104-003+C1		

HMI	RM3136_HMI_01-TS	RM3136_HMI_02-AR	

Components

Description	Tag	Bookmark
LT compressor	COM101	Compressor1
HT compressor	COM401	Compressor2
3-way flow control valve	VS501	Threewayvalve1
Oil return solenoid valve	MV101	Solenoidvalve1
Discharge line shut off solenoid valve	MV102	Solenoidvalve2
LT hot gas defrost solenoid valve	MV103	Solenoidvalve3
Expansion tank oil return solenoid valve	MV204	Solenoidvalve4
Expansion tank solenoid valve	MV201	Solenoidvalve5
Cascade solenoid valve	MV401	Solenoidvalve6
Expansion tank startup solenoid valve	MV202	Solenoidvalve7
Expansion tank solenoid valve	MV203	Solenoidvalve8
Cascade exchanger	HEX703	Cascadeexchanger1
Condenser	HEX705	Condenser1
Tank Return Valve	CVP201	TankReturnValve
Circulation pump	PUM502	Circulationpump1
Dry cooler	DC501	Drycooler1
Evaporator	EV001	Evaporator1
Evaporator fan	EF001	Evaporatorfan1
LT liquid receiver	LR201	LTLiquidreciver1
Expansion tank	ET201	Expansiontank1
Electronic expansion valve	EEV001	Electronicexpansionvalve1
Evaporator air in temp.	TT001	Temperaturetransmitter1
Evaporator air out temp.	TT002	Temperaturetransmitter2
LT Coil temp.	TT003	Temperaturetransmitter3
LT Liquid temp.	TT201	Temperaturetransmitter4
Glycol temp supply	TT501	Temperaturetransmitter5
LT discharge temp.	TT101	Temperaturetransmitter6
HT compressor suction temperature	TT403	Temperaturetransmitter7
HT Discharge line temp.	TT401	Temperaturetransmitter8
HT Liquid line temp.	TT402	Temperaturetransmitter9
Tech space temp.	TT901	Temperaturetransmitter10
Outside temp at drycooler	TT902	Temperaturetransmitter11
LT compressor high pressure switch	PSH101	Pressureswitch2
HT compressor high pressure switch	PSH401	Pressureswitch4
LT Discharge press.	PT101	Pressuretransmitter1
LT Liquid press.	PT201	Pressuretransmitter2
LT Evap Suction press.	PT001	Pressuretransmitter3
LT Tank press.	PT202	Pressuretransmitter4
LT Suction press.	PT102	Pressuretransmitter5
HT discharge press.	PT401	Pressuretransmitter6
HT suction press.	PT402	Pressuretransmitter7
Glycol press.	PT501	Pressuretransmitter8
Hatch heating coil	MHC001	HatchHeatingCoil
Hatch heating Fan	MHF001	HatchHeatingFan
Fan heating	EFH001	FanHeating
Drain Tracing	DT001	DrainTracing
Door switch	DS900	DoorSwitch
Room pressure relief valve heating	RRH901	

Room tracing	RT901	