

Functional Design Specification
Lowenco -40°C/-80°C Blast Freezers

Project: N/A

Units: FR101

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1 Introduction

This document describes the functionality of the control for the -40/-70°C freezer equipment delivered to N/A by Lowenco A/S.

The freezer is designed to freeze 1200 kg. of liquid medicine from +25°C to -70°C in 36 hours.

The system consists of one refrigeration plant, capable of keeping the temperature at the desired level inside the freezers during normal running conditions. The system are controlled on two common HMI's, one located in the anteroom and one in the technical space on top of the freezers. The HMI's communicate internally via 'Ethernet connection. The refrigeration system has its 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 compressors. The LT compressor (COM01) is operating with R473A and is connected to the evaporator inside the evaporator duct. The HT compressor (COM02) is operating with R744 and its purpose is to act as a condenser for the LT compressor (COM01). This means that the R744 circuit is local on the compressor plant and connected to the LT circuit with a cascade heat exchanger (HEX01). As the HT circuit is acting as a condenser for the LT circuit, the LT compressor (COM01) force starts the HT compressor (COM02) to keep the condensing pressure down on the LT circuit.

The condenser for the HT compressor is liquid cooled with Propylene glycol (35%) as cooling medium. The compressor skid is fitted with a circulation pump (PUM01), which circulates the glycol to the associated dry cooler (DC01) installed next to the building. A 3-way valve (VS01) is located on the compressor skid, which determines the flow of the recirculated Propylene glycol (35%) internally on the skid and the dry cooler.

2 References

The control system consists of three control boards as listed:

Panel A1	Main Control board – System1
Panel C1	Room Control board – Common for system 1

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 SYS1

Tag:	Description:
COM01	LT compressor
COM02	HT compressor
MV01 (Normally Closed)	LT compressor oil return solenoid valve
MV02 (Normally Open)	LT compressor discharge line shut off solenoid valve
MV03 (Normally Closed)	LT hotgas defrost solenoid valve
MV04 (Normally Closed)	Expansion tank oil return solenoid valve
MV05 (Normally Open)	Expansion tank solenoid valve
MV06 (Normally Closed)	HT liquid line solenoid valve
MV07 (Normally Closed)	Expansion tank startup solenoid valve
MV08 (Normally Open)	Expansion tank solenoid valve
EEVO1	Electronic expansion valve
VS01	Motorized Valve
EF01	Evaporator fan
EF01 heating	Evaporator fan standstill heating (Under -5°C)
PUM01	Circulation Pump
-	Maintenance hatch heating
-	Door heating + room relief valve heating
-	Drain tracing

3.2 Security access levels

In order to make adjustments to set-points, and control the system, the user needs to log in. Below is the different access levels and their permissions.

Function	Operator	Supervisor	Administrator	Lowenco
View & Acknowledge Alarms	X	X	X	X
Start and Stop	-	X	X	X
Navigating HMI	X	X	X	X
Navigate Trends	X	X	X	X
Manual Defrost Control	-	X	X	X
Settings	-	-	X	X
Administration	-	-	X	X
Service/Maintenance & Manual Control	-	-	-	X

Table of security access levels

X = allowed

4 Power failure and recovery

In the event of a full or partial power failure, the system will go to fail safe condition. All outputs will switch off and the PLC program and working memory settings will be stored on the PLC SD memory card.

The logging data and alarm history for approximately 1 month are stored on a hard disk placed in both HMI's.

Upon power resumption, the PLC program and working memory settings are automatically loaded from the SD card, restoring the program and working memory data.

The system will then be available to start up as normal providing all the relevant interlocks are healthy (startup requires manual intervention). The table below indicates the device fail-safe states.

Item	Fail Safe Condition
Compressors	Compressors will stop
Circulation pump	Circulation pump will stop
Motorized valve	Motorized valve will stop
Evaporator Fans	Evaporator Fans will stop
Evaporator Fan Heaters	Evaporator Fan Heaters will stop
Solenoid valves	Solenoid valves will de-energize and obtain their de-energized state (Normally Open/Normally Closed).

Table of Fail-Safe States

4.1 Software backup procedure

Every controller/PLC is fitted with a memory card corresponding to list of hardware in the Functional design specifications.

In the event of a replacement of a controller the memory card can be swapped to the new unit and all configuration and user program will be automatically loaded from the memory card upon boot.

If the event of the automated Backup procedure from the Simatic memory card in the PLC fails, the program and hardware configuration for the respective PLC must be re-downloaded to the controller.

Open the project in TIA Portal. Connect the PG/PC Programming device to the network or directly to the controller.

Locate the PLC that you wish to re-download, right click and choose "Download to device" from the submenu choose "Hardware configuration" make sure the device you are downloading to is correct by enable Flash and verify the controller is flashing in the 3 system LED's above the PLC's display.

After verification select Download. After successful download of the hardware configuration download the software to the controller by right click and select "Download to device" and submenu "Software All"

After successful download of "Hardware configuration" and "Software All" the PLC is ready for operation.

The project can only be read through Computer with Siemens TIA portal V16 pro.

5 Communication HMI/PLC

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

HMI-303-TS connects primarily with storage freezers System 1.

HMI-304-AR connects primarily with storage freezers System 2.

All storage freezers, the corridor and the anteroom have active communication between the 2 systems so that the HMI panels can access data from both systems routing through either system 1 or system 2.

6 Normal running condition

6.1 Normal running condition -70°C – Normal cooling sequence

When the room temperature reaches a level above the Main set-point (ST1) + Main difference (P1), the system, will start the normal Cooling sequence (Fig.01).

- When the room temperature reaches a level above ST1 + P1. The PLC energizes the electronic expansion valve (EEV01) & the compressors start-up when the suction pressure (PT01) rises to a level above the LT compressor set-point (ST2).
- When the room temperature reaches ST1, the PLC de-energizes the electronic expansion valve (EEV01 & the compressors will stop when the suction pressure (PT01) reaches a level below ST2 - P3.

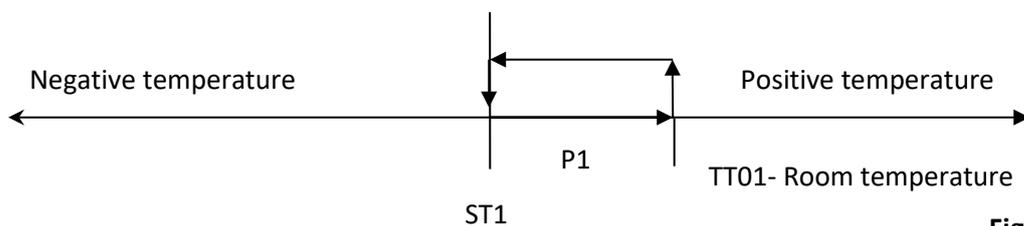


Fig. 01

TT01 are room temperature and used as control temperature. If there is a transmitter error on TT01, TT02 will be used as control temperature.

6.2 Operating condition and startup sequence – HT compressor

- When the HT compressor (COM02) start signal is triggered, the circulation pump (PUM01) is activated, the 3-way flow reg. valve (VS01) output is 100% and the HT liquid line solenoid valve (MV06) is energized. The HT compressor (COM02) is started if the HT compressor set-point (ST4) + HT compressor difference (P5) is reached. The HT liquid line solenoid valve will remain open for CD3 seconds after initial activation in the startup sequence.

HT compressor (fig.04)

- When operational the HT compressor is controlled by the HT compressor pressure set-point (ST4) + the HT compressor difference (P5).
- When the HT suction pressure (PT04) reaches a level above the HT compressor set-point (ST4) the HT compressor (COM02) starts up.
- When the HT suction pressure (PT04) reaches a level below the HT compressor set-point (ST4) - HT compressor difference (P5), the HT compressor (COM02) stops.
- If a situation occurs, where the solenoid valve MV06 is closed before the minimum on time CD1 has run out, the minimum on time will be overruled and the compressor stops when the suction pressure reaches a level below ST4 – P5.

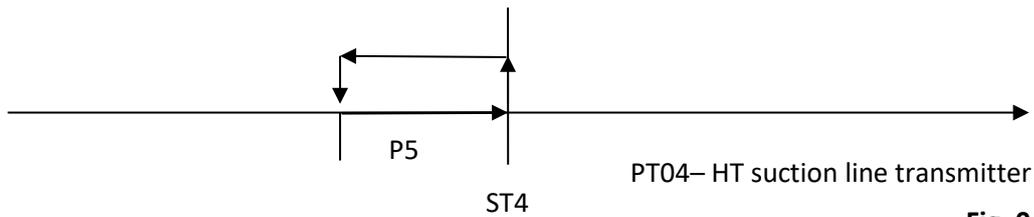


Fig. 04

6.3 Operating condition and startup sequence – LT compressor

- When the LT compressor (COM01) start signal is triggered the sequence described in section 6.2 **Operating condition and startup sequence – HT compressor** is started. 10 seconds after the HT compressor (COM02) starts, the electronic expansion valve (EEV01) is energized & when the suction pressure (PT01) reaches a level above the LT compressor set-point (ST2) + LT compressor difference (P3), the LT compressor (COM01) starts.
- The frequency inverter of the LT compressor operates the compressor at ST2.
- If the suction pressure (PT01) reaches a level below the LT compressor set-point (ST2) - LT compressor difference (P3), the LT compressor (COM01) stops.
- When the electronic expansion valve (EEV01) is de-energized & the suction pressure (PT01) reaches a level above 7 bar, the LT compressor start-up to perform a pump-down cycle. The LT compressor (COM01) will stop when the suction pressure reaches a level below ST2 – P3. (Fig.02)
- When LT compressor have been running for 2 min. MV02 and MV03 energizes for 20 sec. in order to keep pipes inside evaporator coil clean.



6.4 Compressor start/stops per hour

Fig. 02

As a safety function an alarm has been created if the number of start/stops per hour has been exceeded. 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.

7 Stop and pumpdown conditions

7.1 Stop condition – LT compressor (COM01)

When the electronic expansion valve (EEV01) is de-energized due to Stopped condition & the suction pressure (PT01) reaches a level above 7 bar (fixed), the LT compressor (COM01) and the HT compressor (COM02) start-up to perform a pump-down cycle. The LT compressor will stop when the suction pressure reaches a level below ST2 – P3.

7.2 Stop condition – HT compressor (COM02)

When MV06 is de-energized due to Stopped condition & the HT suction pressure (PT04) reaches a level above 7 bar (fixed), the HT compressor start-up to perform a pump-down cycle. The HT compressor (COM02) will stop when the suction pressure reaches a level below ST4 - P5.

If a situation occurs, where the solenoid valve MV06 is closed before the minimum on time CD1 has run out, the minimum on time will be overruled and the compressor stops when the suction pressure reaches a level below ST4 - P5.

7.3 Pumpdown cycle LT Compressor (COM01)

When the system is in offline condition and in automatic mode or the status is changed to lag mode the compressor (COM01) performs a pumpdown cycle. The cycle is performed by closing the electronic expansion valve (EEV01) while the compressor (COM01) is running. This causes the pressure on the suction side to decrease until it reaches its suction pressure reaches ST2 – P3 and stops. Due to the use of high pressure refrigerant (R23), the suction pressure will slowly increase as the liquid refrigerant still trapped in the evaporator will evaporate over time. When the suction side pressure reaches 7 bar (fixed) the compressor (COM01) starts up and decreases the pressure to the suction pressure to ST2 – P3. This cycle continues until the pressure is maintained below 7 bar during standstill. The refrigerant on the discharge side is led to the liquid receiver (LR01) on the R23 circuit. Here a slow evaporation will occur and as the pressure rises on the discharge side of the system the refrigerant gas will be led to the expansion tank (ET01) during standstill.

7.4 Pumpdown cycle HT Compressor (COM02)

When the system is in offline condition and automatic mode or the status is changed to lag mode the compressor (COM02) performs a pumpdown cycle. The cycle is performed by closing the liquid line solenoid valve (MV06) while the compressor (COM02) is running. This causes the pressure on the suction side to decrease until it reaches its suction pressure setpoint (ST4) – difference (P4) and stops. This cycle continues until the pressure is maintained below 7 bar during standstill. The refrigerant on the discharge side is led to the liquid receiver/condenser (CON01).

8 Evaporator fan control

In normal running condition the evaporator fan (EF01) on the compressor system is always on in order to keep the freezer well ventilated, ensuring a temperature as equal as possible in the entire room.

A special feature in the control of the evaporator fan, is that the fan does not turn on after a natural stop i.e. door opening or start after defrost until the evaporator coil temperature (TT03) reaches the desired value (fan release temperature - FT). This is to ensure that any remaining heat in the coil is removed before starting to ventilate the room.

The evaporator fan (EF01) for will stop when the door is opened, and if the emergency stop is activated.

9 Manual control

Due to the use of high pressure refrigerant, the safety switches on the high pressure side of the compressor units cannot be overruled. The following components can be operated in manual mode:

- The electronic expansion valve (EEV01) can be operated manually but only with service access level.
- The HT compressor liquid line solenoid valve (MV06) can be operated manually but only with service access level.
- The circulation pump (PUM01) can be operated manually but only with service access level.
- The evaporator fans (EF01) can be operated but only with service access level.
- The dry cooler fan (DC01) can be operated manually but only with service access level.
- The HT compressor (COM02) can be operated manually but only with service access level.
- The LT compressor (COM01) can be operated manually when the system is offline. The HT compressor (COM02) will start automatically (controlled by the HT exchanger set-point (ST3) + the exchanger difference P4) when operating the LT compressor (COM01) in manual! This means that the startup sequence will be activated when the LT compressor (COM01) is started.
- The Oil return solenoid valve (MV01) can be operated manually but only with service access level.
- The Discharge line shut off solenoid valve (MV02) can be operated manually but only with service access level.
- The LT hotgas defrost solenoid valve (MV03) can be operated manually but only with service access level.
- The Expansion tank oil return solenoid valve (MV04) can be operated manually but only with service access level.
- The Expansion tank solenoid valve (MV05) can be operated manually but only with service access level.
- The Expansion tank startup solenoid valve (MV07) can be operated manually but only with service access level.
- The Expansion tank solenoid valve 5/8" (MV08) can be operated manually but only with service access level
- The Compressor bypass valve (MV09) can be operated manually.
- The 3-way flow control valve (VS01) can be operated manually but only with service access level.
- The maintenance hatch coil heating can be operated manually but only with service access level.
- The Maintenance hatch fan heating can be operated manually but only with service access level.
- The evaporator fan heating can be operated manually but only with service access level.
- The Drain tracing can be operated manually but only with service access level.

10 Defrost sequence

The defrosting of the evaporator is performed with hot-gas defrost by running the LT compressor (COM01) hot-gas directly into the evaporator coil. When the defrost sequence is activated the LT compressor discharge shut off solenoid valve (MV02) will energize (normally open valve) and cut off the refrigerant flow.

If the suction pressure reaches the limits described in the “expansion tank control” section, the solenoid valve MV08 is activated.

During defrost the temperature in the coil is maintained at DC (defrost control temperature) measured on probe TT03.

The compressor frequency is kept between DC and DC minus P6. (Fig. 06).

P6 (Defrost control difference) is an adjustable parameter and can be adjusted between 0 – 10°C

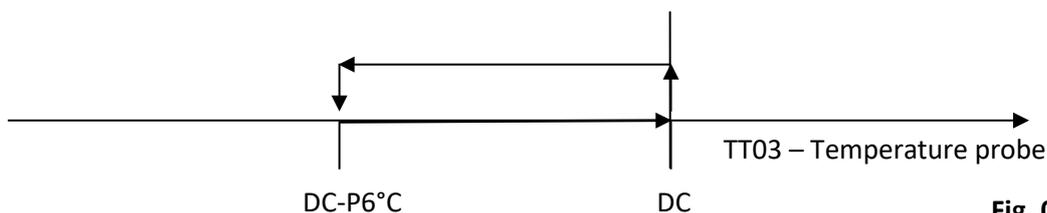


Fig. 06

During hot-gas defrost sequence, the compressor is limited by high temperature monitored on the LT discharge temperature transmitter (TT06 = max.120 °C) and LT discharge pressure transmitter (PT02 = max.25 bar).

If any of these limits are reached, the frequency inverter will automatically decrease the frequency in order to lower pressure or temperature. See frequency inverter section.

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 between 0 – 20°C.

The temperature is measured on the 2 duct temperature probes TT01 and TT02.

If the Defrost stop temperature set-point (DS), on TT01 and TT02, is not reached within the defrost timeout (DT) period, the defrost will stop.

Defrost timeout (DT) period is an adjustable parameter and can be adjusted between 0 – 60 minutes.

After defrost end, the blast freezer is put in "Standby" mode. The freezer will stop until a freeze is activated again.

The blast freezer will activate the defrost sequence in the below described scenarios:

Defrost after stop (D1)

When the system has been running a full freeze cycle, the technicians will pull out the product from the freezer. Once this has been done, the freezer should be stopped and the defrost will automatically happen.

Instant defrost (FD2)

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

This action is only available for Lowenco, as a part of troubleshooting on the system.

11 LT compressor frequency inverter

The system is operating with a frequency inverter on the LT compressor (**COM01**) to perform capacity regulation at various loads. The frequency inverter also ensures that the discharge temperature (TT06) on the LT compressor (**COM01**) is maintained below 120°C to ensure good lubricant performance of the compressor oil. Furthermore, the frequency inverter limits the output if the discharge pressure (PT02) rises to 25 bar (fixed parameter) during operation. The frequency inverter is limited to operate at frequencies between 30 and 60 Hz.

Fixed regulating parameters:

The compressor discharge temperature transmitter (TT06) and the LT discharge pressure transmitter (PT02) are used as reference to ensure the following:

- $TT06 \leq 110^{\circ}\text{C}$ (118°C) = The frequency inverter is allowed to increase the frequency until 60 Hz
- $TT06 > 120^{\circ}\text{C}$ = The frequency inverter automatically decreases the frequency
- $PT02 \leq 23$ bar = The frequency inverter is allowed to increase the frequency until 60 Hz
- $PT02 > 25$ 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 HT compressor frequency inverter

The system is operating with a frequency inverter on the HT compressor (**COM02**) to perform capacity regulation at various loads.

The inverter limits the compressor discharge pressure (PT05) 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 Discharge pressure transmitter (PT05) is used as a reference to ensure the following:
- $PT05 \leq 23$ bar = The frequency inverter is allowed to increase the frequency until 70 Hz
- $PT05 > 25$ 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.

13 Heating control

The system is fitted with the below listed components. 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.

- **Drain tracing**

The drain tracing is active during defrost sequence and driptime (DD) to ensure ice buildups in the drain pipes from the evaporators is melted during a defrost session. This allows water to flow freely through the drain pipes.

- **Maintenance hatch tracing**

The maintenance hatch heating (EV01 maintenance hatch and EF01 maintenance hatch) is active when the system room temperature transmitter (TT01) is reading below -5°C (fixed), and is deactivated when the temperature reaches 0°C.

- **Evaporator fan motor standstill heating**

The evaporator fan motor standstill heating (EF01) is active when system room temperature transmitter (TT01) is reading below -5°C (fixed), and is deactivated when the temperature reaches 0°C.

- **Door heating + room relief valve heating**

The door heating and room relief valve heating is active when the system room temperature transmitter (TT01) is reading below -5°C (fixed), and is deactivated when the temperature reaches 0°C.

14 Expansion tank control

The Normally Open (NO) solenoid valves MV05 and MV08 control the refrigerant flow to the expansion tank (ET01). The valves de-energize (and open) at fixed values as per below:

- MV05 Opening pressure (de-energize): 21 bar, closing pressure (energize): 18 bar.
- MV08 Opening pressure (de-energize): 14 bar, closing pressure (energize): 10 bar.

When the system is in Lead mode, the solenoid valves will remain energized (and closed), unless the values 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

15 Adjustable Parameter List -40°C

Parameter List -40°C	P&ID tag	Parameter	Units	Min.	Max.	Default Value	Parameter Type	Password level			
								Operator	Supervisor	Administrator	Lowenco
Room setpoints											
Main setpoint	TT01	ST1	°C	-80	40	-42	Parameter	-	x	x	x
Main difference		P1	°C	1	10	2	Parameter	-	x	x	x
Alarm setpoints											
Room temperature High	TT01	AH1	°C	-80	40	-35	Alarm	-	x	x	x
Delay Room temperature High		AD1	Min	0	60	30	Alarm	-	x	x	x
Room temperature Hi Hi	TT01	AH2	°C	-80	40	-33	Alarm	-	x	x	x
Delay Room temperature Hi Hi		AD2	Min	0	60	30	Alarm	-	x	x	x
Room temperature Low	TT01	AL1	°C	-80	40	-45	Alarm	-	x	x	x
Delay Room temperature Low		AD3	Min	0	60	5	Alarm	-	x	x	x
Room temperature Lo Lo	TT01	AL2	°C	-80	40	-46	Alarm	-	x	x	x
Delay Room temperature Lo Lo		AD4	Min	0	60	5	Alarm	-	x	x	x
Door open temperature	TT01	DA	°C	-80	40	-30	Alarm	-	x	x	x
Delay High/Hi Hi alarm disable	TT01	AD5	Hour	1	99	48	Alarm	-	x	x	x
Evaporator setpoints											
Evaporator fan release temperature	TT03	FT	°C	-100	50	-20	Parameter	-	x	x	x
Evaporator superheat	TT03 + PT08	ST6	K	2	20	4	Parameter	-	x	x	x
Defrost setpoints											
Defrost control temperature	TT03	DC	°C	0	10	10	Parameter	-	x	x	x
Defrost control difference		P6	°C	0	10	3	Parameter	-	x	x	x
Drip time		DD	Min	0	30	15	Parameter	-	x	x	x
Defrost timeout		DT	Min	0	90	60	Parameter	-	x	x	x
Defrost stop temperature		DS	°C	0	15	5	Parameter	-	x	x	x
LT Compressor setpoints											
LT Compressor pressure	PT01	ST2	Bar	-1	18	2,0	Parameter	-	x	x	x
LT Compressor difference		P3	Bar	0	18	1,0	Parameter	-	x	x	x
HT compressor setpoints											
HT Compressor pressure	PT04	ST4	Bar	-1	18	1,7	Parameter	-	x	x	x
HT Compressor difference	PT04	P5	Bar	0	18	1,0	Parameter	-	x	x	x
Compressor setpoints											
Compressor min. On time		CD1	Sec	0	999	120	Parameter	-	x	x	x
Compressor min. Off time		CD2	Sec	0	999	240	Parameter	-	x	x	x
Delay suction pressure at start		CD3	Sec	0	60	30	Parameter	-	x	x	x
Condenser setpoints											
HT Condensing pressure	PT05	ST5	Bar	10	30	14	Parameter	-	x	x	x
Dry cooler outlet temperature	TT05	ST7	°C	20	40	25	Parameter	-	x	x	x

16 Adjustable Parameter List -70°C

Parameter List -70°C	P&ID tag	Parameter	Units	Min.	Max.	Default Value	Parameter Type	Password Level			
								Operator	Supervisor	Administrator	Lowenco
Room setpoints											
Main setpoint	TT01	ST1	°C	-80	40	-71	Parameter	-	x	x	x
Main difference		P1	°C	1	10	2	Parameter	-	x	x	x
Alarm setpoints											
Room temperature High	TT01	AH1	°C	-80	40	-62	Alarm	-	x	x	x
Delay Room temperature High		AD1	Min	0	60	30	Alarm	-	x	x	x
Room temperature Hi Hi	TT01	AH2	°C	-80	40	-61	Alarm	-	x	x	x
Delay Room temperature Hi Hi		AD2	Min	0	60	30	Alarm	-	x	x	x
Room temperature Low	TT01	AL1	°C	-80	40	-76	Alarm	-	x	x	x
Delay Room temperature Low		AD3	Min	0	60	5	Alarm	-	x	x	x
Room temperature Lo Lo	TT01	AL2	°C	-80	40	-77	Alarm	-	x	x	x
Delay Room temperature Lo Lo		AD4	Min	0	60	5	Alarm	-	x	x	x
Door open temperature	TT01	DA	°C	-80	40	-51	Alarm	-	x	x	x
Delay High/Hi Hi alarm disable	TT01	AD5	Hour	1	99	48	Alarm	-	x	x	x
Evaporator setpoints											
Evaporator fan release temperature	TT03	FT	°C	-100	50	-60	Parameter	-	x	x	x
Evaporator superheat	TT03 + PT08	ST6	K	2	20	4	Parameter	-	x	x	x
Defrost setpoints											
Defrost control temperature	TT03	DC	°C	0	10	5	Parameter	-	x	x	x
Defrost control difference		P6	°C	0	10	3	Parameter	-	x	x	x
Drip time		DD	Min	0	30	15	Parameter	-	x	x	x
Defrost timeout		DT	Min	0	90	60	Parameter	-	x	x	x
Defrost stop temperature		DS	°C	0	15	5	Parameter	-	x	x	x
LT Compressor setpoints											
LT Compressor pressure	PT01	ST2	Bar	-1	18	0,2	Parameter	-	x	x	x
LT Compressor difference		P3	Bar	0	18	0,5	Parameter	-	x	x	x
HT compressor setpoints											
HT Compressor pressure	PT04	ST4	Bar	-1	18	0,4	Parameter	-	x	x	x
HT Compressor difference		P5	Bar	0	18	0,5	Parameter	-	x	x	x
Compressor setpoints											
Compressor min. On time		CD1	Sec	0	999	120	Parameter	-	x	x	x
Compressor min. Off time		CD2	Sec	0	999	240	Parameter	-	x	x	x
Delay suction pressure at start		CD3	Sec	0	60	30	Parameter	-	x	x	x
Condenser setpoints											
HT Condensing pressure	PT05	ST5	Bar	10	20	14	Parameter	-	x	x	x
Dry cooler outlet temperature	TT05	ST7	°C	20	40	25	Parameter	-	x	x	x

17 Parameters

17.1 Adjustable room regulation parameters

Main set-point:	(ST1) the Main set-point is the value of the desired room temperature where the compressor stops
Main difference:	(P1) the Main difference is the temperature deviation from the Main Set-point where the compressor starts.
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 compressors are 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 compressors are 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) this is the time in minutes from when AL2 is exceeded and until the alarm is activated.
Door open temperature alarm:	(DA) is a high temperature alarm that is 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.
Fan release temperature:	(FT) the Fan release temperature is the value of the evaporator temperature (TT03) where the evaporator starts after defrost.

Defrost control temperature:	(DC) the defrost control temperature is used to determine when in a defrost sequence the compressor should begin deceleration in regards to control the temperature of the evaporator coil. The value is measured by TT03.
Defrost control temperature difference:	(P6) the defrost control temperature difference is used to increase or decrease LT compressor frequency under defrost.
Defrost stop temperature:	(DS) the defrost stop temperature defined by TT01 and TT02 to ensure all ice build in evaporator duct system.
Drip time:	(DD) the Defrost drip time is the period in minutes, where the compressor and the evaporator fan is forced in off position, in case there is a call for assistance from the compressor. This is to prevent any remaining water from spraying out into the freezer, when the evaporator fan starts up.
Defrost time out:	(DT) the Defrost time out is a value in minutes, counting from defrost start. Once this value is reached, the defrost is stopped.
LT compressor pressure set-point:	(ST2) this is the pressure measured by the suction pressure transmitter PT01.
LT compressor difference:	(P3) the LT compressor difference is the pressure deviation from ST2.
HT compressor pressure set-point:	(ST4) this is the pressure measured by the suction pressure transmitter PT04, where the HT compressor stop.
HT compressor difference:	(P5) the HT compressor difference is the pressure deviation from ST4 where the HT compressor starts.
Comp. min. on time:	(CD1) this 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) this is the period in seconds where the compressor according to the compressor manufacture must stand still once it has stopped.
Delay suction press. Alarm at start:	(CD3) this is the delay in seconds during compressor start, when suction pressure alarm is disabled.
Delay High/Hi Hi alarm suppression:	(AD5) This delay suppresses Room temp. High (AH1) and Room temp. Hi Hi (AH2) for user defined hours.
Condenser pressure set-point:	(ST5) This value indicates the desired condensing pressure for the HT compressor. Measured on PT05.
Evaporator superheat:	(ST6) This value is visible at the system page. Measured on PT08 and TT03.
Dry cooler outlet temperature:	(ST7) This value indicates the desired outlet temperature from the dry cooler. Measured on TT05.

18 Visible values

Evaporator air in (room) temperature	(TT01) this value is visible & recorded as a temperature trend.
Evaporator air out temperature:	(TT02) this value is visible & recorded as a temperature trend.
Evaporator coil temperature:	(TT03) this value is visible & recorded as a temperature trend.
Exchanger temperature:	(TT04) this value is visible & recorded as a temperature trend.
Dry cooler outlet temperature:	(TT05) this value is visible & recorded as a temperature trend.
LT Discharge line temperature:	(TT06) this value is visible & recorded as a temperature trend.
HT compressor suction temperature:	(TT07) this value is visible & recorded as a temperature trend.
HT compressor discharge temperature:	(TT08) this value is visible & recorded as a temperature trend.
Tech space temperature:	(TT10) this value is visible & recorded as a temperature trend.
Dry cooler temperature:	(TT12) this value is visible & recorded as a temperature trend.
LT Compressor Suction pressure:	(PT01) this value is visible & recorded as a pressure trend.
LT Compressor discharge pressure:	(PT02) this value is visible & recorded as a pressure trend.
Heat Exchanger Control Pressure:	(PT03) this value is visible & recorded as a pressure trend.
HT Compressor Suction pressure:	(PT04) this value is visible & recorded as a pressure trend.
HT Compressor discharge pressure:	(PT05) this value is visible & recorded as a pressure trend.
Expansion tank pressure:	(PT06) this value is visible & recorded as a pressure trend.
Glycol pressure transmitter:	(PT07) this value is visible & recorded as a pressure trend.

Evaporator superheat transmitter: (PT08) this value is visible & recorded as a pressure trend.

Door: (open/closed) (DS01) this indication is visible & recorded on the room trend.

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

19 Definition of colors on the components on the HMI

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

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

20 Safety devices

Emergency stop: In front of the Room Control Panel (C1) and in front of the freezer there is an emergency stop push button that once pressed, will stop the system and activate an alarm. Furthermore, there is an emergency stop at the main control panel which will stop the system.

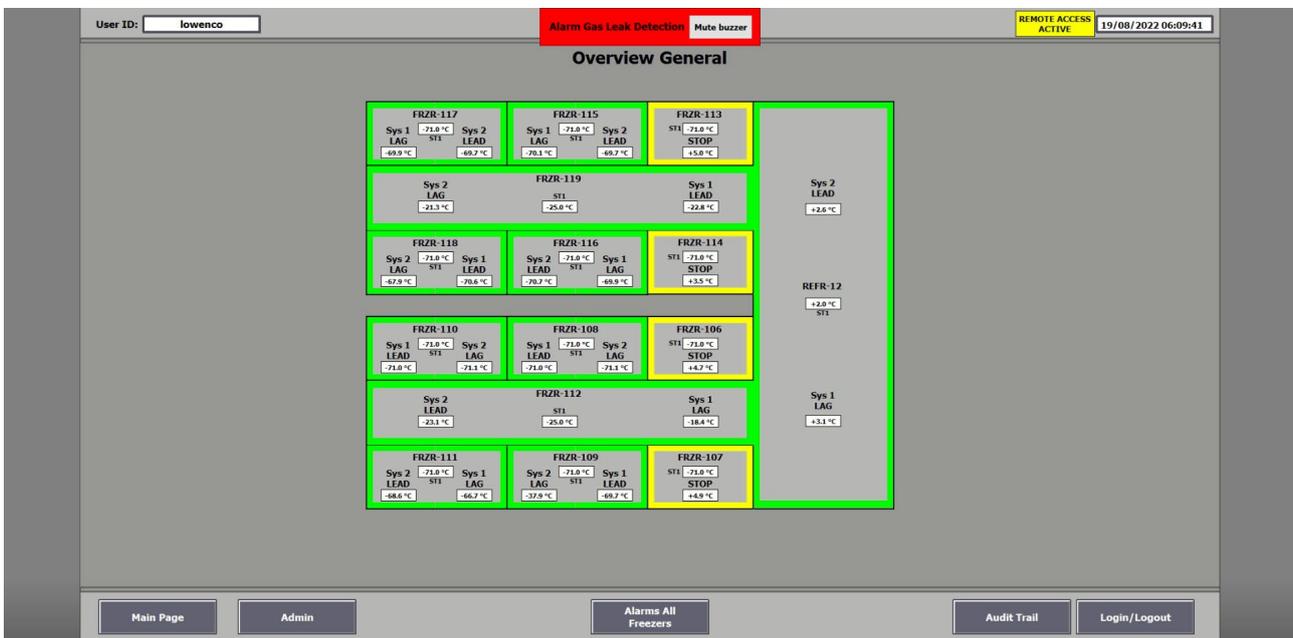
High pressure cut out: The system is fitted with a high-pressure safety cut out device from Danfoss with manual reset. This device stops the compressor and activates an alarm. This alarm must be attended and reset manually at the compressor skid.

20.1 Gasleak Detection

The system has a gasleak detection system, which has the purpose to ensure that there is not any breach on the system, leaking gas in the room. Each -70° freezer compressor skid is fitted with 3 detectors, the -25° corridor skid and the anteroom skid is each fitted with 2 detectors.

On the -70°C freezers the detectors are placed, so gasleak 1 is detecting R449a, gasleak 2 is detecting R23 and gasleak 3 is detecting leakage in the evaporator. As the corridor and anteroom only has one compressor, gasleak 1 is detecting R449a and gasleak 2 is detecting leakage in the evaporator on those systems.

If a gas leak is detected the buzzer in both the anteroom and the corridor is activated, the same as the red lamps above each freezer. On the HMI a red popup will appear in the top, with the possibility to mute the buzzers, but the alarm will stay active until the leakage has been stopped.



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 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 creates 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 3,5mA, 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 21mA, and create a probe failure for the specific probe.

22 Functionality and safe operating conditions of temp. probes

TT01 Evaporator air in (room) temperature probe

The TT01 temperature probe is located in the evaporator duct in the suction side of the evaporator. TT01 is the main temperature probe for regulating the room temperature inside the freezer.

If TT01 fails it will activate a probe failure alarm and the system with the affected probe will use TT02 as control probe.

TT02 Evaporator air out temperature probe

The TT02 temperature probe is located in the evaporator duct in the discharge side of the evaporator.

TT02 is used for monitoring the performance through the evaporator together with TT01.

If TT02 fails it will activate a probe failure alarm, but the system will keep running in normal running mode.

If both TT01 and TT02 fails, the unit will go into lag mode.

TT03 Evaporator coil temperature probe

The TT03 temperature probe is located on the suction line just after the evaporator coil. TT03 is used for controlling the defrost end temperature, stopping the defrost cycle.

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

TT04 Exchanger temperature probe

The TT04 temperature probe is located on the LT liquid line after the HT exchanger. TT04 is used for monitoring the liquid temperature of the LT refrigerant (R473A).

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

TT05 Dry cooler outlet temperature

The TT05 temperature probe is located on the outlet pipe of the dry cooler. TT05 is used for regulating the fanspeed on the drycooler DC01. A failure on this probe will set the dry cooler fan speed output to 100% if system is required to run.

TT06 LT Discharge line temperature probe

The TT06 temperature probe is located on the discharge pipe on the LT compressor and is used for limiting the discharge line temperature by regulating the compressor speed with the frequency inverter.

If TT06 fails it will activate a probe failure alarm and the system with the affected probe will perform a pumpdown cycle and go into lag mode. If the unit is forced back in lead the frequency inverter output is limited to 30 Hz.

TT07 HT Suction temperature transmitter

The TT07 temperature probe is located on the suction line just after the evaporator coil. TT07 is used for measuring the suction gas from the heat exchanger

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

TT08 HT Discharge line temperature probe

The TT08 temperature probe is located on the suction line just after the evaporator coil. TT08 is used for measuring the discharge gas from hotgas.

If TT08 fails it will activate a probe failure alarm and the system with the affected probe will perform a pumpdown cycle and go into lag mode. If the unit is forced back in lead the frequency inverter output is limited to 30 Hz.

TT09 Ambient temperature probe

The TT09 temperature probe is located in the HMI panel in the tech space.

TT09 is used as a Technical convenience for assisting the understanding of the performance of the system.

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

TT10 Tech space temperature probe

The TT10 temperature probe is located in the HMI panel in the tech space.

TT10 is used as a technical convenience for assisting the understanding of the performance of the system.

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

TT12 Dry cooler temperature probe

The TT12 temperature probe is located near the dry coolers.

TT12 is used as a technical convenience for assisting the understanding of the performance of the system, by having a temperature measurement at the dry coolers.

A failure on this probe will activate a probe failure 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 creates 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 22mA, and create a probe failure for the specific probe.

24 Functionality and safe operating conditions pressure probes

PT01 LT compressor suction pressure transmitter

The PT01 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.

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

PT02 LT compressor discharge pressure transmitter

The PT02 transmitter is connected directly to the discharge side of the LT compressor & is used to limit the speed of the LT compressor in order to control the high pressure at a required level. If PT02 fails it will activate a probe failure alarm and the system with the affected probe will perform a pumpdown cycle and go into lag mode and limits the frequency inverter output to 30 Hz. If the unit is forced back in lead the frequency inverter output is limited to 30 Hz.

PT03 Heat exchanger control pressure transmitter

The PT03 is located on the LT liquid line just before the HT exchanger.

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

PT04 HT compressor suction pressure transmitter

The PT04 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.

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

PT05 HT compressor discharge pressure transmitter

The PT05 transmitter is connected directly to the discharge side of the compressor & is used as a technical convenience for assisting the understanding of the performance of the system.

A failure on this probe will activate a probe failure alarm, and the 3-way valve (VS01) will set the output to 100% open.

PT06 Expansion tank pressure transmitter

The PT06 transmitter is connected directly to the expansion tank & is used as a technical convenience for assisting the understanding of 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 (MV04) 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

PT07 Glycol pressure transmitter

The PT07 transmitter is connected directly to the glycol circuit on the pressure side of the circulation pump & is used as a pump dry running protection.

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

PT08 Evaporator superheat pressure transmitter

The PT08 transmitter is connected directly to the evaporator suction pipe & is used for measuring the pressure in order to regulate the gas superheat from the evaporator.

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

25 Definition of signal lights on HMI main page

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:

Blue light flashing:	The system is defrosting.
Green light:	Indicates normal operating condition.
Red light is 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 is flashing:	The system is in alarm mode.
Yellow light:	An alarm is acknowledged but still active (e.g. high temperature alarm).

26 Definition of signal lights in front of freezer

On top of the freezer doors a common signal light is mounted.

Blue light is flashing:	The unit is defrosting.
Red light:	The unit is in alarm mode and is stopped.
Red light + sound:	Door open alarm is active.

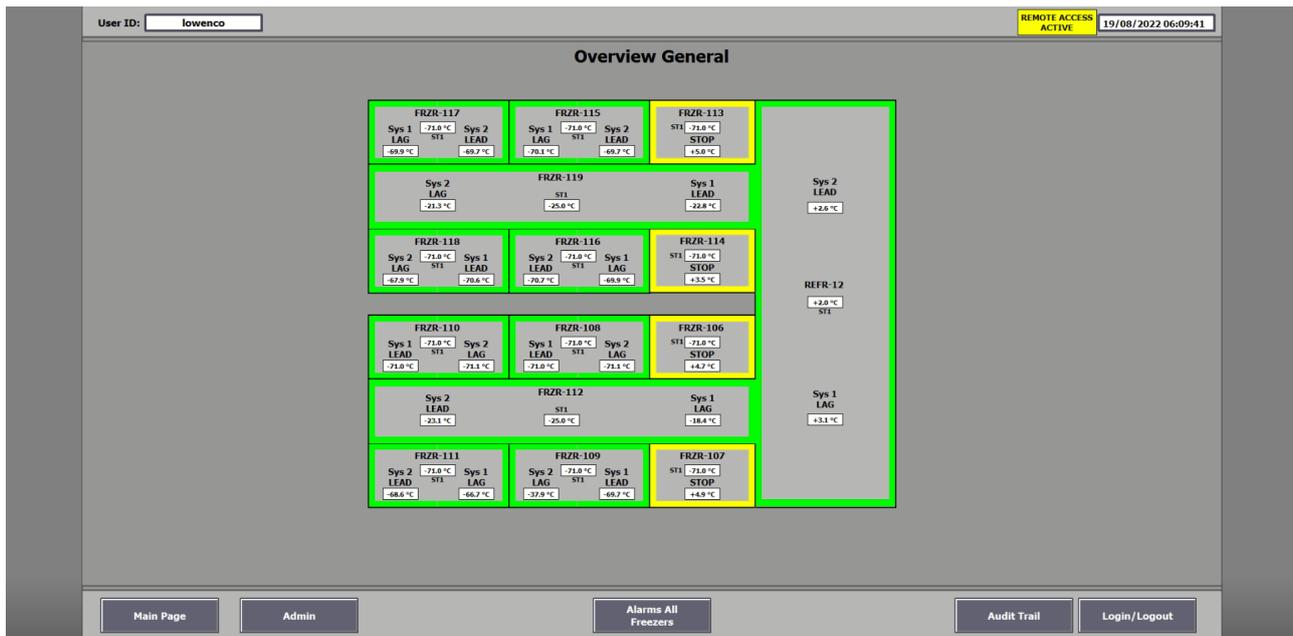
27 Acknowledge alarms/failures

If a situation occurs where 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 flashlight 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 as soon it is fixed. When a failure has been fixed it needs a reset to disappear.

28 Operating the system

The 2 HMI's located in the tech space above the freezers and on the ground floor. The system is outlined in order 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 in order to see the general status of the system i.e. set-points, temperatures, trend curves, alarm lists.

28.1 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.

Furthermore, easy navigation to the system of preference etc. Freezer 1 can 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.

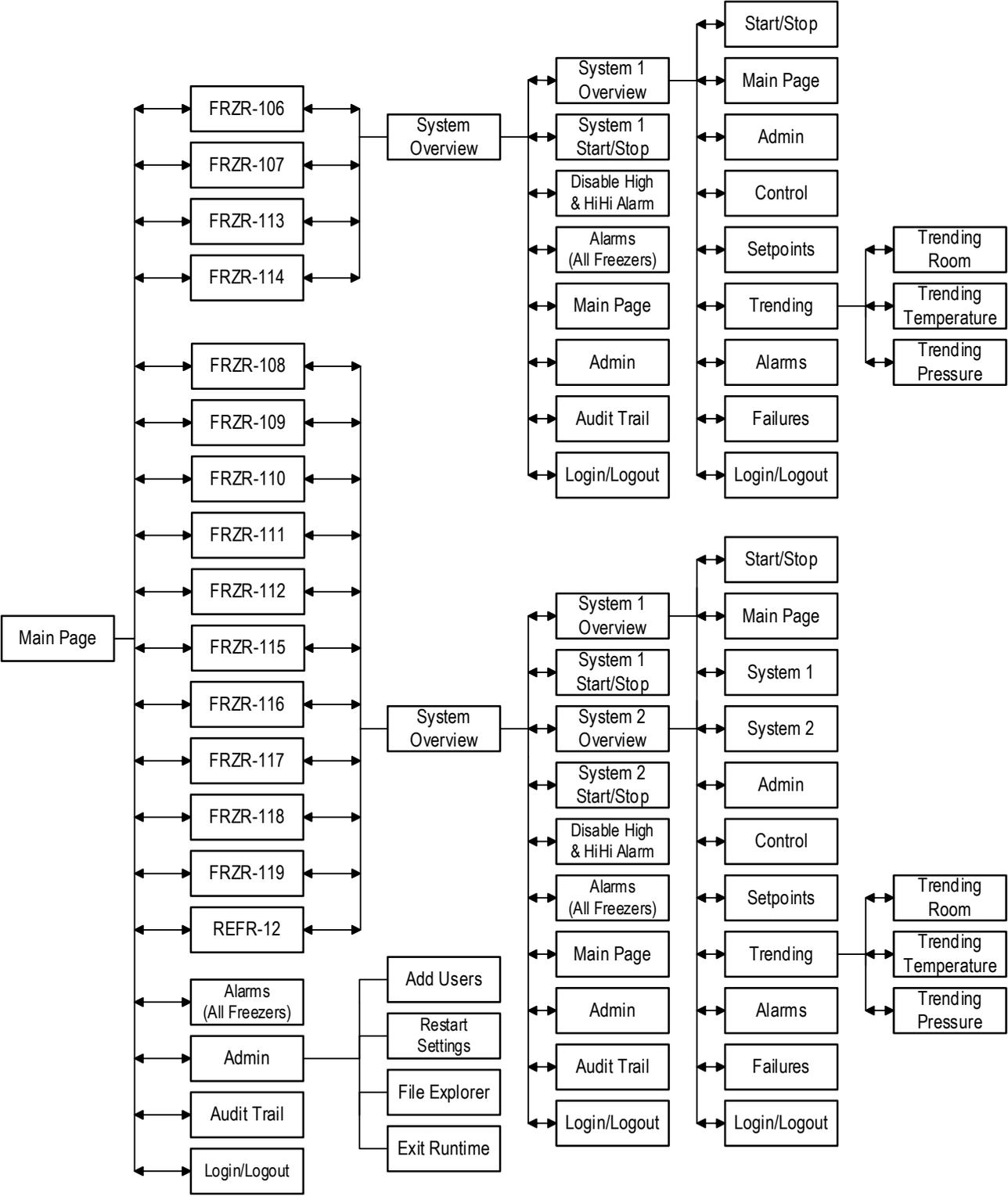
Admin: The Admin button, allows the appropriate user to use the file explorer, choose the restart settings, stop wincc runtime (Close the HMI) and the remote access settings.

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.

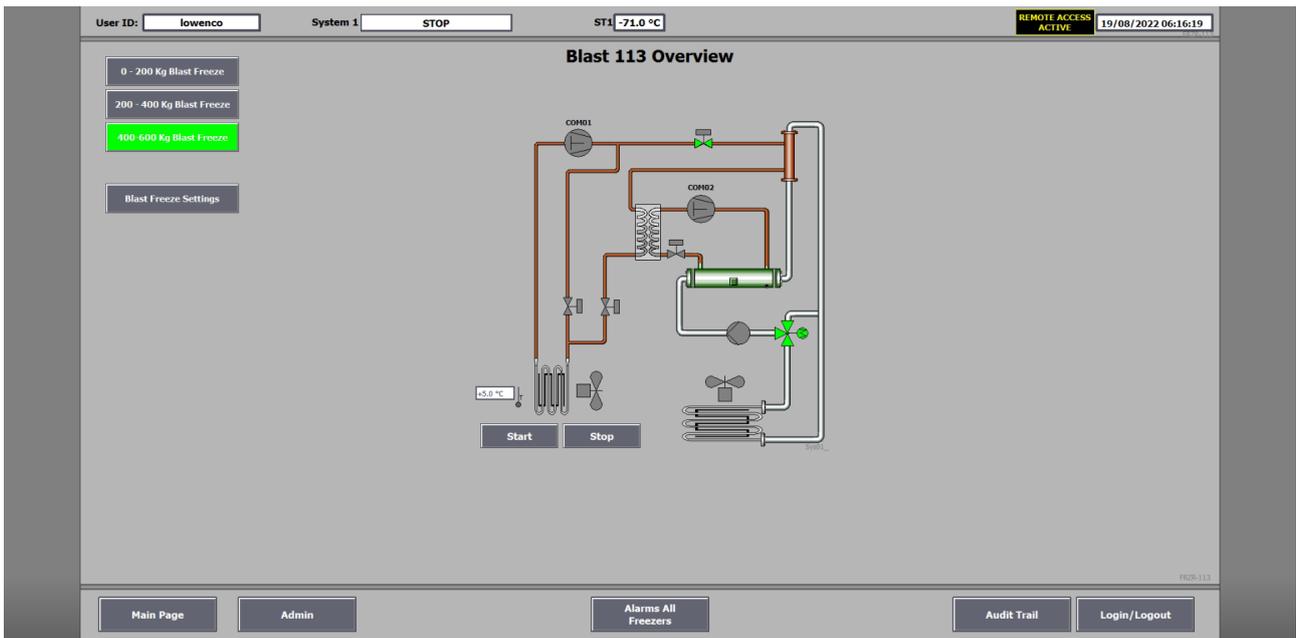
Audit Trail: The Audit Trail Button allows the user to view the registered changes on the systems and export the Audit trail.

Login/Logout: The login/logout buttons allows the change of users on the HMI.

28.2 HMI Overview



28.3 Freezer Overview

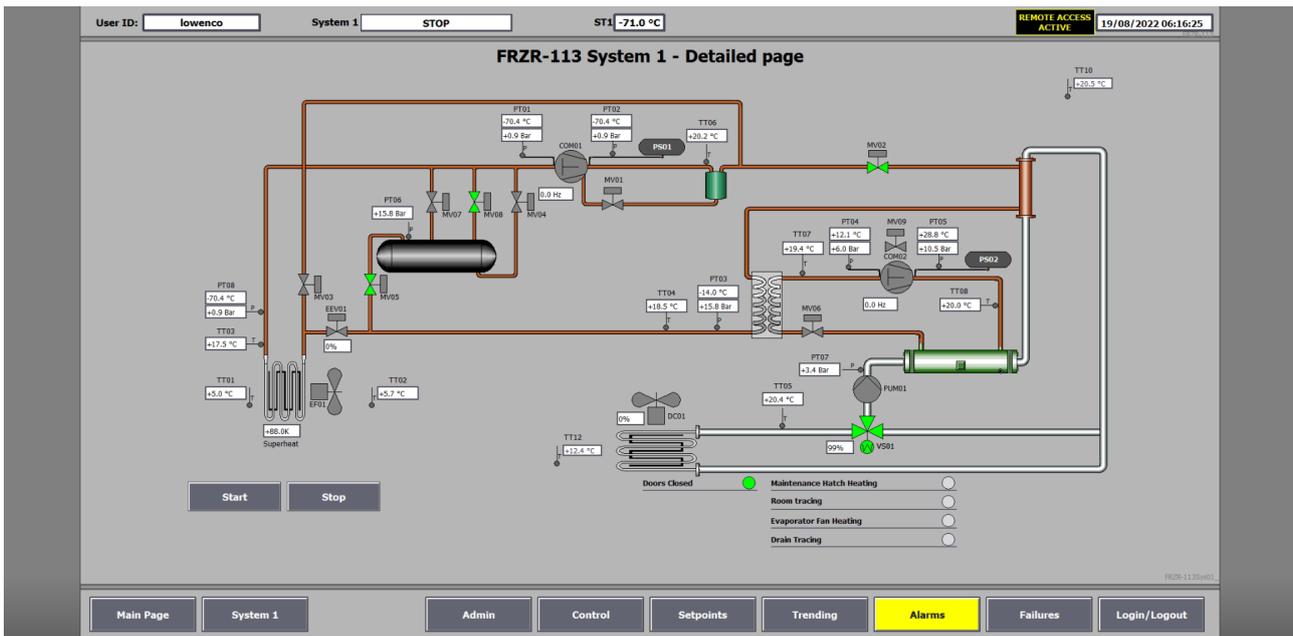


This is the main screen that shows the actual status of the system for a general overview of the entire freezer. In the top of the screen the status of the system can be seen.

By pressing the middle of the system, a detailed graphical system overview is shown (See System overview).

From this screen it is possible to start/stop the systems (depending on access levels), it is furthermore possible to disable High & HiHi Alarms for a specified period of time (adjusted in the setpoint page) due to warm products entering the freezer etc.

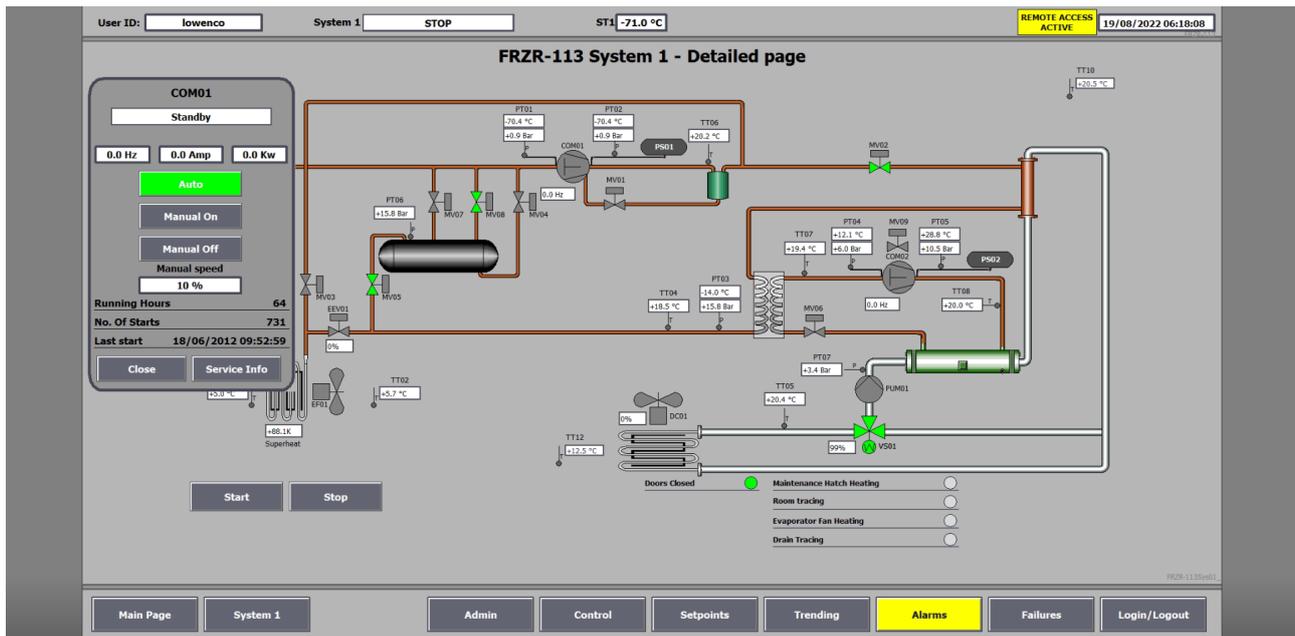
28.4 System detailed overview



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

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

28.5 Manual Control



Pressing the individual automated components will create a pop-up window with different possibilities of manual control:

- 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.

28.6 Control page

User ID: System 1: ST1: REMOTE ACCESS: 19/08/2022 06:16:30

Blast 113 - Control page

Defrost Setpoints	
DC: Defrost Control Temperature	+5.000 °C
P6: Defrost Control Difference	+3.000 °C
DD: Drip Time	15 Min.
DT: Defrost Timeout	60 Min.
Next schedule defrost	30/12/1999 00:00:00
Last Defrost	18/06/2012 09:48:37

Evaporator Setpoints	
FT: Evaporator Fan Release Temperature	-60.0 °C
ST6: Evaporator Superheat	4.0 K

Compressor Info	
LT Compressor No. Starts Last Hour	0
HT Compressor No. Starts Last Hour	0

LT Compressor Setpoints	
ST2: LT Compressor Pressure	+0.2 Bar
P3: LT Compressor Difference	0.5 Bar

HT Compressor Setpoints	
ST4: HT Compressor Pressure	+0.4 Bar
P5: HT Compressor Difference	0.5 Bar

HT Compressor Setpoints	
CD1: Compressor Min. Off Time	120 Sec.
CD2: Compressor Min. Off Time	240 Sec.
CD3: Delay Suction Pressure at Start	30 Sec.

Service	
<input type="button" value="Service Reset"/>	
Last Service	01/01/1970 00:00:00

#29-1135001

Main Page | System 1 | Admin | Control | Setpoints | Trending | **Alarms** | Failures | Login/Logout

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

28.7 Setpoints page

Blast 113 - Setpoint page

Category	Parameter	Value	Unit
Room Setpoints	ST1: Main Setpoint	-71.0	°C
	P1: Main Difference	2.0	°C
Alarm Setpoints	AH1: Room Temperature High	-62.0	°C
	AD1: Delay Room Temperature High	30	Min.
	AH2: Room Temperature HiHi	-61.0	°C
	AD2: Delay Room Temperature HiHi	30	Min.
	AL1: Room Temperature Low	-76.0	°C
	AD3: Delay Room Temperature Low	5	Min.
	AL2: Room Temperature LoLo	-77.0	°C
	AD4: Delay Room Temperature LoLo	5	Min.
	DA: Door Open Temperature	-51.0	°C
AD5: Delay High/Hi Hi alarm disable	48	Hr.	
Evaporator Setpoints	FT: Evaporator Fan Release Temperature	-60.0	°C
	ST6: Evaporator Superheat	+4.0	K
Defrost Setpoints	DC: Defrost Control Temperature	+5.0	°C
	P6: Defrost Control Difference	+3.0	°C
	DD: Drip Time	15	Min.
	DT: Defrost Timeout	60	Min.
Compressor Setpoints	ST5: HT Condensing Pressure	14.0	Bar
	ST7: Dry Cooler Outlet Temperature	+25.0	°C

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

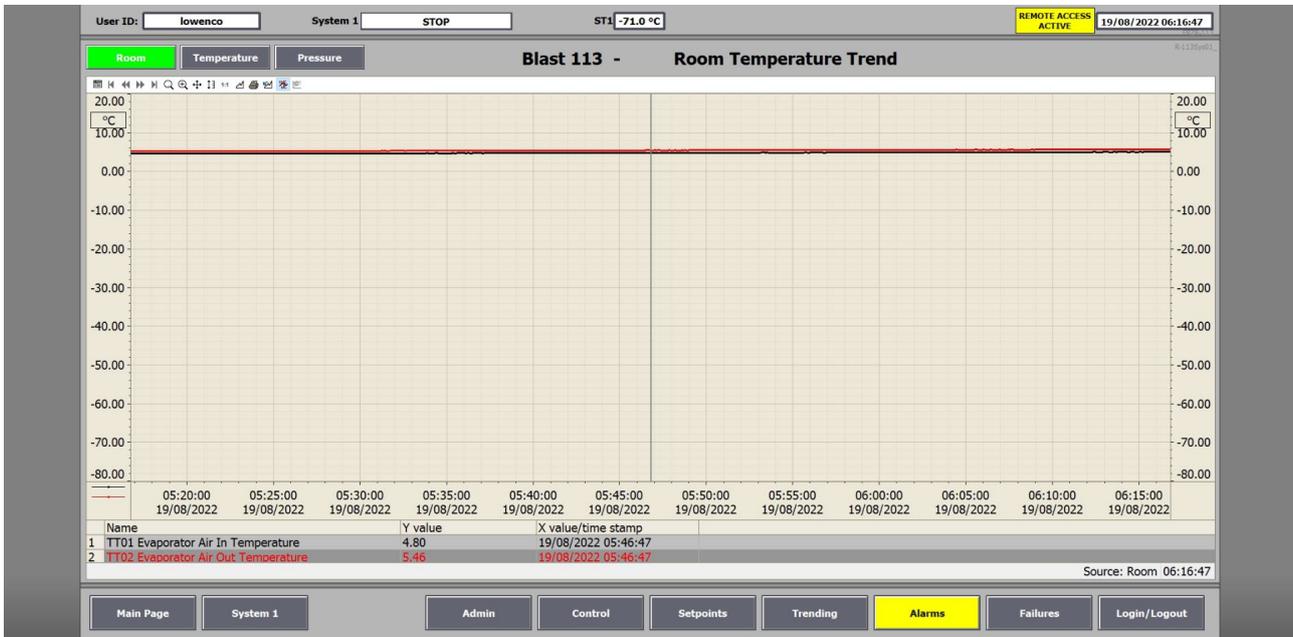
The page also contains a button to restore default -40/-70°C setpoints.

The Default settings buttons will restore default settings on the freezer if pressed.

28.8 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.

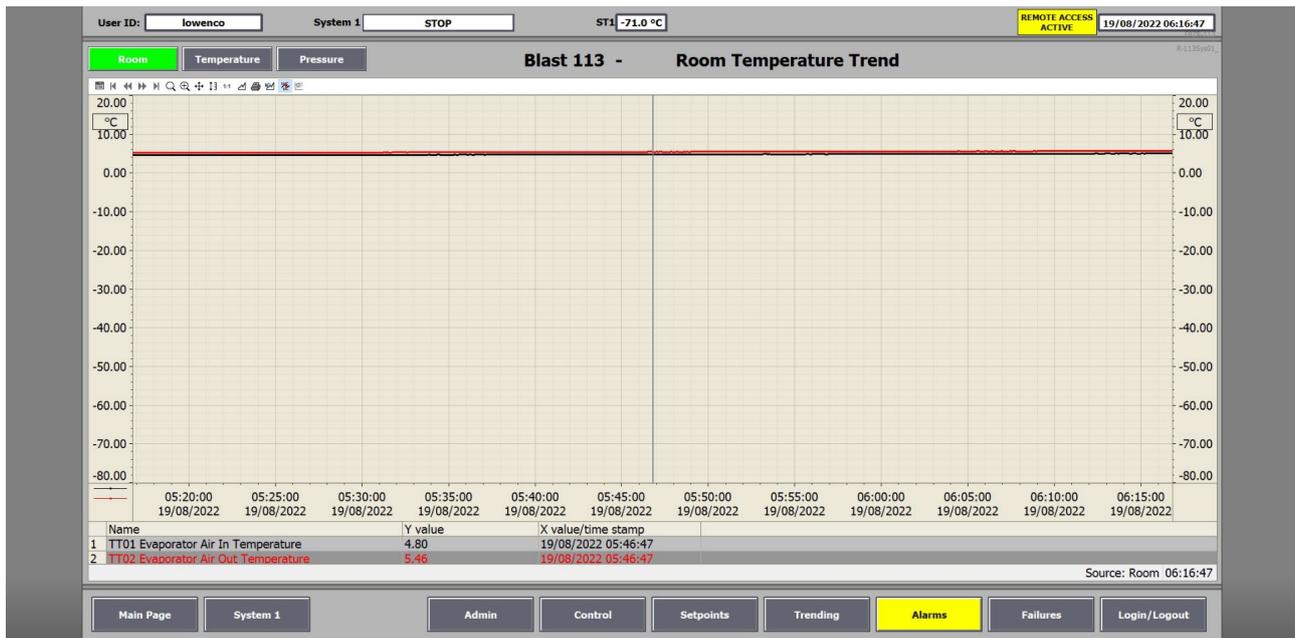
View change between temperature and pressure trends is performed in the top left corner by pressing "Room", "Temperature" or "Pressure".



Visible trends tags are listed below:

Temperature:	Pressure:
TT01 – Evaporator air in (room) temperature	PT01 – LT compressor suction pressure
TT02 – Evaporator air out	PT02 – LT compressor discharge pressure
TT03 – Evaporator coil temperature	PT03 – Heat exchanger control pressure
TT04 – Exchanger temperature	PT04 – HT compressor suction pressure
TT05 – Dry cooler outlet temperature	PT05 – HT compressor discharge pressure
TT06 – LT compressor discharge temperature	PT06 – Expansion tank pressure
TT07 – HT compressor suction temperature	PT07 – Glycol circuit pressure
TT08 – HT compressor discharge temperature	PT08 – Evaporator superheat pressure
TT10 – Tech Space temperature	
TT12 – Dry cooler temperature	
Superheat – Evaporator superheat	

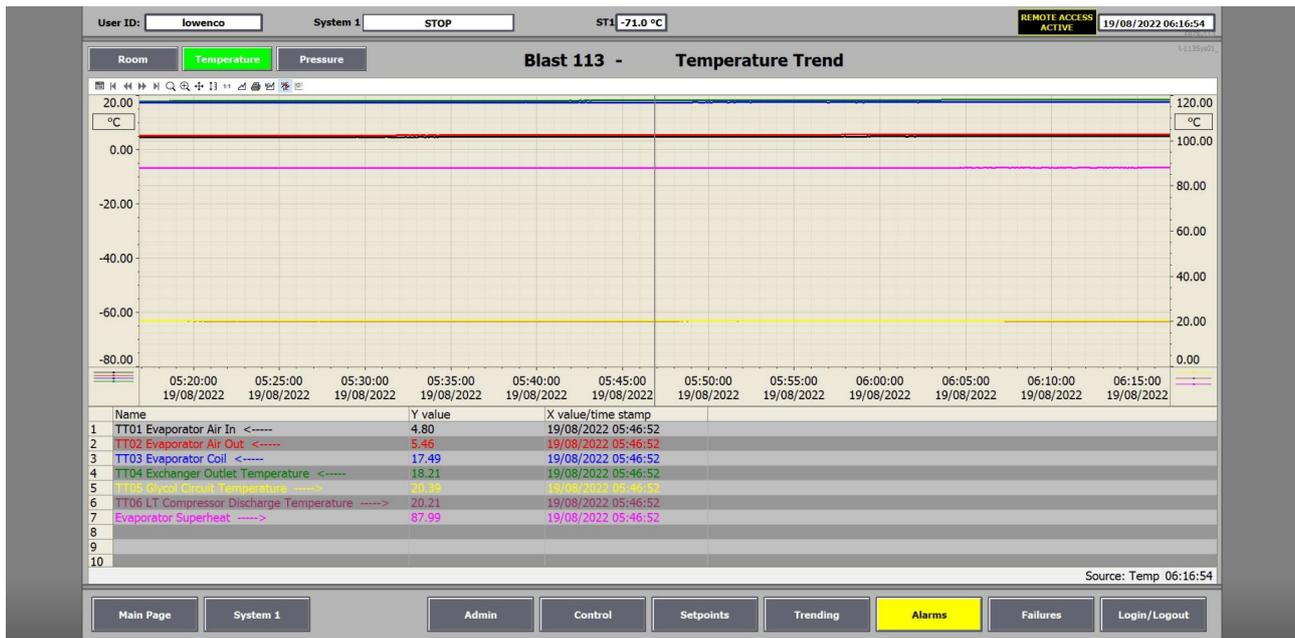
28.9 Trending - Room temperature trend



In this screen, trends of TT01 and TT02 can be viewed.

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

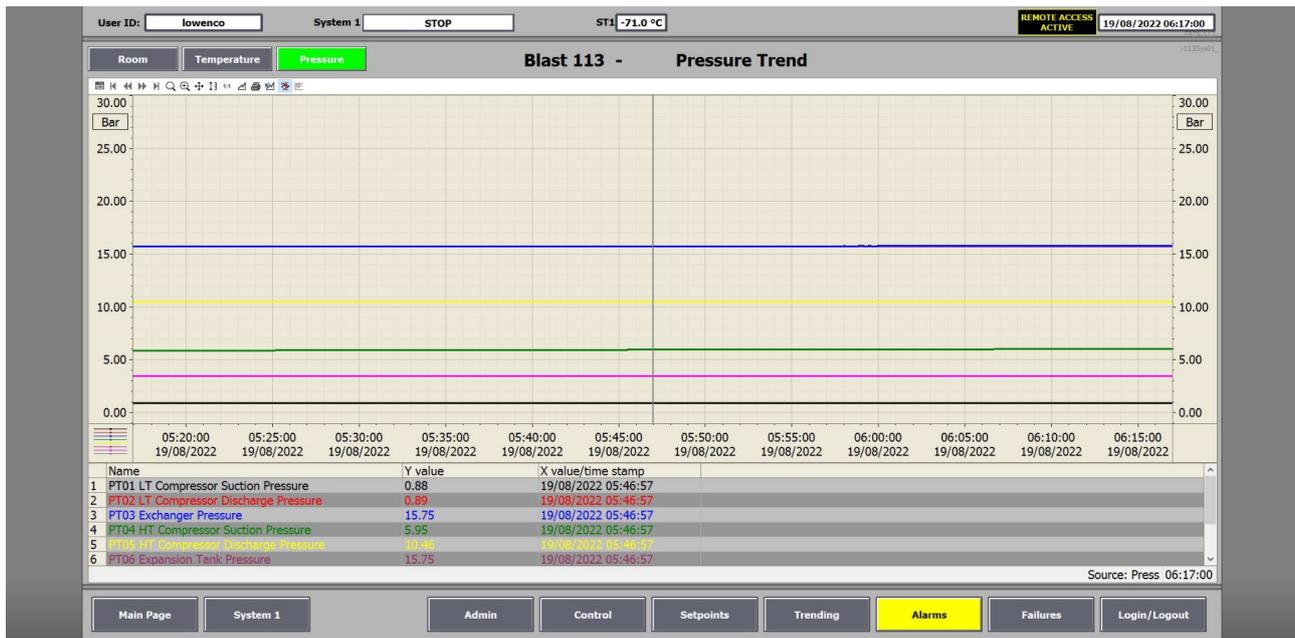
28.10 Trending - Temperature trend



Detailed trended values on: TT01, TT02, TT03, TT04, TT05, TT06, TT07, TT08, TT10, TT12 and the evaporator superheat value.

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

28.11 Trending – Pressure trend



Detailed trended values on: PT01, PT02, PT03, PT04, PT05, PT06, PT07 and PT08.

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

28.12.1 Alarm log

User ID: System 1: ST1: REMOTE ACCESS ACTIVE 19/08/2022 06:17:39

FRZR-113 - Alarm Log page

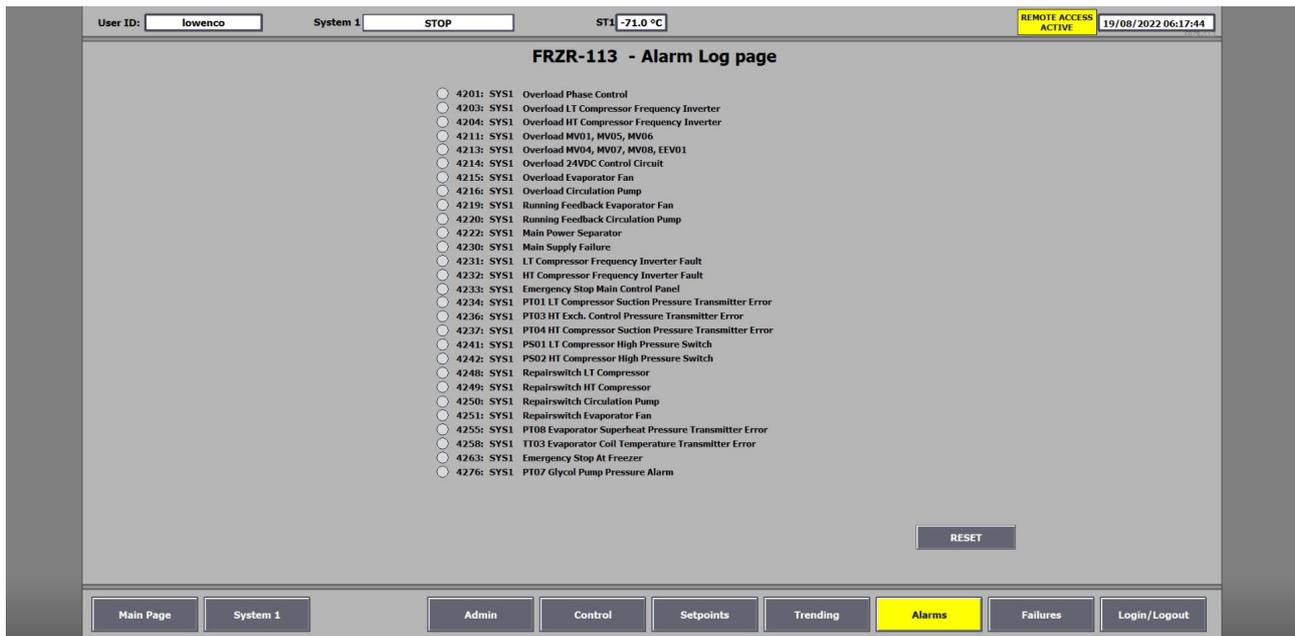
ID	Alarm class	ID	Date	Time	Status	Alarm text
1	FRZR-113 Failure	4241	18/08/22	15:32:35.102	D	SYS 1 PS01 LT Compressor High Pressure Switch
2	FRZR-113 Alarms	4275	18/08/22	15:32:35.102	D	SYS 1 Common Trouble Alarm
3	FRZR-113 Failure	4241	18/08/22	15:32:08.102	A	SYS 1 PS01 LT Compressor High Pressure Switch
4	FRZR-113 Alarms	4272	18/08/22	15:32:08.102	A	SYS 1 System is stopped
5	FRZR-113 Alarms	4275	18/08/22	15:32:08.102	A	SYS 1 Common Trouble Alarm
6	FRZR-113 Failure	4241	18/08/22	15:31:57.103	C	SYS 1 PS01 LT Compressor High Pressure Switch
7	FRZR-113 Alarms	4272	18/08/22	15:31:57.102	C	SYS 1 System is stopped
8	FRZR-113 Alarms	4275	18/08/22	15:31:57.102	C	SYS 1 Common Trouble Alarm
9	FRZR-113 Alarms	4272	18/08/22	08:30:16.956	D	SYS 1 System is stopped
10	FRZR-113 Failure	4241	18/08/22	07:59:36.038	D	SYS 1 PS01 LT Compressor High Pressure Switch
11	FRZR-113 Alarms	4275	18/08/22	07:59:36.038	D	SYS 1 Common Trouble Alarm
12	FRZR-113 Failure	4241	18/08/22	07:59:33.039	A	SYS 1 PS01 LT Compressor High Pressure Switch
13	FRZR-113 Alarms	4272	18/08/22	07:59:33.039	A	SYS 1 System is stopped
14	FRZR-113 Alarms	4275	18/08/22	07:59:33.039	A	SYS 1 Common Trouble Alarm
15	FRZR-113 Alarms	4272	18/08/22	07:56:10.053	C	SYS 1 System is stopped
16	FRZR-113 Alarms	4275	18/08/22	07:56:10.053	C	SYS 1 Common Trouble Alarm
17	FRZR-113 Failure	4241	18/08/22	07:56:09.052	C	SYS 1 PS01 LT Compressor High Pressure Switch
18	FRZR-113 Alarms	4225	17/08/22	16:58:49.594	A	SYS 1 Gas Leak Detection High
19	FRZR-113 Alarms	4225	17/08/22	16:56:50.600	D	SYS 1 Gas Leak Detection High
20	FRZR-113 Alarms	4225	17/08/22	16:56:09.602	C	SYS 1 Gas Leak Detection High
21	FRZR-113 Alarms	4224	17/08/22	16:56:01.603	D	SYS 1 Gas Leak Detection
22	FRZR-113 Alarms	4225	17/08/22	16:56:01.603	D	SYS 1 Gas Leak Detection High
23	FRZR-113 Alarms	4224	17/08/22	15:40:36.817	A	SYS 1 Gas Leak Detection
24	FRZR-113 Alarms	4224	17/08/22	15:15:25.891	C	SYS 1 Gas Leak Detection
25	FRZR-113 Alarms	4272	17/08/22	15:07:06.911	D	SYS 1 System is stopped
26	FRZR-113 Alarms	4272	17/08/22	15:05:12.916	A	SYS 1 System is stopped
27	FRZR-113 Alarms	4272	17/08/22	14:55:31.943	C	SYS 1 System is stopped
28	FRZR-113 Alarms	4272	17/08/22	11:00:01.609	D	SYS 1 System is stopped
29	FRZR-113 Alarms	4272	17/08/22	10:50:31.418	A	SYS 1 System is stopped
30	FRZR-113 Failure	4241	17/08/22	10:50:27.637	D	SYS 1 PS01 LT Compressor High Pressure Switch

Ready Pending: 51 To acknowledge: 31 Hidden: 0 List: 675 06:17:39

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

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

28.13 Failures



User ID: lowenco System 1: STOP ST1: -71.0 °C REMOTE ACCESS ACTIVE 19/08/2022 06:17:44

FRZR-113 - Alarm Log page

- 4201: SYS1 Overload Phase Control
- 4203: SYS1 Overload LT Compressor Frequency Inverter
- 4204: SYS1 Overload HT Compressor Frequency Inverter
- 4211: SYS1 Overload MV01, MV05, MV06
- 4213: SYS1 Overload MV04, MV07, MV08, EEV01
- 4214: SYS1 Overload 24VDC Control Circuit
- 4215: SYS1 Overload Evaporator Fan
- 4216: SYS1 Overload Circulation Pump
- 4219: SYS1 Running Feedback Evaporator Fan
- 4220: SYS1 Running Feedback Circulation Pump
- 4222: SYS1 Main Power Separator
- 4230: SYS1 Main Supply Failure
- 4231: SYS1 LT Compressor Frequency Inverter Fault
- 4232: SYS1 HT Compressor Frequency Inverter Fault
- 4233: SYS1 Emergency Stop Main Control Panel
- 4234: SYS1 PT01 LT Compressor Suction Pressure Transmitter Error
- 4236: SYS1 PT03 HT Exch. Control Pressure Transmitter Error
- 4237: SYS1 PT04 HT Compressor Suction Pressure Transmitter Error
- 4241: SYS1 PS01 LT Compressor High Pressure Switch
- 4242: SYS1 PS02 HT Compressor High Pressure Switch
- 4248: SYS1 Repairswitch LT Compressor
- 4249: SYS1 Repairswitch HT Compressor
- 4250: SYS1 Repairswitch Circulation Pump
- 4251: SYS1 Repairswitch Evaporator Fan
- 4255: SYS1 PT08 Evaporator Superheat Pressure Transmitter Error
- 4258: SYS1 TT03 Evaporator Coil Temperature Transmitter Error
- 4263: SYS1 Emergency Stop At Freezer
- 4276: SYS1 PT07 Glycol Pump Pressure Alarm

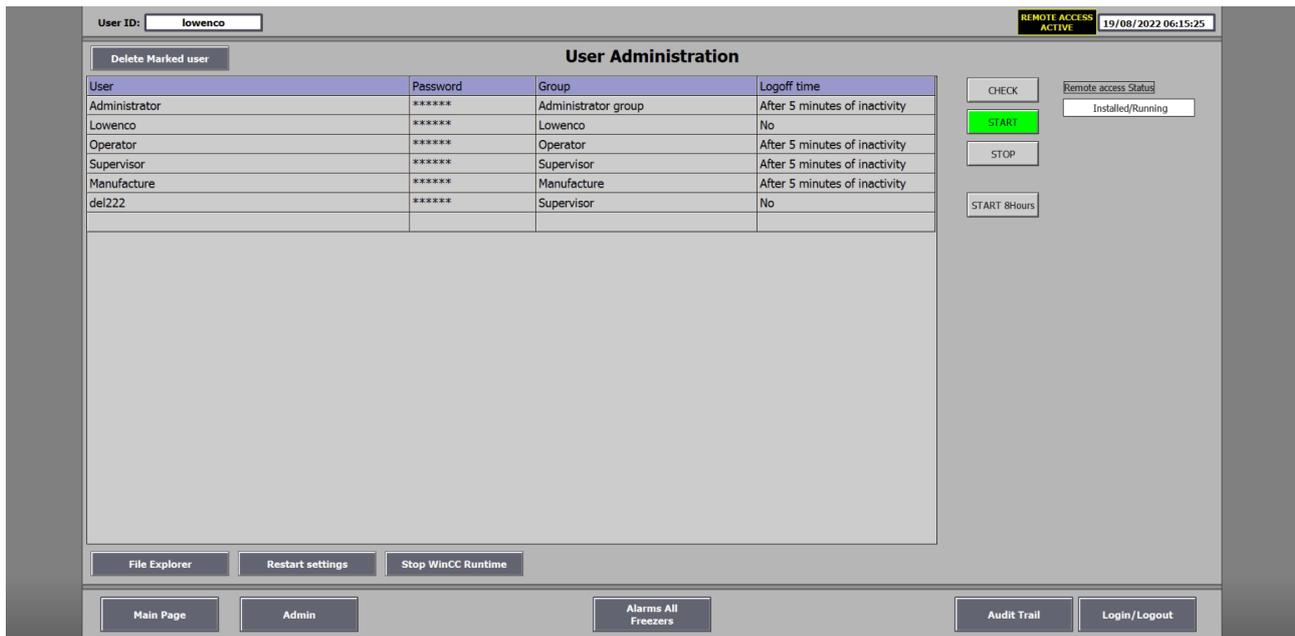
RESET

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

The failure page button is located 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)

28.14 Administration



User ID: REMOTE ACCESS ACTIVE 19/08/2022 06:15:25

Delete Marked user

User Administration

User	Password	Group	Logoff time
Administrator	*****	Administrator group	After 5 minutes of inactivity
Lowenco	*****	Lowenco	No
Operator	*****	Operator	After 5 minutes of inactivity
Supervisor	*****	Supervisor	After 5 minutes of inactivity
Manufacture	*****	Manufacture	After 5 minutes of inactivity
del222	*****	Supervisor	No

CHECK Remote access Status
Installed/Running
 START
 STOP
 START 8Hours

File Explorer Restart settings Stop WinCC Runtime

Main Page Admin Alarms All Freezers Audit Trail Login/Logout

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

28.15 Audit Trail

The equipped Audit Trail is FactoryTalk View SE.

The screenshot displays the 'Audit Trail' window in FactoryTalk View SE. At the top, it shows 'User ID: lowenco' and 'REMOTE ACCESS ACTIVE' with a timestamp of '19/08/2022 06:15:33'. The main area contains a table with columns for Date, Time, TAG Name & Old/New Value, User name, Old Value, and New Value. The table lists various system events such as manual logins, invalid logins, and parameter changes for components like FRZR-1185sys01 and FRZR-1185sys02. At the bottom, there are navigation buttons for 'Main Page', 'Admin', 'Alarms All Freezers', 'Audit Trail', and 'Login/Logout', along with an 'Audit Trail Export' button and a 'List: 1000' indicator.

Date	Time	TAG Name & Old/New Value	User name	Old Value	New Value
19/08/22	06:13:28.317	FRZR-1185sys01_PUT_TO_LAG_Other_Sys: lowenco new=1 old=0	lowenco	0	1
19/08/22	06:13:28.254	FRZR-1185sys01_START: lowenco new=1 old=0	lowenco	0	1
19/08/22	06:09:31.320	USERT:DESKTOP-SB6CO22:Manual login	lowenco		
19/08/22	06:09:22.343	USERT:DESKTOP-SB6CO22:Invalid login name/password			
18/08/22	18:56:44.887	USERT:DESKTOP-SB6CO22:Manual logout	lowenco		
18/08/22	18:56:41.445	FRZR-1185sys02_START: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:51:01.903	FRZR-1185sys01_START: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:46:46.255	FRZR-1185sys02_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:46:46.190	FRZR-1185sys01_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:46:46.122	FRZR-1185sys02_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:46:46.057	FRZR-1185sys01_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:46:44.521	FRZR-1185sys02_STOP: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:46:43.513	FRZR-1185sys01_STOP: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:44:30.685	FRZR-1185sys02_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:44:30.622	FRZR-1185sys01_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:41:20.288	FRZR-1185sys02_PUT_TO_LAG_Other_Sys: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:41:20.222	FRZR-1185sys02_START: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:41:16.438	FRZR-1185sys02_Com01.HMI_Command: lowenco new=256 old=1024	lowenco	1024	256
18/08/22	18:41:12.475	FRZR-1185sys02_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:41:12.411	FRZR-1185sys01_HMI_ACK: lowenco new=1 old=0	lowenco	0	1
18/08/22	18:40:48.510	FRZR-1185sys02_Com01.HMI_Command: lowenco new=1024 old=256	lowenco	256	1024
18/08/22	18:33:24.104	FRZR-1185sys02_Defrost_Heating.HMI_Command: lowenco new=256 old=512	lowenco	512	256
18/08/22	18:33:23.545	FRZR-1185sys02_Defrost_Heating.HMI_Command: lowenco new=512 old=1024	lowenco	1024	512
18/08/22	18:33:23.240	FRZR-1185sys02_Defrost_Heating.HMI_Command: lowenco new=1024 old=256	lowenco	256	1024
18/08/22	18:33:21.380	FRZR-1185sys02_Evaporator_Fan_Heating.HMI_Command: lowenco new=256 old=512	lowenco	512	256
18/08/22	18:33:20.957	FRZR-1185sys02_Evaporator_Fan_Heating.HMI_Command: lowenco new=512 old=1024	lowenco	1024	512
18/08/22	18:33:20.418	FRZR-1185sys02_Evaporator_Fan_Heating.HMI_Command: lowenco new=1024 old=256	lowenco	256	1024
18/08/22	18:33:18.104	FRZR-1185sys02_Room_Tracing.HMI_Command: lowenco new=256 old=1024	lowenco	1024	256
18/08/22	18:33:17.140	FRZR-1185sys02_Room_Tracing.HMI_Command: lowenco new=1024 old=512	lowenco	512	1024

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

Data

Customer name	N/A
Address	N/A
Project no.	N/A
Project name	N/A
Pulldown time	36 Hours
PLC CPU type	Siemens S7-1500
LT refrigerant	R473A
HT refrigerant	R744
Condensing Medium	Propylene glycol (35%)
FDS Name	N/ A

	Freezer	Corridor	Anteroom
Name	FR101	FRZR-112	REFR-12
System 1	Sys1	FRZR-112-A	REFR-12-A
System 2	Sys2	FRZR-112-B	REFR-12-B
Panel 1	Sys1 panel	=CP-FRZR112+A1	=CP-REFR12+A1
Panel 2	System2 panel	=CP-FRZR112+B1	=CP-REFR12+B1
Common Panel	Common panel	=CP-FRZR112+C1	=CP-REFR12+C1

HMI	HMI-303-TS	HMI-304-AR	
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Components

Description	Tag	Bookmark
LT compressor	COM01	Compressor1
HT compressor	COM02	Compressor2
3-way flow control valve	VS01	Threewayvalve1
Oil return solenoid valve	MV01	Solenoidvalve1
Discharge line shut off solenoid valve	MV02	Solenoidvalve2
LT hot gas defrost solenoid valve	MV03	Solenoidvalve3
Expansion tank oil return solenoid valve	MV04	Solenoidvalve4
Expansion tank solenoid valve	MV05	Solenoidvalve5
HT liquid line solenoid	MV06	Solenoidvalve6
Expansion tank startup solenoid valve	MV07	Solenoidvalve7
Expansion tank solenoid valve 5/8"	MV08	Solenoidvalve8
Cascade exchanger	HEX01	Cascadeexchanger1
Condenser	CON01	Condenser1
Circulation pump	PUM01	Circulationpump1
Dry cooler	DC01	Drycooler1
Evaporator	EV01	Evaporator1
Evaporator fan	EF01	Evaporatorfan1
LT liquid receiver	LR01	LTLiquidreciver1
Expansion tank	ET01	Expansiontank1
Electronic expansion valve	EEV01	Electronicexpansionvalve1
Evaporator air in temp.	TT01	Temperaturetransmitter1
Evaporator air out temp.	TT02	Temperaturetransmitter2
Coil temp.	TT03	Temperaturetransmitter3
Exchanger temp.	TT04	Temperaturetransmitter4
Glycol temp.	TT05	Temperaturetransmitter5
LT discharge temp.	TT06	Temperaturetransmitter6
HT Suction temp.	TT07	Temperaturetransmitter7
HT Discharge line temp.	TT08	Temperaturetransmitter8
Defrost temp.	TT09	Temperaturetransmitter9
Tech space temp.	TT10	Temperaturetransmitter10
Anteroom temp.	TT11	Temperaturetransmitter11
Dry cooler temp.	TT12	Temperaturetransmitter12
LT compressor low pressure switch	PS01	Pressureswitch1
LT compressor high pressure switch	PS02	Pressureswitch2
HT compressor low pressure switch	PS03	Pressureswitch3
HT compressor high pressure switch	PS04	Pressureswitch4
LT suction press.	PT01	Pressuretransmitter1
LT discharge press.	PT02	Pressuretransmitter2
Exchanger press.	PT03	Pressuretransmitter3
HT suction press.	PT04	Pressuretransmitter4
HT discharge press.	PT05	Pressuretransmitter5
Expansion tank press.	PT06	Pressuretransmitter6
Glycol pressure transmitter	PT07	Pressuretransmitter7
Expansion tank press.	PT08	Pressuretransmitter8