Review Comments

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University of Kentucky – Research Building 2	15576-00
Project Name	Project Number
Energy Recovery System	2/28/19
Description	Date
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Submittal Identification Number	
CJA / EJ	1 of 1
Reviewer	Page

Action:

- ☐ Approved as Submitted
- ☐ Approved as Noted (Refer to Individual Items Below)
  - ☒ Resubmittal Not Required
  - ☐ Resubmit Noted Portions Only
  - ☐ Resubmit
- ☐ Not Approved
- ☒ Reviewed Only/No Approval Action Required
- ☐ Review Not Required by Contract Documents
- ☐ Other

Reviewed only for general conformance with design concept and information given in the Contract Documents. Corrections or comments made by reviewer on the submittal do not relieve the contractor from compliance with of the Contract Documents. Approval of a specific item shall not infer approval of an assembly of which the item is a component. The contractor is responsible for all dimensions, field conditions, coordination with other trades, and information that pertains solely to the fabrication process.

1. Page 191, Control Sequences 3.1, 4 AHUs are primary, 4 AHUs are standby. (Currently the submittal shows 7 AHUs primary and 1 AHU standby).

237214

HEAT RECOVERY EQUIPMENT

Table of Contents

Vendor

Konvekta USA, Inc.
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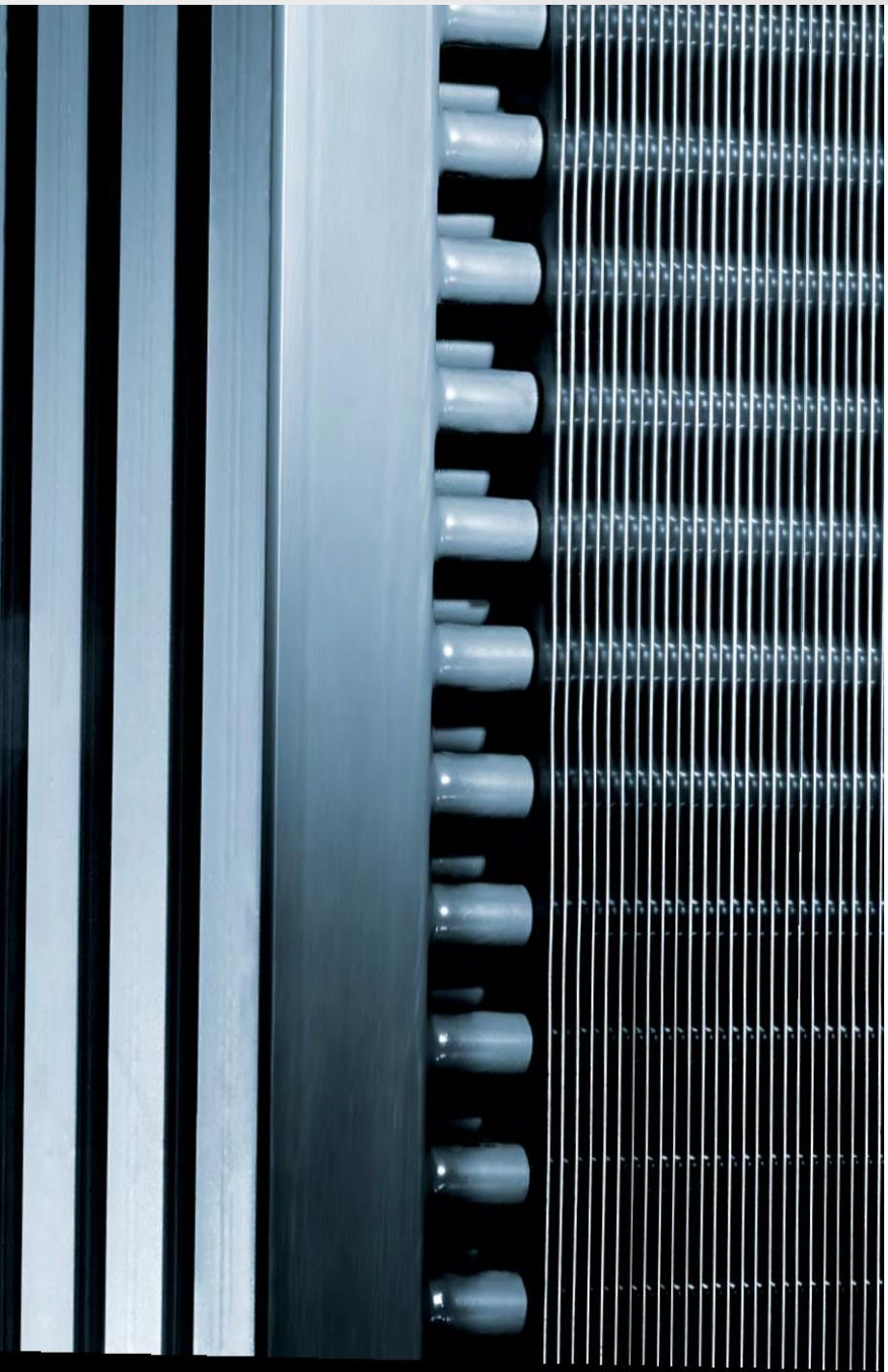
konvekta

Installation, Operating and Maintenance Instructions



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Applicable standards and
local, national, and
international regulations
shall apply and must be followed.

1 General information

These installation, operating, and maintenance instructions are a part of the product and must be stored accessibly. They must be read, understood, and observed by all persons executing work on the device. For components or installation components not described in these instructions, the individual instructions must be observed.
Any work on the device must be performed by qualified and trained personnel only.
The manufacturer shall not be liable for damages or malfunctions caused by noncompliance with these instructions. In the case of independent and/or unapproved retrofits and changes to the device, the manufacturer's warranty shall be voided.

1.1 Target group

These instructions address operators, maintenance personnel, and installers of the energy recovery system.

2 Abbreviations

Table 1 – Abbreviations

Abbr.	Description	Explanation
acc	**acc**ording to	
AF	**A**ir **F**ilter	An air filter is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mold, and bacteria from the air.
AHU	**A**ir **H**andling **U**nit	An air handler, or air handling unit is a device used to condition and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system.
	Air **V**olume	Rate of airflow, normally expressed in cubic feet per minute (cfm) or cubic meter per hour (m^3/h).
BAS	**B**uilding **A**utomation **S**ystem	A computer-based control system installed in buildings System that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems.
BCS	**B**uilding **C**ontrol **S**ystem	A computer-based control system installed in buildings System that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems.
BMS	**B**uilding **M**anagement **S**ystem	A computer-based control system installed in buildings System that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems.
	Bypass	A pipe used to convey fluid to or around another pipe.
CC	**C**ooling **C**oil	A heat exchanger for efficient heat transfer from one medium to another. The cooling coil is supplied by chilled water to cool down the air.
CPU	**C**entral **P**rocessing **U**nit	The part of a computer that interprets and executes instructions.
CW	**C**ooling **W**ater	Energy contained in cold water used to supplement energy recovery.
DB	**D**ry **B**ulb Temperature	The temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture.
	Diabatic **c**ooling	The process of cooling air by adding humidification.
	Dehumidification	The process to remove atmospheric moisture.
DP	**D**ew **P**oint	The atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can from.
DU	**D**emister **U**nit	Device for separating/removingliquid droplets from gases or vapors.
EA	**E**xhaust **A**ir	Commonly known as return air. The air mechanically removed from a building.
ECA	**E**lectrical **Ca**binet	An electrical cabinet is an enclosure for electrical or electronic equipment.
EHRC	**E**xhaust **H**eat **R**ecovery **C**oil	A heat exchanger in the exhaust air handling unit for efficient heat transfer from one medium to another.
ERC	**E**nergy **R**ecovery **C**oil	Energy Recovery Heat Exchanger

ERS	**E**nergy **R**ecovery **S**ystem	A system to reclaim and recycle waste heat from other sources, such as building exhaust air, in order to reduce the need for the primary energy source.
FA	**Fa**n	A fan is a machine used to create flow within a fluid, typically a gas such as air.
FC	**F**ree **C**ooling	An economical method of using low external air temperatures to assist in chilling water that can be used in mechanical processes.
FL	**Fl**ap	A flap is used to shut off air handling units or parts of it
HC	**H**eating **C**oil	A heat exchanger for efficient heat transfer from one medium to another. The heating coil is supplied by hot water to warm up the air.
HE	**H**eat **E**xchanger	A fin heat exchanger in the air handling unit for efficient heat transfer from one medium to another which typically is air to liquid.
HM	**H**ydronic **M**odule	Prefabricated unit containing mechanical equipment, controls, valves and sensors.
HRC	**H**eat **R**ecovery **C**oil	A heat exchanger in the air handling unit for efficient heat transfer from one medium to another.
HRS	**H**eat **R**ecovery **S**ystem	A system to reclaim and recycle waste heat from other sources, such as building exhaust air, in order to reduce the need for the primary energy source.
HVAC	**H**eating, **v**entilation and **a**ir **c**onditioning	
HW	**H**eating **W**ater	
% r.H.	**H**umidity **r**elative	The ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature.
LED	**L**ight-**E**mitting **D**iode	A device that lights up and displays information when electricity passes through it.
	Latent **H**eat	The quantity of heat absorbed or released by a substance undergoing a change of state.
n.r.	**n**ot **r**elevant	
OA	**O**utside **A**ir	Air taken from the external atmosphere not previously circulated through the building.
PHE	**P**late **H**eat **E**xchanger	A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids
PHE-HW	**P**late & Frame **H**eat **E**xchanger **H**eating **W**ater	A plate heat exchanger supplied by hot water
PHE-CW	**P**late & Frame **H**eat **E**xchanger **C**ooling **W**ater	A plate heat exchanger supplied by chilled water
PHE	**P**late & Frame **H**eat Exchanger	A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids.
RA	**R**eturn **A**ir	Describes the air leaving a room. It may be recycled or purged to the environment.
RecA	**Rec**irculating **A**ir	Air that is extracted, treated, and mixed with outside air, and returned.
RA-HUM	**R**eturn **A**ir **H**umidifier	A device, which increases humidity in the exhaust air
RA-SP	**R**eturn **A**ir **S**prinkler	A device, which is sprinkling water over the EHRC
RARS	**R**unning **A**round **R**ecovery **S**ystem	A very efficient type of energy recovery system that consists of heat exchangers in the supply and exhaust air streams, piping (containing a heat transfer fluid) between the heat exchangers and a

		pump. Sophisticated systems communicate with the BMS and include controls and monitoring equipment.
RCA	**Rec**irculating **A**ir	Air recirculation is when a circulation device moves air in a closed space around more than once
RHC	**R**e-**H**eat **C**oil	A heat exchanger for efficient heat transfer from one medium to another.
SA	**S**upply **A**ir	Air that has been conditioned entering a room.
SA-HUM	**S**upply **A**ir **H**umidifier	A humidifier is a HVAC appliance that increases humidity (moisture).
	Sensible **H**eat	Heat exchanged by a body or thermodynamic system that has as its sole effect a change of temperature.
SHRC	**S**upply **H**eat **R**ecovery **C**oil	A heat exchanger in the supply air handling unit for efficient heat transfer from one medium to another.
SHRC-PH	**SHRC p**re-**h**eater	A heat exchanger in the supply air handling unit for efficient heat transfer from one medium to another. Typically located in front of the air filter to reduce relative humidity.
SHRC-SH	**SHRC s**upplementary **h**eater	A heat exchanger in the supply air handling unit for efficient heat transfer from one medium to another.
UPS	**U**ninterruptable **P**ower **S**upply	Voltage supply bridging the time between a power outage and emergency power.
	Ventilation	The process of "changing" or replacing air in a space to provide high indoor air quality.
VFD	**V**ariable **F**requency **D**rive	Power control conversion devise for 3 phases motors.
VPN	**V**irtual **P**rivate **N**etwork	A network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization’s network.
WD	**W**atch**d**og	Watchdog unit which detects malfunctions of an intelligent device such as a CPU.
WB	**W**et **B**ulb Temperature	The temperature at which water, by evaporating into air, can bring the air to saturation at the same temperature.
WDT	**W**atch**d**og **T**imer	An electronic timer that is used to detect and recover from computer malfunctions.
WHR	**W**aste **H**eat **R**ecovery	Waste heat recovery is to recover energy from hot streams with potential high energy content, such as waste water from different cooling processes.

3 Safety

The energy recovery system and its components are built according to the state of the art and acknowledged safety rules. They correspond with the applicable safety requirements. However, in the case of improper use or use different from the intended use, danger for life and limb may exist for the user or third parties and/or impacts on the device and other material assets.

In the interest of your safety and the safety of other persons, carefully read this safety information prior to installation and commissioning of the energy recovery system!

The device must only be operated in technically flawless condition according to its intended use and while keeping safety and potential dangers in mind. Malfunctions that could impact safety must be immediately corrected.

Installation work and commissioning must be performed exclusively by trained expert personnel.

For components not described, the individual instructions must be observed. The operating instructions must be carefully read by fitters, installers, and operating personnel prior to installation and commissioning. Furthermore, these operating instructions must be available on site at all times. Observing these operating instructions is the only way to prevent errors and achieve fault-free operation. The device is part of a ventilation system and must only be operated after installation of the complete system.

3.1 Intended use

All information on the device and in the following instructions must be followed accurately.

The energy recovery systems delivered by KONVEKTA are used exclusively for recovery of thermal energy in ventilation and air-conditioning systems for transporting and conditioning air without corrosive or abrasive content under the operating conditions acc. to the order-related documentation.

3.2 Safety symbols and signal words

The safety symbols are divided by possible consequences of a danger. This hierarchy is marked with signal words, danger symbols, and optical presentation.

DANGER

- In the case of medium to high risk factors, non-observance will lead to fatal or most severe injuries.

CAUTION

- In the case of low risk factors, non-observance will lead to medium to minor injuries.

ATTENTION

- The exclamation mark in the black triangle always indicates property or environmental damage.

NOTE

- Refers to important or explanatory information.

3.3 Safety information for avoiding personal damage

Installation, commissioning, and maintenance work must be performed exclusively by trained expert personnel.
Protective measures: Safety gloves, safety glasses, protective clothing

3.3.1 Danger due to unloading and/or transporting

⚠ DANGER

- Most severe personal damage due to falling loads.
- Avoid standing under suspended loads.

3.3.2 Danger due to rotating and moving parts

⚠ CAUTION

- Danger of crushing: never bring hands in close proximity to rotating parts, such as pumps, valves, if these are in operation.
- For work on rotating or moving parts, always wait for complete standstill of all rotating or moving parts.

3.3.3 Danger due to sharp objects

⚠ CAUTION

- Danger of cutting injuries: Always wear gloves when working on objects with sharp parts, such as heat exchangers.

3.3.4 Danger due to electrical energy

⚠ DANGER

- Danger of electric shock causing up to fatal injuries due to contact with voltage-carrying parts: Always work with the device in de-energized condition.
- Danger of electric shock causing up to fatal injuries. Some circuits in the electrical system part can still be energized for several minutes after the power supply was disconnected:
  Wait at least 15 minutes after deactivation before starting work on or in close proximity to electrical parts!
- Danger of electric shock causing up to fatal injuries, due to potential-free contacts that are still energized even after the power supply was disconnected:
  Only touch potential-free contacts after ensuring that they are de-energized!
- Danger of electric shock causing up to fatal injuries due to contact with different voltage-carrying parts, such as the inner lighting of the electrical system part, earthed sockets (Schuko), and measurement and control as well as safety circuits:
  Only touch voltage-carrying parts after ensuring that the system is de-energized.
- Danger of electric shock due to short-circuits when connecting electrical parts:
  All cables must be checked for assembly damage and/or damage to the insulation, as well as expert installation prior to commissioning.
- Danger of electric shock due to wet cleaning of the voltage-carrying device:
  Always perform cleaning with the device in de-energized condition.

3.3.5 Dangers caused by operating materials/materials

⚠ CAUTION

- Danger of poisoning, chemical burns, or allergic reactions caused by the use of operating materials, such as anti-freeze, refrigerant, etc.:
  Always observe the manufacturer's information, avoid contact with operating materials, and take the necessary precautions, such as safety gloves, eye protection, etc.
- Danger of poisoning and chemical burns caused by filling, venting, and emptying brine:
  Avoid body contact with operating materials, and take the necessary precautions, such as safety gloves, eye protection, mask, etc.
- Danger of poisoning caused by inhalation of vapors in the event of a fire:
  Avoid the danger zone and take the necessary precautions, such as mask
- Danger of allergic reactions caused by contact with operating materials, such as contact, inhalation, or swallowing:
  Avoid body contact and take the necessary precautions, such as safety gloves and eye protection.
- Danger of damage to health due to splashes or spray of refrigerant:
  Avoid skin and eye contact, avoid inhalation and swallowing.

3.3.6 Danger caused by steam heaters

⚠ DANGER

- Danger of burns in the case of external steam caused by hot steam (>100°C/212°F) at high pressure:
  Make sure that no steam pressure is present and the system cooled down prior to work on steam piping.

3.3.7 Danger caused by hot or cold parts

⚠ CAUTION

- Danger of burns or scolding in the case of hot or warm system parts:
  Avoid the danger zone and take safety precaution, such as safety gloves. Wait for device standstill and interrupt the heating medium supply for maintenance work.
- Danger of frostbites in the case of cold system parts:
  Avoid the danger zone and take safety precaution, such as safety gloves. Wait for device standstill and interrupt the refrigerant supply for maintenance work.
- Danger of burns caused by hot water splashes on opening of pipe unions or other system parts. Always close the shut-off valve and have the system cool down prior to any work!

3.3.8 Danger caused by contaminations

⚠ DANGER

- There is danger of contamination with substances hazardous to health when working on the ventilation systems. The safety measures specified by the operating company must be realized, such as wearing of respirators with filter insert and safety gloves.

3.4 Safety information for avoiding property and environmental damage

No unauthorized changes are permissible to the device. Always use genuine spare parts. The device must only be operated according to the intended use with the specified parameters.

3.4.1 Damage due to unloading and transporting

⚠ **ATTENTION**

- Most severe property damage due to falling loads.
- Severe property damage to parts such as heat exchanger connections or fins, panels, and other add-on parts due to direct application of force to the components.
  Any force caused by transporting, unloading, or shifting of parts should always affect the base frame or specifically designated suspensions or transport fixtures.

3.4.2 Damage caused by pump operation

⚠ **ATTENTION**

- Severe damage to pumps due to improper operation in e.g. insufficiently vented or non-cleaned pipe systems.

3.4.3 Damage caused by the use of operating materials

⚠ **ATTENTION**

- Danger of environmental damage due to the use of operating material. Observe the manufacturer's information.
- Danger of environmental damage due to anti-freeze. Comply with the local disposal regulations.

4 Product delivery

Unless agreed differently, delivery is without unloading.

Upon arrival, all parts and devices must be immediately checked for transport damage of any kind and completeness of the scope of delivery. Transport damage and missing parts must be documented on the transport papers and immediately, however latest 3 days after goods receipt, communicated. Complaints about transport damage or delivery incompleteness cannot be recognized at a later point of time.

4.1 Intermediate storage prior to commissioning

If devices or parts are intermediately stored after product delivery, the following points must be observed. This applies whether intermediate storage takes place at the installation location or somewhere else.
During intermediate storage, it must be ensured that the devices are protected against contamination, damage and weather influences. Furthermore, they must also be protected against air contaminated with aggressive media. This also applies to any work on the construction site at the installation location. The following storage conditions must be met:

Table 2 – Storage conditions

Technical data	Heat exchangers	Assemblies, control cabinets, and loose components
Storage temperature	5°C – 60°C / 40°F – 140°F	5°C – 60°C / 40°F – 140°F
Relative humidity	max. 95 % without condensation	max. 80 %

The devices must not be stored outdoors or under a canopy. They should be stored in closed and heated rooms, where the components are sufficiently protected against weather influences. When covering the components, condensation must be particularly avoided.

If devices with rotating parts, such as motors, pumps, valves, etc. are intermediately stored or not used for more than two weeks, any rotating parts and/or shafts must be rotated by at least 5 revolutions every 10-12 days. This prevents bearing damage. No liability is assumed for bearing damage caused by noncompliance with this information.

⚠ **ATTENTION**

- Risk of component damage if stored beyond specified conditions.

4.2 Unloading and transport to the installation location

4.2.1 Heat exchangers

DANGER

- Most severe personal or property damage due to falling loads.
- Observe the safety regulations for conveyor vehicles and transport means.
- Do not stand under suspended loads.

When unloading the heat exchangers, make sure that no damage occurs to the fittings attached to the heat exchanger. The suspension eyes attached to the outlet side are exclusively used as transport and lifting aid. During unloading, lifting force must only be applied via the designated suspensions.

Figure 1 – Suspension eyes

ATTENTION

- Do not any belts or tensioning straps for heat exchanger lifting, as this may damage the fins.
- Never rotate or place devices or components vertically for transporting them.
- Devices may never be lifted on heat exchanger connections, flexible connection pieces, sheet metal coverings, or other add-on parts.
- Do not climb on devices

NOTE

- The suspension eyes are merely designated for lifting the respective heat exchanger. It is not permissible to lift several heat exchangers together on the suspension eyes.

4.2.1.1 Unloading by crane

Unloading and/or transport by crane is recommended for larger devices. Only suitable and permissible lifting slings (ropes, straps, etc.) may be used. Spacers must be used to protect fins, cover sheets, connections, and add-on parts against damage.

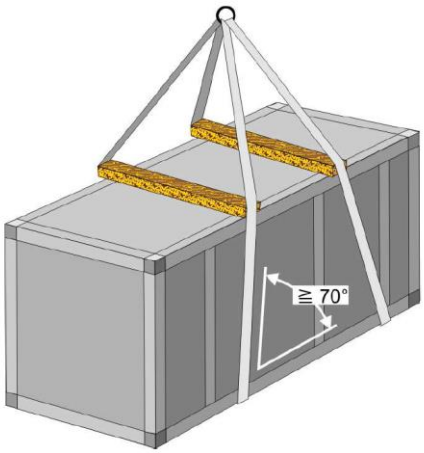


Figure 2 – Unloading

Figure 2 is a schematic illustration only.
The respectively marked lifting points must be used for transporting.

Figure 3 – Lifting point

4.2.2 Hydraulic assemblies and control cabinets

⚠ DANGER

- Most severe personal or property damage due to falling loads.
- Observe the safety regulations for conveyor vehicles and transport means.
- Do not stand under suspended loads.

The devices are delivered as unit or individual components. When unloading the hydraulic components and control cabinets, make sure that no damage occurs to the fittings attached to the devices. The suspension eyes attached to the device or the device frame must be used as transport and lifting aid. Respective markings exist. During unloading, lifting force must only be applied via the designated suspensions or the device frame.

Figure 4 – Lifting

⚠ ATTENTION

- Never rotate or place devices or components vertically for transporting them
- Never drop pump parts
- Devices may never be lifted on pipe connections, flexible connection pieces, or other add-on parts.
- Do not climb on devices

4.3 Unpacking

Packaging must be carefully removed to avoid damage to the device. Packaging consists of different materials: Wood, cardboard, nylon, etc. Packaging material must be recycled separately to keep environmental pollution at a minimum.

5 Installation and commissioning

⚠ ATTENTION

- Remove transport locks prior to device commissioning!

5.1 Heat exchangers

The installation location of the heat exchangers must enable proper device maintenance. This means that a maintenance clearance of device width +300mm/12inch must be available on the operating sides for possible device removal. For heat exchanger cleaning and inspection, a vacant unit / maintenance station is to be provided in the ventilation unit respectively in the duct upstream and downstream of the heat exchangers.

⚠ DANGER

- Most severe personal or property damage due to falling loads.
- Observe the safety regulations for conveyor vehicles and transport means.
- Do not stand under suspended loads.

When placing the heat exchangers, make sure that no damage occurs to the fittings attached to the heat exchanger. The suspension eyes attached to the outlet side are used as transport and lifting aid. During lifting, lifting force must only be applied via the designated suspensions.

Figure 5 – Suspension eyes

⚠ ATTENTION

- Do not any belts or tensioning straps for heat exchanger lifting, as this may damage the fins.
- Never rotate or place devices or components vertically for transporting them.
- Devices may never be lifted on heat exchanger connections, flexible connection pieces, sheet metal coverings, or other add-on parts.
- Do not climb on devices.

NOTE

- The suspension eyes are merely designated for lifting the respective heat exchanger. It is not permissible to lift several heat exchangers together on the suspension eyes.
- The cover sheets must not be used for fastening or suspension. These must merely be used as fins protection and as stop for sealing on the air side.

The heat exchangers must have suitable and secure contact at the installation location. Falling down, tilting over, or shifting must be avoided using suitable measures. The entire contact area, however at least the entire collector area of the heat exchanger must be supported. The lower heat exchanger can be used as support for stacked heat exchangers.
The heat exchangers must be securely attached to the inside of the air duct using vertical guide rails, horizontal rails, steel frames or similar. Respective side cover sheets must be used for sealing off on the air side (no bypassing of the fins heat exchanger).

⚠ ATTENTION

- Mechanical machining (such as drilling, grinding, or sawing) of the heat exchangers is not permissible. This does not apply to suspension gear and fastening brackets.

5.1.1 Corrosion protection variants

The following corrosion protection variants are available:

KO 1: Normal corrosion protection
For heat exchangers in dry rooms without undercutting of the dew point. Cover made of galvanized sheet metal.

KO 2: Increased corrosion protection
Collectors and frames coated with two-component paint (approx. 40 μm), cover made of galvanized sheet metal.
For air heaters in humid rooms and air coolers with temporary water separation (air without aggressive media).

KO 31: Heavy-duty corrosion protection (aluminum fins)
Collectors, frames, welding and soldering points sand-blasted (scale, cinders, and flux residues completely removed); next coated with two-component primer and two-component top coat (approx. 100 μm in total), frame consistently welded (to prevent crevice corrosion). Cover made of chromium steel V2A (1.4301).
For air cooler with larger water separation across an extended period of time (air without aggressive media).

KO 32: The same as KO 31, however, aluminum fins additionally coated.
Collectors, frames, welding and soldering points sand-blasted after welding and soldering completion (scale, cinders, and flux residues completely removed); next coated with two-component primer and two-component top coat (approx. 100 μm in total), frame consistently welded (to prevent crevice corrosion). Cover made of chromium steel (1.4301). Fins made of coated aluminum.

KO 42: Entire heat exchanger with acid-resistant coating
Collectors, frames, welding and soldering points sand-blasted after welding and soldering completion (scale, cinders, and flux residues completely removed); frame consistently welded (to prevent crevice corrosion), next entire heat exchanger coated with two-component primer and two-component top coat (total layer thickness of the collectors approx. 100 μm, at least 3 layers on top of one another. Total layer thickness of the fins approx. 80 μm). Fins division 4mm/0.16inch, fins thickness 0.4mm/15.6mil. Cover made of chromium steel V4A (1.4475).

5.1.2 Installation variants

The following three installation variants are offered for the heat exchanger attachment. The sealing surfaces on the air side are respectively shown in **red**. It is important to consistently seal the heat exchanger. They must be completely sealed on the sides, top and bottom.

NOTE

- Improper sealing leads to reduced heat exchanger performance and can lead to measuring errors.

5.1.2.1 Monoblock installation (type 0)

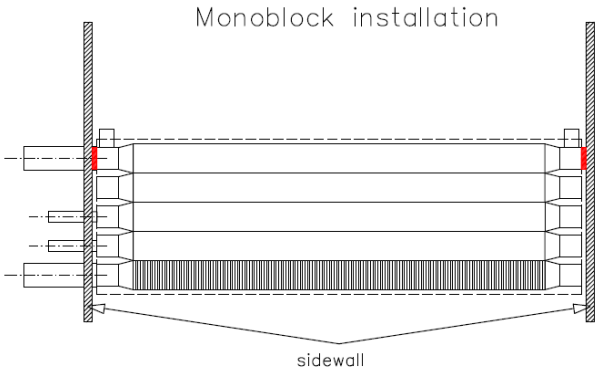


Figure 6 – Type 0

5.1.2.2 Wall installation (type 1)

The cover sheets are used for top and bottom sealing on the air side. They are flush with U-profiles.

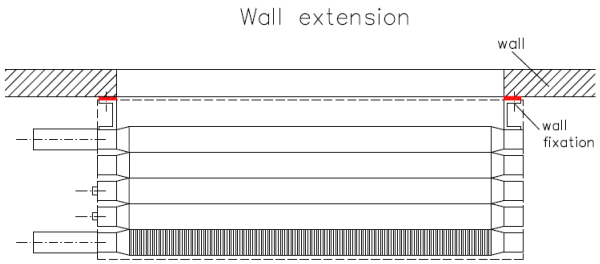


Figure 7 – Type 1

5.1.2.3 Duct installation (type 2)

The cover sheets are used for top and bottom sealing on the air side. They are flush with U-profiles.

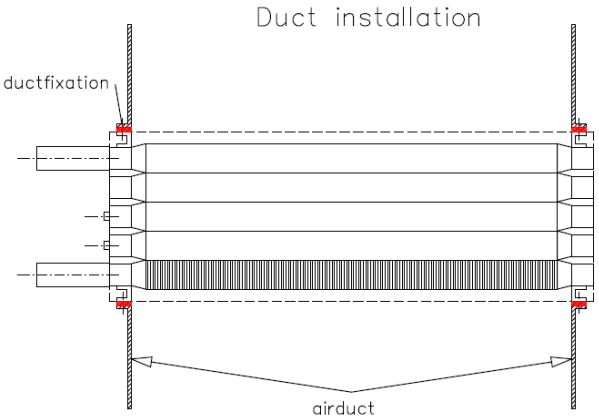


Figure 8 – Type 2

5.1.2.4 Angle bracket attachment (special)

If a fastening bracket is available, it can be drilled and bolted. It can be additionally used for sealing on the air side.

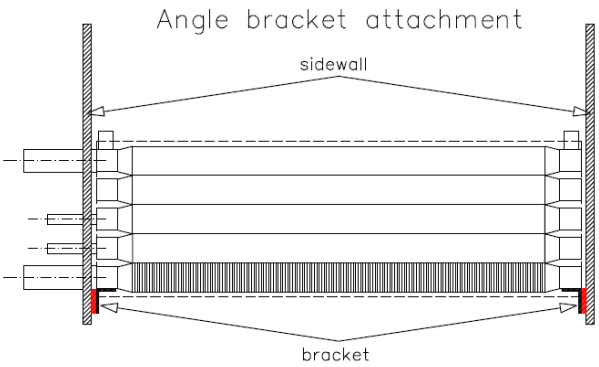


Figure 9 – Angle bracket attachment

5.1.3 Installation of the KO 42 heat exchanger

The coating of the KO 42 heat exchanger must be protected against damage. Aggressive media can penetrate through smallest cracks and cause corrosion. In this case, coating delaminates starting from the base material.

⚠ ATTENTION

- Mechanical machining (such as drilling, grinding, or sawing) of the heat exchangers is not permissible. This does not apply to suspension gear and fastening brackets. Any machined points must be retroactively protected against corrosion.
- The coating of the KO 42 heat exchanger must be protected against damage

For this reason, the coated fins of the KO 42 heat exchanger are packed at the plant using wooden plates for protection against damage during transport and installation. These plates must only be removed after heat exchanger installation to prevent any damage.
Upon request, paint including hardening agent is provided to the customer for spot-repairs on the coating. For this reason, the heat exchange must be thoroughly checked for coating damage prior to commissioning. The paint spots to be repaired should be mechanically roughened, thoroughly cleaned and degreased using thinner. Next, paint the damaged spot twice with the special paint.

5.1.4 Flow direction

NOTE

- The heat exchanger must be connected acc. to the information on the order confirmation (in cross or counter-flow)!

The following heat exchangers are always connected in cross flow:

- Fins heat exchangers with one or two rows of pipes
- Heat exchanger for steam operation

The following heat exchangers are always connected in counter flow:

- Air cooler for cold water operation with more than two rows of pipes
- Heat exchanger for operation with water-glycol mixture with two or more rows of pipes
- Air heater for hot water operation with more than two rows of pipes

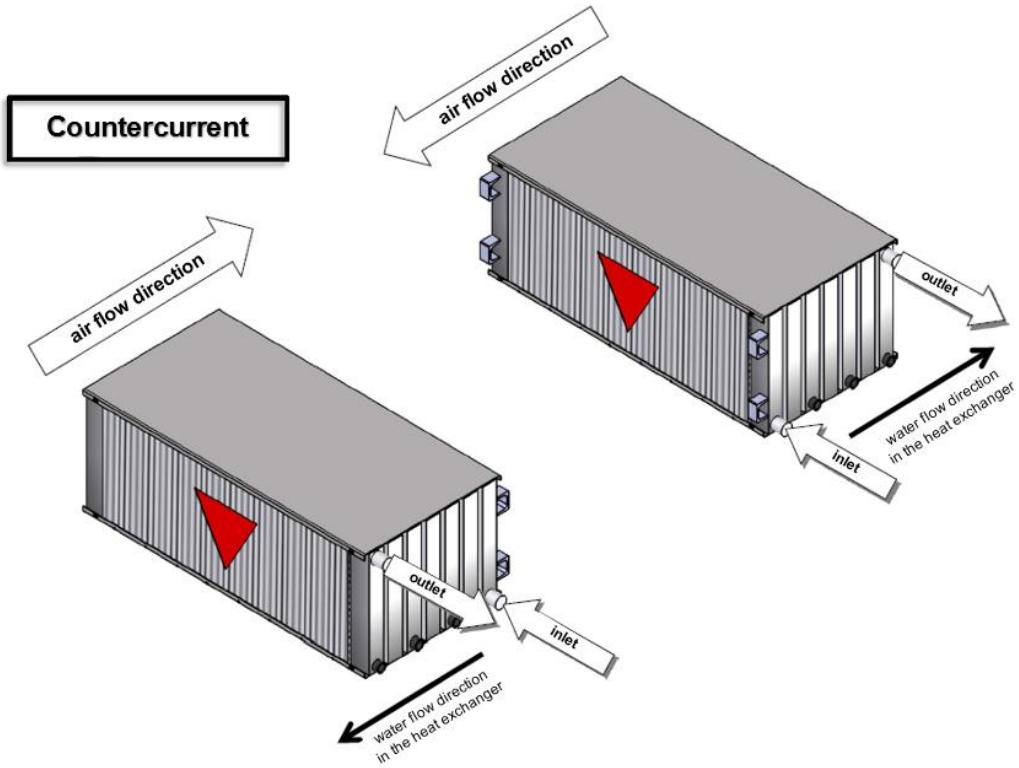


Figure 10 – Connection in counter flow

Height of the two-part heat exchanger: Connect in parallel on the water side

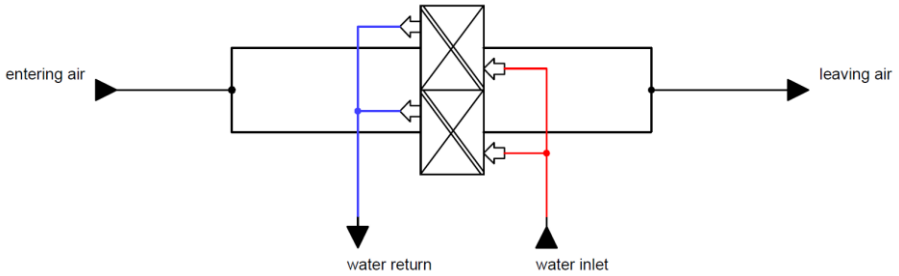


Figure 11 – Height of the two-part heat exchanger

Construction depth of the two-part heat exchanger in air direction: Connect in series on the water side

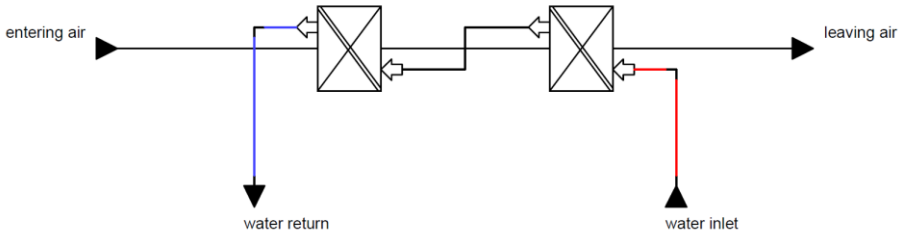


Figure 12 – Construction depth of the two-part heat exchanger

5.1.5 Heat exchanger connection

All connection lines to the components of the ventilation and air conditioning installation must be routed such that ease of component removal is ensured by opening detachable connections.

Prior to heat exchanger connection, the pipe system must be thoroughly cleaned, see chapter 6 Filling an energy recovery system. To prevent damage to the heat exchanger connections, they must be counter-held using a pipe wrench during bolting.

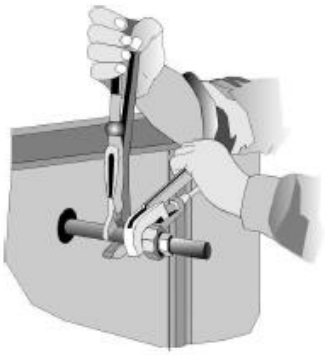


Figure 13 – Heat exchanger connections

The heat exchangers must be connected such that no mechanical tension is introduced from the pipe system into the heat exchanger. Mechanical or static loading of the connection fittings in not permissible. Furthermore, vibration transfer and elongations between heat exchangers and pipe system must be prevented. The connections of steam and hot water air heaters as well as hot oil heat exchangers (starting from 100 ºC) must be flexibly designed (metal hoses or expansion joints).

⚠ ATTENTION

- Shearing and compression forces or torques must not influence the heat exchanger, which can lead to damage.

During piping, it must be observed that the pipes should not prevent a possible heat exchanger removal required for maintenance purposes.
An air vent must be installed at the highest point in the pipe system, upstream and downstream of every heat exchanger. A drain is to be installed at the lowest point for pipe system emptying.
The plastic threaded protective caps must be removed prior to connection to the pipe system. Drains and vents must be closed after any possible deposits were removed. In the case of a heat exchanger for duct installation, the condensate drain (if present) must be connected by the customer. The threads of the connection fittings and sleeves are coated with paint for corrosion protection reasons. During line and fitting installation, the paint is to be removed to such an extent only that no unprotected, bare spots occur. Non-coated spots must be professionally spot-repaired as needed.

5.1.6 Condensate drain

When installing the heat exchanger, it must be ensured that the condensate can drain without problems. The holes in the edges must not be obstructed.

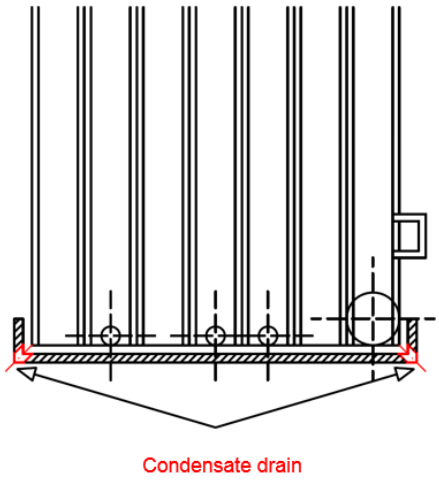


Figure 14 – Condensate drain

5.1.7 Droplet separators in ventilation systems

If outside air or outgoing air is cooled using a fins heat exchanger and the surface temperatures of the pipes and fins are underneath the dew point of air, condensate is generated.
It can occur that the condensate is carried out from the fins package with the air flow. Although different measurements were performed, no rule can be defined, under which conditions and with what throwing distance the water droplets are carried along.
Major influencing parameters:

- Condensate quantity
- Air velocity
- Fins division
- Height with fins

As no generally applicable statement can be made, it must be separately clarified for every system, whether a droplet separator must be installed or not. In this context, it is important, which components are arranged downstream of the heat exchanger and whether single droplets are acceptable. In the case of doubt or in critical cases, it is recommended to use a droplet separator for safety reasons.
In any case, a continuous tray with connection adapters and siphon must be installed in the device parts underneath and immediately downstream of the heat exchangers.

5.1.8 Frost protection in ventilation systems

The frost protection thermostat is responsible for protecting water-filled heat exchangers against freezing. Frost protection must be implemented on the air side, if water-filled heat exchangers or other device that must be protected against frost are present in the ventilation system or downstream in the direction of the airflow. If the temperature drops below the adjusted switching threshold at any point within the ventilation system, the frost alarm must be triggered. Among others, a frost alarm results in deactivation of supply air and exhaust air fans as well as in closing of supply air and exhaust air flaps.

The frost protection thermostat must be placed in airflow direction downstream of the heat exchangers of energy recovery. As described in chapter 5.3, the heat exchangers of the energy recovery system are operated with a frost protection solution and must not be protected using a frost thermostat.

⚠ ATTENTION

- In any case, the devices in airflow direction downstream of the heat exchangers of the energy recovery system must be protected using a frost protection thermostat. The energy recovery system does not offer any protection function.

5.1.9 Filling a heat exchanger

⚠ DANGER

- Danger of cutting injuries: Always wear gloves when working on objects with sharp parts, such as heat exchangers.
- Danger of burns or scolding in the case of hot or warm system parts: Avoid the danger zone and take safety precaution, such as safety gloves. Wait for device standstill and interrupt the heating medium supply for maintenance work.
- Danger of burns caused by hot water splashes on opening of pipe unions or other system parts. Always close the shut-off valve and have the system cool down prior to any work!
- There is danger of contamination with substances hazardous to health when working on the ventilation systems. The safety measures specified by the operating company must be realized, such as wearing of respirators with filter insert and safety gloves.

5.1.9.1 Heat exchanger with water-glycol mixture

KONVEKTA recommends Antifrogen N (Clariant) or DOWCAL/DOWTHERM (DOW) for heat exchangers with water-glycol mixture. As KONVEKTA does not perform chemical analyses, we cannot assess other water-glycol mixtures. In the case of other glycol brands, the glycol manufacturer must confirm that the water-glycol mixture has characteristics comparable with the recommended heat transfer fluids with respect to heat transfer and corrosion protection inhibitors.

5.1.10 Emptying a heat exchanger

When emptying a heat exchanger, it must always be observed that the entire heat exchanger is completely emptied. For design reasons, the heat exchanger often consists of several so-called pipe rows, which must be separately emptied. The number depends on the construction depth of the heat exchanger in airflow direction. There is no one single central point, where the entire heat exchanger could be emptied.

⚠ ATTENTION

- Incomplete emptying of a heat exchanger can lead to subsequent damage.

NOTE

- Always empty all pipe rows including the pipe connection for emptying a heat exchanger.

Figure 15 – Heat exchanger drains at time of delivery

Figure 15 shows a heat exchanger with two drains and the pipe connection in as-delivered condition. By default, the drains are realized with a ½" nipple. Shut-off valves must be installed here after installation.

NOTE

- Do not confuse the drains with pipe connections. Drains are usually of smaller dimensions than the pipe connections.

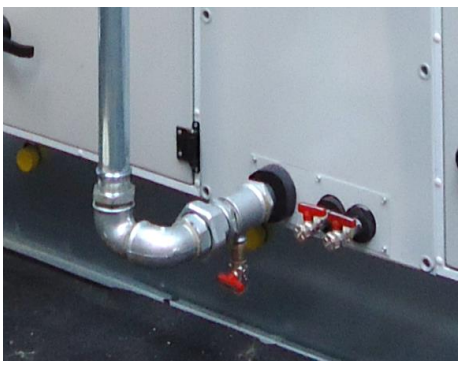


Figure 16 – Heat exchanger drains in installed condition

Figure 16 shows the heat exchanger in installed condition. Both drains must be fitted with a shut-off valve each. The pipe connection installed by the customer must also be fitted with a drain valve.

Perform the following steps to empty the heat exchanger:

1. Open all drain valves
2. Empty the pipe connection at a suitable drain position
3. Wait until the medium drained completely

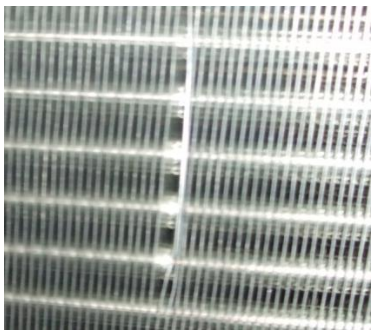
The lower pipe connection is used for draining as well in addition to the two drains. For this reason, it must be observed that the pipe installed by the customer is fitted with a drain valve at its lowest point.
To completely empty the heat exchanger, all drains available at the heat exchanger as well as the drain of the customer-installed pipe must be opened.

5.1.11 Damage prevention/correction

DANGER

- Danger of cutting injuries: Always wear gloves when working on objects with sharp parts, such as heat exchangers.
- Danger of burns or scolding in the case of hot or warm system parts: Avoid the danger zone and take safety precaution, such as safety gloves. Wait for device standstill and interrupt the heating medium supply for maintenance work.
- Danger of burns caused by hot water splashes on opening of pipe unions or other system parts. Always close the shut-off valve and have the system cool down prior to any work!
- There is danger of contamination with substances hazardous to health when working on the ventilation systems. The safety measures specified by the operating company must be realized, such as wearing of respirators with filter insert and safety gloves.

Bent fins must not be straightened using a comb. They must be individually aligned using flat nose pliers.



misaligned fins

flat nose pilers

comb

Figure 17 – Fins alignment

Paint damage caused by transport or assembly must be spot-repaired prior to commissioning, in particular in the case of heat exchangers with heavy-duty corrosion protection. The coating of the heat exchanger must be protected against damage. Aggressive media can penetrate through smallest cracks and cause corrosion. In this case, coating delaminates starting from the base material. For this reason, the coated fins of the heat exchanger are packed at the plant using wooden plates for protection against damage during transport and installation. These plates must only be removed after heat exchanger installation. Upon request, paint including hardening agent is provided to the customer for spot-repairs on the coating. For this reason, the heat exchange must be thoroughly checked for coating damage prior to commissioning. The paint spots to be repaired must be mechanically roughened, thoroughly cleaned and degreased using thinner. Next, the damaged spot must be painted twice with the special paint.

5.2 Hydraulic assembly

At the installation location, it must be ensured that the devices are protected against contamination, damage and weather influences. Furthermore, they must also be protected against air contaminated with aggressive media. This also applies to any work on the construction site at the installation location. The conditions to be maintained at the installation location are:

Table 3 – Conditions at the installation location

Technical data	Assemblies, control cabinets, and loose components
Ambient temperature	5°C – 30°C / 40°F – 85°F
Relative humidity	max. 80 %

The devices must not be installed outdoors or under a canopy. They must be installed in suitable closed rooms only, such as an engineering room, where the components are sufficiently protected against weather influences. The components must not be covered. Sufficient ventilation must be ensured.

5.2.1 Foundation/base frame

The installation location of the devices must enable proper device maintenance. This means that a maintenance clearance of at least 800mm/3ft must be available on the operating sides for the possible removal of components. The opening area of doors and possibly required escape routes must be considered as well.

The foundation must comply with the customer's requirements regarding structural analysis, acoustics, and proper water drainage. It must be flat and leveled and must not have any inclinations in any directions nor unevenness. The natural frequency of the sub-construction must be sufficiently away from the exciter frequency of rotating parts (motors, pumps, etc.).
Suitable foundations are: Solid foundation made of concrete, strip foundations or steel beam constructions.

⚠ **ATTENTION**

- Unevenness in the foundation can cause jammed doors or other device malfunctions.

In the case of liquid-carrying components, liquid can leak in the case of damage. The device must be installed such that possibly leaking liquid will not cause subsequent damage.

5.2.2 Vibration isolation

The hydraulic assembly is designed such that the vibrations of individual elements, such as pumps, are absorbed, where they are generated. For this reason, no additional vibration isolation is required. However, if this is required due to local regulations, cork boards, Mafound boards or resistant damper mats can be used acc. to the respective requirements. In special cases, the devices can also be installed on vibration dampers.
Bolting of the hydraulic assembly to the foundation is generally not required.

5.2.3 Line insulation

From a technical point of view, the lines on the hydraulic assembly of energy recovery systems must be insulated acc. to the following criteria:

Cold energy recovery pipe leg:
The cold pipe leg must be insulated as cold water line (e.g. Armaflex 30mm/1inch), condensation formation must be prevented.

Hot energy recovery pipe leg:
The hot pipe leg must only be insulated, if the pipes are routed outdoors or in rooms with temperatures below 15°C/60°F.

Cold water feed
The cold water feed must be insulated as cold water line (e.g. Armaflex 30mm/1inch), condensation formation must be prevented.

Hot water feed
The hot water feed must be insulated as heating line (e.g. Armaflex 30mm/1inch).

Steam feed
The steam feed must be insulated as steam line (e.g. mineral wool).

NOTE

- Applicable standards as well as the local, national, and international regulations apply and must be followed.

5.2.4 Hydraulic assembly connection

All connection lines to the components of the ventilation and air conditioning installation must be routed such that ease of component removal is ensured by opening detachable connections.

Prior to hydraulic assembly connection, the pipe system must be thoroughly cleaned, see chapter 6 Filling an energy recovery system. To prevent damage to the hydraulic assembly connections, they must be counter-held using a pipe wrench during bolting.

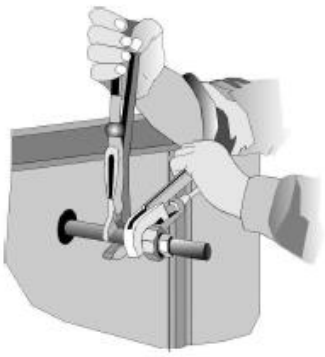


Figure 18 – Heat exchanger connections

The hydraulic assembly must be connected such that no mechanical tension is introduced from the pipe system into the hydraulic assembly. Mechanical or static loading of the connection fittings in not permissible. Furthermore, vibration transfer and elongations between hydraulic assembly and pipe system must be prevented. The connections of steam and hot water supplies must be flexibly designed (metal hoses or expansion joints).

⚠ ATTENTION

- Shearing and compression forces or torques must not influence the hydraulic assembly, which can lead to damage.

5.3 Glycol operating medium

For energy recovery systems in closed loop applications, a monoethylene glycol with corrosion protection inhibitors must be used only. The inhibitors should be designed for a service life of at least 10 years and matched to the materials used for the energy recovery system.

⚠ ATTENTION

- The use of car radiator anti-freeze is not permissible.
- Different glycol brands and products must not be mixed, as they are not compatible.

The glycol brand used must be documented. The following information must be posted well visibly at the energy recovery system

- Brand
- Manufacturer
- Supplier
- Filling date and filled by
- Mixing ratio

The use of propylene glycol can only be recommended in exceptional cases, as the heat transfer properties are significantly worse. Furthermore, viscosity is higher at low temperatures. Propylene glycol may only be used after consultation with KONVEKTA.

NOTE

- In any case, KONVEKTA specifications regarding glycol concentration and glycol type are binding.

5.3.1 Glycol concentration

The specifications regarding the concentration of the water-glycol mixture must be obtained from the technical system documentation. The concentration is system-specific. No standard exists.

5.3.2 Service life

Requirements for a long glycol service life are:

- Inhibitors suitable for energy recovery systems (observe the respective temperature range)
- Continuous compliance with the specified concentration
- Proper system filling
- Closed system with as little as possible oxygen influx (use suitable fittings)
- Regular checks acc. to the specifications of the glycol manufacturer

Based on our experiences so far, a service life significantly above 10 years can be expected under these conditions. Glycol itself is not consumed, however, the corrosion protection inhibitors are.

⚠ ATTENTION

- Glycol with insufficient or consumed inhibitors is very aggressive and can destroy a energy recovery system and its components within the shortest time

5.3.3 Brand

KONVEKTA recommends Antifrogen N (Clariant) or DOWCAL/DOWTHERM (DOW) for heat exchangers with water-glycol mixture.

NOTE

- In the case of other glycol brands, the glycol manufacturer must confirm that the water-glycol mixture has characteristics comparable with the recommended heat transfer fluids with respect to heat transfer and corrosion protection inhibitors.

⚠ CAUTION

- If swallowed, water-glycol mixture is a health hazard for humans and animals. Immediately seek medical attention in the case of accidental swallowing.

⚠ ATTENTION

- According to the catalog of water-polluting substances, ethylene glycol, is classified in water pollution class 1 (mildly water-polluting). This also applies to mixtures of ethylene glycol with water.

5.4 Pipe system, components, and connections

5.4.1 General specifications

For components or installation components not or only partly described in these instructions, the individual instructions must be observed.

⚠ ATTENTION

- Improper installation or commissioning can lead to damage to system parts.

The corrosion protection inhibitors of the specified glycol-water mixture are optimized for the following materials:

- Black steel pipes
- V4A
- Copper
- Gray cast iron
- Brass
- Red brass

Other material combinations are not permissible.

⚠ ATTENTION

- The use of unsuitable components or material combinations can lead to damage to system parts.

All fittings used must be suitable for the use with glycol-water mixture.

The entire piping system, including all fittings, must be realized acc. to pressure rating as indicated on the system documentations highest pressure relief valve. Which typically is 16bar/230PSI at a temperature range of -29°C/-20°F up to 38°C/100°F. Further information regarding the pressure rating must be obtained from the system-specific documentation.

⚠ ATTENTION

- The use of unsuitable components not complying with the required pressure rating can lead to damage to system parts.

5.4.2 Pipe network and fittings

5.4.2.1 Insulation

The lines of the energy recovery systems must be insulated acc. to the following criteria:

Cold energy recovery pipe leg:
The cold pipe leg must be insulated as cold water line (e.g. Armaflex 30mm/1inch), condensation formation must be prevented.

Hot energy recovery pipe leg:
The hot pipe leg must only be insulated, if the pipes are routed outdoors or in rooms with temperatures below 15°C/60°F.

Cold water feed
The cold water feed must be insulated as cold water line (e.g. Armaflex 30mm/1inch), condensation formation must be prevented.

Hot water feed
The hot water feed must be insulated as heating line (e.g. Armaflex 30mm/1inch).

Steam feed
The steam feed must be insulated as steam line (e.g. mineral wool)

5.4.3 Safety valves

At least one, however mostly several safety valves must be installed in the pipe network. Some standards specify that material discharged through these valves must be discharged via a separate line with at least the same diameter as the valve discharge and whose weight it not applied onto the valve. The valves can discharge liquid in the case of an error. The liquid must be discharged via line routing in a controlled manner.

⚠ CAUTION

- Route discharged material to locations, where no persons can be injured by the liquid jet.
- If swallowed, water-glycol mixture is a health hazard for humans and animals. Immediately seek medical attention in the case of accidental swallowing.

⚠ ATTENTION

- According to the catalog of water-polluting substances, ethylene glycol, is classified in water pollution class 1 (mildly water-polluting). This also applies to mixtures of ethylene-glycol with water.

NOTE

- Applicable standards as well as the local, national, and international regulations apply and must be followed.

5.4.4 Strainers

If strainers are required, they must be installed such that they can be cleaned with the system filled. For this purpose, respective shut-off valves must be provided.
In the initial operating phase, the strainers must be cleaned several times. If the entire pipe network is thoroughly flushed, the majority of contamination should be washed out.

NOTE

- Contaminate strainers lead to reduced system performance and can even cause system failures!

5.4.4.1 Variable-area flowmeters

For economic reasons, the flow in energy recovery systems must be adjusted as accurately as possible to the design value. Too much as well as too little volume circulated can lead to a drastic performance reduction of the energy recovery system. However, it is extremely difficult for installers to adjust the water-glycol amount without aids. For this reason, KONVEKTA recommends the installation of variable-area flowmeters per heat exchanger.

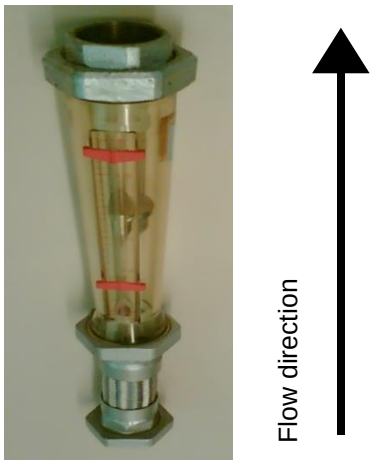


Figure 19 – Type of float: V – 250

Figure 20 – Type of float: BGN – 120

Other flowmeters can be used after consultation with KONVEKTA. The installation and maintenance regulations of the respective manufacturer apply. If measuring devices without view on the water-glycol mixture are used, an inspection glass must be integrated into the pipe system for medium assessment.

5.4.4.1.1 Insulation

If possible, variable-area flowmeters should always be installed in the hot pipe legs. If this is not possible, the flowmeters must be insulated to avoid condensate formation. Flowmeters can be insulated using throw-on insulation or detachable half shells. In any case, the technical data sheet must be considered regarding the permissible medium temperature. In the case of insulated measuring devices, the respective installation locations must be respectively marked.

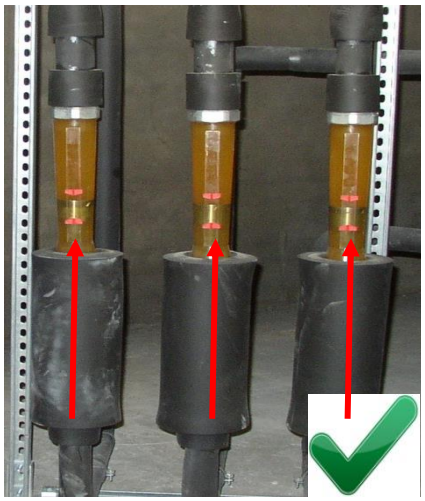


Figure 21 – Throw-on insulation

Figure 22 – Insulation with 2 half-shells

5.4.4.1.2 Installation

Variable-area flowmeters must always be installed in agreement with the manufacturer's documentation. However, the following points apply in general:

Prior to installation:

1. Remove the protective transport net
2. Clean the pipe from contamination and welding beads by thorough flushing, see chapter 6 Filling an energy recovery system
3. Vertical installation position
4. Flow from bottom to top
5. A shut-off valve should be installed upstream and downstream of the flowmeter, in close proximity to the flowmeter

Installation:

1. Insert the measuring device in the correct orientation, start of the scale pointing down, tension-free (use seals) into the pipe.
2. Support the pipe upstream and downstream of the measuring device. No mechanical tension must occur.
3. Installation of a vibration damper at the inlet of the measuring tube (for V-250 type)
4. If a vibration damper is used, the pipe must not be supported between vibration damper and measuring device.

Recommendation:

NOTE

- To avoid turbulences in the measuring tube, the following flow calming section must be met upstream and downstream of the measuring tube:
  - At the inlet → 5 times the line diameter
  - At the outlet → 3 times the line diameter

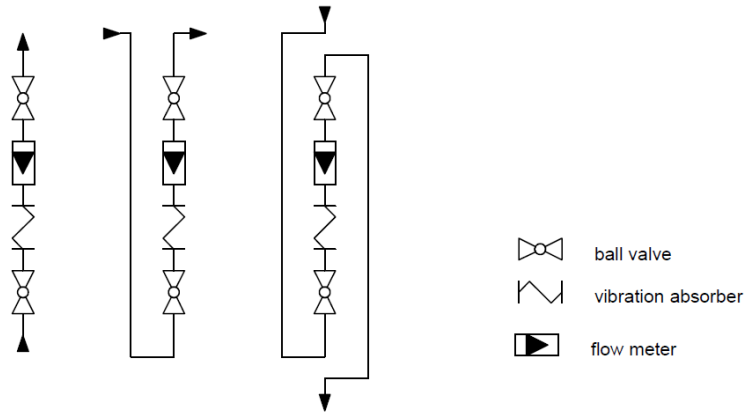


Figure 23 – Variable area flowmeter installation

5.4.5 Pipe venting

Upstream and downstream of the heat exchangers, as well as at the highest point of the line system, generously dimensioned air vents must be provided. Drains/vent must not be connected to one another, as this would hydraulically bypass the heat exchanger. In the case of a water-glycol mixture, the effort to eliminate air from the system is significantly greater than in the case of pure water. For this reason, a sufficient number of sufficiently dimensioned air vents must be provided. Vents must be installed at the highest point of the air vent. Down-routing via pipe unnecessarily complicates the venting process and is thus unpractical.
As an alternative, an automatic venting device and/or a manual venting valve can be installed at the highest point of the air vent according to Figure 24 left-hand side. The automatic venting device should be equipped with a shut-off in order to shut it off and replace it if it does not seal anymore correctly.

Figure 24 – Examples of pipe vents

NOTE

- Equip air vent with an automatic venting device. If possible, place a shut-off valve upstream of the automatic venting device.
- Select air vent diameter as generously as possible. One or two dimensions greater than the pipe is recommended.
- No constrictions and no down-routing of the venting valve.

5.4.6 Temperature sensors

Proper function of the energy recovery system requires certain temperatures within the ventilation system. The installation type and installation location is of great importance, as incorrect measured values can lead to serious loss in system performance.
The number as well as the position of the individual temperature sensors are to be obtained from the system-specific documentation. In the following, generally applicable installation guidelines are listed.

NOTE

- All temperature sensors must be mounted such to ensure accessibility for maintenance purposes.

Temperature sensors in the ventilation system
The distance of the temperature sensors at the inlet or outlet of the heat exchangers of energy recovery should be at least 50mm/2inch in the airflow direction. The distance of the temperature sensors at the inlet or outlet of the cold water or hot water heat exchangers should be at least 200mm/8inch in the airflow direction.

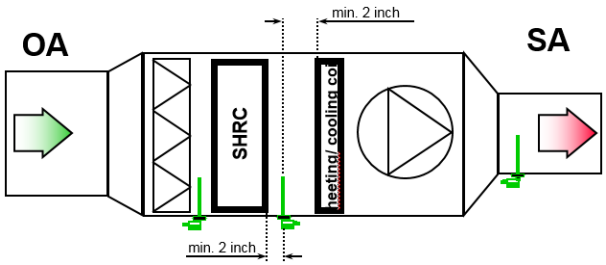


Figure 25 – Small outside air device

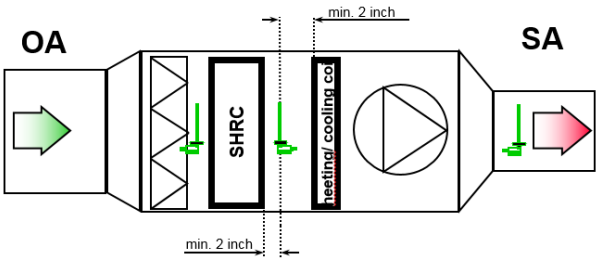


Figure 26 – Large outside air device

Furthermore, temperature sensor installation in the ventilation device depends on the size of the ventilation device. In the case of smaller devices with dimensions below 2m/10ft, duct sensors can be attached to the device wall acc. to Figure 25 and/or Figure 27. In the case of larger devices with dimensions greater than 2m/10ft, the temperature sensors must be installed within the device acc. To Figure 26 and/or Figure 28.

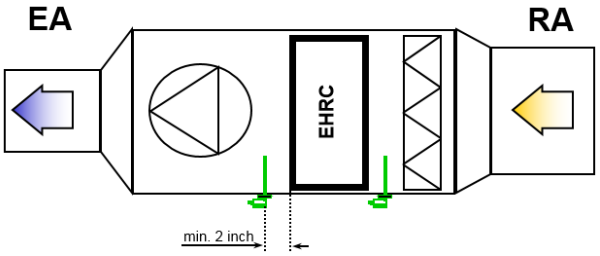


Figure 27 – Small exhaust air device

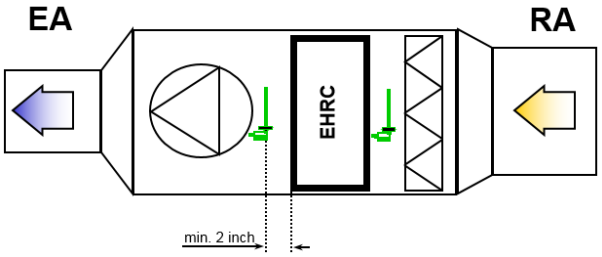


Figure 28 – Large exhaust air device

Duct sensors

If the temperature sensors can be attached to the device wall of smaller ventilation devices, a sensor with a lance length of at least 300mm/12inch must be selected.

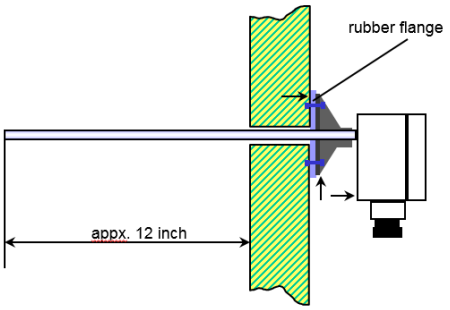


Figure 29 – Duct sensor

At the same time, air-tight installation with suitable assembly flange and rubber seal must be ensured.

Multi-point measurement

In the case of devices with greater cross-section areas, several sensors may be required for one measured value. A multi-point measurement should compensate for temperature layering or temperature differences caused by occurring air vortexes using several measured values across the entire cross-section. If this is planned, the sensors should be distributed across the cross-section as evenly as possible.

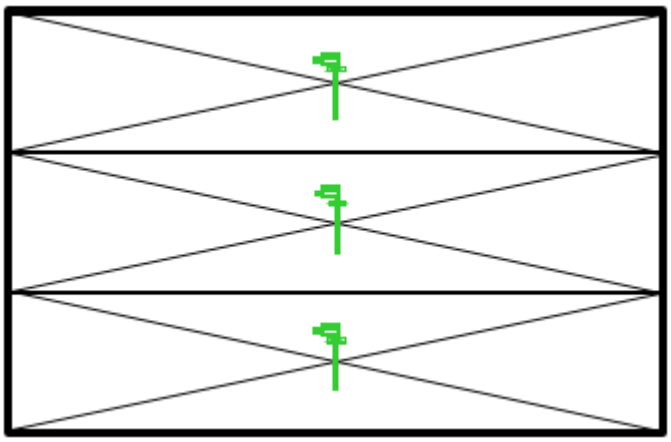


Figure 30 – Multi-point measurement

In Figure 30 above, an example with three heat exchangers on top of one another and a multi-point measurement consisting of three individual temperature sensors.

5.4.7 Electrical connections

DANGER

- Danger of electric shock causing up to fatal injuries due to contact with voltage-carrying parts: Always work with the device in de-energized condition.
- Danger of electric shock due to short-circuits when connecting electrical parts:
  All cables must be checked for assembly damage and/or damage to the insulation, as well as expert installation prior to commissioning.

Electrical work must only be performed by expert technicians observing any international and local regulations. Holes must be drilled into the housing at suitable locations for the power supply to the electrical components within the switchgear assembly (e.g. main supply, actuators, sensors, etc.). Cable glands must be used. The cable glands must be splash-proof.

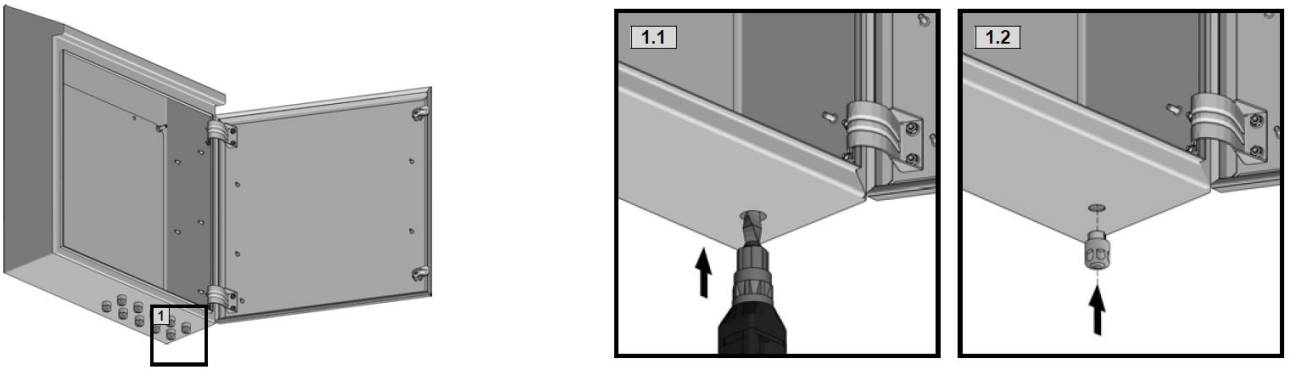


Figure 31 – Cable glands

NOTE

- Cable entry from the side and top promotes the contamination deposits and water ingress. For this reason, cable entry from the housing bottom is preferred.

It must be ensured that the mains voltage matches the nominal device data (voltage, number of phases, frequency) on the type plate. The power connection is realized using a three-pole cable plus neutral conductor and ground cable or with a one-pole cable (one per phase) + ground using the minimum cross-sections specified in the circuit diagram.

NOTE

- Applicable standards as well as the local, national, and international regulations apply and must be followed.

The ground connection is legally required. The installer must connect the yellow-green ground cable to the respective terminal in the switch cabinet.

Prior to commissioning, it must be verified that the power is correctly connected and all terminals are tightened.

5.4.7.1 Terminal connections

The switchgear assembly (SGK) either features WAGO or Weidmüller terminals. A short overview of correct connection of the respective field devices is provided in the following for both cases.

5.4.7.1.1 WAGO terminals

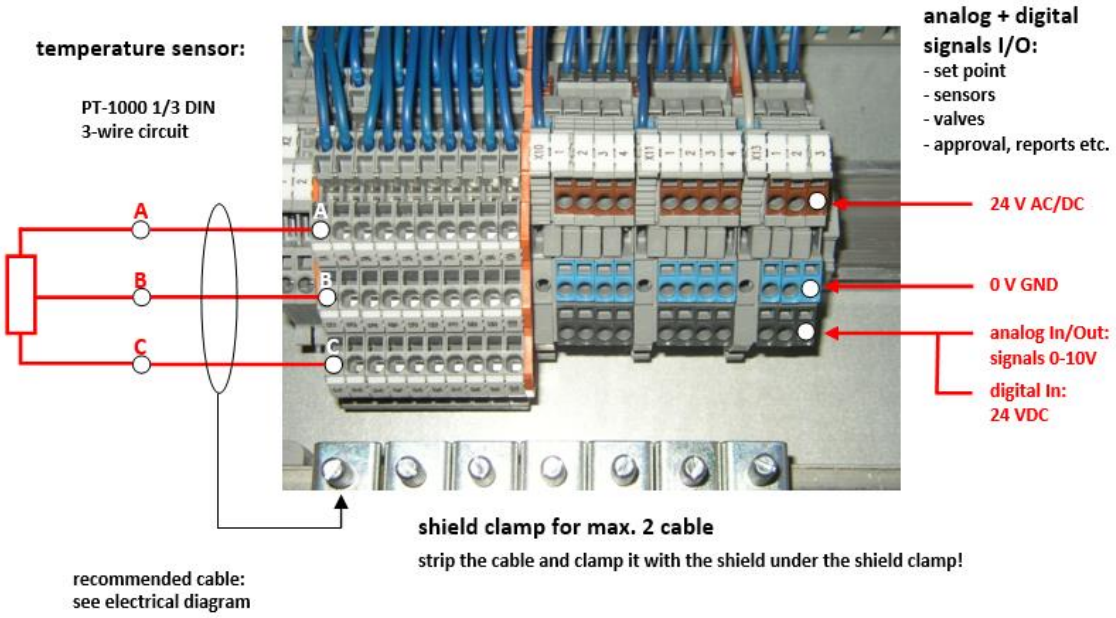


Figure 32 – WAGO terminals

5.4.7.1.2 Weidmuller terminals

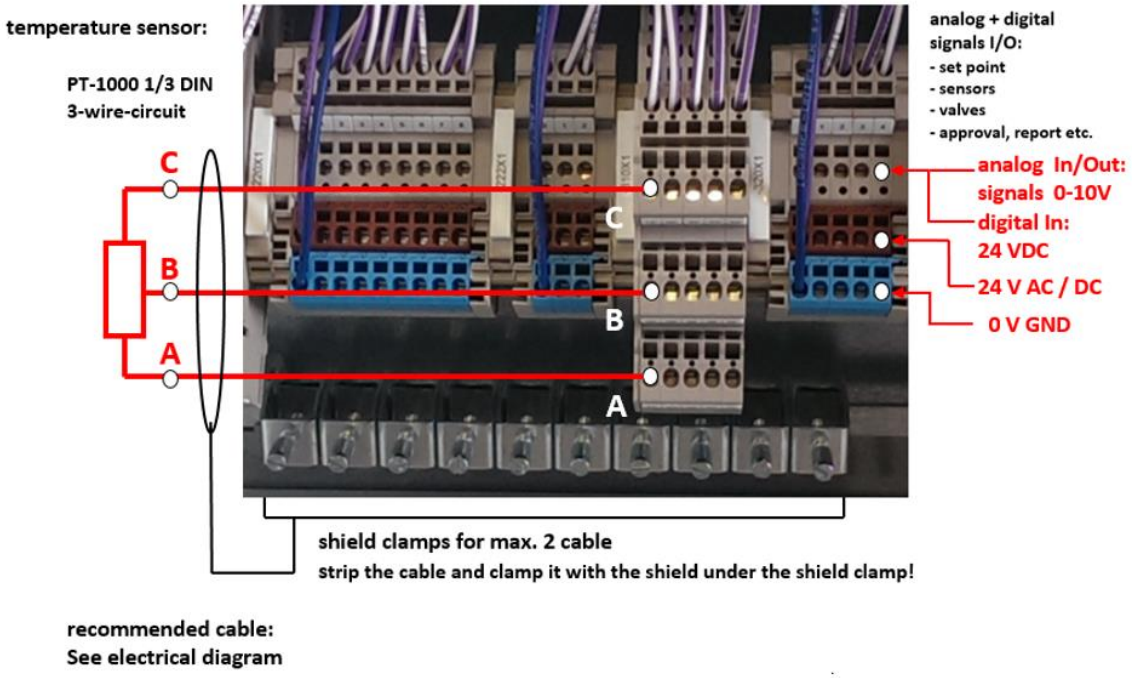


Figure 33 – Weidmüller terminals

6 Filling an energy recovery system

6.1 Pressure test

After completion of all piping work, the energy recovery system must be filled with water or water glycol mixture and pressurized. The entire system must be checked for leak-tightness. As the entire pipeline system, including all fittings, must be realized acc. to pressure rating as indicated on the system documentations highest pressure relief valve. Which typically is 16bar/230PSI at a temperature range of -29°C/-20°F up to 38°C/100°F. Further information regarding the pressure rating must be obtained from the system-specific documentation.

NOTE

- On the suction side of the pump, a safety group consisting of a safety valve, expansion vessel, and manometer is located. This safety group must be hydraulically isolated (close main shut-off valve) prior to the pressure test.

Screw connections in the pipe network and on the hydraulic assembly must be re-tightened as needed.

⚠ ATTENTION

- Risk of icing if the pressure test is performed with pure water. Observe the ambient temperatures.

After the pressure test is completed with water or water glycol mixture, the systems should remain filled, until the next work step to avoid corrosion along the liquid/water phase boundary. System parts filled with water and exposed to temperatures around or below freezing must be immediately and completely emptied.

6.2 Flushing

After successful pressure test completion, the entire energy recovery system must be thoroughly flushed. For this purpose, all drains must be opened. It must be flushed, until no rust particles or scale are washed out anymore. Rust and scale reduce corrosion protection and thus the service life of the water-glycol mixture as well as of the system components. For this reason, pipe network and heat exchangers must be completely emptied. In the case of systems that are already filled, flushing must be continued, until no residues of the old system filling are present anymore.

Emptied systems should be filled again within a few days. Prior to filling with water-glycol mixture, the corrosion condition of the system must be thoroughly inspected by the system operator. Measures may be required to ensure a flawless, clean metal surface. Corroded systems with traces of rust cannot be operated later on corrosion-proof with water-glycol mixture, as uneven metal inhibition and premature inhibitor consumption may occur.

⚠ ATTENTION

- The use of car radiator anti-freeze is not permissible.
- Different glycol brands and products must not be mixed, as they are not compatible.

Next, the energy recovery system is completely emptied. For this purpose, all vents and drains must be opened. After completion of the flushing process, all available strainers must be cleaned.

⚠ ATTENTION

- Risk of icing if flushing is performed with pure water. Observe the ambient temperatures.

6.3 Filling the energy recovery system

Immediately after flushing, the energy recovery system must be filled with the water-glycol mixture to prevent corrosion formation. Although commercially available water-glycol mixtures can be mixed in any ratio with water, two third of the water quantity should be filled first in the case of systems with circulating pumps. Next, the glycol is added, and then filled with water. By starting up the circuit, complete mixing is achieved. Depending on the system, this may take several days.
The specified mixing ratio is to be checked and exactly maintained. Use drinking water with a chloride content of less than 100 mg/kg or 100ppm.

NOTE

- Use a ready-made mixture

⚠ ATTENTION

- Risk of system damage if the energy recovery system is filled with insufficient antifreeze.

6.4 Leaks

If leaks are detected during system filling, the respective screw connections must be re-tightened. Hydraulic assemblies are checked for leak-tightness in the factory. Despite that, leaks may occur during system filling. Possible causes of leaks on hydraulic assemblies are:

- shocks or vibrations during assembly installation
- improper handling
- insufficient locking
- tensions at the connection fittings

⚠ ATTENTION

- Do not climb on devices. Pipes should not be used as ladder!

NOTE

- Counter-pieces of screw connections must be locked to prevent loosening
- Install connections without tension

6.5 Venting

After the energy recovery system is filled, it is vented next. The easiest way to vent the entire energy recovery system is repeating the following process several times:

1. Open all valves
2. Close energy recovery main bypass
3. Vent energy recovery pump
    a. Close the shut-off valves of the suction and pressure line and open the vent plugs.
    b. Open the shut-off valve in the suction line stepwise, until liquid discharges from the vent plug. Next, close the vent plug.
    c. Fully open the shut-off valves in the suction and pressure line.
4. Switch on the energy recovery pump. Have it run for approx. 10 min at maximum speed
5. Switch off the energy recovery pump. Wait for approx. 10 min so that air bubbles can collect at the highest points of the system
6. Vent heat exchangers, lines, pumps, etc.
7. Refill system
8. Continue with point 3

Continue venting, until no air is present anymore in the system, the nominal volumes circulated are reached, and no pressure loss can be detected at the pump on the suction side.

NOTE

- During first pump activation, the relatively low surface tension of the glycol and the related detachment of scale and rust cause temporary clouding of the water-glycol mixture.

6.6 Hydraulic system adjustment

The volumes circulated of the water-glycol mixture in the hydraulic system of an integrated system must be adjusted according to the specifications of the energy recovery system manufacturer. An improperly adjusted hydraulic system leads to reduced performance and increased pressure losses, and thus increased power consumption by the circulating pumps. For this reason, a correct calibration of the adjustment valves is particularly important.

NOTE

- An improperly adjusted hydraulic system leads to reduced performance

The calibration approach is explained based on the system topology in Figure 34. It shows an integrated system with three supply air systems and three exhaust air systems. In general, every supply and exhaust air zone must be equipped with a separate adjusting valve.

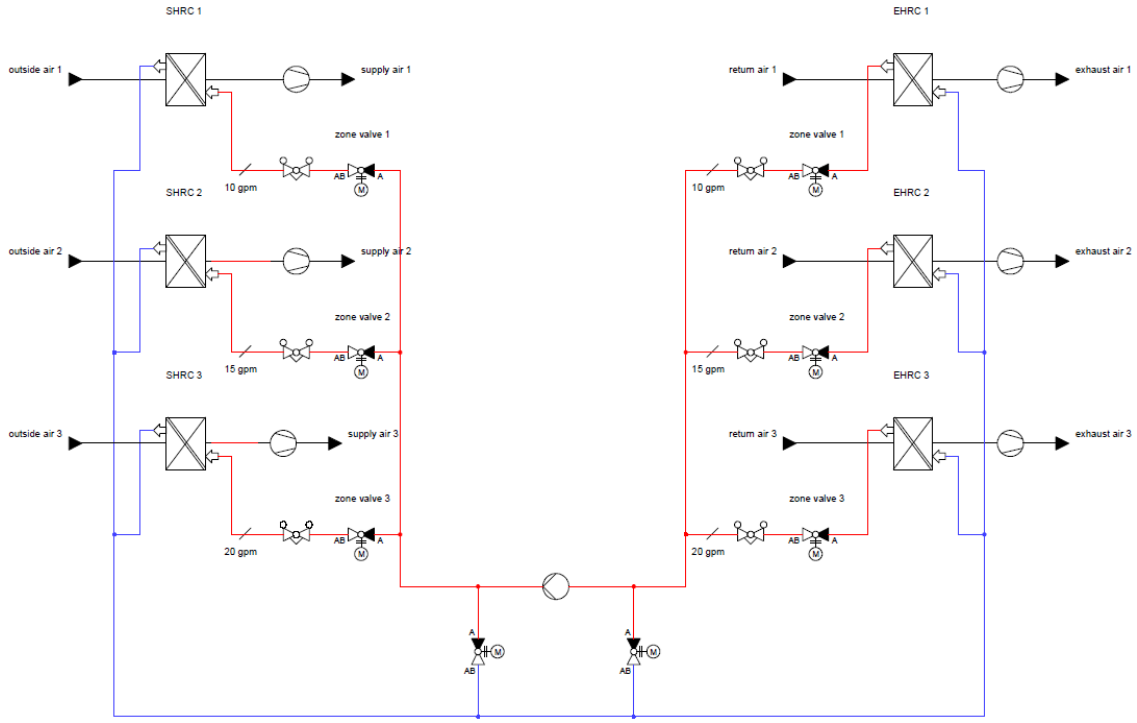


Figure 34 – Integrated system with 3 supply air and exhaust air zones

Every adjusting valve features a handwheel, using which the valve can be adjusted. Depending on the type, the number of revolutions of the handwheel and the scale resolution can be different. In the case of Oventrop Hydrocontrol valves, the default value can be adjusted between 0.0 and 10.0/12.0 with a step size of 0.5. However, in the case of STA valves by IMI, the default value can be adjusted between 0.0 and 4.0 with a step size of 0.1. The KV values of the respective adjustment positions can be obtained from the respective data sheets.

Figure 35 – Valve closed

Figure 36– Valve in position 2.3

Figure 37 – Valve opened

The figures above show three possible valve positions using the STA valves by IMI as example: 0.0/closed in Figure 35, a certain adjustment value of 2.3 in Figure 36, and 4.0/fully opened in Figure 37.

The approach for calibrating the supply air side is as follows:

1. Obtain the projected flow volumes from the technical documentation
   - In the example acc. to Figure 34, these are 10 gpm, 15 gpm respectively 20 gpm for zones 1-3.
2. The entire hydraulic system must be fully vented
   - See chapter 6.5 Venting
3. The zone valves of the energy recovery system must be fully opened
   - This can be realized either directly at the valve acc. to chapter 7.3.1, via the emergency operation level acc. to chapter 7.2.2 or via the web interface acc. to chapter 7.1.10.
4. The bypass valve downstream of the pump, and if present, the bypass valve upstream of the pump must be fully closed
   - This can be realized either directly at the valve acc. to chapter 7.3.1, via the emergency operation level acc. to chapter 7.2.2 or via the web interface acc. to chapter 7.1.10.
5. The circulating pump must be operated at maximum speed
   - This can be realized either via the emergency operation level acc. to chapter 7.2.2 or via the web interface acc. to chapter 7.1.10.
6. Move the adjusting valves into the center position
   - E.g. position 2.0 for the valves above
7. Measure the flow volumes per zone
   - Document the measured values
   - Calculate the zone with the lowest relative deviation from the projected flow volume

Table 4 – Zone with the lowest relative deviation

Supply air zone	Projected flow	Measured flow	Relative deviation
1	10 gpm	12 gpm	+20 %
2	15 gpm	16.5 gpm	+10 %
3	20 gpm	28 gpm	+40 %

8. Calculate the flow volumes to be adjusted
   - In step 7, the zone with the lowest relative deviation was calculated with + 10 %. This means that the other two zones are adjusted to the projected flow + 10 %.

Table 5 – Calculation of the flow to be adjusted

Supply air zone	Projected flow	Relative deviation	Calculated flow target	Valve position
1	10 gpm	+10 %	11 gpm	adjust
2	15 gpm	+10 %	16.5 gpm	fully open
3	20 gpm	+10 %	22 gpm	adjust

9. The valves must be adjusted such that the calculated flow volumes acc. to Table 5 are reached
   - In this example, valve 2 remain fully opened
10. The volumes circulated and the valve positions must be documented after the calibration

The same approach applies to the exhaust air side.

7 Operation

7.1 Eiger web interface

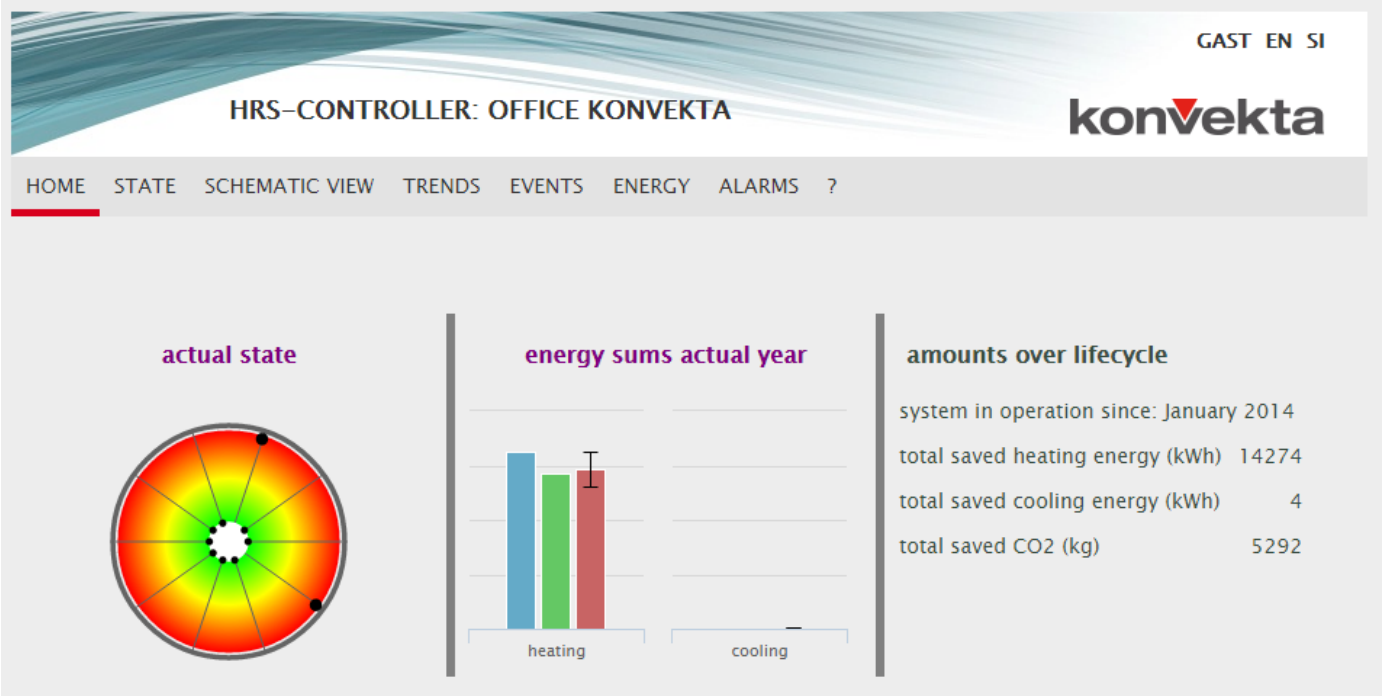


Figure 38 – Eiger web interface start page

The start page of the Eiger web interface is horizontally divided into two panes. In the upper pane, the menu is arranged. In the lower pane, a cockpit is shown containing the most important system data of your energy recovery system.

NOTE

Correct network settings are a must, if you would like to access the web interface from a different system using your Internet browser. Follow the following steps:

1. Establish the connection to the system
2. Open browser (Google-Chrome is suggested)
3. Enter IP address

If you have difficulties connecting to the web interface, please contact your KONVEKTA representative.

7.1.1 Menu

Figure 39 – Menu

No.	Meaning/function
1	Link to start page
2	Link to current state "KONVEKTA-Eye"
3	Link to scheme (system overview)
4	Link to trend data
5	Link to events
6	Link to energy data
7	Link to list of alarms
8	User administration
9	Language setting
10	Unit conversion

Using this menu, you can access the different pages, which are described in the following chapters. User administration (8), language setting (9), and unit conversion (10) are explained in chapter 7.1.9 Administration.

7.1.2 Cockpit

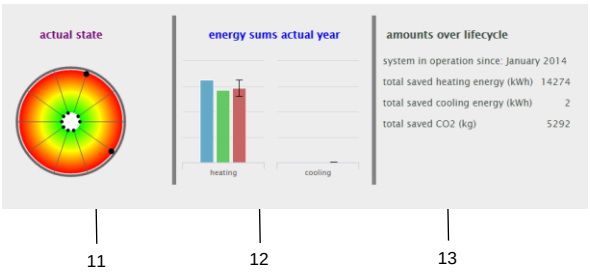


Figure 40 – Cockpit

No.	Meaning/function
11	Current time and date
12	Current state
13	Energy quantities, current year
14	Energy quantities, total

The cockpit is a compilation of important system data of your energy recovery system. In addition to the current time (11), the current state (12), the accumulated energy quantities of the current year (13), the accumulated energy quantities across the entire operating duration of the system (14) are presented on one page.

7.1.3 State

The purpose of every energy recovery system is optimum net energy recovery and thus optimum operating costs saving throughout the entire service life of the system. Optimum and fault-free operation is a prerequisite. Installation errors, defective components, and incorrectly adjusted target values of the control must be detected.

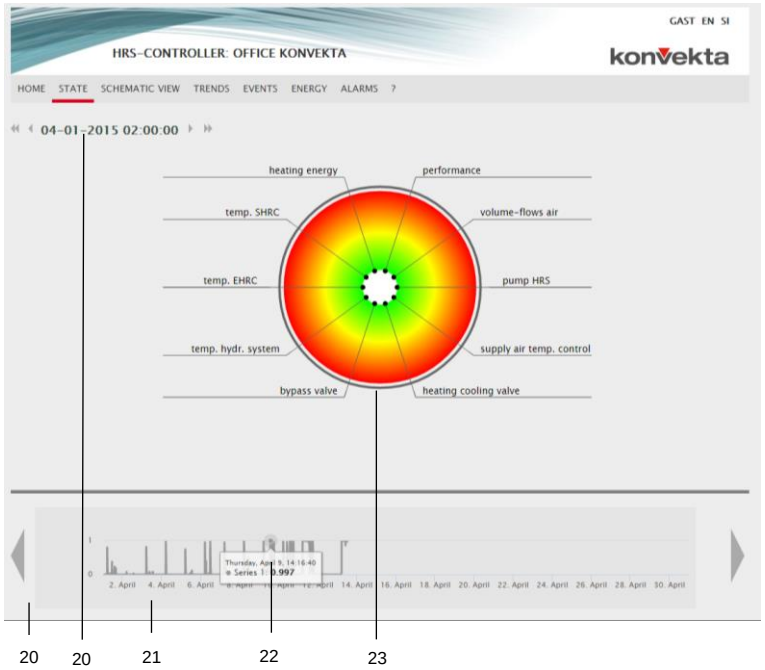
Comprehensive information at a glance
The increased use of electronics and software leads to higher complexity. For this reason, it is important to receive safe, easy-to-interpret information about the operating state and possible malfunctions at all times. Using new visual function monitoring with Auto-Reporting*plus*, the most important data is present graphically. Thanks to a clear presentation of all important functions and key figures, it can be assessed at a glance, whether the high-performance energy recovery system functions optimally and achieves the guaranteed performance.

Properties of Auto-Reporting*plus*

- Comprehensive information at a glance, whether the system functions optimally and without malfunctions, and achieves the expected performance
- Continuous automatic function monitoring
- Automatic error detection, also of upstream or downstream systems, such as primary-side power supply or SA or EA humidification functions
- Quick response times due to automatic malfunction messages

Functionality of Auto-Reporting*plus*
In the case of a minor deviation from the target value, the point moves from the green to the yellow area. In the case of a severe malfunction, the point moves into the red area.

The current system state can be observed on the < STATE > page. The values are continuously updated.



No.	Meaning/function
20	Navigation
21	Monthly time axis
22	Current pointer position
23	Auto-Reporting*plus* state chart

Figure 41 – State

Using the time axis (21), the values of the Auto-Reporting*plus* state chart can be called up for any point in time in the past. For this purpose, the mouse pointer is placed on the time axis (21). The values at the cursor position are directly displayed (22). By pressing on the desired time axis position, the Auto-Reporting*plus* data is called up and displayed. Navigation arrows (20) can also be used for detail navigation. Using the [show realtime values] button, the view returns to the current values.

7.1.4 Scheme

The current system operation can be observed on the < SCHEMATIC VIEW > page. The values are continuously updated. The scheme corresponds to the basic design of the energy recovery system.

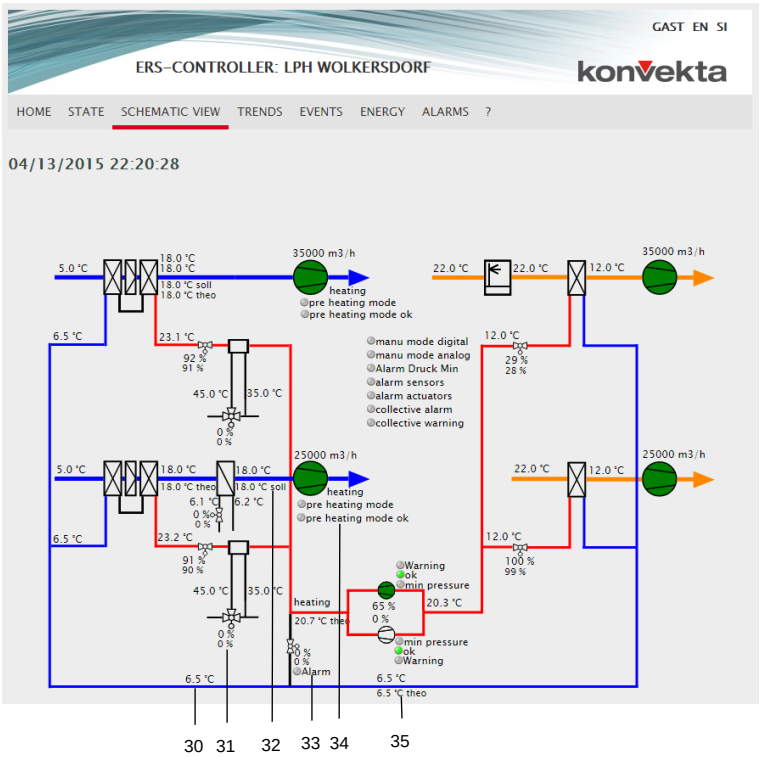


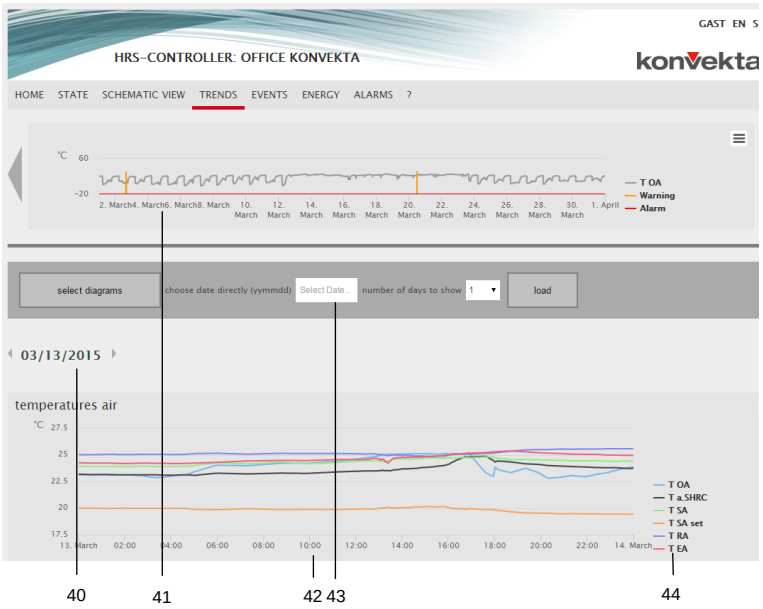
Figure 42 – Scheme

No.	Meaning/function
30	Temperature measurement value
31	Valve adjustment value and feedback
32	Target temperature value
33	Alarm point
34	Status message
35	theor. target value, Auto-Reporting*plus*

All temperature values (3) recorded by the system are displayed. In the case of valve drives with position feedback, not only the actuating value - top - but also the valve feedback - bottom - are shown (31). Specific alarm points (33) are also graphically illustrated, as well as status messages (34), target temperature values (32), and theoretically calculated target values of the Auto-Reporting*plus* (35) add-on software.

7.1.5 Trends

On the < TRENDS > page, the trends of all data relevant for the systems are shown.

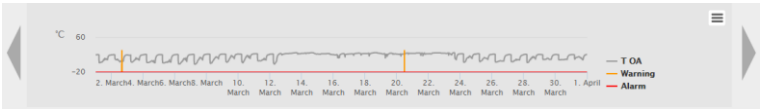


No.	Meaning/function
40	Navigation
41	Monthly time axis
42	Daily time axis
43	Direct date input
44	Legend

Figure 43 – Trends

7.1.5.1 Navigation on the monthly time axis (41)

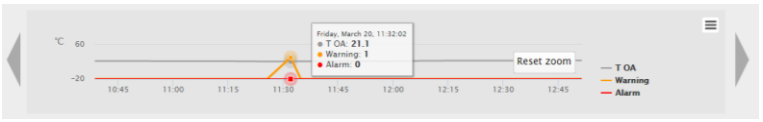
The outside temperature curve across the current month can be seen on the monthly time axis (41). Moving the mouse pointer over the trend line, displays the respectively current value. By clicking, the trend of the respective day can be called up.



Using the arrow keys on the left-hand and right-hand side of the time axis, it can be browsed to the previous or next month.

Figure 44 – Navigation

If a certain event on the monthly axis is of interest, e.g. the first warning in the graphic above, the respective area can be marked and zoomed in.



For this purpose, move the mouse pointer across the area to be zoomed in, while pressing and holding the mouse button. This also simplifies navigating to a certain point in time

Figure 45 – Navigation

Using the < Reset zoom > button, it can be switched back to the original monthly time axis.

7.1.5.2 Direct date input (43)

If a certain date should be called up, the < choose date directly (yymmdd) > can be used.

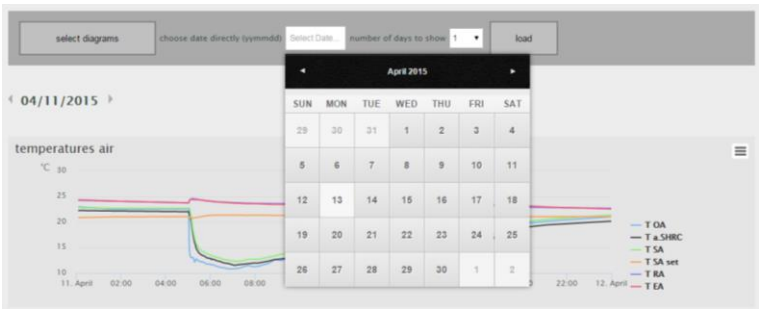


Figure 46 – Date entry

Clicking on the < Select Date… > field opens a calendar view, where the desired date can be selected and confirmed. If needed, several days can be called up via < number of days to show>. Using the < load > button, the selected dates are loaded.

7.1.5.3 Navigation on the daily time axis (42)

The curve of the different data series across the current day can be seen on the daily time axis (42). Moving the mouse pointer over the trend line, displays the respectively current values. By clicking on a data point within the data series, the respective scheme view can be directly accessed from the trend data.
If a certain event on the daily axis is of interest, the respective area can be marked and zoomed in.

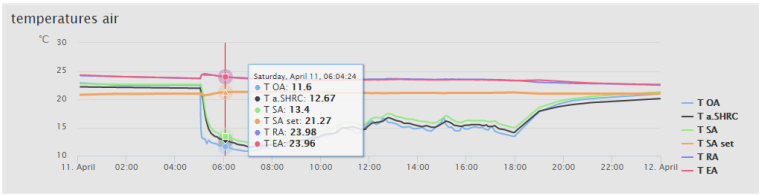


Figure 47 – Daily date axis

For this purpose, move the mouse pointer across the area to be zoomed in, while pressing and holding the mouse button. This also simplifies navigating to a certain point in time

Using the < Reset zoom > button, it can be switched back to the original daily time axis.

7.1.5.4 Trend data configuration

Individual trend data can be shown or hidden to arrange the available trend charts more clearly.

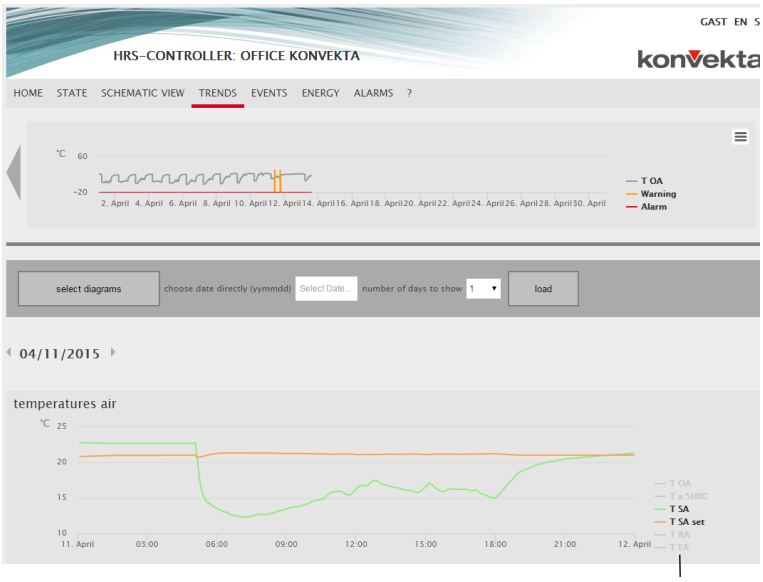


Figure 48 – Trend data

Here, the data series can be selected by simply clicking on the respective legend entry (44). Hidden data series are shown in gray in the legend (44).

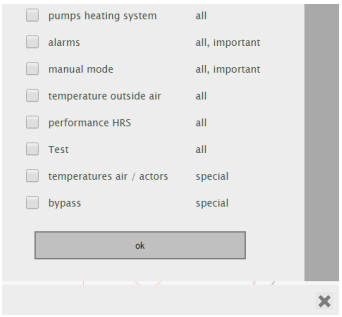


Figure 49 – Trend data configuration

It can also be configured, which trend charts should be shown at all. The selection menu can be called up via the < select diagrams > button. After selecting the desired charts, confirm with < OK >.

7.1.6 Events

System events influencing optimum system operation are listed on the < EVENTS > page. The events are controlled via user administration. This means that depending on the access level, more or less event types are visible.

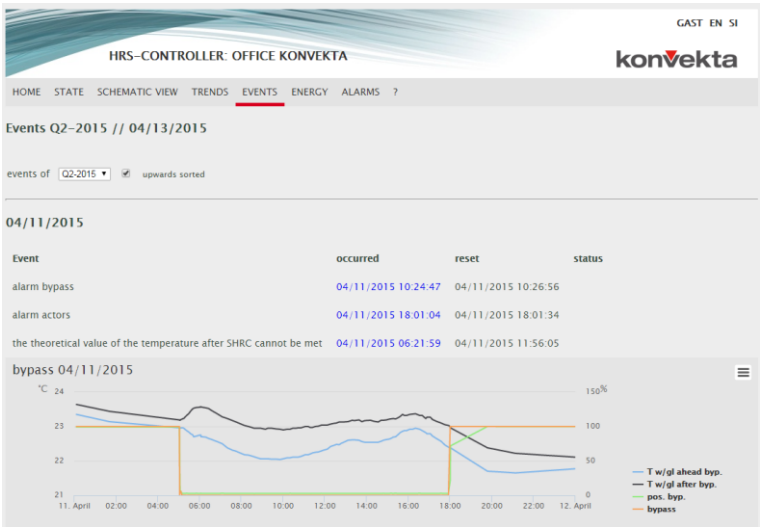


Figure 50 – Event list

Opposite to the list of alarms acc. to chapter 7.1.8 Alarms, the event list does not only contains active alarms, but also acknowledged alarms and further events. This e.g. also includes, whether a system was newly started or whether manual operation was activated.
The event list can be called up per quarter.
Using the "occured" time stamp, the respective scheme can be called up with the data available for the time of the event using a simple click.

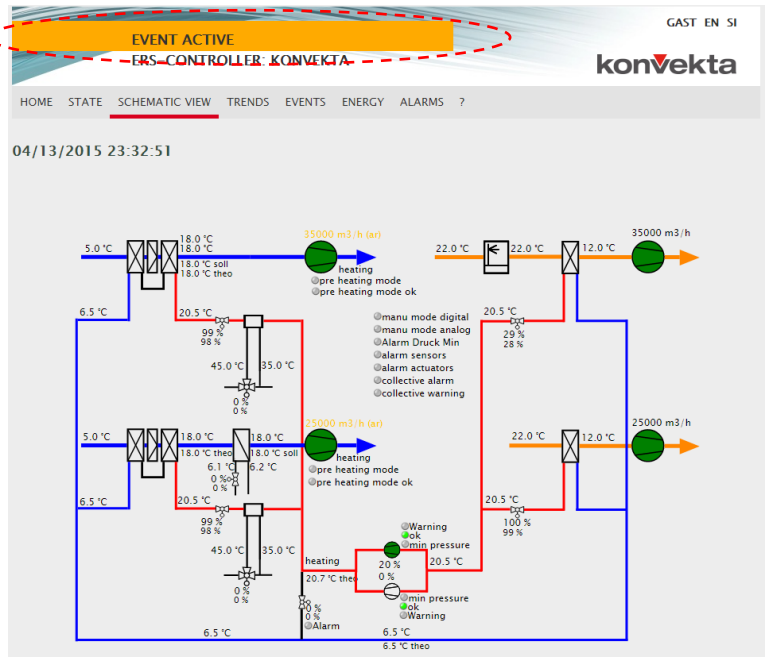


Figure 51 – Event

An active event is displayed on the <SCHEMATIC VIEW > page. In the example on the left, the air volume flows are far above the design air volumes. An active event is signaled with an orange bar and the text "EVENT ACTIVE". Furthermore, the respective word is shown in orange. As soon as the event condition is not met anymore, the orange warnings disappear.

7.1.7 Energy

All recorded or calculated energy data of the system is listed on the < ENERGY > page. This enables an overview of the energy data of the system and (among others) a comparison between heat requirement and actual energy recovery.
The amount of energy required to heat/cool the outside air from the outside air temperature to the supply air target value under the present volume flows, is calculated as heat requirement (blue). The measured energy recovery (green) is the heat effectively recovered by the energy recovery system. Possible power feeds or external energies are deducted.
Using the Auto-Reporting*plus* add-on software, further information is available to the observer. For example, the theoretically possible energy recovery is calculated based on the respectively current system data using the characteristic heat exchanger fields. The result is a calculated energy recovery (red). External interferences and measuring tolerances (I) can result in a difference between calculated and measured energy recovery. However, if the difference is unusually large, this may be caused by a system malfunction.

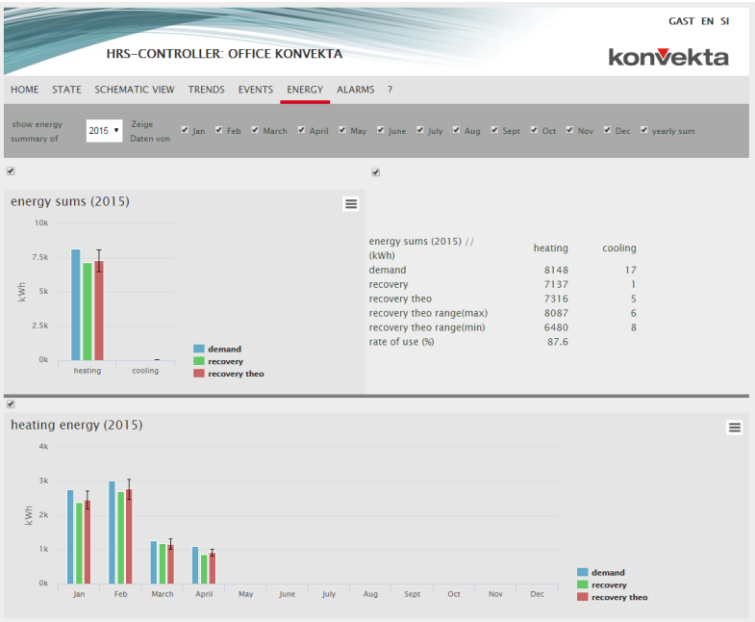


Figure 52 – Energies

Using the checkboxes, individual months as well as every chart can be individually shown and/or hidden.

7.1.8 Alarms

All active alarms of the system are listed on the < ALARMS > page.

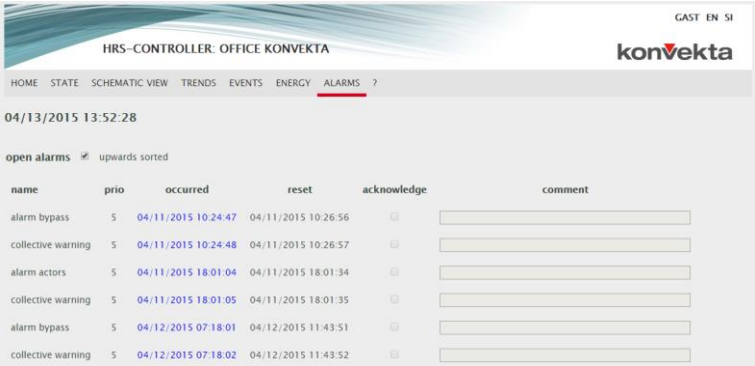


Figure 53 – List of alarms

Opposite to the event list acc. to chapter 7.1.6 Events, the alarm list exclusively contains actively pending alarms. Using the "occured" time stamp, the respective scheme can be called up with the data available for the time of the alarm using a simple click.

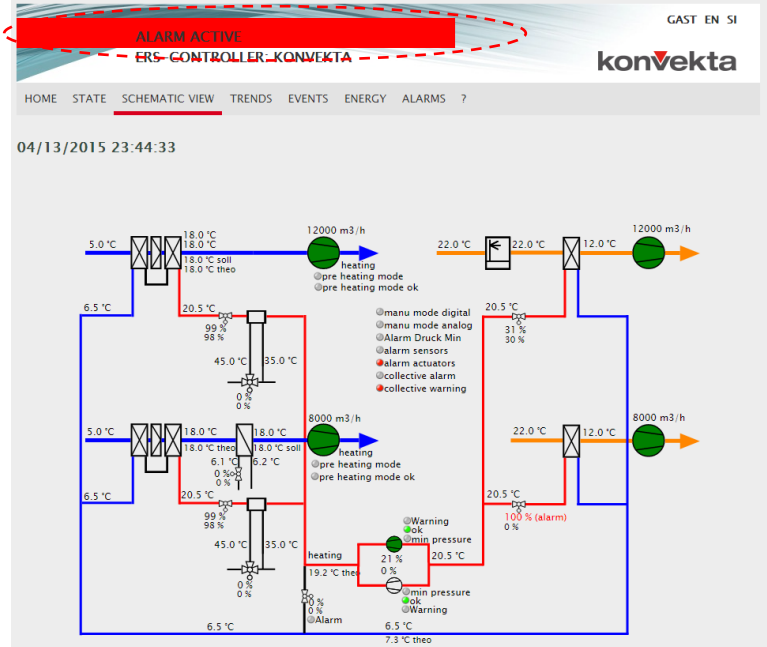


Figure 54 – Alarm

An active alarm is displayed on the < SCHEMATIC VIEW > page. In the example on the left side, a valve feedback does not match the actuating value. A pending alarm is signaled with a red bar and the text "ALARM NOT HANDLED". Furthermore, the respective word is shown in red.

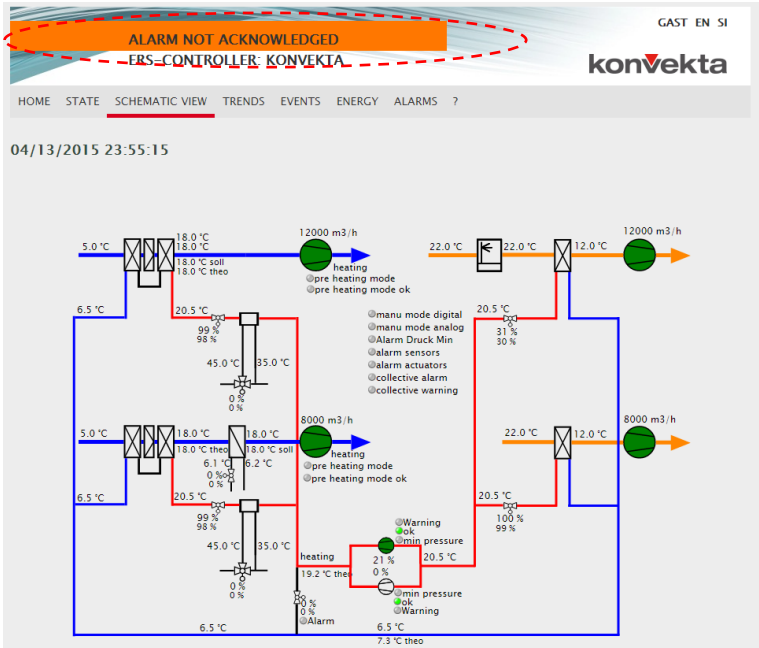


Figure 55 – Alarm not acknowledged

As soon as the alarm condition is not met anymore, the red warnings disappear.
They are replaced with an orange bar with the text "ALARM NOT ACKNOWLEDGED", until the alarm is acknowledged.

7.1.8.1 Alarm acknowledgment

Every occurring alarm must be acknowledged by the user. This takes place on the < ALARME > (alarms) page. This page lists all alarms as described above. This is signaled with an orange bar with the text "ALARM NOT ACKNOWLEDGED", until the alarm is acknowledged.

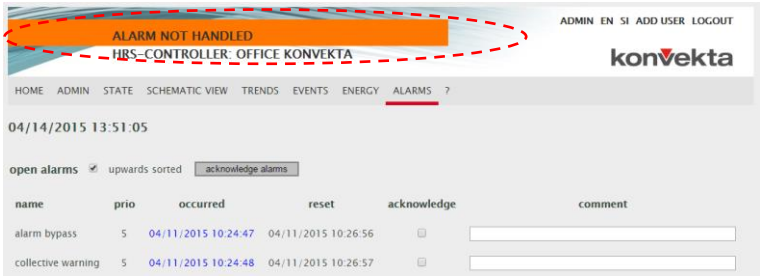


Figure 56 – Alarm acknowledgment

The respective checkbox of the alarm entry to be acknowledged must be checked for acknowledgment. If needed, an information text can be added to the alarm. Using the < acknowledge alarms > button, the selected alarms are acknowledged.

7.1.9 Administration

The login window is accessed via the user administration button (8). Here, users can log in using their personal login credentials.

Figure 57 – Administration

No.	Meaning/function
8	User administration
9	Language setting
10	Unit conversion

If available, the language can also be changed via the language setting button (9). The same applies to the units, which can be changed via (10). The unit and language settings may not always be present and depend on the delivery condition of the system.

7.1.10 Manual operation

The Eiger web interface features a manual operation mode, using which all actuators, such as pumps or valves, can be individually traveled by hand.

⚠ ATTENTION

- Manual operation via the web interface is always of higher importance than automatic operation.
- Manual operation must only be used by trained personnel.
- Switching the system or system parts into impermissible system states or system states hazardous for the system or its environment must be avoided.

Manual operation is only available to users with the respective authorization. E.g., a guest user does not have this authorization and cannot activate manual operation.

NOTE

- Manual operation is available with respective authorization only

7.1.10.1 Activate manual operation of an individual actuator

Manual operation for actuators is called from the Schematic View page acc. to chapter 0. Simple clicking on the icon of the desired actuator opens a pop-up for manual operation acc. to the following figures.

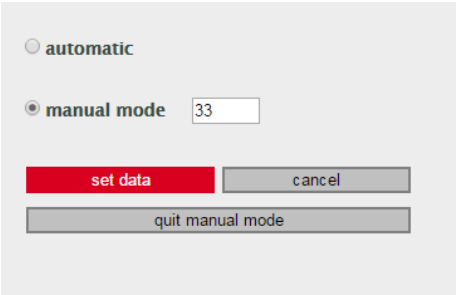


Figure 58 – Manual operation

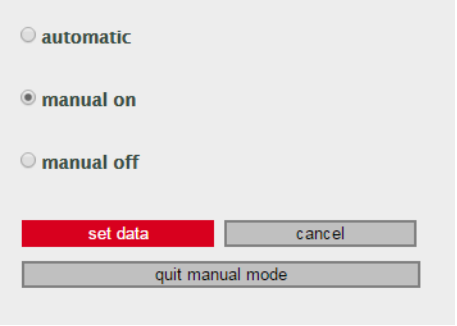


Figure 59 – Manual operation

Manual operation for an actuator with analog actuating value

An actuator with analog actuating signal acc. to Figure 58 can be switched into manual operation as follows:

1. Check the < manual mode > checkbox
2. Enter the desired actuating value
3. Activate manual operation via the < set data > button

Manual operation for an actuator with digital actuating value

An actuator with digital actuating signal acc. to Figure 59 can be switched into manual operation as follows:

1. Set the checkbox to < manual on > or < manual off >
2. Activate manual operation via the < set data > button

Active manual operation is indicated directly at the actuator via color assignment as well as by a bar flashing in orange with the text "manual mode active".

7.1.10.2 Exit manual operation

Manual operation for actuators is called from the Schematic View page acc. to chapter 0. Simple clicking on the icon of the desired actuator opens a pop-up for manual operation acc. to the following figures.

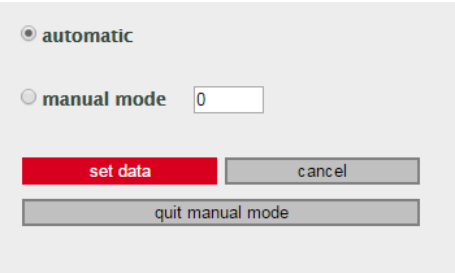


Figure 60 – Manual operation

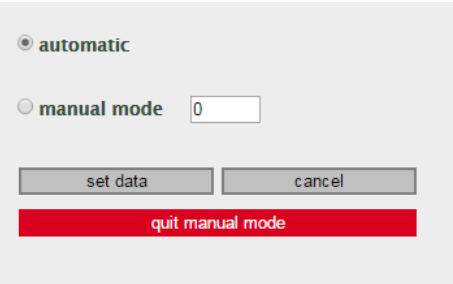


Figure 61 – Manual operation

Manual operation of a single actuator acc. to Figure 60 can be exited as follows:

1. Check the < automatic > checkbox
2. Deactivate manual operation via the < set data > button

Manual operation of the entire system acc. to Figure 61 can be exited as follows:

1. Deactivate manual operation via the < quit manual mode > button

NOTE

- In the case of systems with redundant pump design, the pump currently in operation must be switched off first prior to switching to the redundant pump.

7.2 Emergency operation level

Depending on the system design, the controller features emergency operation modules. The figures shown below briefly explain the user interfaces of digital and analog emergency operation.

Digital emergency operation module **Analog emergency operation module**

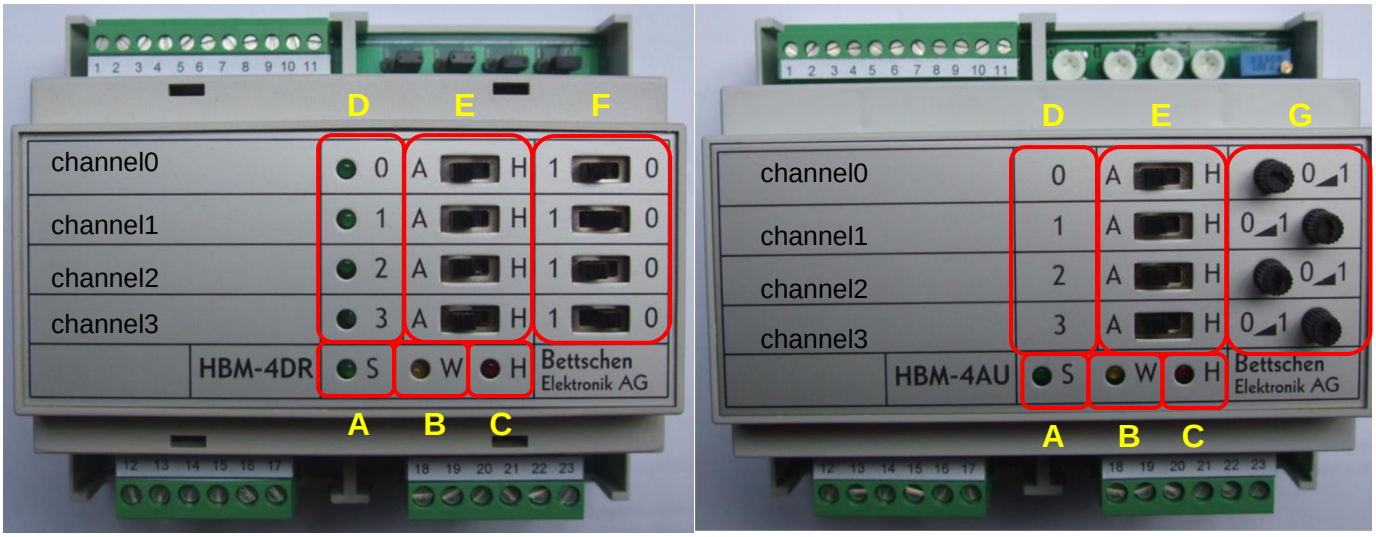


Figure 62 – Emergency operation module

A) LED, voltage supply (is illuminated, if the +24 VDC voltage supply is connected)
B) LED, watchdog (is illuminated, if no voltage is applied to WD-IN)
C) LED, manual (is illuminated, if an automatic/manual switch is set to manual mode)
D) LED operation indicator (is illuminated, if a channel is switched on)
E) Automatic/manual switch
F) On/off switch (superordinate to manual mode)
G) Rotary dial (superordinate to manual mode)

7.2.1 Automatic operation

The emergency operation modules have no function in automatic operation (LED, manual is not illuminated). The respective input signals are directly relayed to the outputs without overriding them.

7.2.2 Manual operation

An emergency operation module is in manual operation, if at least one automatic/manual switch is in the manual position. Manual operation is signaled via the manual LED, which is illuminated in red. As soon as one or several emergency operation modules are in manual operation, a respective alarm is issued by the control.
Every channel can be swished individually into manual operation via switch E. As soon as the channel is in manual operation, the output signal of the respective channel can be overridden using switch F respectively rotary encoder G.

⚠ ATTENTION

- Manual operation via the emergency operation modules is always of highest priority. Manual operation must only be used by trained personnel.
- Switching the system or system parts into impermissible system states or system states hazardous for the system or its environment must be avoided.

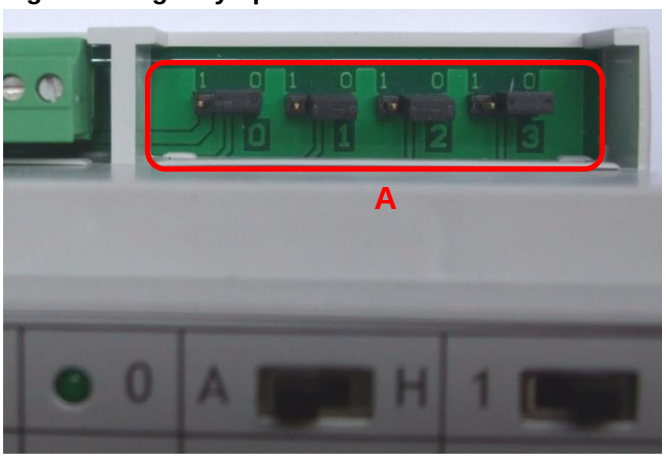
NOTE

- In the case of systems with redundant pump design, the pump currently in operation must be switched off first prior to switching to the redundant pump.

7.2.3 Emergency operation

The emergency operation modules feature a so-called watchdog monitoring the controller. As soon as program execution is malfunctioning respectively the CPU is not operational, the watchdog signal will be missing. Emergency operation is signaled via the watchdog LED, which is illuminated in orange.
In emergency operation, all outputs of the emergency operation modules are set to predefined values. The digital emergency operation modules are fitted with four jumpers. The analog emergency operation modules are fitted with four potentiometers. The jumpers are set to position 0 or 1 according to their designation prior to commissioning. The potentiometers are adjusted to the desired target values.

Digital emergency operation module



Analog emergency operation module

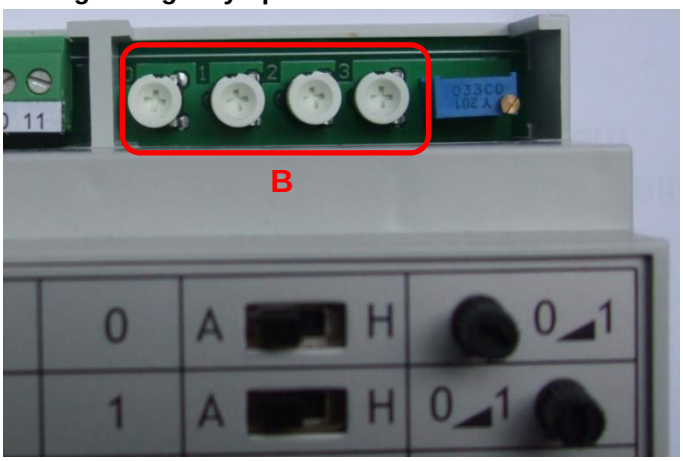


Figure 63 – Watchdog settings

A) Jumpers (channels 0 to 3)
B) Potentiometer (channels 0-3)

⚠ ATTENTION

- The jumpers and potentiometers are not included in the user interface of the emergency operation modules and may only be adjusted or changed by employees of or upon instruction by KONVEKTA.

7.3 Further operating elements

7.3.1 Valves

Valves with integrated manual adjustment are used only. Belimo actuators provide a pushbutton for this purpose.

Figure 64 – Belimo actuator

Manual adjustment is possible via a pushbutton. Pressing the button unlocks the gearbox and the drive can be moved into the desired position using the rotary knob. The gearbox is disengaged, as long as the button is pushed and/or locked. To loosen the lock, the button must be pressed again briefly.

7.3.2 Main and service switch

The main switch of the entire energy recovery system is located at the electrical cabinet assembly, as well as the service switch of the energy recovery pump, assuming that they are located in close proximity of the electrical cabinet assembly. Otherwise, the service switches can be found close to the handles of the respective energy recovery pumps.

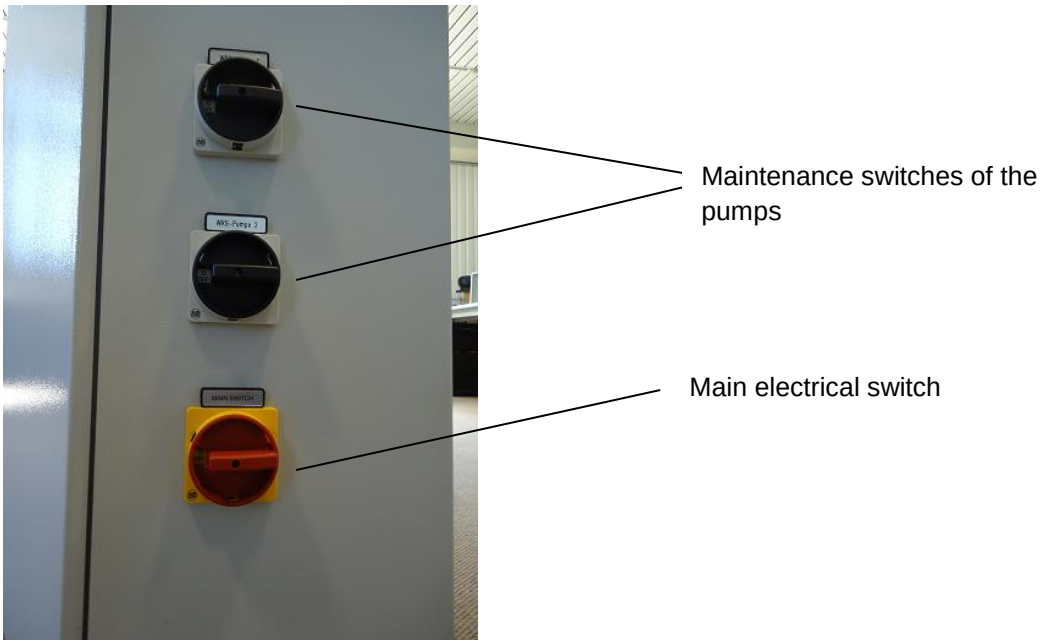


Figure 65 – Main and service switch

7.3.3 Alarm Reset

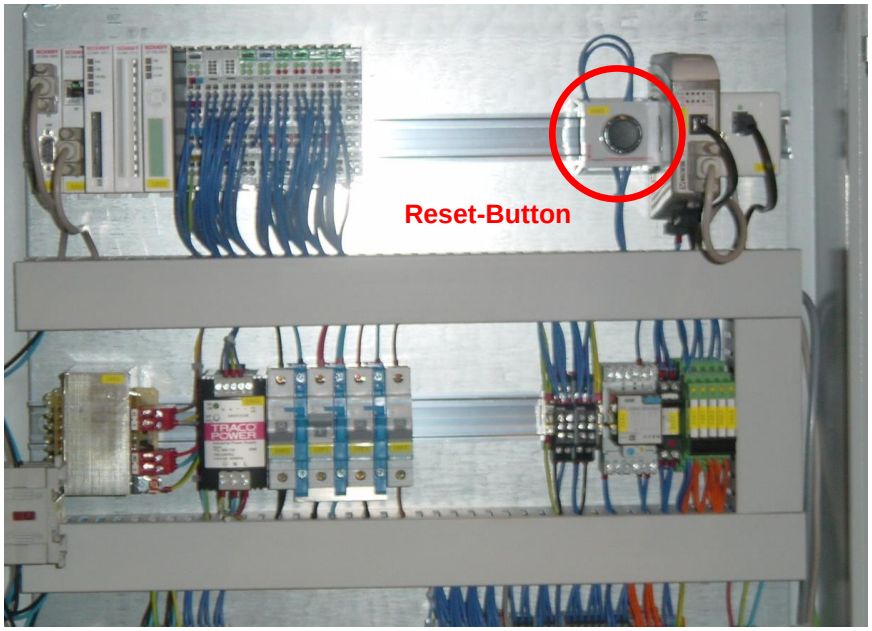


Figure 66 – Reset button

If an alarm, such as the pressure alarm, is triggered, it must be manually reset after error correction. A respective button as shown above in Figure 66 can be found in the controllers electrical cabinet. This button must be actuated to acknowledge the pressure alarm.

7.3.4 Replacement of the Flash card

The Flash card may have to be replaced in special cases. In this case, you can obtain a replacement card from KONVEKTA.

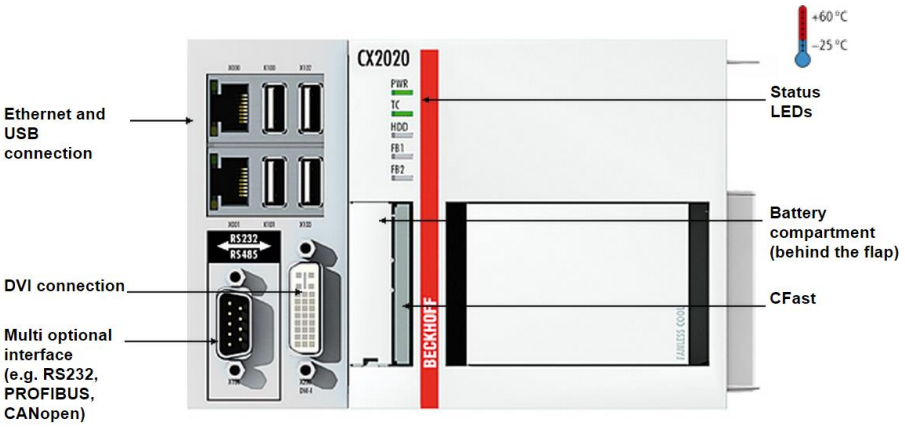


Figure 67 – CPU

Approach when replacing a Flash card (CFast)

DANGER

- Danger of electric shock causing up to fatal injuries due to contact with voltage-carrying parts: Always work with the device in de-energized condition.
- Danger of electric shock causing up to fatal injuries. Some circuits in the electrical system part can still be energized for several minutes after the power supply was disconnected:
  Wait at least 15 minutes after deactivation before starting work on or in close proximity to electrical parts!

1. Switch off the electrical cabinet via the main switch located on the side panel of the electrical cabinet. See also chapter 7.3.2 Main and service switch.
2. Wait for 15 minutes, until the system is completely de-energized.
3. Open the doors.
4. The CFast card is unlocked by gentle pressing on it. The CFast card is pushed out from the card slot.
5. Remove the card from the slot and insert the new card. Make sure that the card is inserted in the right orientation so that it fits into the slot.
6. After the replacement is completed, switch on the electrical cabinet again via the main switch. See also chapter 7.3.2 Main and service switch.
7. The system starts automatically in automatic operation.

8 Cleaning and maintenance

8.1 Maintenance intervals

Ventilation and air conditioning installation systems and their components must be considered machines requiring regular maintenance. The specified maintenance intervals are approximate information and refer to normal ambient conditions respectively normally polluted air based on VDI 6022. In the case of poor ambient conditions (dust, contamination, humidity, etc.) or severely polluted air, the maintenance intervals must be respectively shortened. Regular maintenance does not release the operating company from their due diligence to regularly check the system for function and/or damage.

NOTE

- The operating company is responsible for defining suitable inspection intervals

Cleaning and maintenance:
The individual components of the ventilation and air conditioning installation systems must be fully accessible for cleaning.

- Remove coarse contaminations dry using an industrial vacuum
- Use a damp cloth for any other contaminations
- Using a grease or oil removing cleaning agent (neutral cleaning agent with pH value between 8 and 9 as concentrate).
- Treat galvanized parts with preservative spray
- Treat all moving parts, such as door levers, hinges, regularly using lubricating spray
- Treat seals, in particular door seals, regularly with talcum or Vaseline
- Correct any damage to the coating and/or traces of corrosion immediately using spot repair paint

Every device must be thoroughly cleaned from construction dust and other contamination deposits.

8.2 Water glycol mixture

The instructions of the respective glycol manufacturer with respect to minimum concentration, maximum service life, and inspection intervals of the water-glycol mixture must be met. Respective suppliers offer analyses regarding concentration and corrosion protection inhibitors for their respective brands as free service.

Based on experience, water glycol mixtures in the systems can be used over many years. However, the concentration in the system should be checked once a year. This check is also recommended, when liquid is refilled. Frost protection testers are available from specialist shops. Furthermore, the functionality of the water-glycol mixture should be verified every two years.

Recommended inspection intervals of the recommended heat transfer fluids:

1st sample after approx.	2-6 months	operating time
2nd sample after approx.	1-2 years	operating time
3rd sample after additional	2 years	operating time

The inspection intervals listed above are based on the results of the first three analyses. Depending on the result of the inspection, the water-glycol mixture can be further used or must be replaced. When the corrosion protection inhibitors are consumed after years, the water-glycol mixture becomes aggressive and must be replaced. For this purpose, the system must be completely emptied. Afterwards, it must be thoroughly flushed. Acids and sludge products built up over the years must be completely removed prior to new filling. See also chapter 6.2 Flushing.

8.3 Heat exchangers

⚠ DANGER

- Danger of cutting injuries: Always wear gloves when working on objects with sharp parts, such as heat exchangers.
- If the heat exchanger is operated with hot media, there is a risk of burns.
- If the air contains aggressive substances, protective clothing must be worn during cleaning. Collect and dispose of the wastewater properly!

⚠ ATTENTION

- When cleaning the heat exchangers, it must be ensured that the corrosion protection is not damaged by mechanical cleaning devices. Cleaning using the water jet of a high-pressure cleaner is possible.

Contaminated heat exchangers cause increased air resistance and a reduced power output. As the required cleaning intervals vary greatly from system to system, the heat exchangers must be periodically inspected. Thus, the cleaning interval is based on the degree of air pollution respectively it's filtering.
In the case of large amounts of dust, the heat exchanger must be vacuumed from the dust air side. In the case of cleaning using a high-pressure cleaner or installed washers, it must be observed that the corrosion protection is not mechanically damaged. Furthermore, acid and lye residues can form an aggressive, highly concentrated medium in the layers of contamination. This medium can destroy even the best coatings within short time.

Heat exchanger in air containing aggressive media
The cleaning frequency for these heat exchangers must prevent crust formation on their surface. In the case of cleaning using a high-pressure cleaner or installed washers, it must be observed that the corrosion protection is not mechanically damaged.

8.4 Surface humidifier

Service and maintenance of humidifiers must always be in agreement with the manufacturer's documentation.

⚠ ATTENTION

- The humidifier must be automatically switched off, as soon as the ventilation and air conditioning installation system is switched off or fails.
- An advance circuit must ensure that the humidifier chamber is run dry first in the case of a planned shutdown.
- In the case of humidifier systems, it must be ensured that downstream (in the direction of the airflow) no droplets are generated (condensation) and that the relative humidity in the supply air pipe system does not exceed 90 %, even in the case of a ventilation system failure or if the supply air flow is missing or too low.

Pump

The following points must be followed for a long pump service life:

- Never let pump run dry. The pump should be in water even if switched off. Provide a respective siphon as needed.
- No solid materials must enter into the pump.
- Avoid extended pump standstills
- We recommend switching on the pump every 7 days for approx. 1 min.

In the case of a standstill of more than 48 hours, the surface humidifier must be emptied and cleaned.

The fresh water supply must be dimensioned such that the fresh water volume is always and in every operating state less than the maximum possible discharge volume through the overflow.

The water quality is particularly important for humidifiers. Depending on the carbonate hardness of the fresh water and the operational importance of the device, a respective water treatment process must be used. For further details, please refer to the manufacturer's documentation.

8.5 Sprinkling system

The Konvekta sprinkling system is a highly efficient and ecological way to cool the outside air indirectly and to reduce energy consumption of buildings. For this, the return air heat exchanger of the Konvekta ERS system are equipped with sprinkler cassettes. The separation of the supply and return air means that the supply air is only pre-cooled, but not humidified.

DANGER

- Improper hygienic monitoring can result in a significant risk to people and environment

ATTENTION

- Sprinkler systems are only suitable for the use in exhaust units

8.5.1 Hygienic cleanness

Depending on temperature, downtime, etc. legionella or bacteria can multiply in water. A possible risk of infection by Legionella is only achieved by inhaling Legionella-containing aerosols. Aerosols are water droplets in the air, which can be caused by spraying water and thus enter the environment. For safety reasons a periodic inspection of the irrigation water carry on Legionella and bacteria has to be executed by trained operators. This should be carried out specifically in areas of the sprinkler system and their feed to the sprinkler system, where stagnant water can be located.

NOTE

- The system has to be monitored continuously by suitable trained personnel
- On condition that the facility is regularly inspected according corresponding guidelines the system is hygienically safe.

In the case of bacteria or Legionella contamination appropriate measures have to be taken immediately. A Legionella contamination as an example, can be disinfected with hydrogen peroxide or chlorine dioxide.

NOTE

- In case of bacteria or Legionella contamination appropriate disinfection must be carried out immediately.

Codes related to Legionella

- The circulating water has to be inspected at least weakly with respect to the general colony-forming units of Pseudomonas aeruginosa and Legionella spp. The results are to be compared with the antecedent results.
- If general colony-forming units of more than 1,000 CFU / 100ml of Legionella spp. or Pseudomonas aeruginosa are measured, an immediate disinfection has to be initiated.
- The interval of hygienic inspection is highly dependent of the system setup and surrounding conditions. With the appropriate experience, the intervals can be adjusted.
- At the end of the period of use in fall it is recommended to perform a holistic disinfection and then completely empty all wells and tanks.

8.5.2 Pump

The following points must be followed for a long pump service life:

- Never let pump run dry. The pump should be in water even if switched off. Provide a respective siphon as needed.
- No solid materials must enter into the pump.
- Avoid extended pump standstills
- We recommend switching on the pump every 7 days for approx. 1 min.

8.5.3 Irrigation water

The makeup water supply must be dimensioned such that the fresh water volume is always and in every operating state less than the maximum possible discharge volume through the overflow.

The water quality is particularly important for sprinkling systems. Depending on the carbonate hardness of the makeup water and the operational importance of the device, a respective water treatment process must be used.

The service water quality should be within the following range:

Water	RO water
pH value	6.5 … 7.5
Conductance	< 50 µS/cm
Total hardness	max. 7°D or 125 ppm $CaCo_3$

As lime can deposit even with compliance with the limit values above, the device performance can worsen over the years due to the deposits. The better the makeup water treatment, the higher the expected service life of the system.

8.5.3.1 Desalination / Blow down

The circulating water must be continuously monitored by a conductivity measurement. If the water conductivity exceeds about 1000 µS / cm during operation it should be drained.

Preferably overnight (or when it is not in use) the system should be completely drained.

If this is not possible or the maximum conductivity of the water is achieved during operation, then the drain valve opens during operation until the minimum water level is reached. The valve is then close and the tank refilled with makeup water up to the maximum operating level of the tank. If necessary, this step can be repeated as often as necessary.

8.6 Plate heat exchangers

Plate heat exchangers have no moving parts and thus are almost maintenance-free. Service and maintenance of plate heat exchangers must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the plate heat exchangers according to the usage conditions and hazard potential for leak and damage prevention.
It is recommended to clean the heat exchanger occasionally and to check the insulation shell. If the system is built with manually operated redundant PHE, it is recommended to switch over the PHE yearly.

8.7 Control valves

⚠ ATTENTION

- The device must only be opened in the manufacturer's plant. It does not contain any parts replaceable or repairable by the user.
- No cables must be removed from the device.
- The device contains electrical and electronic components and must not be disposed of in the household waste.

The standard Belimo ball valves and rotary drives are maintenance-free. In the case of service work on the actuator, the power supply t the rotary drive must be switched off (disconnect electrical cables as needed). The pumps of the respective pipe section must be switched off and the corresponding shut-off valves must be closed (have cooled down as needed and system pressure reduced to ambient pressure level). Re-commissioning may only take place, after ball valve and rotary drive are properly installed and the pipes correctly filled.

8.8 Safety valves

According to PED/DEP 97/23/EC, safety valves are part of the equipment of pressure systems. For this reasons, they are checked at the factory. Depending on the country of destination, they can be subjected to periodic tests.

Periodic tests

The safety valves must be regularly checked for their functionality, as well as for validity of seal and data label. The valve is actuated as periodic runnability test. The time intervals correspond to the national regulations. If medium escapes at the discharge, this can usually corrected by actuation as well.

8.9 Measuring sensors/measuring sensors with immersion pocket

Service and maintenance of measuring sensors and measuring sensors with immersion pocket must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the measuring sensors according to the usage conditions and hazard potential for leak and damage prevention.
In the case of deviations, the measuring sensor must be calibrated or replaced as needed.

8.10 Shut-off valves/drain valves

Service and maintenance of shut-off valves and drain valves must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the shut-off valves and drain valves according to the usage conditions and hazard potential for leak and damage prevention.

8.11 Diaphragm expansion vessel

Service and maintenance of the diaphragm expansion vessel must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the diaphragm expansion vessel according to the usage conditions and hazard potential for leak and damage prevention. The maintenance interval of once a year applies to water-tight systems with yearly leakage ≤ 3 liters / 1 gal and/or ≤ 0.5 % of the system volume. Systems with higher leakage volumes require an expert assessment and shorter maintenance intervals. Deviations from the adjustment value during commissioning should not be greater than +/- 0.2 bar or +/- 3 PSI within the maintenance interval. The diaphragm expansion vessel must be depressurized for the yearly maintenance.

8.12 Strainers

Service and maintenance of strainers must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the strainers according to the usage conditions and hazard potential for leak and damage prevention. The screen of the strainer must be regularly cleaned. The strainer must be depressurized for cleaning and screen replacement. For this purpose, the shut-off valves upstream and downstream of the strainer must be closed and the section with the strainer emptied.

8.13 Vibration damper

Service and maintenance of the vibration dampers must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the vibration dampers according to the usage conditions and hazard potential for leak and damage prevention.

8.14 General screw connections

Service and maintenance of general screw connections must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the general screw connections according to the usage conditions and hazard potential for leak and damage prevention.

8.15 Indicating measuring devices - inspection glasses - flowmeters

Service and maintenance of indicating measuring devices/inspection glasses/flowmeters must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the indicating measuring devices according to the usage conditions and hazard potential for leak and damage prevention.

8.16 Pressure switches

Service and maintenance of pressure switches must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the pressure switches according to the usage conditions and hazard potential for leak and damage prevention.

8.17 Pump

Service and maintenance of pumps must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the pumps according to the usage conditions and hazard potential for leak and damage prevention.
The operating company must ensure that all maintenance, inspection, and assembly work is performed by authorized and qualified expert personnel sufficiently informed through thorough studying of the installation and operating instructions. Work on the pump is only permissible with the pump at standstill.
The approach for shutting down the pump described in the installation and operating instructions must be complied with. Immediately after work completion, all safety and protective devices must be installed again and/or their functionality reestablished.

8.18 Air vessel/quick venting device/centrifugal air separator

Service and maintenance of air vessels/quick venting devices/centrifugal air separators must always be in agreement with the manufacturer's documentation. The operating company must conduct regular visual inspection of the air vessels/quick venting devices/centrifugal air separators according to the usage conditions and hazard potential for leak and damage prevention.

9 Maintenance table of the system parts

Activity	Measure	Monthly	Quarterly	Yearly	Every ... years
Heat exchangers					
Check for contamination, damage, and corrosion	Cleaning and repair		X		
Check for condensation	Cleaning		X		
Check water drain and odor trap for function	Cleaning and repair			X	
Check drains and vents for leaks	Cleaning and repair			X	

Air humidifier and sprinkler					
Check for contamination, damage, and corrosion	Cleaning and repair		X		
Check for condensation	Cleaning		X		
Check water drain and odor trap for function	Cleaning and repair			X	
Check drains and vents for leaks	Cleaning and repair			X	
Check water feed function	New adjustment			X	
Check tray/container for leaks and contamination	Cleaning and repair	X			
Check water level	New adjustment			X	
Check strainers for contamination	Cleaning and repair			X	
Check pump for functionality	Repair			X	
Check feed valve for functionality	Repair			X	
Function check of the conductivity measurement	Repair			X	
Complete emptying and drying of the humidifier system	Cleaning			X	
Check for hygienic cleanness	Check	continuous			

Pipe system					
Check the outside of accessible pipes for damage, leaks, and attachment	Cleaning and repair			X	
Check heat insulation for damage and completeness	Repair			X	
Check system pressure	New adjustment		X		
Check frost protection of the heat carrier in the KV system	Repair				2
Check vibration dampers for leaks	Cleaning and repair			X	
Check expansion vessel for functionality	Cleaning and repair			X	
Fittings in general	Cleaning and repair			X	
Check fittings for leaks	Repair			X	
Switch over manually operated redundant PHE or SHE	Switch over			X	
Check strainers for contamination	Cleaning and repair			X	
Check expansion joints for damage	Repair			X	
Check temperature and pressure measuring devices for damage and display	Repair			X	
Check trigger pressure of the pressure monitors	New adjustment			X	
Check pressure monitors for functionality	Repair			X	
Check flowmeters for functionality	Repair			X	
Check the adjusted flow volumes	Repair			X	

Activity	Measure	Monthly	Quarterly	Yearly	Every ... years
Energy recovery pumps					
Check for function	Repair			X	
Check for contamination, damage, and corrosion	Cleaning and repair			X	
Check for attachment	Repair			X	
Check installation and ambient conditions	Repair			X	
Check electrical connections for tight fit	Repair			X	
External function-preserving cleaning	Cleaning			X	
Check for smoothness and heating	Repair			X	
Check pump operating time and lubrication interval	Repair	Acc. to pump operating time			
Replace motor bearings	Repair				5[1]
Check parameter programming	Repair			X	

Valves, temperature and moisture sensors, flow sensors					
Check for function	Repair			X	
Check for contamination, damage, and corrosion	Cleaning and repair			X	
Check installation and ambient conditions	Repair			X	
Function-preserving cleaning	Cleaning			X	
Check actuator signals and actuating range	Repair			X	
Stroke setting calibration	New adjustment			X	
Check actuator feedback	Repair			X	
Calibrate temperature sensors	New adjustment				2-3
Replace heat-conducting paste in immersion pockets	Repair				2

Control cabinet					
Check for contamination, damage, and corrosion	Cleaning and repair			X	
Check protective covers for completeness	Repair			X	
Function-preserving cleaning	Cleaning			X	
Check safety elements	Repair			X	
Check power failure and recovery behavior	Repair			X	
Screw check for current-carrying components	Repair			X	
Check uninterrupted power supply for functionality	Repair			X	
Check cooling unit for functionality	Repair			X	
Check fans and filters	Repair			X	
Check all alarm messages in hardware (relay contacts) from and to facilities (BMS)	Repair			X	
Lighting	Repair			X	
Check display and operating devices for functionality, perform key check	Repair			X	
Check storage devices for contamination, damage, and corrosion	Repair			X	
Replace Flash card	Replace				3-4
Replace backup battery	Replace				5
Check emergency operation for functionality	Repair			X	

[1] Lubrication cycles

10 Decommissioning and disposal

10.1 Decommissioning

If a system is decommissioned for an extended period of time, the following tasks must be performed:

- Stop and/or disconnect energy supply (power, pressure, temperature, etc.)
- For devices with integrated switch cabinet, a switch cabinet heater should be switched on
- Rotating parts must be periodically rotated
- Prior to re-commissioning, go through the instructions from the start

In general, the same provisions apply to temporary decommissioning as to intermediate storage acc. to chapter 4.1 Intermediate storage prior to commissioning.

10.2 Disposal

The following tasks must be performed:

- The system must be disassembled by an authorized expert company only.
- All operating materials of the system (such as water, oils, refrigerant) must be separated and disposed of according to the local provisions
- Metal and plastic parts must be recycled acc. to the applicable provisions.

The heat exchangers can be returned to KONVEKTA for disposal on a fee-charging basis or returned to any material collection point.

10.2.1 Water glycol mixture

According to the Administrative Regulation (VwVwS dated 05/17/1999), monoethylene glycol, the basic product of the recommended heat transfer fluids, is classified in water pollution class 1 (mildly water-polluting).

Consumed water-glycol mixture can be disposed in a hazardous waste incineration plant observing the local regulations.

The product can be recycled. We will be happy to provide you with the contact information of waste management companies and/or collection points upon inquiry.

NOTE

- Applicable standards as well as the local, national, and international regulations apply and must be followed.
- The specifications of the glycol manufacturer are binding.

Further safety-relevant information can be found in the respectively applicable EC safety data sheet.

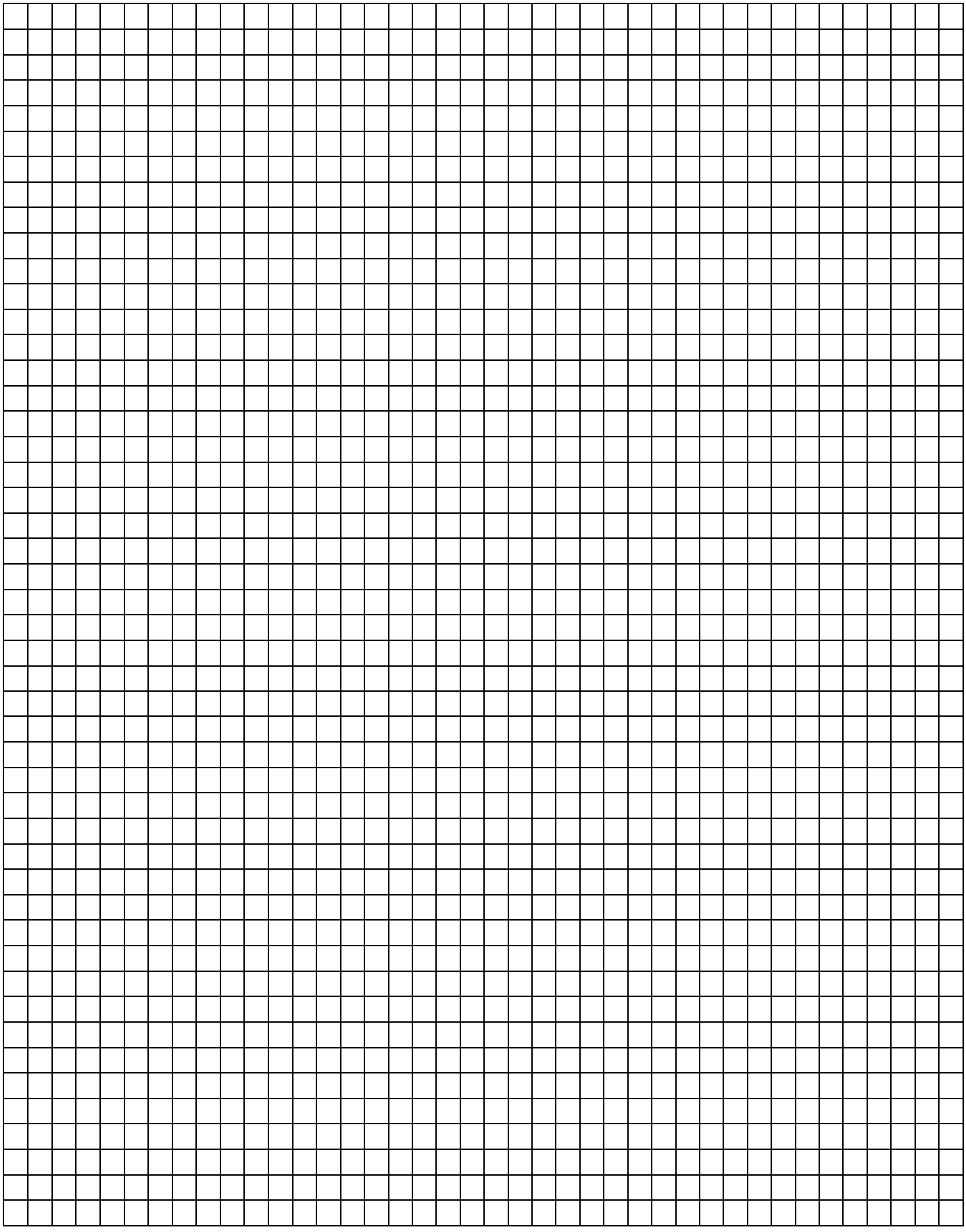
LIST OF TABLES

LIST OF FIGURES

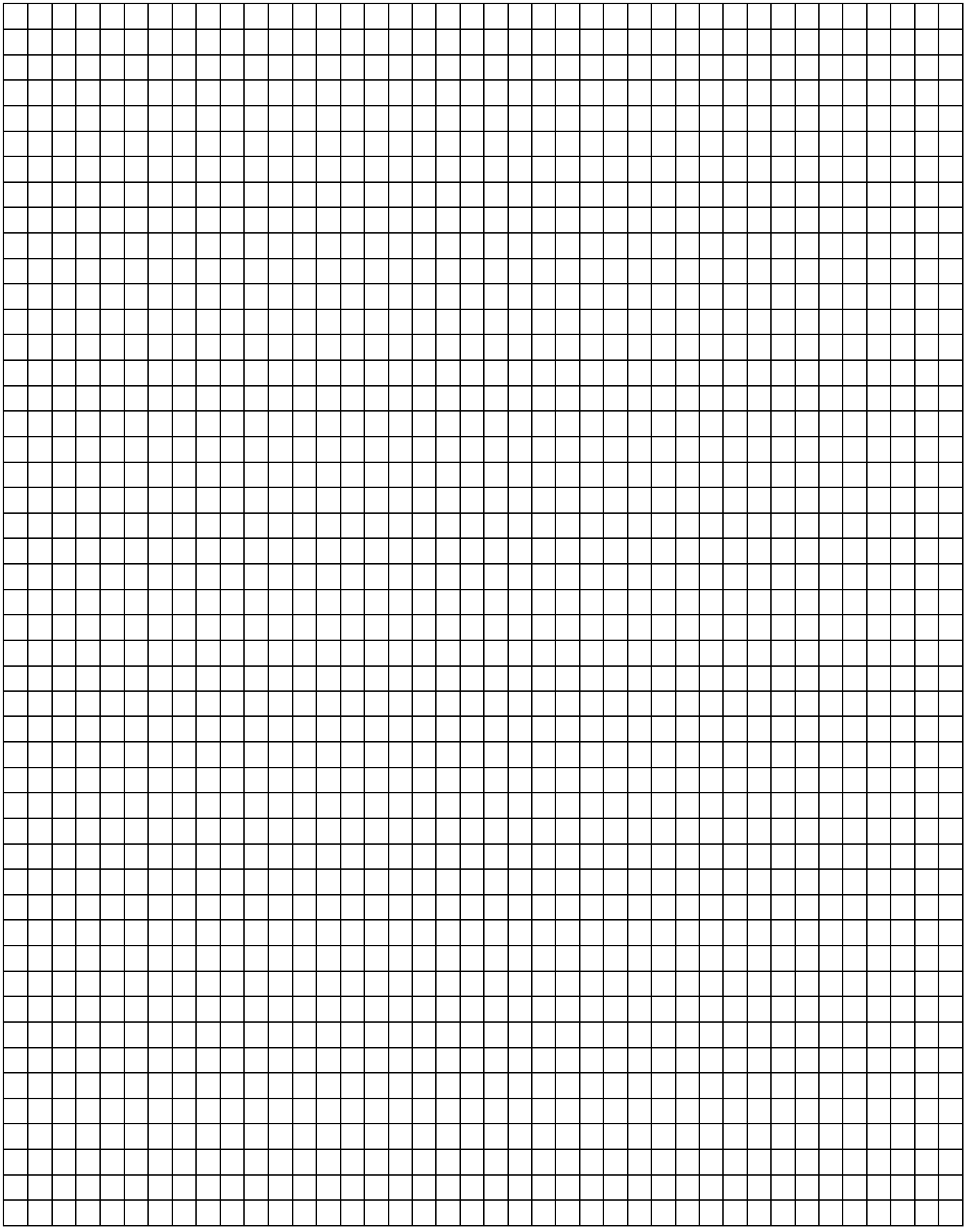
In the case of uncertainties or doubts, please contact your Konvekta representative.

Subject to technical changes, misprints, and typographical errors.

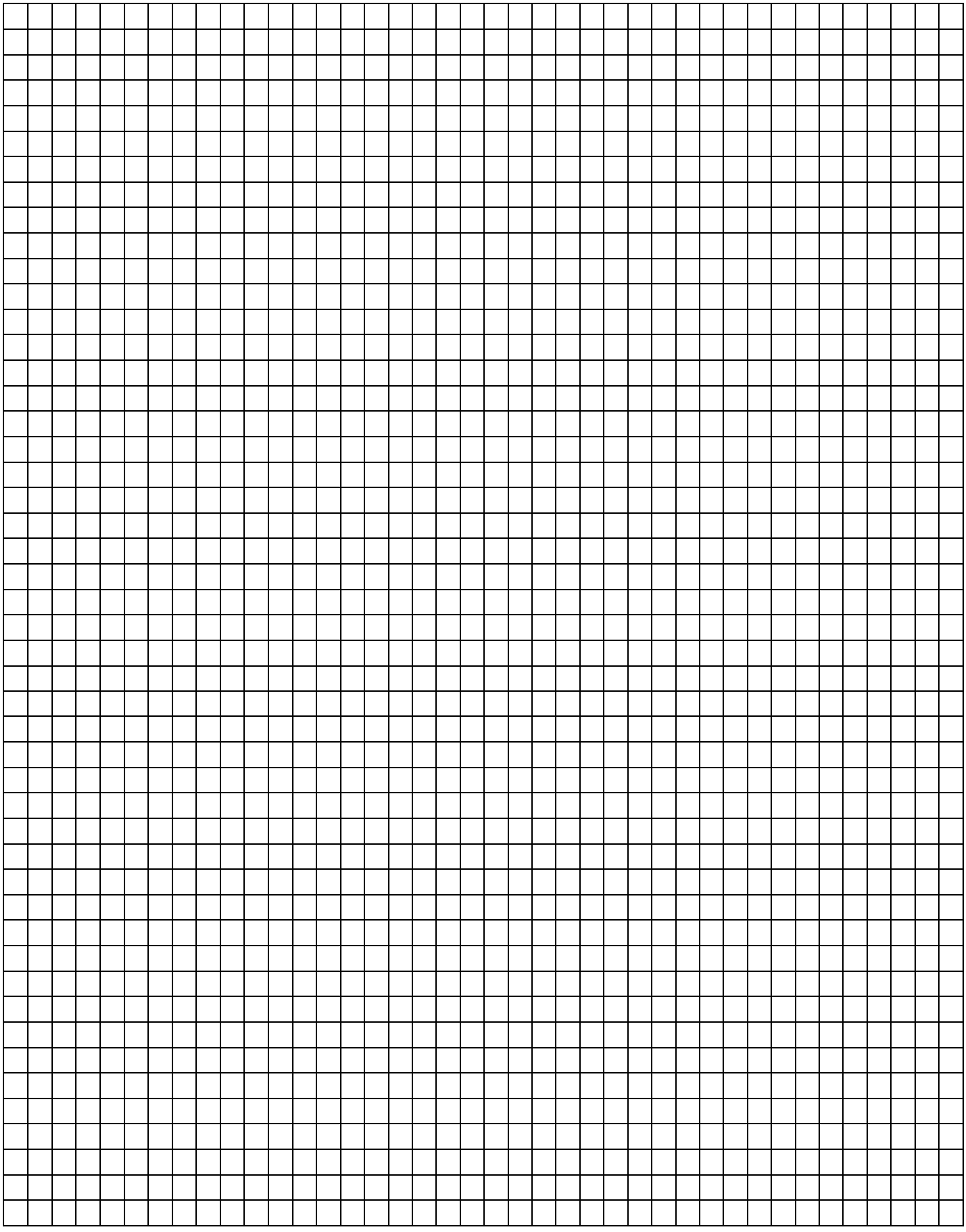
Notes



Notes



Notes



BACNET variables ERS-Controller
project: 84160120 University of Kentucky RB 2

konvekta

editor	date	version	comment
Kog	2016-12-01	V1_0	created
Nad	02/15/2018	V2_0	Meefog Input added, AHU5+6 and AHU 7+8 each 1 setpoint temperature
Nad	02/21/2018	V3_0	Meefog outputs changed
Nad	04/06/2018	V4_0	RH(pt. 135-138) and system state (pt. 73) datapoints added
Nad	04/17/2018	V5_0	added valve feedback signals (73-88)
Kog	08/20/2018	V6_0	added valve FC medium chilled water

BACnet ID :	2001
device name:	Konvekta BACNET
vendor:	Beckhoff Automation GmbH

no. datapoint	datatyp bacnet	range of value	unit	direction	name on bacnet	discription	COV increment	notification class	analog low Limit	analog high Limit	binary alarm value	instance number	Comments
0	BinaryOutput	0 / 1	Other_no_units	OUT	ERS in use	ERS in use					active	0	1 = ERS in use
1	BinaryOutput	0 / 1	Other_no_units	OUT	general system alarm	general system alarm		10			inactive	1	1 = general system alarm
2	BinaryOutput	0 / 1	Other_no_units	OUT	general system maintenance	general system maintenance					inactive	2	1 = general system maintenance
3	BinaryValue	0 / 1	Other_no_units	OUT	free cooling possible	free cooling possible						0	1 = free cooling possible
4	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 1	start-up completed AHU 1						1	1= ERS is ready for start of AHU 1 Fan(s)
5	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 2	start-up completed AHU 2						2	1= ERS is ready for start of AHU 2 Fan(s)
6	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 3	start-up completed AHU 3						3	1= ERS is ready for start of AHU 3 Fan(s)
7	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 4	start-up completed AHU 4						4	1= ERS is ready for start of AHU 4 Fan(s)
8	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 5	start-up completed AHU 5						5	1= ERS is ready for start of AHU 5 Fan(s)
9	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 6	start-up completed AHU 6						6	1= ERS is ready for start of AHU 6 Fan(s)
10	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 7	start-up completed AHU 7						7	1= ERS is ready for start of AHU 7 Fan(s)
11	BinaryValue	0 / 1	Other_no_units	OUT	start-up completed AHU 8	start-up completed AHU 8						8	1= ERS is ready for start of AHU 8 Fan(s)
12	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal humidifier EAHU 1	control signal humidifier EAHU 1	3.0					0	0 = off, 1-31 stages = 1-100%
13	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal humidifier EAHU 2	control signal humidifier EAHU 2	3.0					1	0 = off, 1-31 stages = 1-100%
14	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal humidifier EAHU 3	control signal humidifier EAHU 3	3.0					2	0 = off, 1-31 stages = 1-100%
15	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal humidifier EAHU 4	control signal humidifier EAHU 4	3.0					3	0 = off, 1-15 stages = 1-100%
16	AnalogOutput	0 ..	Power_btus_per_hour	OUT	Performance	Performance	200.0					4	
17	BinaryOutput	0 / 1	Other_no_units	OUT	alarm sensors	alarm sensors					active	3	1 = alarm sensors
18	BinaryOutput	0 / 1	Other_no_units	OUT	alarm actuators	alarm actuators					active	4	1 = alarm actuators
19	BinaryOutput	0 / 1	Other_no_units	OUT	alarm bypass	alarm bypass					active	5	1 = alarm bypass
20	BinaryOutput	0 / 1	Other_no_units	OUT	manual mode active display	manual mode active display						6	1 = manual mode active display
21	BinaryOutput	0 / 1	Other_no_units	OUT	manual mode active (digital EO-modules)	manual mode active (digital EO-modules)						7	1 = manual mode active (digital EO-modules)
22	BinaryOutput	0 / 1	Other_no_units	OUT	manual mode active (analog EO-modules)	manual mode active (analog EO-modules)						8	1 = manual mode active (analog EO-modules)
23	BinaryOutput	0 / 1	Other_no_units	OUT	ERS-pump 1 in use	ERS-pump 1 in use						9	1 = ERS-pump 1 in use
24	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal ERS-pump 1	control signal ERS-pump 1	3.0					5	
25	BinaryOutput	0 / 1	Other_no_units	OUT	alarm ERS-pump 1	alarm ERS-pump 1					active	10	1 = alarm ERS-pump 1
26	BinaryOutput	0 / 1	Other_no_units	OUT	maintenance ERS-pump 1	maintenance ERS-pump 1						11	1 = maintenance ERS-pump 1
27	BinaryInput	0 / 1	Other_no_units	OUT	pressure limit switch low alarm ERS-pump 1	pressure limit switch low alarm ERS-pump 1					active	0	1 = pressure limit switch low alarm ERS-pump 1
28	BinaryOutput	0 / 1	Other_no_units	OUT	ERS-pump 2 in use	ERS-pump 2 in use						12	1 = ERS-pump 2 in use
29	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal ERS-pump 2	control signal ERS-pump 2	3.0					6	
30	BinaryOutput	0 / 1	Other_no_units	OUT	alarm ERS-pump 2	alarm ERS-pump 2					active	13	1 = alarm ERS-pump 2
31	BinaryOutput	0 / 1	Other_no_units	OUT	maintenance ERS-pump 2	maintenance ERS-pump 2						14	1 = maintenance ERS-pump 2
32	BinaryInput	0 / 1	Other_no_units	OUT	pressure limit switch low alarm ERS-pump 2	pressure limit switch low alarm ERS-pump 2					active	1	1 = pressure limit switch low alarm ERS-pump 2
33	BinaryOutput	0 / 1	Other_no_units	OUT	free cooling-pump 1 in use	free cooling-pump 1 in use						15	1 = free cooling-pump 1 in use
34	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal free cooling-pump 1	control signal free cooling-pump 1						7	
35	BinaryOutput	0 / 1	Other_no_units	OUT	alarm free cooling-pump 1	alarm free cooling-pump 1					active	16	1 = alarm free cooling-pump 1
36	BinaryOutput	0 / 1	Other_no_units	OUT	maintenance free cooling-pump 1	maintenance free cooling-pump 1						17	1 = maintenance free cooling-pump 1
37	BinaryOutput	0 / 1	Other_no_units	OUT	free cooling-pump 2 in use	free cooling-pump 2 in use						18	1 = free cooling-pump 2 in use
38	AnalogOutput	0.0 .. 100	Other_percent	OUT	control signal free cooling-pump 2	control signal free cooling-pump 2						8	
39	BinaryOutput	0 / 1	Other_no_units	OUT	alarm free cooling-pump 2	alarm free cooling-pump 2					active	19	1 = alarm free cooling-pump 2
40	BinaryOutput	0 / 1	Other_no_units	OUT	maintenance free cooling-pump 2	maintenance free cooling-pump 2						20	1 = maintenance free cooling-pump 2
41	BinaryValue	0 / 1	Other_no_units	OUT	water/glykol-temperature low switch ahead PHE-FC	water/glykol-temperature low switch ahead PHE-FC						9	
42	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 1	air temperature leaving Konvekta Coils AHU 1	1.0		-58.0	122.0		0	
43	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 1	water/glycol-temperature return line SHRC AHU 1	1.0		-58.0	122.0		1	
44	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 2	air temperature leaving Konvekta Coils AHU 2	1.0					2	
45	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 2	water/glycol-temperature return line SHRC AHU 2	1.0					3	
46	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 3	air temperature leaving Konvekta Coils AHU 3	1.0					4	
47	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 3	water/glycol-temperature return line SHRC AHU 3	1.0					5	
48	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 4	air temperature leaving Konvekta Coils AHU 4	1.0					6	
49	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 4	water/glycol-temperature return line SHRC AHU 4	1.0					7	
50	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 5	air temperature leaving Konvekta Coils AHU 5	1.0					8	
51	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 5	water/glycol-temperature return line SHRC AHU 5	1.0					9	
52	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 6	air temperature leaving Konvekta Coils AHU 6	1.0					10	
53	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 6	water/glycol-temperature return line SHRC AHU 6	1.0					11	
54	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 7	air temperature leaving Konvekta Coils AHU 7	1.0					12	
55	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 7	water/glycol-temperature return line SHRC AHU 7	1.0					13	
56	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	air temperature leaving Konvekta Coils AHU 8	air temperature leaving Konvekta Coils AHU 8	1.0					14	
57	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line SHRC AHU 8	water/glycol-temperature return line SHRC AHU 8	1.0					15	
58	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line EHRC EAHU 1	water/glycol-temperature return line EHRC EAHU 1	1.0		-58.0	122.0		16	
59	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line EHRC EAHU 2	water/glycol-temperature return line EHRC EAHU 2	1.0		-58.0	122.0		17	
60	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line EHRC EAHU 3	water/glycol-temperature return line EHRC EAHU 3	1.0		-58.0	122.0		18	
61	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature return line EHRC EAHU 4	water/glycol-temperature return line EHRC EAHU 4	1.0		-58.0	122.0		19	
62	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature after pump	water/glycol-temperature after pump	1.0		-58.0	122.0		20	
63	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature after PHE-HW	water/glycol-temperature after PHE-HW	1.0		-58.0	122.0		21	
64	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water-temperature supply line PHE-HW	water-temperature supply line PHE-HW	1.0		-58.0	122.0		22	
65	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water-temperature return line PHE-HW	water-temperature return line PHE-HW	1.0		-58.0	122.0		23	
66	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glykol-temperature return line AHU 1-8	water/glykol-temperature return line AHU 1-8	1.0		-58.0	122.0		24	
67	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature ahead bypass valve	water/glycol-temperature ahead bypass valve	1.0		-58.0	122.0		25	
68	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature after bypass valve	water/glycol-temperature after bypass valve	1.0		-58.0	122.0		26	
69	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature ahead PHE-FC	water/glycol-temperature ahead PHE-FC	1.0		-58.0	122.0		27	
70	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water/glycol-temperature after PHE-FC	water/glycol-temperature after PHE-FC	1.0		-58.0	122.0		28	
71	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water-temperature supply line PHE-FC	water-temperature supply line PHE-FC	1.0		-58.0	122.0		29	
72	AnalogInput	-40.0 .. 262.0	Temperature_degrees_Fahrenheit	OUT	water-temperature return line PHE-FC	water-temperature return line PHE-FC	1.0		-58.0	122.0		30	
73	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 1	control signal zone valve AHU 1	3.0					31	
74	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 2	control signal zone valve AHU 2	3.0					32	
75	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 3	control signal zone valve AHU 3	3.0					33	
76	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 4	control signal zone valve AHU 4	3.0					34	
77	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 5	control signal zone valve AHU 5	3.0					35	
78	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 6	control signal zone valve AHU 6	3.0					36	
79	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 7	control signal zone valve AHU 7	3.0					37	
80	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve AHU 8	control signal zone valve AHU 8	3.0					38	
81	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve EAHU 1	control signal zone valve EAHU 1	3.0					39	
82	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve EAHU 2	control signal zone valve EAHU 2	3.0					40	

83	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve EAHU 3	control signal zone valve EAHU 3	3.0					41	
84	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal zone valve EAHU 4	control signal zone valve EAHU 4	3.0					42	
85	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal control valve PHE-HW	control signal control valve PHE-HW	3.0					43	
86	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal bypass after pump	control signal bypass after pump	3.0					44	
87	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal FC-3-way-control-valve	control signal FC-3-way-control-valve	3.0					45	
88	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal FC-butterfly-valve	control signal FC-butterfly-valve	3.0					46	
89	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 1	feedback signal zone valve AHU 1	3.0					47	
90	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 2	feedback signal zone valve AHU 2	3.0					48	
91	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 3	feedback signal zone valve AHU 3	3.0					49	
92	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 4	feedback signal zone valve AHU 4	3.0					50	
93	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 5	feedback signal zone valve AHU 5	3.0					51	
94	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 6	feedback signal zone valve AHU 6	3.0					52	
95	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 7	feedback signal zone valve AHU 7	3.0					53	
96	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve AHU 8	feedback signal zone valve AHU 8	3.0					54	
97	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve EAHU 1	feedback signal zone valve EAHU 1	3.0					55	
98	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve EAHU 2	feedback signal zone valve EAHU 2	3.0					56	
99	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve EAHU 3	feedback signal zone valve EAHU 3	3.0					57	
100	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal zone valve EAHU 4	feedback signal zone valve EAHU 4	3.0					58	
101	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal control valve PHE-HW	feedback signal control valve PHE-HW	3.0					59	
102	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal bypass after pump	feedback signal bypass after pump	3.0					60	
103	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal FC-3-way-control-valve	feedback signal FC-3-way-control-valve	3.0					61	
104	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback signal FC-butterfly-valve	feedback signal FC-butterfly-valve	3.0					62	
105	AnalogOutput	0 ..	Other_no_units	OUT	system state indication	system state indication	1.0					9	0= economizer,1= heating, 2= cooling
106	AnalogInput	0.0 .. 100	Other_percent	OUT	control signal FC valve m. chilled water	control signal FC valve m. chilled water	3.0					63	
107	AnalogInput	0.0 .. 100	Other_percent	OUT	feedback FC valve m. chilled water	feedback FC valve m. chilled water	3.0					64	
108	AnalogOutput	0 .. 60	Other_no_units	OUT	heartbeat out	heartbeat out	3.0					10	
109	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 1	fan in use AHU 1						10	1 = fan in use AHU 1
110	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 2	fan in use AHU 2						11	1 = fan in use AHU 2
111	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 3	fan in use AHU 3						12	1 = fan in use AHU 3
112	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 4	fan in use AHU 4						13	1 = fan in use AHU 4
113	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 5	fan in use AHU 5						14	1 = fan in use AHU 5
114	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 6	fan in use AHU 6						15	1 = fan in use AHU 6
115	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 7	fan in use AHU 7						16	1 = fan in use AHU 7
116	BinaryValue	0 / 1	Other_no_units	IN	fan in use AHU 8	fan in use AHU 8						17	1 = fan in use AHU 8
117	BinaryValue	0 / 1	Other_no_units	IN	fan in use EAHU 1	fan in use EAHU 1						18	1 = fan in use EAHU 1
118	BinaryValue	0 / 1	Other_no_units	IN	fan in use EAHU 2	fan in use EAHU 2						19	1 = fan in use EAHU 2
119	BinaryValue	0 / 1	Other_no_units	IN	fan in use EAHU 3	fan in use EAHU 3						20	1 = fan in use EAHU 3
120	BinaryValue	0 / 1	Other_no_units	IN	fan in use EAHU 4	fan in use EAHU 4						21	1 = fan in use EAHU 4
121	BinaryValue	0 / 1	Other_no_units	IN	Meefog pump skid OK	Meefog pump skid OK						22	1 = Meefog pump skid OK
122	BinaryValue	0 / 1	Other_no_units	IN	Meefog pump skid alarm	Meefog pump skid alarm						23	1 = Meefog pump skid alarm
123	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 1	start-up request AHU 1						24	1 = fan start-up requested AHU 1
124	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 2	start-up request AHU 2						25	1 = fan start-up requested AHU 2
125	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 3	start-up request AHU 3						26	1 = fan start-up requested AHU 3
126	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 4	start-up request AHU 4						27	1 = fan start-up requested AHU 4
127	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 5	start-up request AHU 5						28	1 = fan start-up requested AHU 5
128	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 6	start-up request AHU 6						29	1 = fan start-up requested AHU 6
129	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 7	start-up request AHU 7						30	1 = fan start-up requested AHU 7
130	BinaryValue	0 / 1	Other_no_units	IN	start-up request AHU 8	start-up request AHU 8						31	1 = fan start-up requested AHU 8
131	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 1	volumetric airflow AHU 1	300.0					0	
132	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 2	volumetric airflow AHU 2	300.0					1	
133	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 3	volumetric airflow AHU 3	300.0					2	
134	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 4	volumetric airflow AHU 4	300.0					3	
135	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 5	volumetric airflow AHU 5	300.0					4	
136	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 6	volumetric airflow AHU 6	300.0					5	
137	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 7	volumetric airflow AHU 7	300.0					6	
138	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow AHU 8	volumetric airflow AHU 8	300.0					7	
139	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow EAHU 1	volumetric airflow EAHU 1	300.0					8	
140	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow EAHU 2	volumetric airflow EAHU 2	300.0					9	
141	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow EAHU 3	volumetric airflow EAHU 3	300.0					10	
142	AnalogValue	0 ..	VolumeFlow_cubic_feet_per_minute	IN	volumetric airflow EAHU 4	volumetric airflow EAHU 4	300.0					11	
143	AnalogValue	50.0 .. 86.0	Temperature_degrees_Fahrenheit	IN	setpoint temperature after Konvekta coils AHU 1	setpoint temperature after Konvekta coils AHU 1	0.5					12	
144	AnalogValue	50.0 .. 86.0	Temperature_degrees_Fahrenheit	IN	setpoint temperature after Konvekta coils AHU 2	setpoint temperature after Konvekta coils AHU 2	0.5					13	
145	AnalogValue	50.0 .. 86.0	Temperature_degrees_Fahrenheit	IN	setpoint temperature after Konvekta coils AHU 3	setpoint temperature after Konvekta coils AHU 3	0.5					14	
146	AnalogValue	50.0 .. 86.0	Temperature_degrees_Fahrenheit	IN	setpoint temperature after Konvekta coils AHU 4	setpoint temperature after Konvekta coils AHU 4	0.5					15	
147	AnalogValue	50.0 .. 86.0	Temperature_degrees_Fahrenheit	IN	setpoint temperature after Konvekta coils AHU 5_6	setpoint temperature after Konvekta coils AHU 5_6	0.5					16	
148	AnalogValue	50.0 .. 86.0	Temperature_degrees_Fahrenheit	IN	setpoint temperature after Konvekta coils AHU 7_8	setpoint temperature after Konvekta coils AHU 7_8	0.5					17	
149	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 1	temperature entering air Konvekta coils AHU 1	0.5					18	
150	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 2	temperature entering air Konvekta coils AHU 2	0.5					19	
151	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 3	temperature entering air Konvekta coils AHU 3	0.5					20	
152	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 4	temperature entering air Konvekta coils AHU 4	0.5					21	
153	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 5	temperature entering air Konvekta coils AHU 5	0.5					22	
154	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 6	temperature entering air Konvekta coils AHU 6	0.5					23	
155	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 7	temperature entering air Konvekta coils AHU 7	0.5					24	
156	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature entering air Konvekta coils AHU 8	temperature entering air Konvekta coils AHU 8	0.5					25	
157	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead humidifier EAHU 1	air-temperature ahead humidifier EAHU 1	0.5					26	
158	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead humidifier EAHU 2	air-temperature ahead humidifier EAHU 2	0.5					27	
159	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead humidifier EAHU 3	air-temperature ahead humidifier EAHU 3	0.5					28	
160	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead humidifier EAHU 4	air-temperature ahead humidifier EAHU 4	0.5					29	
161	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead Konvekta Coils EAHU 1	air-temperature ahead Konvekta Coils EAHU 1	0.5					30	
162	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead Konvekta Coils EAHU 2	air-temperature ahead Konvekta Coils EAHU 2	0.5					31	
163	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead Konvekta Coils EAHU 3	air-temperature ahead Konvekta Coils EAHU 3	0.5					32	
164	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	air-temperature ahead Konvekta Coils EAHU 4	air-temperature ahead Konvekta Coils EAHU 4	0.5					33	
165	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature leaving air EAHU 1	temperature leaving air EAHU 1	0.5					34	
166	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature leaving air EAHU 2	temperature leaving air EAHU 2	0.5					35	
167	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature leaving air EAHU 3	temperature leaving air EAHU 3	0.5					36	
168	AnalogValue	0 ..	Temperature_degrees_Fahrenheit	IN	temperature leaving air EAHU 4	temperature leaving air EAHU 4	0.5					37	
169	AnalogValue	0.0 .. 100	Humidity_percent_relative_humidity	IN	RH ahead humidifier EAHU 1	RH ahead humidifier EAHU 1	0.5					38	
170	AnalogValue	0.0 .. 100	Humidity_percent_relative_humidity	IN	RH ahead humidifier EAHU 2	RH ahead humidifier EAHU 2	0.5					39	
171	AnalogValue	0.0 .. 100	Humidity_percent_relative_humidity	IN	RH ahead humidifier EAHU 3	RH ahead humidifier EAHU 3	0.5					40	
172	AnalogValue	0.0 .. 100	Humidity_percent_relative_humidity	IN	RH ahead humidifier EAHU 4	RH ahead humidifier EAHU 4	0.5					41	
173	AnalogValue	0.0 .. 100	Humidity_percent_relative_humidity	IN	ambient temperature (sensor outside building)	ambient temperature (sensor outside building)	0.5					42	
174	AnalogValue	0 .. 60	Other_no_units	IN	heartbeat in	heartbeat in	3.0					43	

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ERS-Controller

customer	
project	**University of Kentucky Research Building 2**
site designator	
drawing number	**84160120-401**
commission	**84160120**

manufact.	Konvekta AG
path (V:\Projects_V3\...)	84-Objekte_USA\84160120_Kentucky_Research_Building_2
supplier cabinet	
type	
site	
drawer	
speciality	

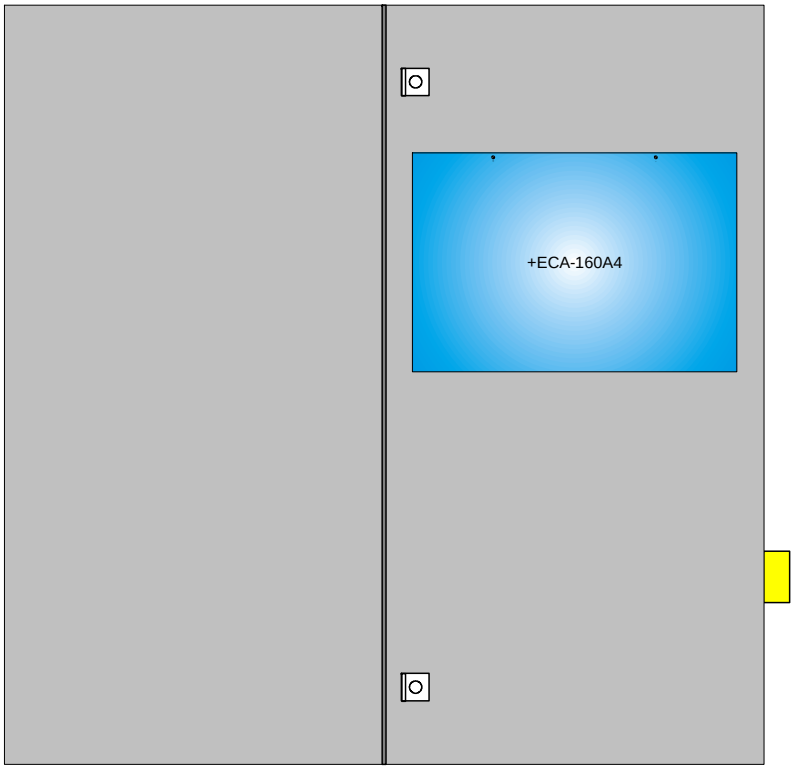
revised on: 9/3/2018 by (abbr.) nad

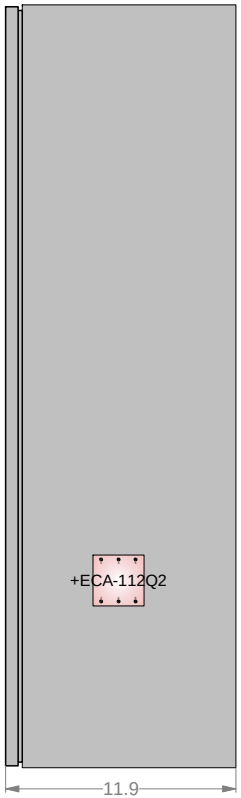
E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	cover	konvekta
created:	11/11/2016	gei	drawing no.:	84160120-401			location: =+
edited:	9/3/2018	nad	TAP-number:	T_160823_16			sheet no. 0
approved:	12.01.2017	gei	version:	7.0	customer:		

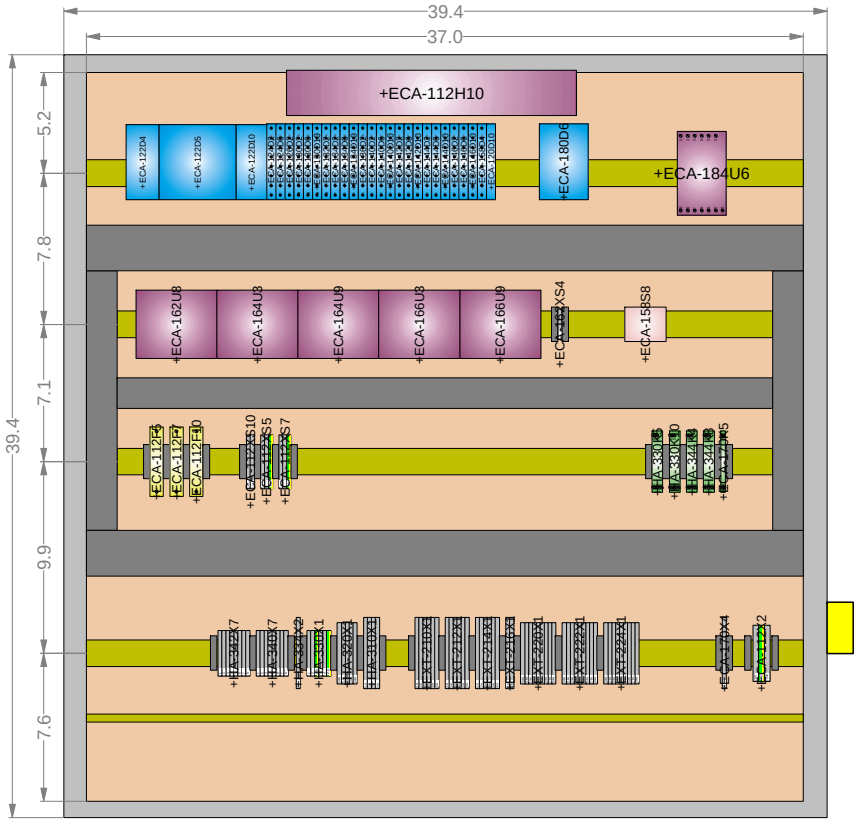
pos	sheet-type	plant	location	sheet	title	installed	modified
1	cover			0	cover	11/11/2016	12/1/2016
2	cover	MA	AG	10	revisions index	11/11/2016	12/1/2016
3	electrical cabinet	MA	AG	11	electrical cabinet 24V master	11/11/2016	12/1/2016
4	electrical cabinet	MAIN	AG	12	electrical cabinet 460V	11/11/2016	12/1/2016
5	electrical cabinet	SL1	AG	13	electrical cabinet 24V slave	11/11/2016	12/1/2016
6	drawing	MA	AG	14	topology	11/11/2016	12/1/2016
7	drawing	MA	AG	15	one line diagram	11/11/2016	12/1/2016
8	drawing	MA	AG	16	legend	11/11/2016	12/1/2016
9	drawing	MA	AG	17	P&ID	11/24/2016	12/1/2016
10	drawing	MA	AG	18	P&ID	11/24/2016	12/1/2016
11	drawing	MA	AG	19	P&ID	11/24/2016	12/1/2016
12	drawing	MA	ECA	100	blank sheet	11/11/2016	12/1/2016
13	drawing	MA	ECA	112	Supply	11/11/2016	12/1/2016
14	drawing	MA	ECA	120	PLC module overview	11/11/2016	12/1/2016
15	drawing	MA	ECA	122	CPU	11/11/2016	12/1/2016
16	drawing	MA	ECA	124	digital inputs	11/11/2016	12/1/2016
17	drawing	MA	ECA	126	digital outputs	11/11/2016	12/1/2016
18	drawing	MA	ECA	130	analog inputs	11/11/2016	12/1/2016
19	drawing	MA	ECA	132	analog inputs	11/28/2016	12/1/2016
20	drawing	MA	ECA	134	analog outputs	11/11/2016	12/1/2016
21	drawing	MA	ECA	136	analog outputs	11/28/2016	12/1/2016
22	drawing	MA	ECA	140	temperature sensors	11/11/2016	12/1/2016
23	drawing	MA	ECA	142	temperature sensors	11/11/2016	12/1/2016
24	drawing	MA	ECA	144	temperature sensors	11/11/2016	12/1/2016
25	drawing	MA	ECA	146	temperature sensors	11/28/2016	12/1/2016
26	drawing	MA	ECA	158	diode array terminal	11/11/2016	12/1/2016

pos	sheet-type	plant	location	sheet	title	installed	modified
27	drawing	MA	ECA	160	HMI	11/11/2016	12/1/2016
28	drawing	MA	ECA	162	emergency overwrite modules	11/11/2016	12/1/2016
29	drawing	MA	ECA	164	emergency overwrite modules	11/11/2016	12/1/2016
30	drawing	MA	ECA	166	emergency overwrite modules	11/11/2016	12/1/2016
31	drawing	MA	ECA	180	BACnet	11/17/2016	12/1/2016
32	drawing	MA	ECA	182	BACnet Field Server	11/11/2016	12/1/2016
33	drawing	MA	ECA	184	network	11/11/2016	12/1/2016
34	drawing	MA	EXT	200	blank sheet	11/11/2016	12/1/2016
35	drawing	MA	EXT	210	temperature sensors	11/28/2016	12/1/2016
36	drawing	MA	EXT	212	temperature sensors	11/28/2016	12/1/2016
37	drawing	MA	EXT	214	temperature sensors	11/28/2016	12/1/2016
38	drawing	MA	EXT	216	temperature sensors	11/28/2016	12/1/2016
39	drawing	MA	EXT	220	control valves	11/28/2016	12/1/2016
40	drawing	MA	EXT	222	control valves	11/28/2016	12/1/2016
41	drawing	MA	EXT	224	control valves	11/28/2016	12/1/2016
42	drawing	MA	HA	300	blank sheet	11/11/2016	12/1/2016
43	drawing	MA	HA	310	temperature sensors	11/28/2016	12/1/2016
44	drawing	MA	HA	320	control valves	11/28/2016	12/1/2016
45	drawing	MA	HA	330	pressure limit switch	11/11/2016	12/1/2016
46	drawing	MA	HA	334	pressure transmitter	11/24/2016	12/1/2016
47	drawing	MA	HA	340	ERS-pump 1	11/24/2016	12/1/2016
48	drawing	MA	HA	342	ERS-pump 2	11/24/2016	12/1/2016
49	drawing	MA	HA	344	pump interlock	11/11/2016	12/1/2016
50	drawing	MAIN	ECA	400	blank sheet	11/11/2016	12/1/2016
51	drawing	MAIN	ECA	410	Supply	11/11/2016	12/1/2016
52	drawing	MAIN	HA	420	blank sheet	11/11/2016	12/1/2016

pos	date	version	modified	initials	sheet no.
1	24.11.2016	1.0	created	kog	
2	17.01.2017	2.0	revised after checking	kog	
3	13.4.2017	3.0	AHU5/6/7/8: BMK temperature sensors changed, pipedimension changed, AI/AO/DI changed EAHU2: STA changed	nad	
4	30.08.2017	4.0	Changed from Bacnet MS/TP to Bacnet IP	kelj	182
5	11.12.2017	5.0	label error on PID - balancing valve 3" is DN80 not DN65	kog	19
6	9.1.2018	6.0	pipe dimension AHU 5 changed from 4"-3"	nad	17
7	3.9.2018	7.0	FC valve added, IP addresses changed	nad	

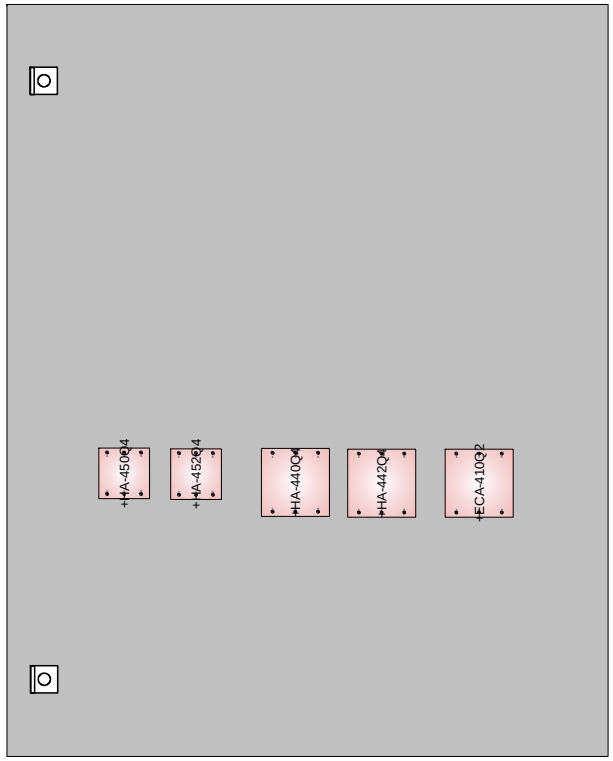


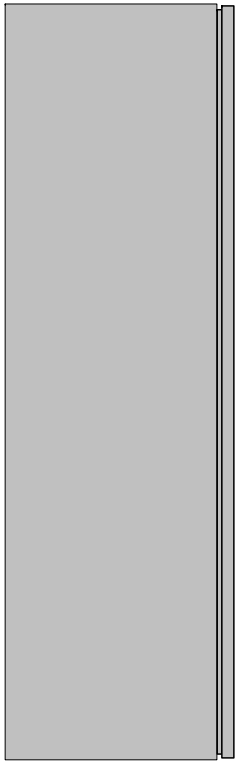


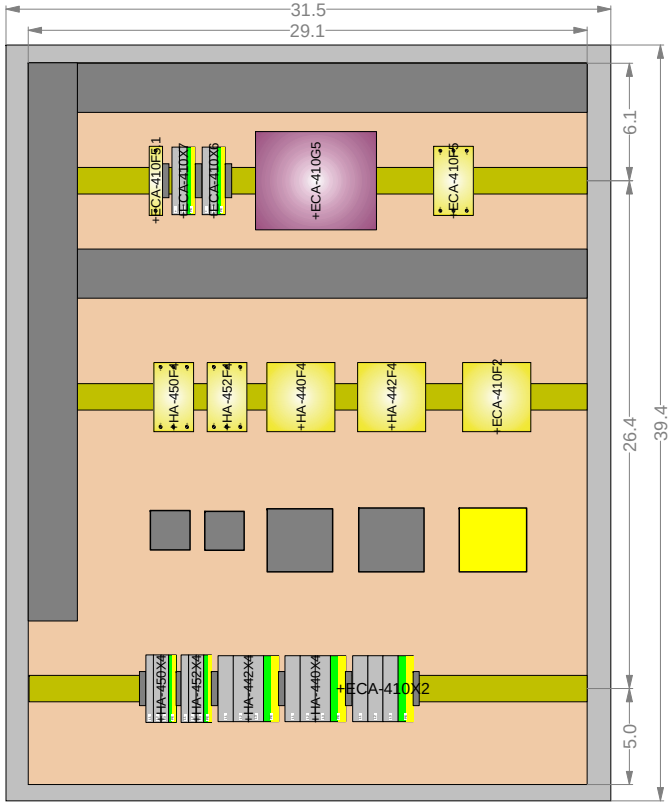


Electrical Cabinet Rittal AE1110.500
47.24in x 47.24in x 11.8in

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	electrical cabinet 24V master	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+AG
State	9/3/2018	nad		T_160823_16			Sheet no. 11
Approved	12/01/2017	gei	version:	7.0	customer:		

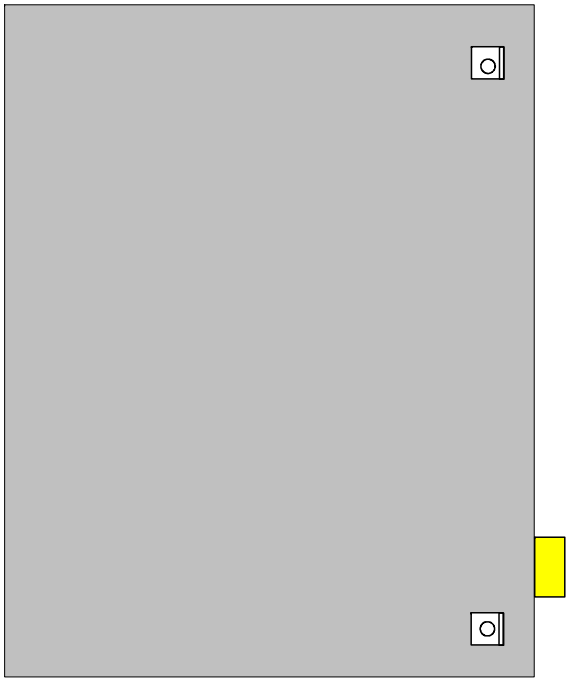


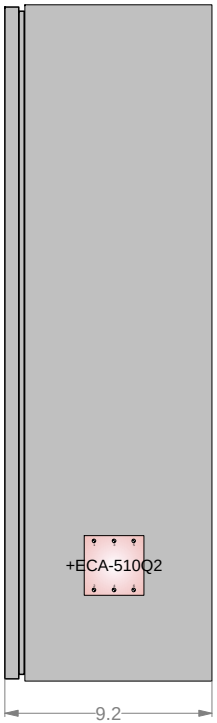


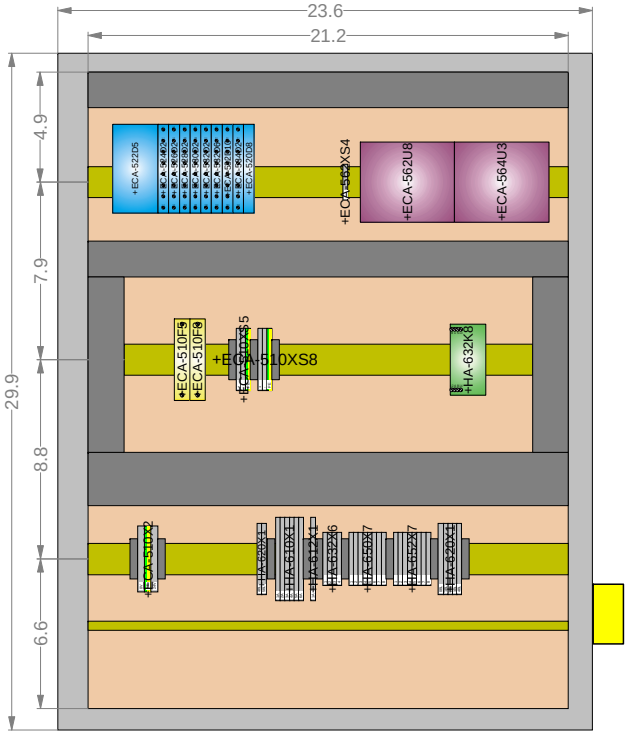


Electrical Cabinet Rittal AE1180.500
31.5in x 39.4in x 11.8in

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	electrical cabinet 460V	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MAIN+AG
State Edited	9/3/2018	nad		T_160823_16			Sheet no. 12
Approved	12/01/2017	gei	version:	7.0	customer:		

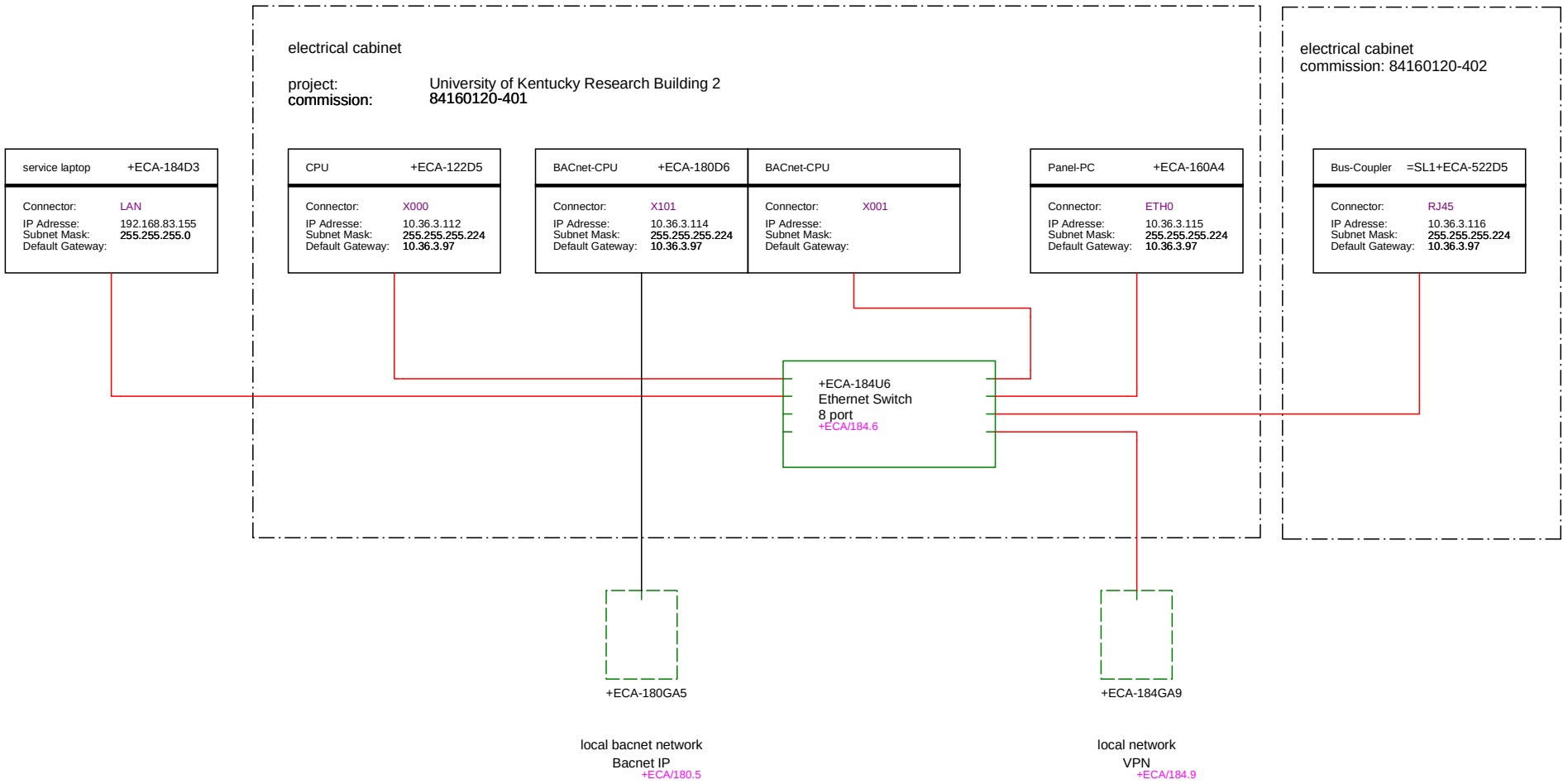






Electrical Cabinet Rittal AE1076.500
29.9in x 23.6in x 8.3in

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	electrical cabinet 24V slave	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+AG
State	9/3/2018	nad		T_160823_16			Sheet no. 13
Approved	12/01/2017	gei	version:	7.0	customer:		



General details:

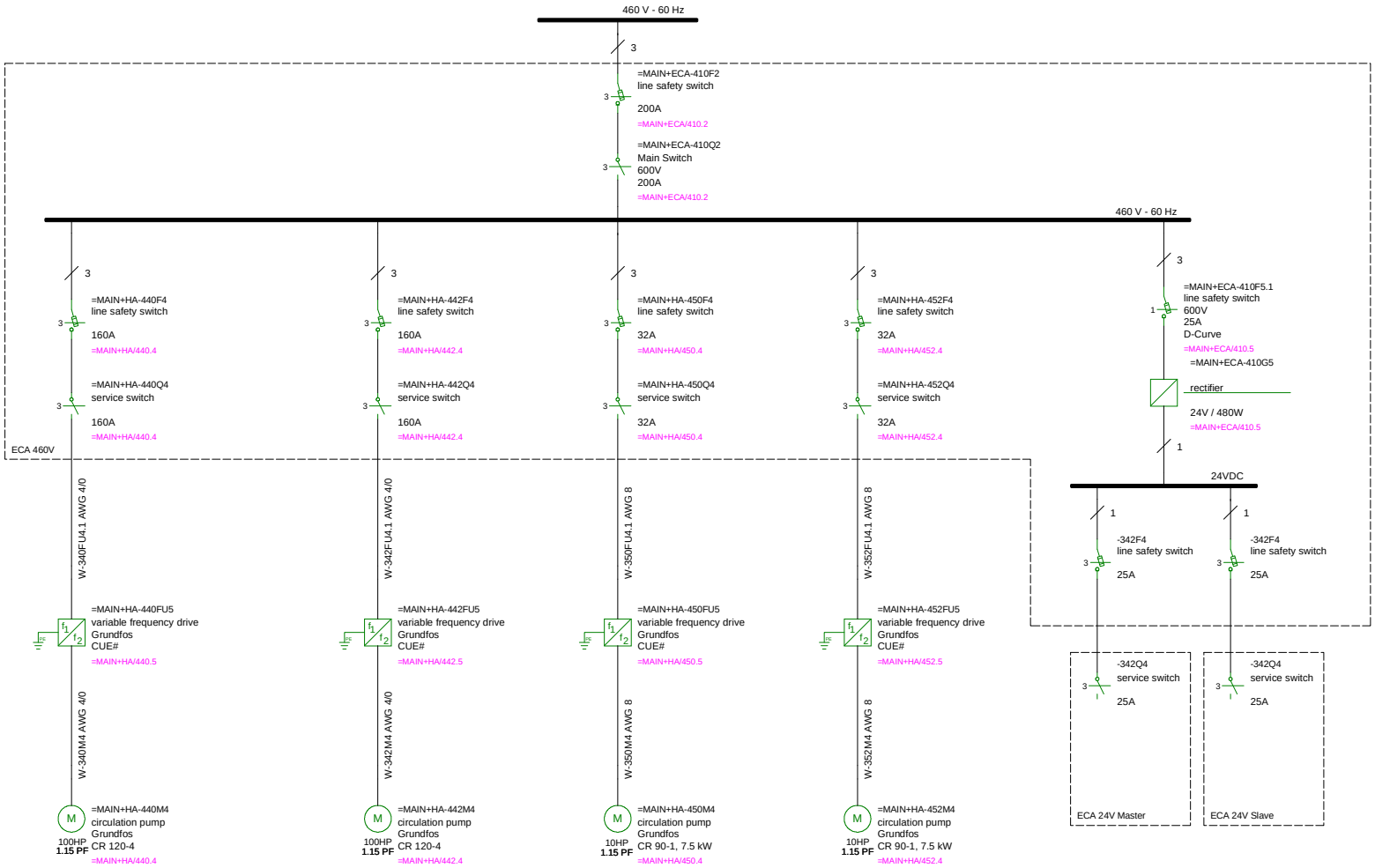
- The creation of the communications cabling is a part of customers side.
- It needs to be used shielded TP cabling Cat 5e for ethernet cables, the cable length may not exceed 90 meters.
- A repeater must be used, if the maximum cable length of 90 meters can't be met.
- This repeater is not included in the scope of delivery by Konvekta.
- The repeater in operation must comply the requirements for Industrial Ethernet.
- Fieldbus connections for building control: The specifications of the system integrator are to maintain.

The following standards apply as a guide: IEC 61158, IEC 61784-2, ISO 15745-4

legend

- shielded TP cabling Cat 5e for ethernet cables
- optical fiber
- fieldbus connections for building control

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	topology	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+AG
State	9/3/2018	nad		T_160823_16			Sheet no. 14
Approved	12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	one line diagram	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+AG
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 15
	Approved 12/01/2017	gei	version:	7.0	customer:		

computer function **field mounted**

computer function **primary location**

computer function **auxiliary location**

instrument **field mounted**

instrument **on main control panel**

instrument **on local control panel**

INSTRUMENT IDENTIFICATION LETTERS

	first letter		succeding letters		
	measured or **initiating variable**	modifier	readout or **passive function**	output function	modifier
A	analysis		alarm		
B	burner, combustion				
C				control	continuous
D	density	differential			
E	voltage		sensor (primary element)		
F	flow rate	ration (fraction)			
G			glass, viewing port		
H	hand				high, open
I	current		indicate		
J	power	scan			
K	time, schedule	time rate of change		control station	
L	level		light		low, close
M	moisture	momentary			middle, intermediate
N					
O					on-off
P	pressure, vacuum		point connection (test)		
Q	quantity	intregate, totalize			
R	radiation		record		
S	speed, frequency	safety, state		switch	
T	temperature			transmit	
U	multivariabel		multifunction	multifunction	multifunction
V	vibration, viscosity			valve, damper	
W	weight, force		well		
X	unclassified	X-axis	unclassified	unclassified	unclassified
Y	radiation	Y-axis		relais, convert	
Z	radiation	Z-axis		emergency	

graphic symbols

ventilation

heat recovery coil

heating coil

cooling coil

regulator for constant **volumetric air flow**

regulator for variable **volumetric air flow**

bypass flap

air filter

ventilation flap

protective grating

flow straightener

humidifier

changeover flap

silencer

throttle flap

trap

demister unit

fan

radial fan

axial fan

sensor

armatures

sliding valve

cock (straight-way)

butterfly valve

non-return valve **general**

non-return flap

shut-off **non-return valve**

manual activated

selenoid activator

motor driven

lift drive

diaphragm activated

with throttle

with cap

STA

emergency position

closed

open

retain

hydraulics

membrane **expansion tank**

strainer

tank general

safety valve

vibration absorber

flange connection **general**

coupling **general**

screw connection **general**

plate heat exchanger

sleeve

measuring device, indicative

view port

flow meter **magneto-inductive, ultrasonic**

flow meter **float**

pressure limit switch

circulation pump

sensor **with sleeve**

air vent

drain valve

hydraulics

air separator

air vent

conductivity measurement

level detector

jet pump

misc

tie-in point **(Konvekta)**

tie-in point **(customer)**

scope of delivery **Konvekta**

tie-in point numbering

01-10: HRS connections
11-20: heating water
21-30: cooling water
31... : special

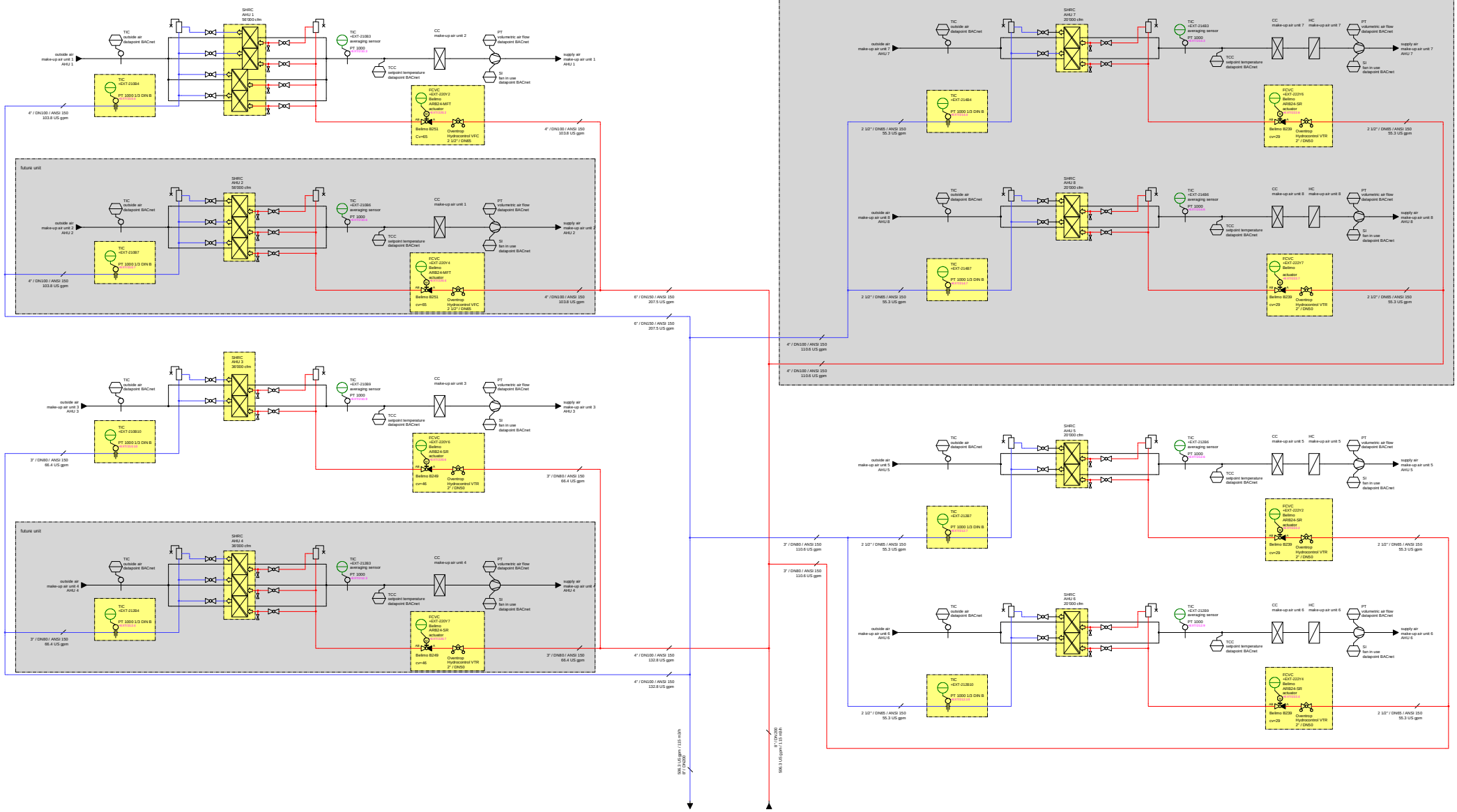
abbreviations

ERS	heat recovery system
SA	supply air
OA	outside air
RA	return air
RCA	recirculating air
EA	exhaust air
AHU	air handling unit
MAU	make-up air unit
RAU	return air unit
SHRC-PH	SHRC pre-heater
SHRC	supply heat recovery coil
SHRC-SH	SHRC supplementery heater
EHRC	exhaust heat recovery coil
HC	heating coil
CC	cooling coil
PHE	plate heat exchanger
HW	heating water
CW	cooling water
FC	free cooling
WHR	waste heat recovery
FL	flap
AF	air filter
SL	silencer
FA	fan
DU	demister unit
RC	re-cooling

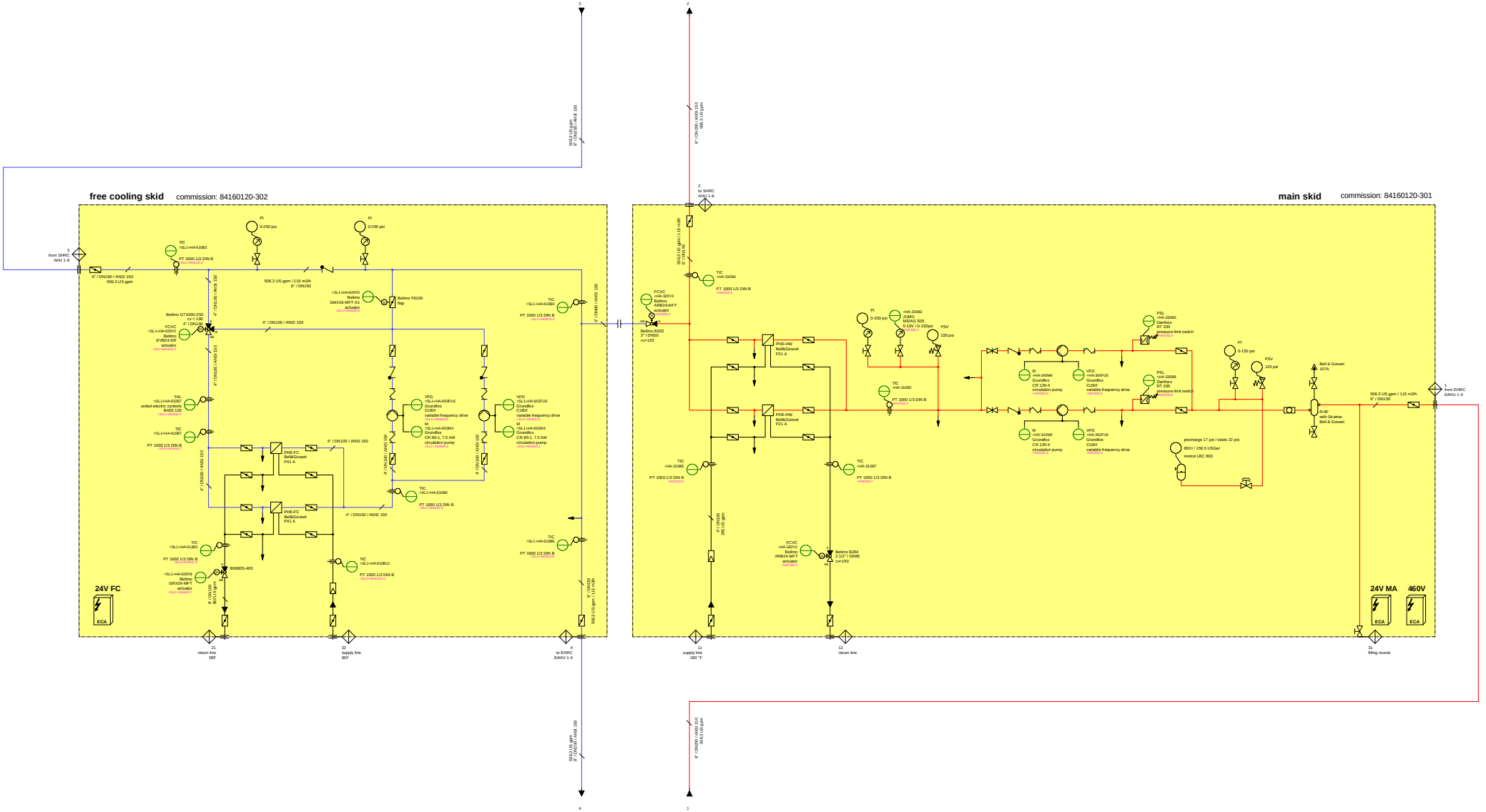
common instrument function / armatures codes

AP	Analysis Point Connection	blind flange connection to attach measuring device
F	filter	(particle) filter, diffusor, silencer
FAL	Flow Alarm Low	alarm at low flow
FC	Flow Control	mass flow controller
FCV	Flow Control Valve	flow regulating valve
FCVC	Flow Control Valve Continuous	flow regulating valve continuous
FCVO	Flow Control Valve on-off	shut-off valve
FI	Flow Indication	flow meter
FISL	Flow Indication Switch Low	flow meter with indication and switch function
FO	Flow Orifice	orifice plate in pipe, flow restriction
GC	Position Controll	servo drive controller
GI	Position Indication	(analog) position feedback
GS	Position Switch	position switch
GSH	Position Switch High	open position switch, substrate present switch, limit switch
GSHL	Position Switch High Low	open / closed position switch
GSL	Position Switch Low	closed position switch, limit switch
GSM	Position Switch Middle	middle position switch, origin position (drive)
HIC	Hand Indication Control	hand input for controller with indication
HS	Hand Switch	EMS button
HV	Hand Valve	hand valve
M	motor	motor
MIC	Moisture Indication Control	moisture control device with (local) indication
PAH	Pressure Alarm High	high pressure alarm
PC	Pressure Control	pressure control device
PCV	Pressure Control Valve	pressure reducer
PI	Pressure Indication	manometer or indicating pressure meter
PIC	Pressure Indication Control	pressure indication control
PIAH	Pressure Indication Alarm High	pressure indication and alarm
PISL	Pressure Indication Switch Low	pressure indication and switch
PSH	Pressure Switch High	atmospheric switch, high or over pressure switch
PSHL	Pressure Switch High Low	combined high and low pressure switch
PSL	Pressure Switch Low	vacuum switch, low or under pressure switch
PSV	Pressure Safety Valve	safety valve
PT	Pressure Transmitter	pressure measuring device
SI	State Indication	state indication (on/off)
TAHL	Temperature Alarm High Low	combined over and under temperature warnings (alarms)
TAL	Temperature Alarm Low	under temperature warning (alarm)
TC	Temperature Control	temperature control device
TDA	Temperature Difference Alarm	temperature difference alarm
TI	Temperature Indication	thermometer
TIC	Temperature Indication Control	temperature control device with (local) indication
TICA	Temperature Indication Control Alarm	temperature control device with (local) indication and alarm function
TICAH	Temperature Indication Control Alarm High	temperature control device with (local) indication and alarm function
TSH	Temperature Switch High	over temperature switch
TSL	Temperature Switch Low	under temperature switch

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	legend	location: =MA+AG
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 16

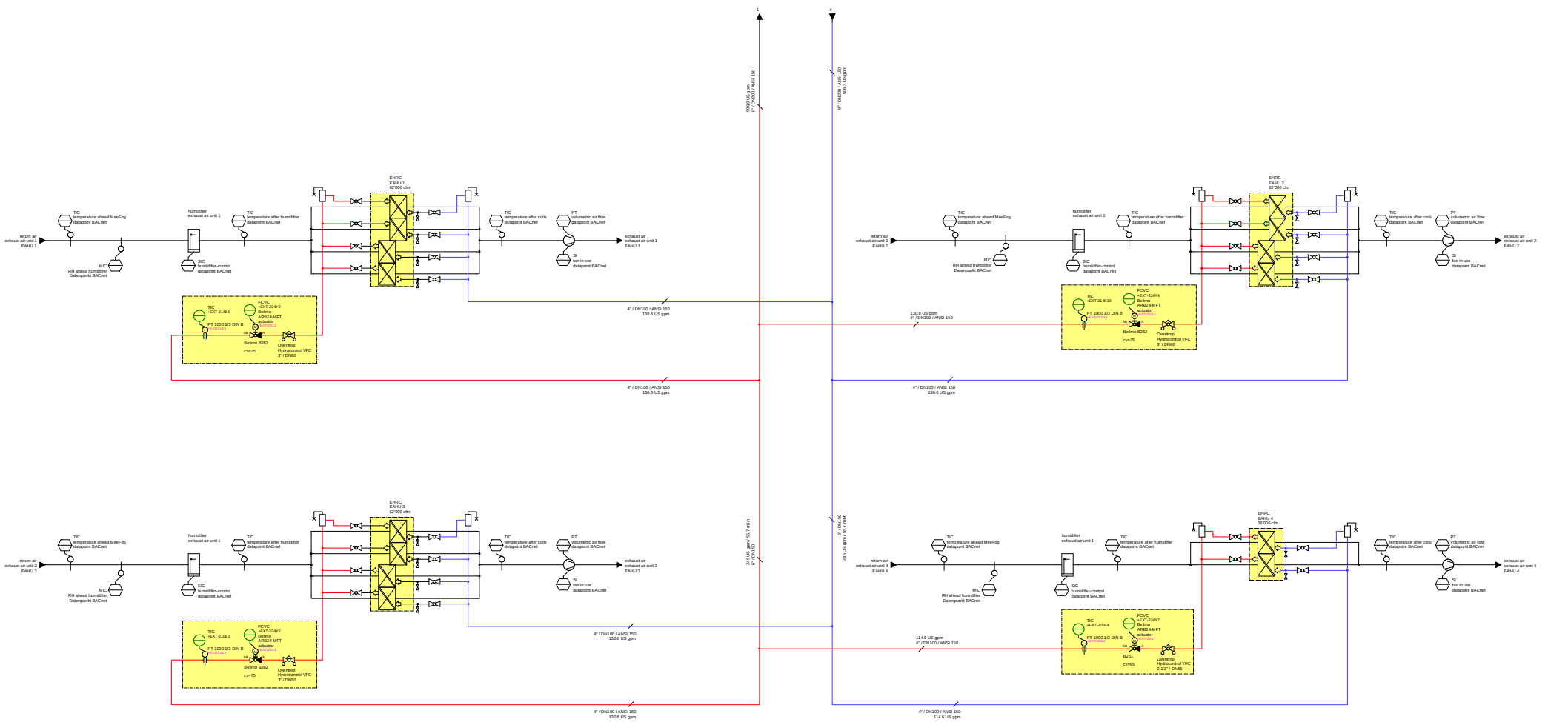


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	P&ID	location: =MA+AG
Approved	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 17



pump							variable frequency drive					
device tag	typ	supplier	part-no.	rated power	rated voltage	rated current	device tag	typ	supplier	part-no.	rated power	mains supply
340/342 M 4	CR120-4	Grundfos USA	tbd	100 HP	3 x 460 V	110 A	340/342 FU 5	CUE 75 kW	Grundfos USA	91136893	100 HP	1.15
650/652 M 4	CR90-1	Grundfos USA	tbd	15 HP	3 x 460 V		650/652 FU 5	CUE 11 kW	Grundfos USA	91136885	15 HP	1.15

E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	P&ID	konvekta
created:	11/24/2016	kog	drawing no.:	84160120-401			location: =MA+AG
edited:	9/3/2018	nad	TAP-number:	T_160823_16			sheet no. 18
approved:	12.01.2017	gei	version:	7.0	customer:		

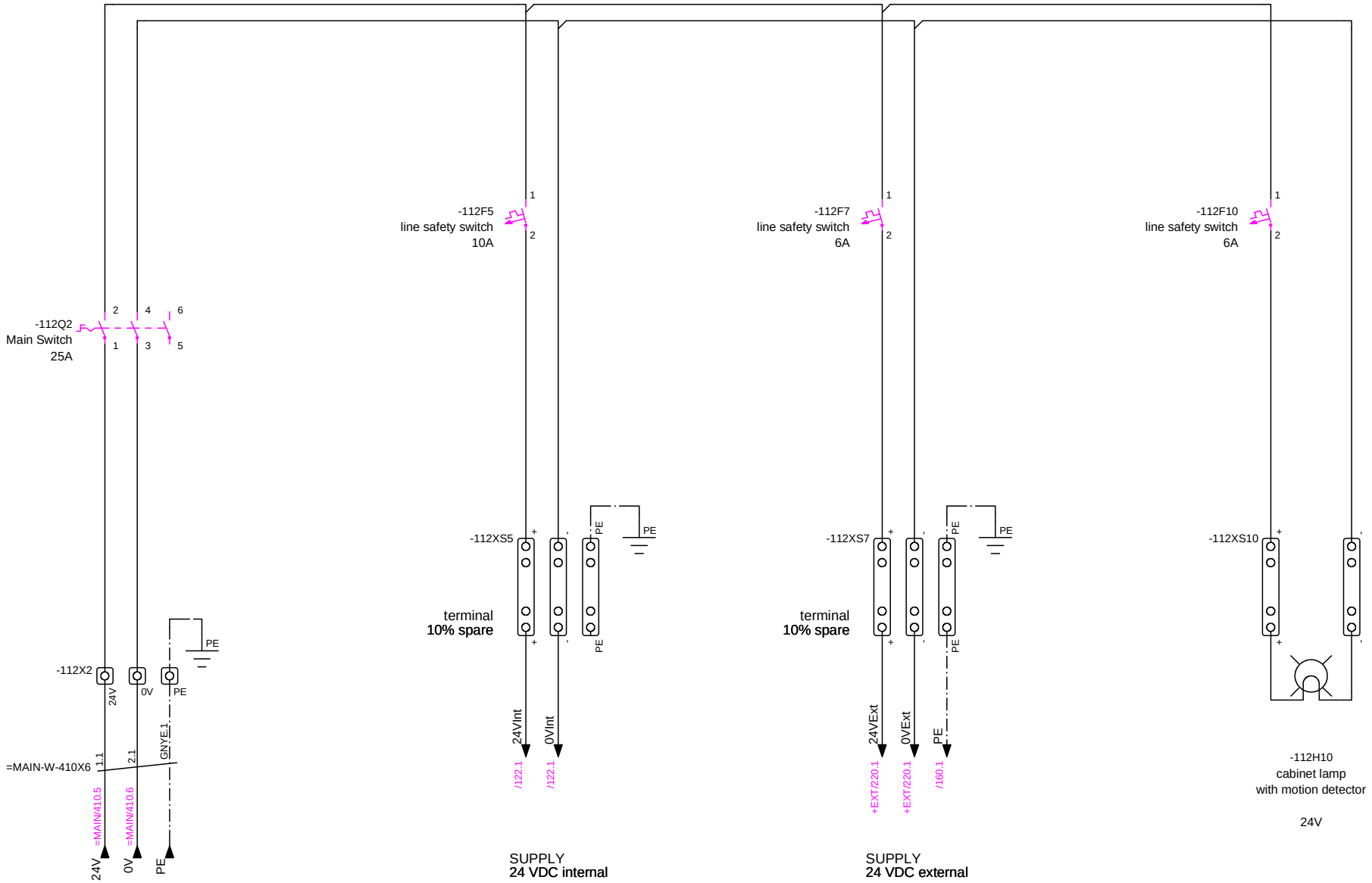


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401	P&ID	location: =MA+AG
State Edited	12/11/2017	kog		T_160823_16		Sheet no. 19
Approved	12/11/2017	gei	version:	7.0	customer:	

electrical cabinet 24V

master

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 100
	Approved 12/01/2017	gei	version:	7.0	customer:		

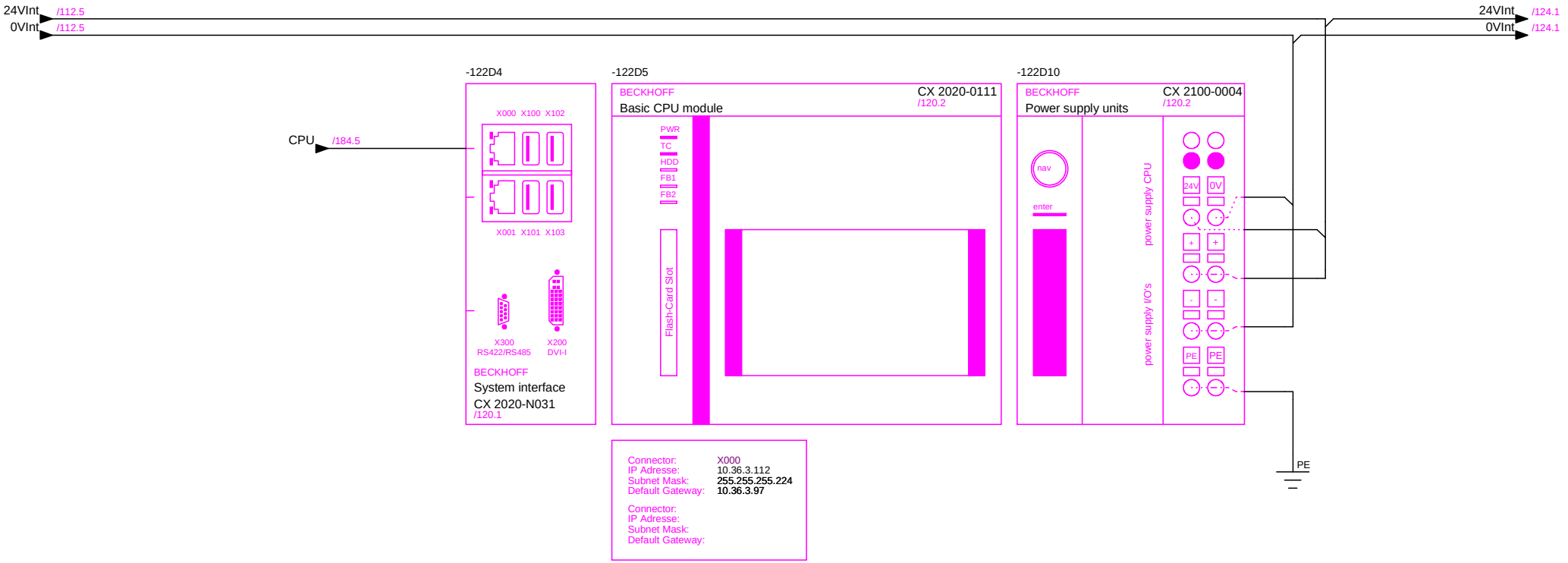


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401	Supply	location: =MA+ECA
State	9/3/2018	nad		T_160823_16		Sheet no. 112
Approved	12/01/2017	gei	version:	7.0	customer:	

-122D4	-122D5	-122D10	-124D2	-124D6	-126D2	-130D2	-130D6	-130D10	-132D2	-134D2	-134D6	-134D10	-136D2	-140D2	-140D6	-140D10	-142D2	-142D6	-142D10	-144D2	-144D6	-144D10	-146D2	-146D6	-146D10	-158D4	-120D10
System interface CX 2020-N031 122.4	Basic CPU module CX 2020-0111 122.5	Power supply units CX 2100-0004 122.10	8-channel digital intput terminal KL1408 124.2	8-channel digital intput terminal KL1408 124.6	8-channel digital output terminal KL2408 126.2	4-channel analog input terminal 0...10 V KL3064 130.2	4-channel analog input terminal 0...10 V KL3064 130.6	4-channel analog input terminal 0...10 V KL3064 130.10	4-channel analog input terminal 0...10 V KL3064 132.2	4-channel analog output terminal 0...10 V KL4004 134.2	4-channel analog output terminal 0...10 V KL4004 134.6	4-channel analog output terminal 0...10 V KL4004 134.10	4-channel analog output terminal 0...10 V KL4004 136.2	2-channel input terminal (RTD) KL3202-0028 140.2	2-channel input terminal (RTD) KL3202-0028 140.6	2-channel input terminal (RTD) KL3202-0028 140.10	2-channel input terminal (RTD) KL3202-0028 142.2	2-channel input terminal (RTD) KL3202-0028 142.6	2-channel input terminal (RTD) KL3202-0028 142.10	2-channel input terminal (RTD) KL3202-0028 144.2	2-channel input terminal (RTD) KL3202-0028 144.6	2-channel input terminal (RTD) KL3202-0028 144.10	2-channel input terminal (RTD) KL3202-0028 146.2	2-channel input terminal (RTD) KL3202-0028 146.6	2-channel input terminal (RTD) KL3202-0028 146.10	Diode array terminal KL9302 158.4	End terminal KL9010
BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF

-180D6
Basic CPU module CX 8091 180.6
BECKHOFF

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	PLC module overview	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	Edited 1/17/2017	kog		T_160823_16			Sheet no. 120
	Approved 12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401	CPU	location: =MA+ECA
State	Edited 9/3/2018	nad		T_160823_16		Sheet no. 122
	Approved 12/01/2017	gei	version:	7.0	customer:	

1 2 3 4 5 6 7 8 9 10 11 12

24VInt /122.12 — 24VInt /126.1
0VInt /122.12 — 0VInt /126.1

-124D2

BECKHOFF KL1408 — 8-channel digital intput terminal /120.2

channel 1	channel 2	channel 3	channel 4	channel 5	channel 6	channel 7	channel 8
DI_001	DI_002	DI_003	DI_004	DI_005	DI_006	DI_007	DI_008
1-I1	5-I2	2-I3	6-I4	3-I5	7-I6	4-I7	8-I8
DI_001 +HA330.4	DI_002 +HA330.9	DI_003 +HA340.8	DI_004 +HA340.8	DI_005 +HA342.8	DI_006 +HA342.8	DI_007 /162.9	DI_008 /166.10
pressure limit switch low ERS-pump 1	pressure limit switch low ERS-pump 2	pump in use ERS-pump 1	service ERS-pump 1	pump in use ERS-pump 2	service ERS-pump 2	manual mode active digital modules	manual mode active analog modules

-124D6

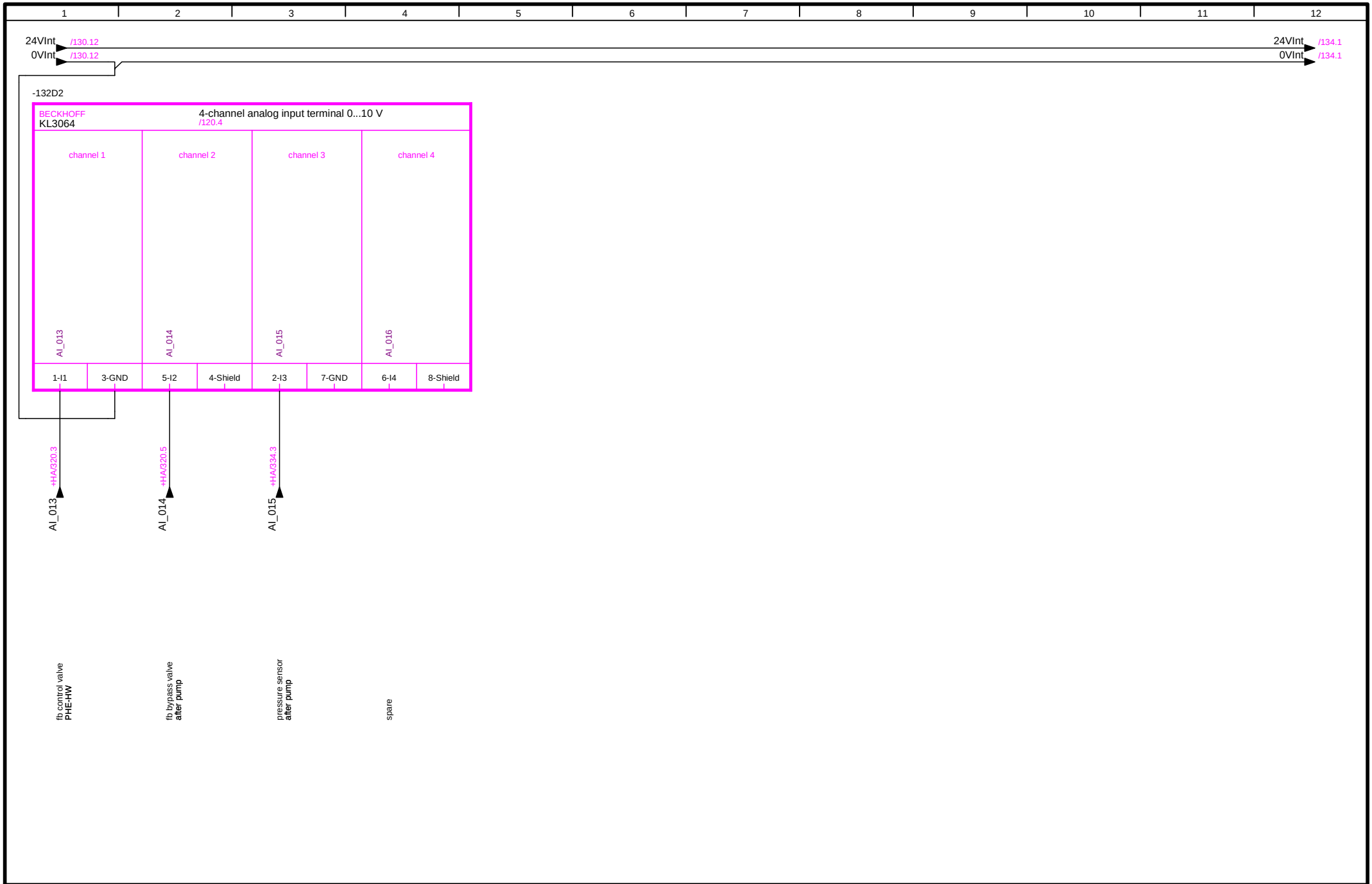
BECKHOFF KL1408 — 8-channel digital intput terminal /120.3

channel 1	channel 2	channel 3	channel 4	channel 5	channel 6	channel 7	channel 8
DI_009	DI_010	DI_011	DI_012	DI_013	DI_014	DI_015	DI_016
1-I1	5-I2	2-I3	6-I4	3-I5	7-I6	4-I7	8-I8
DI_009 /158.5							
acknowledge alarm	spare	spare	spare	spare	spare	spare	spare

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	Edited 4/30/2018	nad		T_160823_16	digital inputs	location: =MA+ECA
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 124

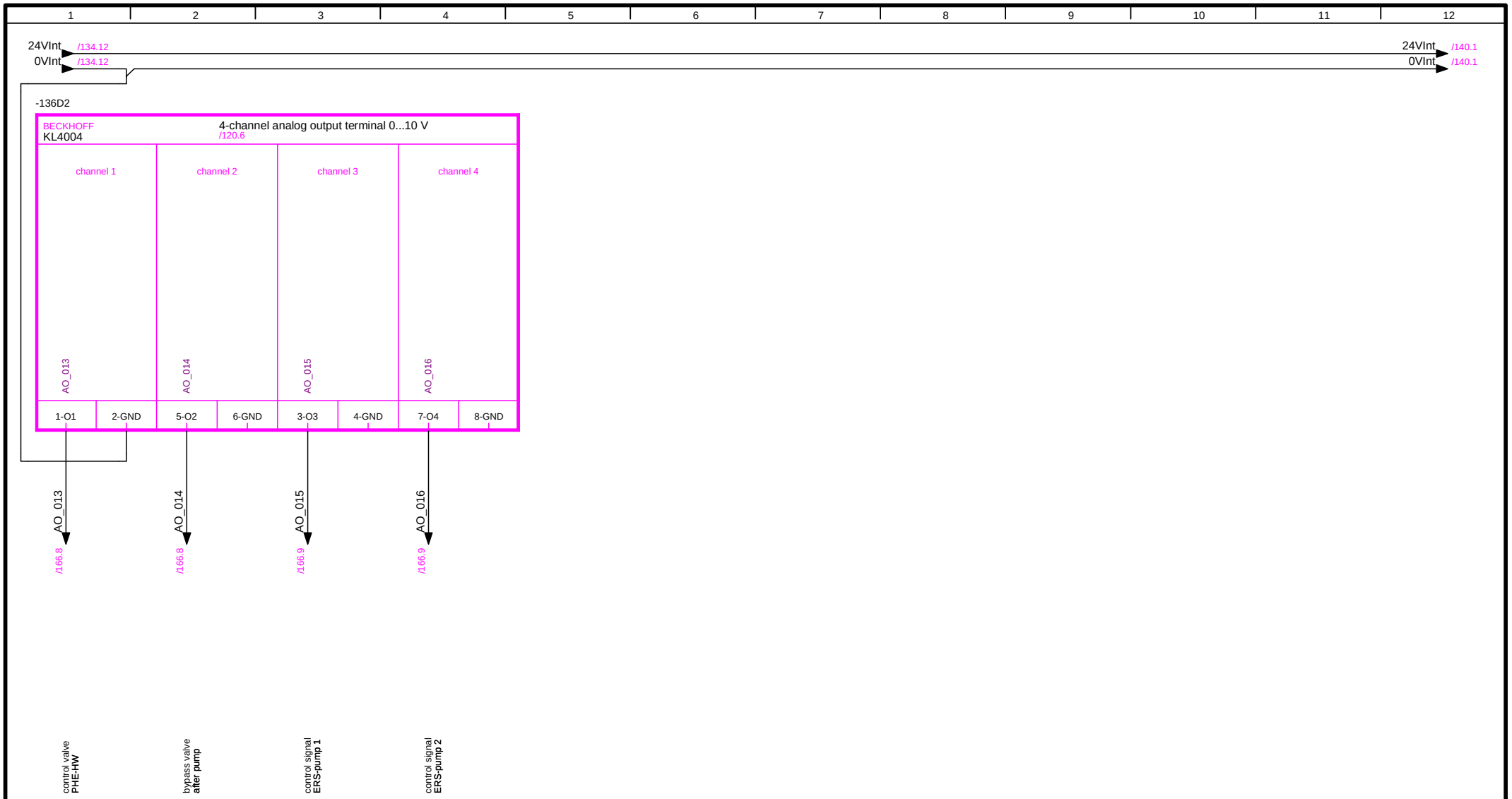
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	Edited	8/30/2017	nad		T_160823_16	digital outputs	location: =MA+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 126

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	analog inputs	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	1/17/2017	kog		T_160823_16			Sheet no. 130
Approved	12/01/2017	gei	version:	7.0	customer:		



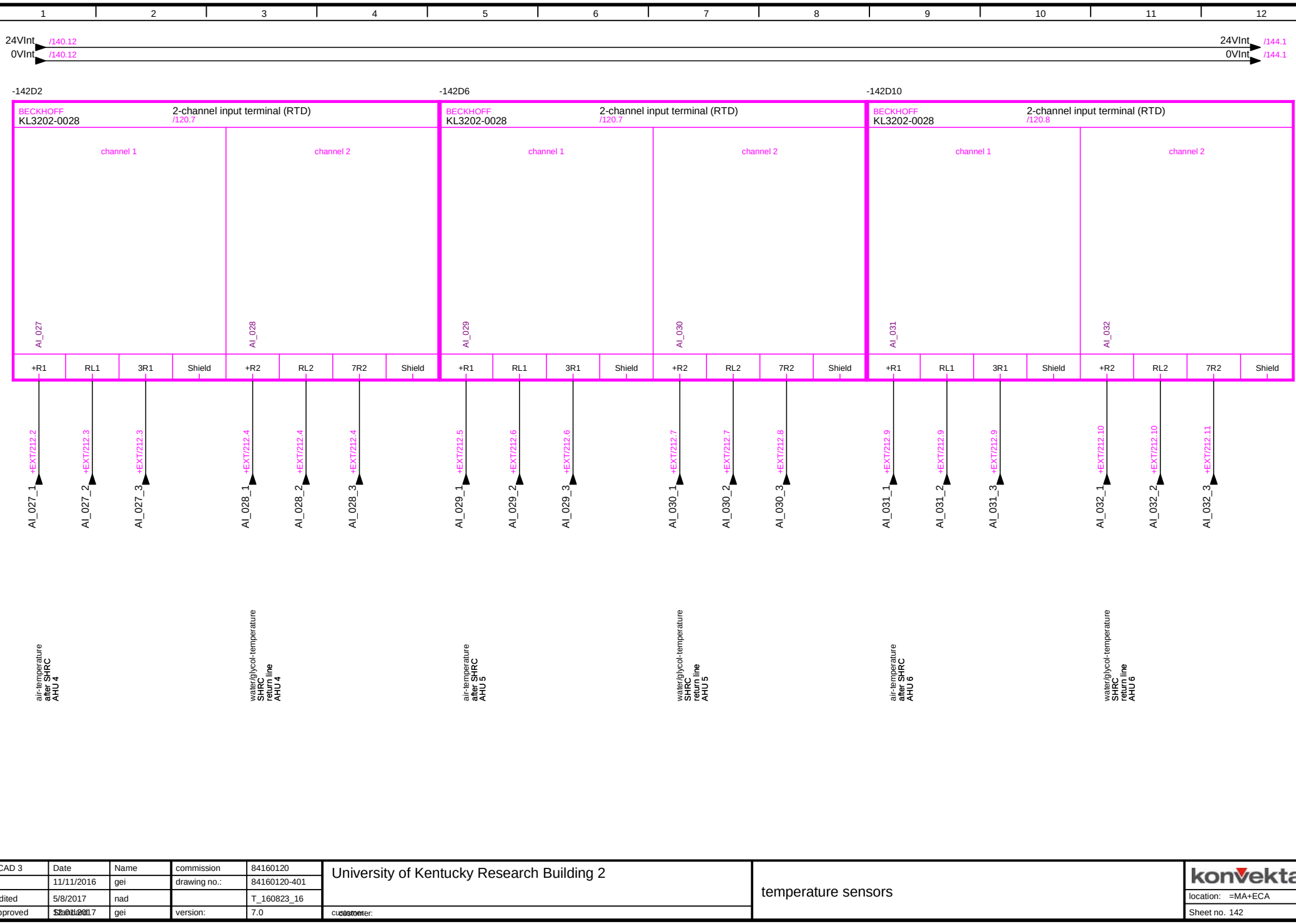
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401	analog inputs	location: =MA+ECA
State	Edited 1/17/2017	kog		T_160823_16		Sheet no. 132
	Approved 12/01/2017	gei	version:	7.0	customer:	

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	analog outputs	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	1/17/2017	kog		T_160823_16			Sheet no. 134
Approved	12/01/2017	gei	version:	7.0	customer:		



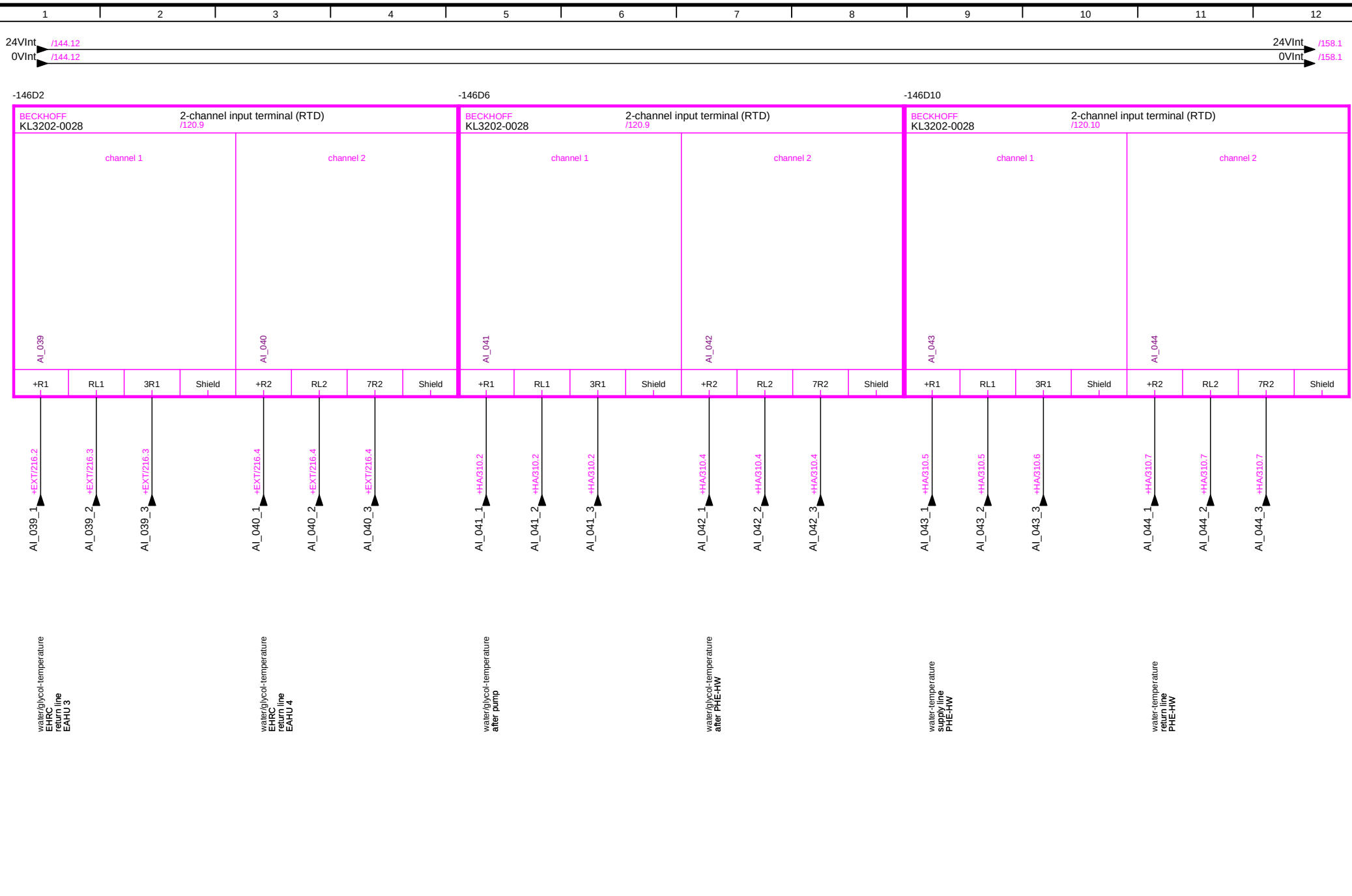
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	analog outputs	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401			location: =MA+ECA
State	Edited 1/17/2017	kog		T_160823_16			Sheet no. 136
	Approved 12/01/2017	gei	version:	7.0	customer:		

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	temperature sensors	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	5/8/2017	nad		T_160823_16			Sheet no. 140
Approved	12/01/2017	gei	version:	7.0	customer:		

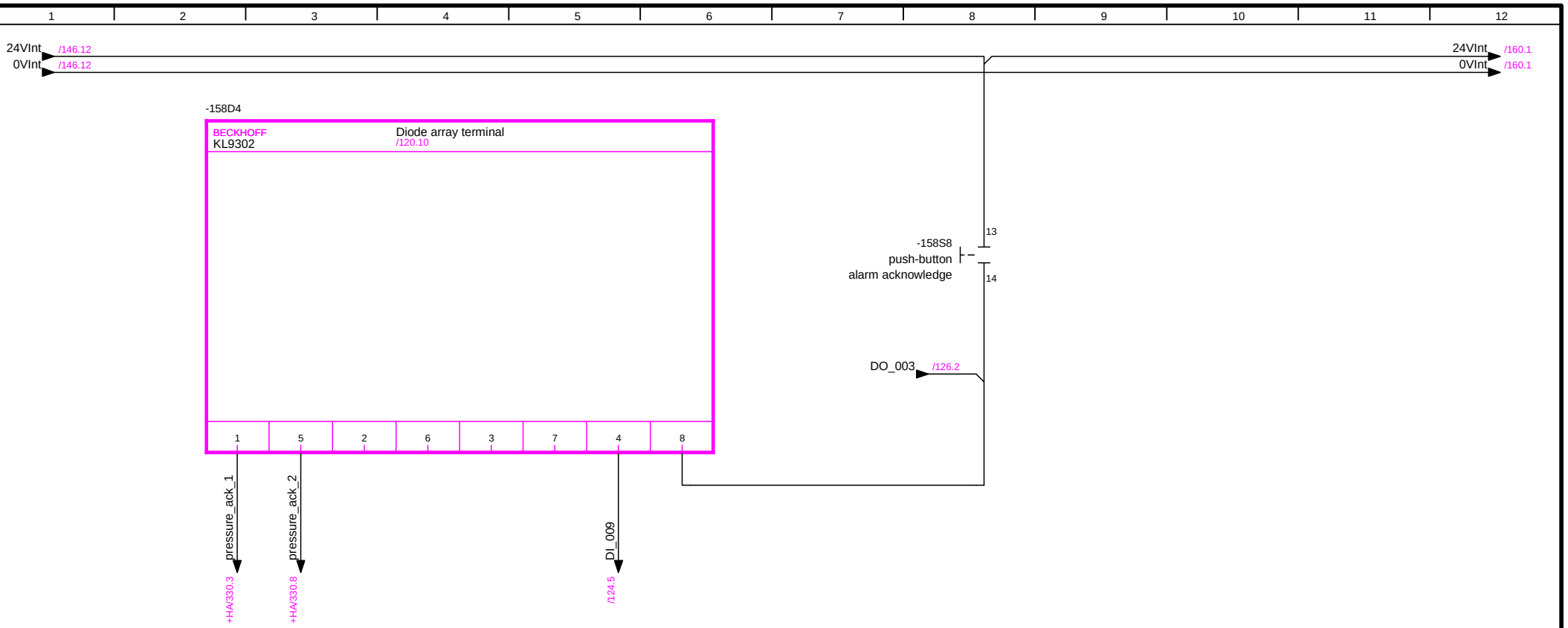


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	5/8/2017	nad		T_160823_16	temperature sensors	location: =MA+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 142

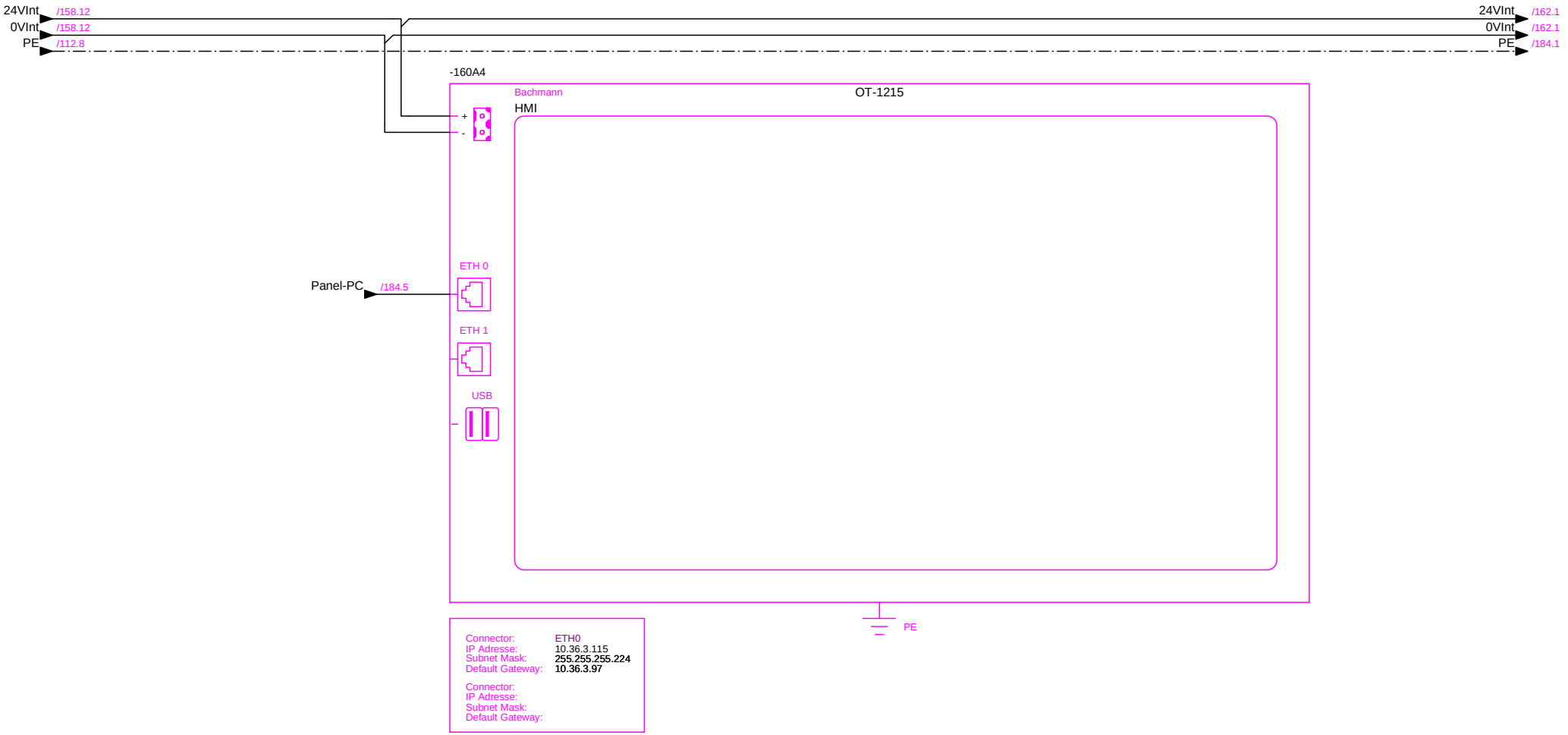
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	temperature sensors	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	5/8/2017	nad		T_160823_16			Sheet no. 144
Approved	12/01/2017	gei	version:	7.0	customer:		



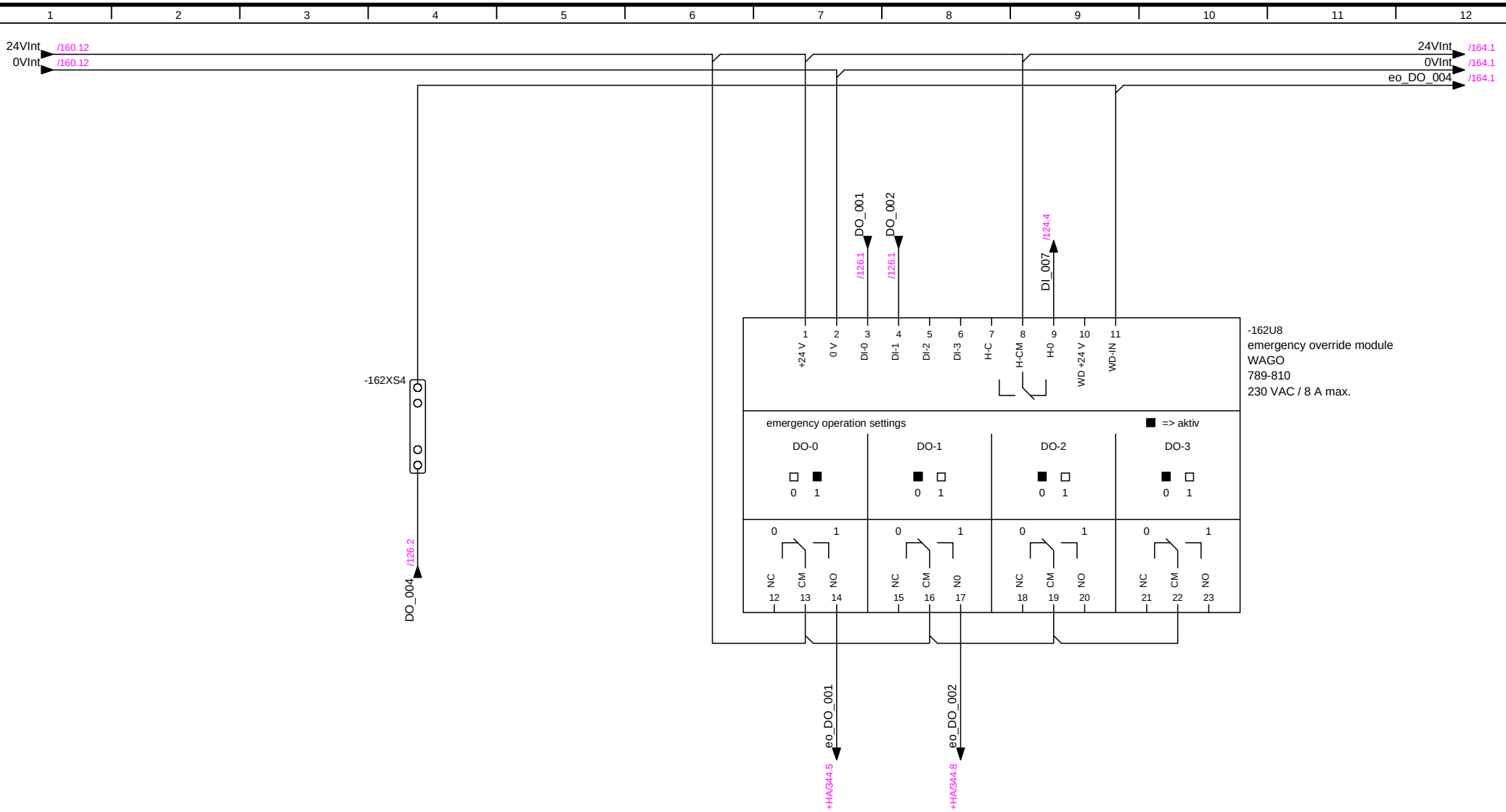
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401		
State	5/8/2017	nad		T_160823_16	temperature sensors	location: =MA+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 146



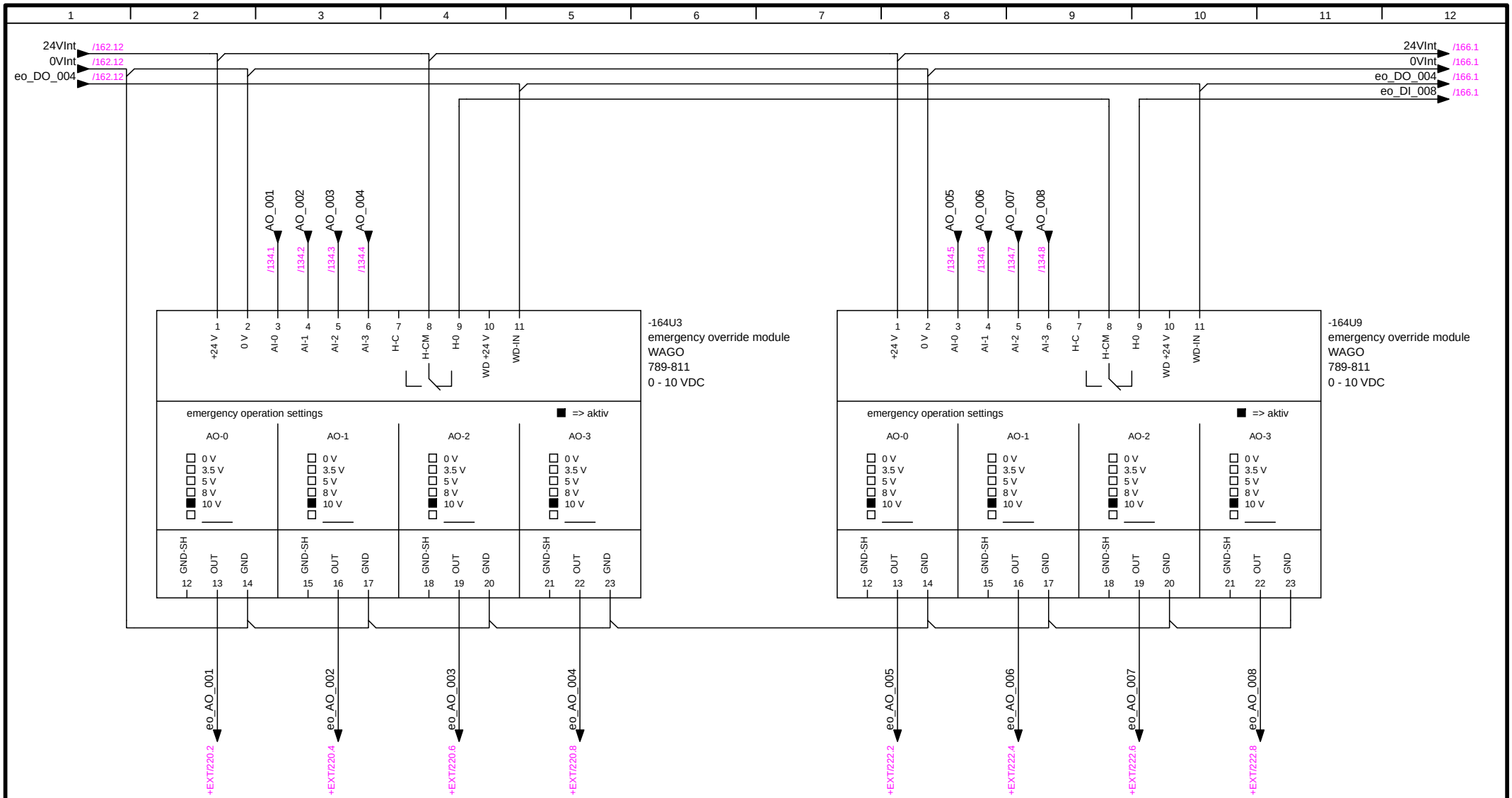
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	1/17/2017	kog		T_160823_16	diode array terminal	location: =MA+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 158



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	HMI	location: =MA+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 160

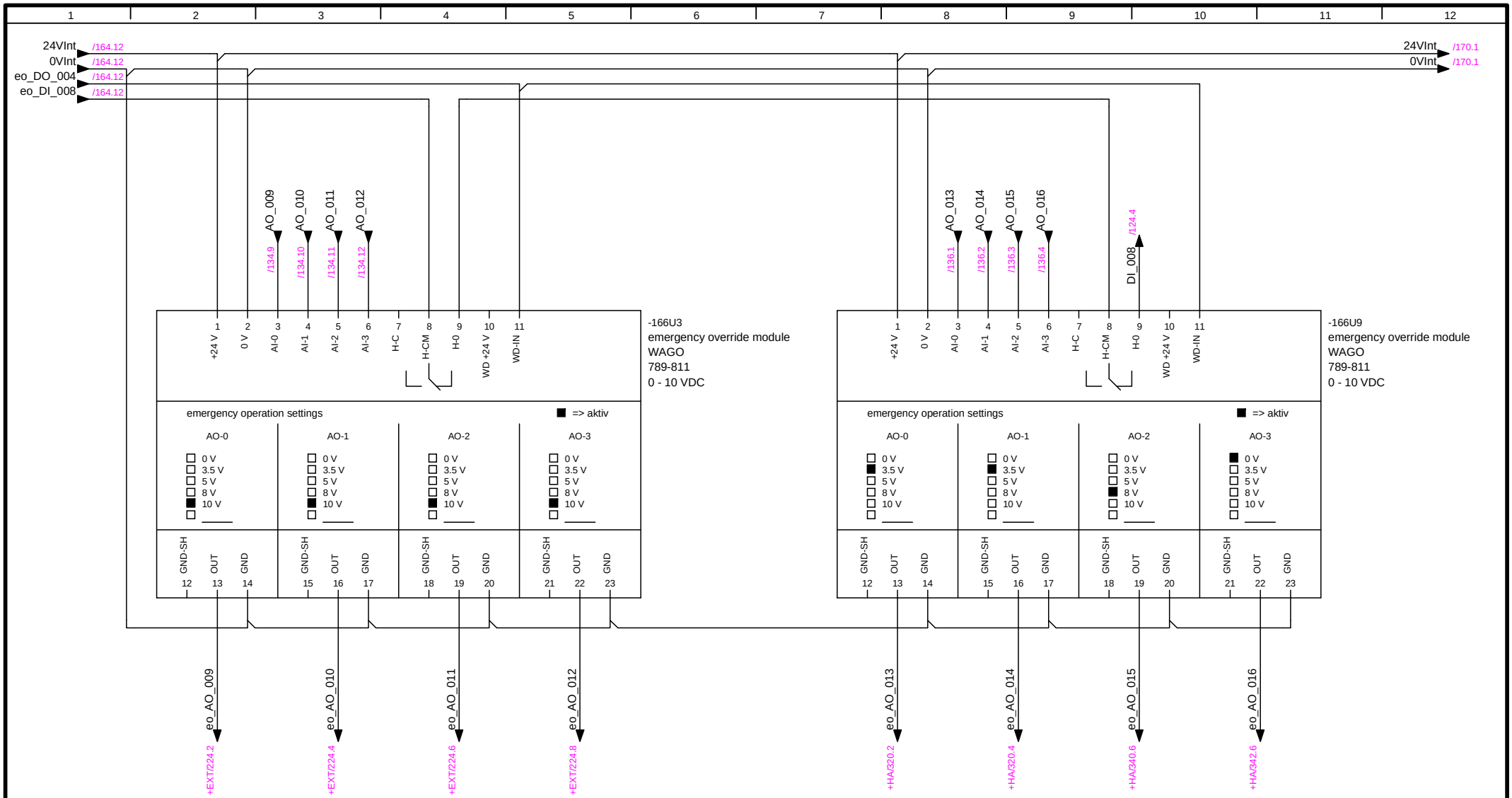


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	emergency overwrite modules	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	Edited 3/31/2017	nad		T_160823_16			Sheet no. 162
	Approved 12/01/2017	gei	version:	7.0	customer:		

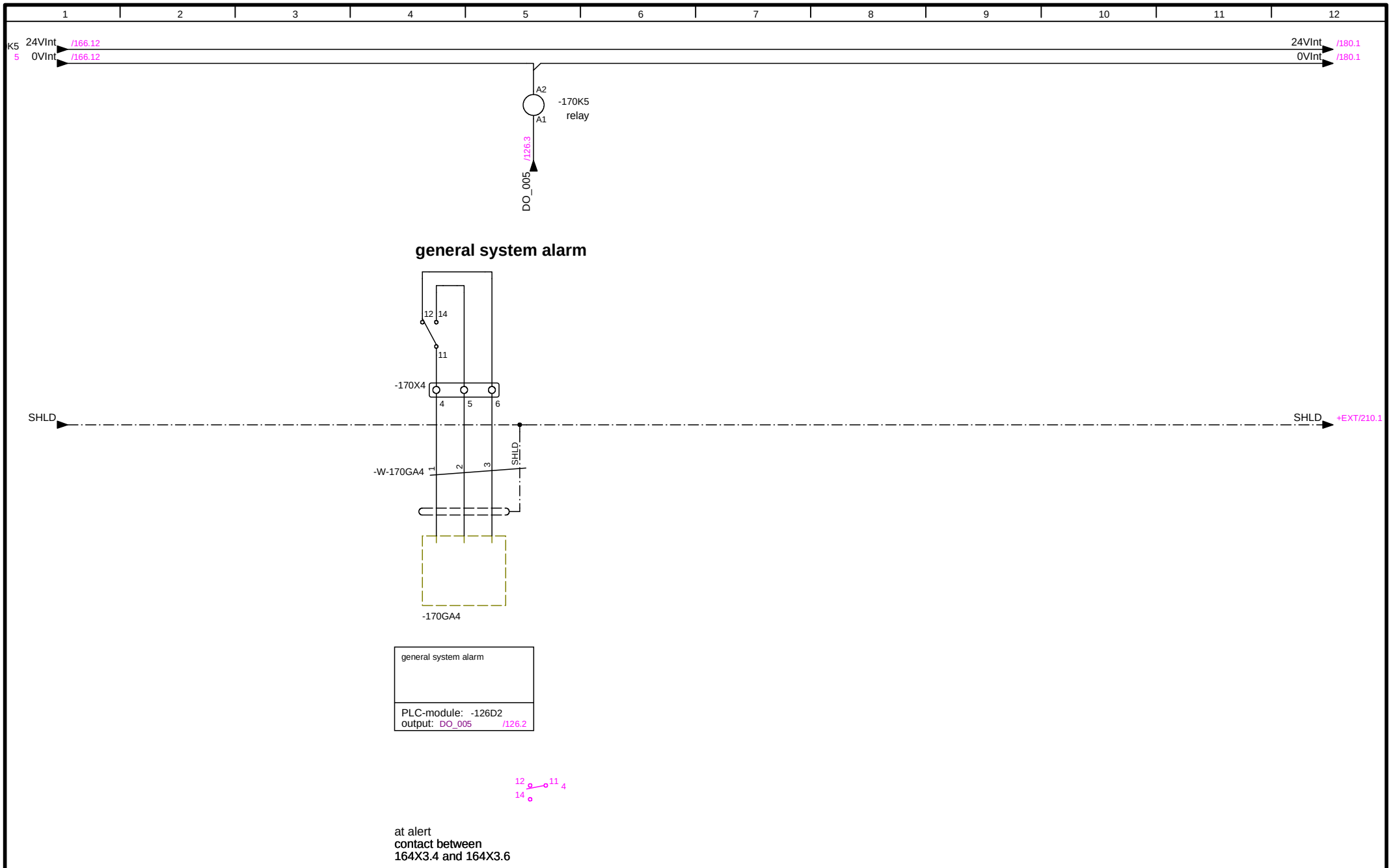


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	emergency overwrite modules
State	11/11/2016	gei	drawing no.:	84160120-401		
State	1/17/2017	kog		T_160823_16		
Approved	12/01/2017	gei	version:	7.0	customer:	

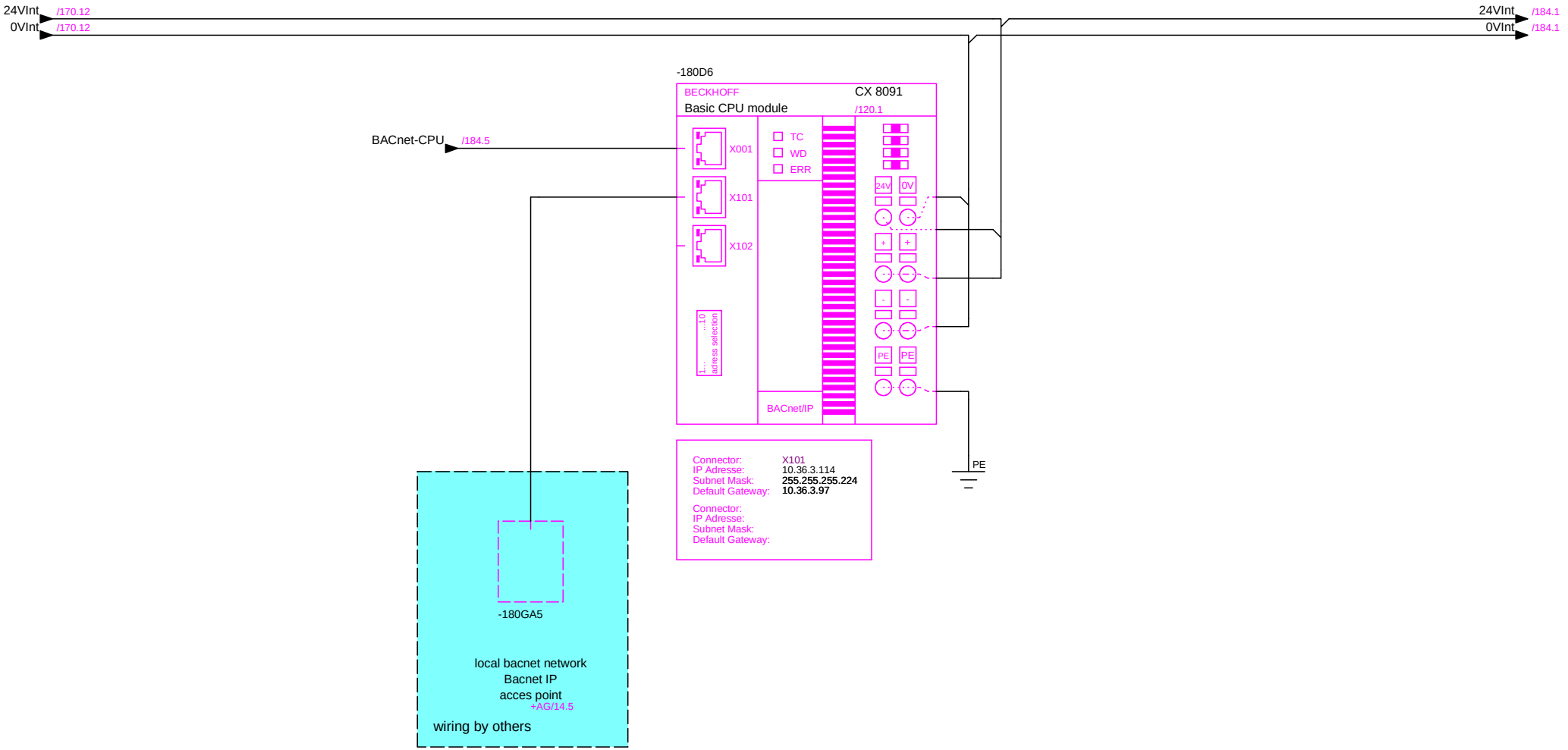
konvekta
location: =MA+ECA
Sheet no. 164



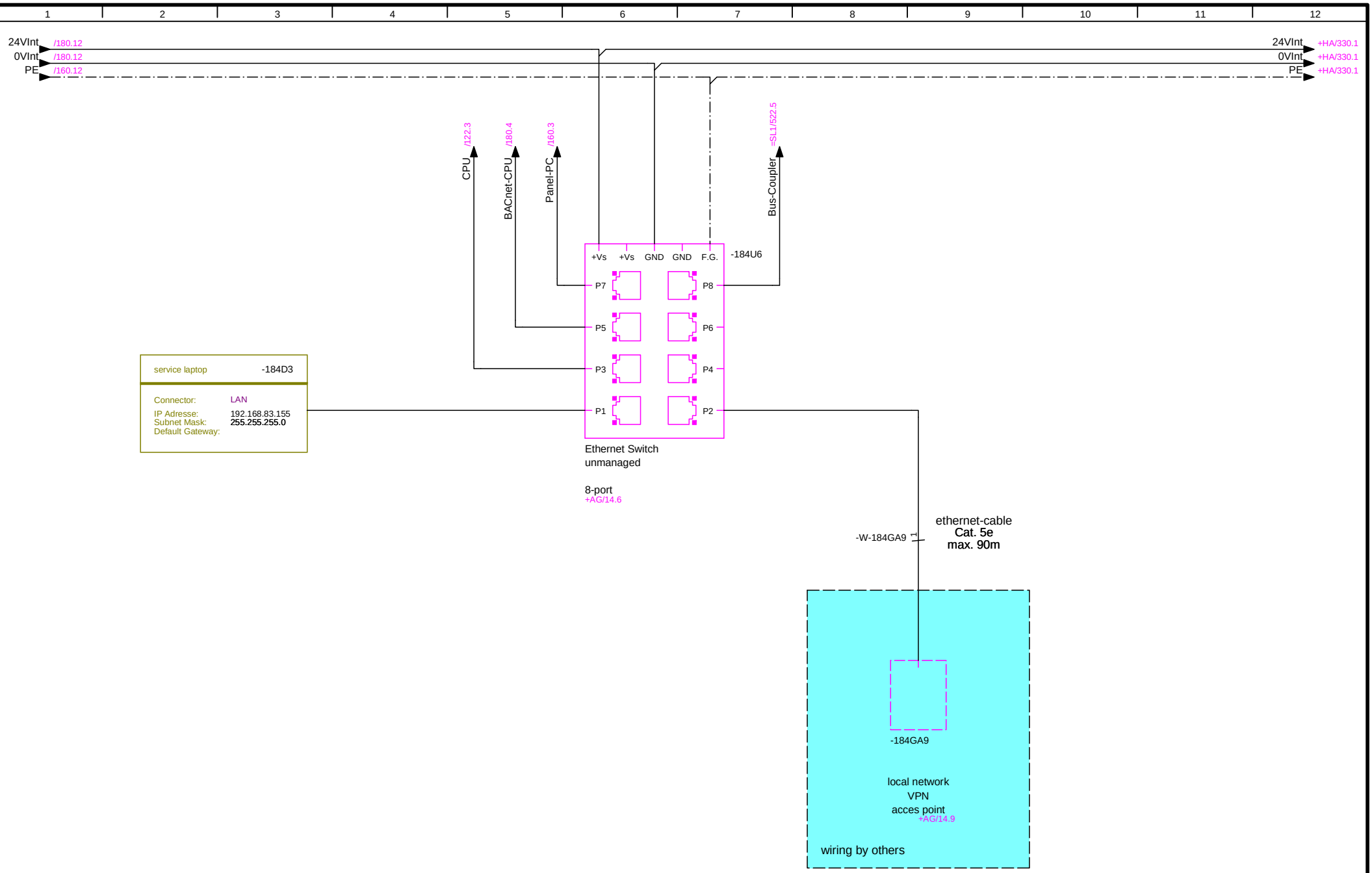
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	emergency overwrite modules	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+ECA
State	1/17/2017	kog		T_160823_16			Sheet no. 166
Approved	12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	signal processing	konvekta
State	1/17/2017	kog	drawing no.:	84160120-401			location: =MA+ECA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 170
	Approved 12/01/2017	gei	version:	7.0	customer:		



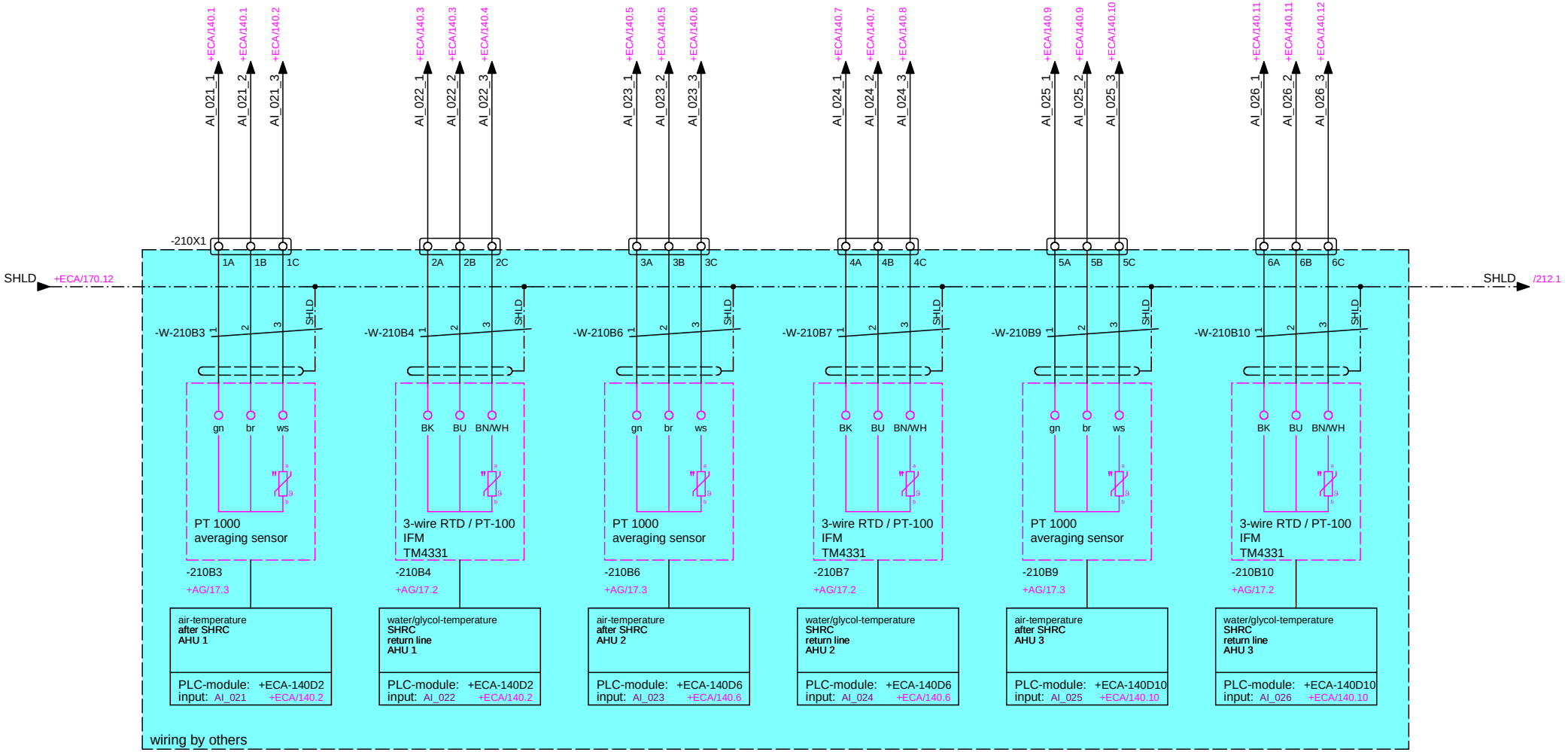
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/17/2016	gei	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	BACnet CPU	location: =MA+ECA
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 180



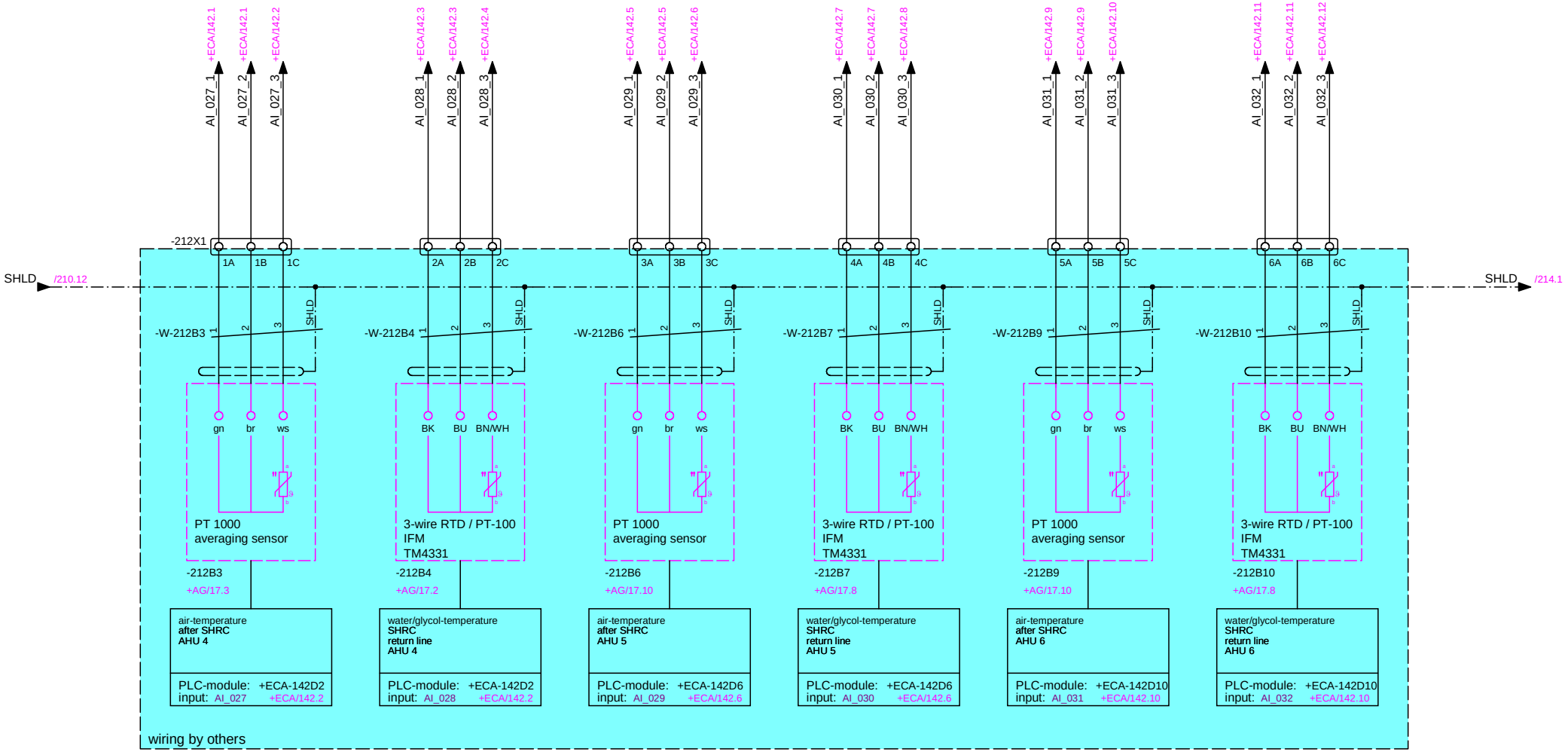
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	network
State	8/30/2017	nad	drawing no.:	84160120-401		konvekta
State	Edited 9/3/2018	nad		T_160823_16		location: =MA+ECA
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 184

field devices

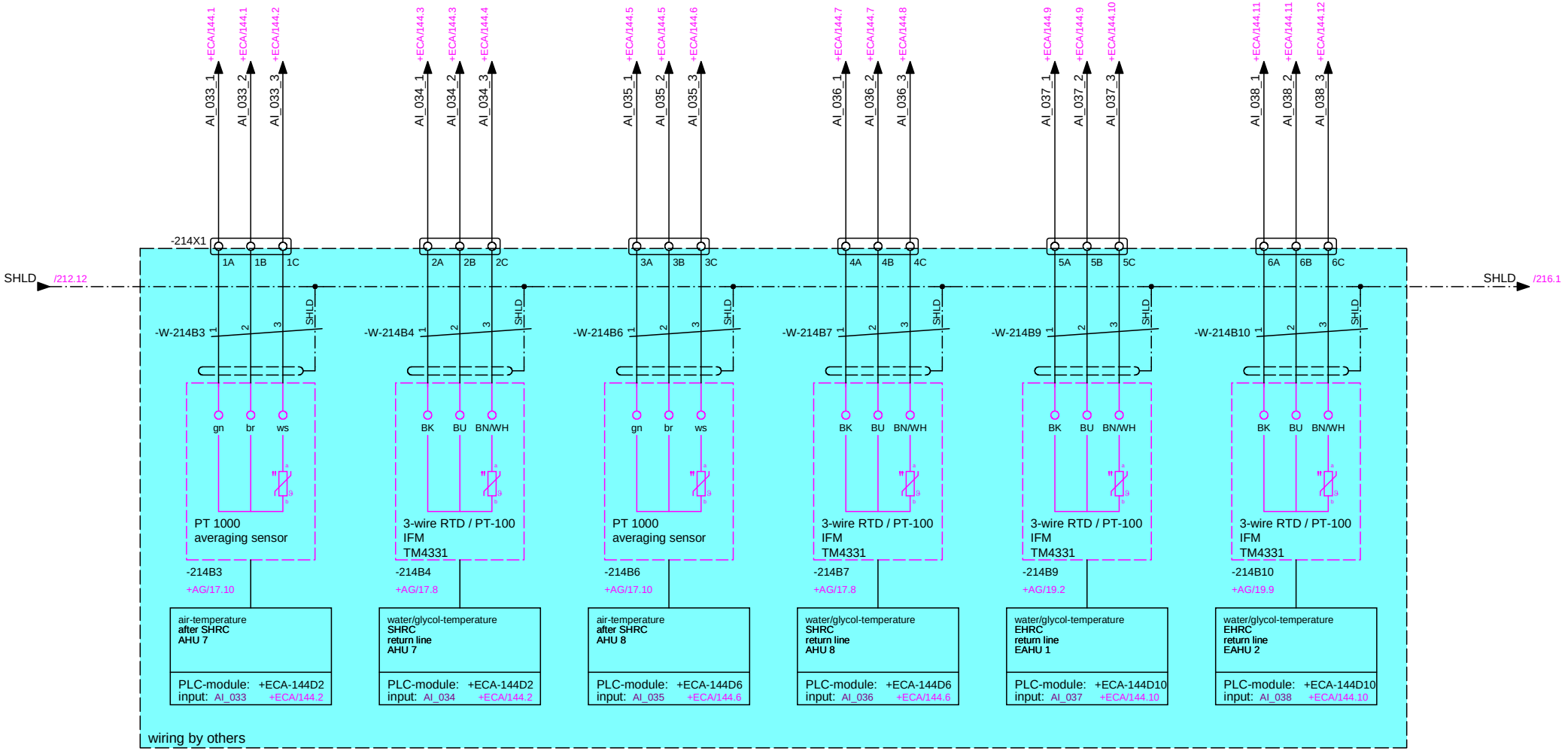
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+EXT
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 200
	Approved 12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	temperature sensors	location: =MA+EXT
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 210



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401	temperature sensors	location: =MA+EXT
State	Edited 9/3/2018	nad		T_160823_16		Sheet no. 212
	Approved 12/01/2017	gei	version:	7.0	customer:	



ECAD 3	Date	Name	commission	84160120
State	11/28/2016	kog	drawing no.:	84160120-401
State	Edited 9/3/2018	nad		T_160823_16
	Approved 12/01/2017	gei	version:	7.0

University of Kentucky Research Building 2

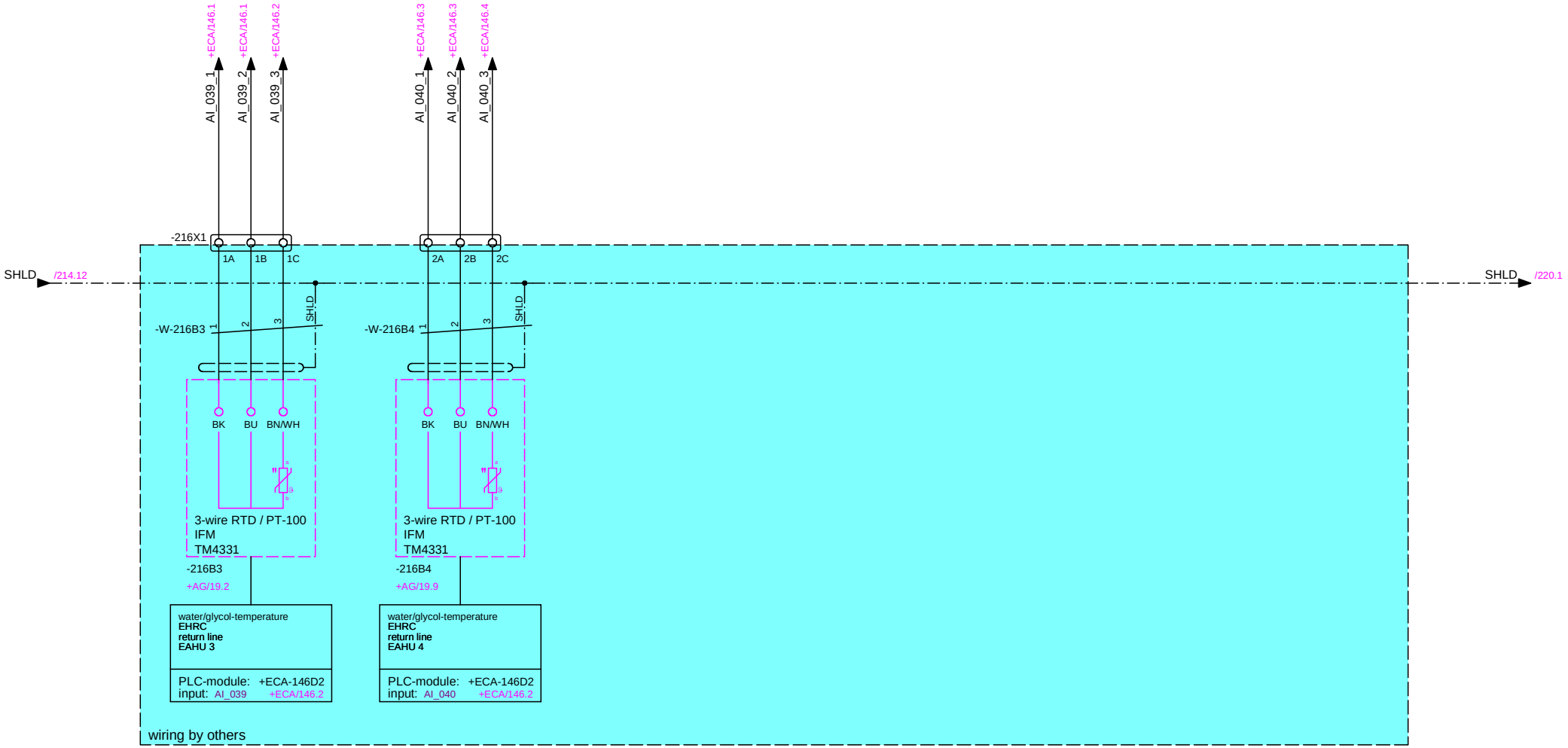
customer:

temperature sensors

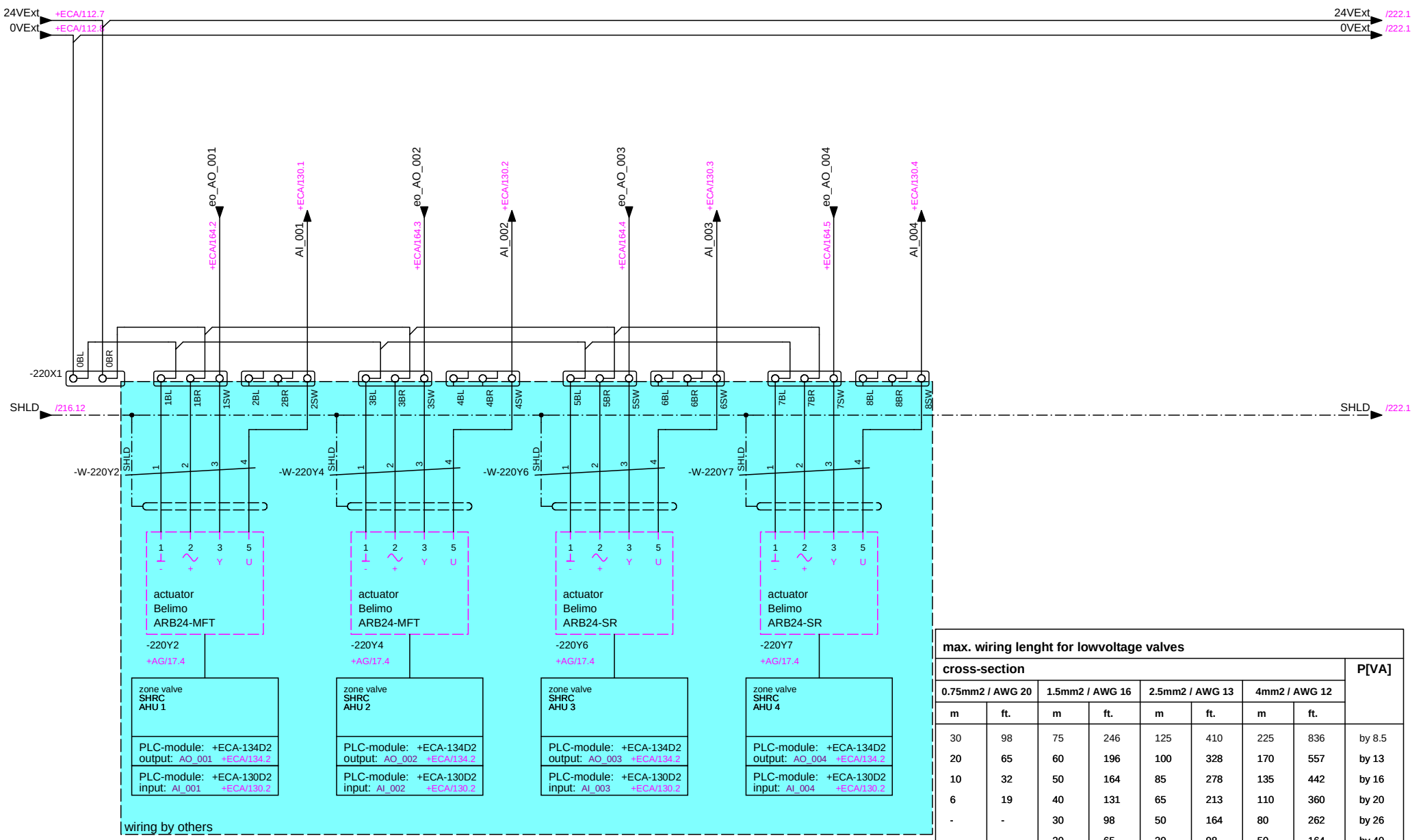
konvekta

location: =MA+EXT

Sheet no. 214

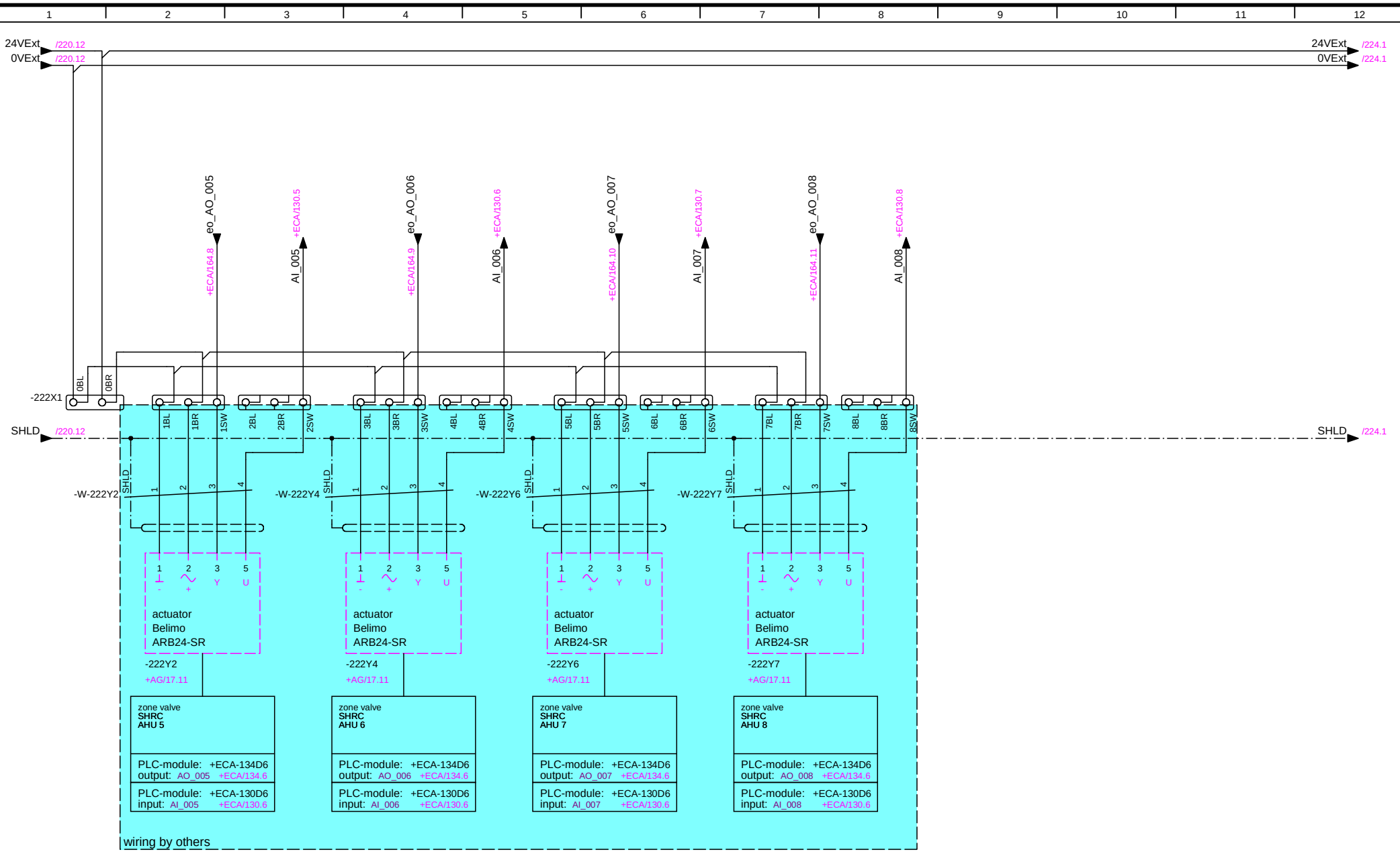


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	temperature sensors	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401			location: =MA+EXT
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 216
	Approved 12/01/2017	gei	version:	7.0	customer:		

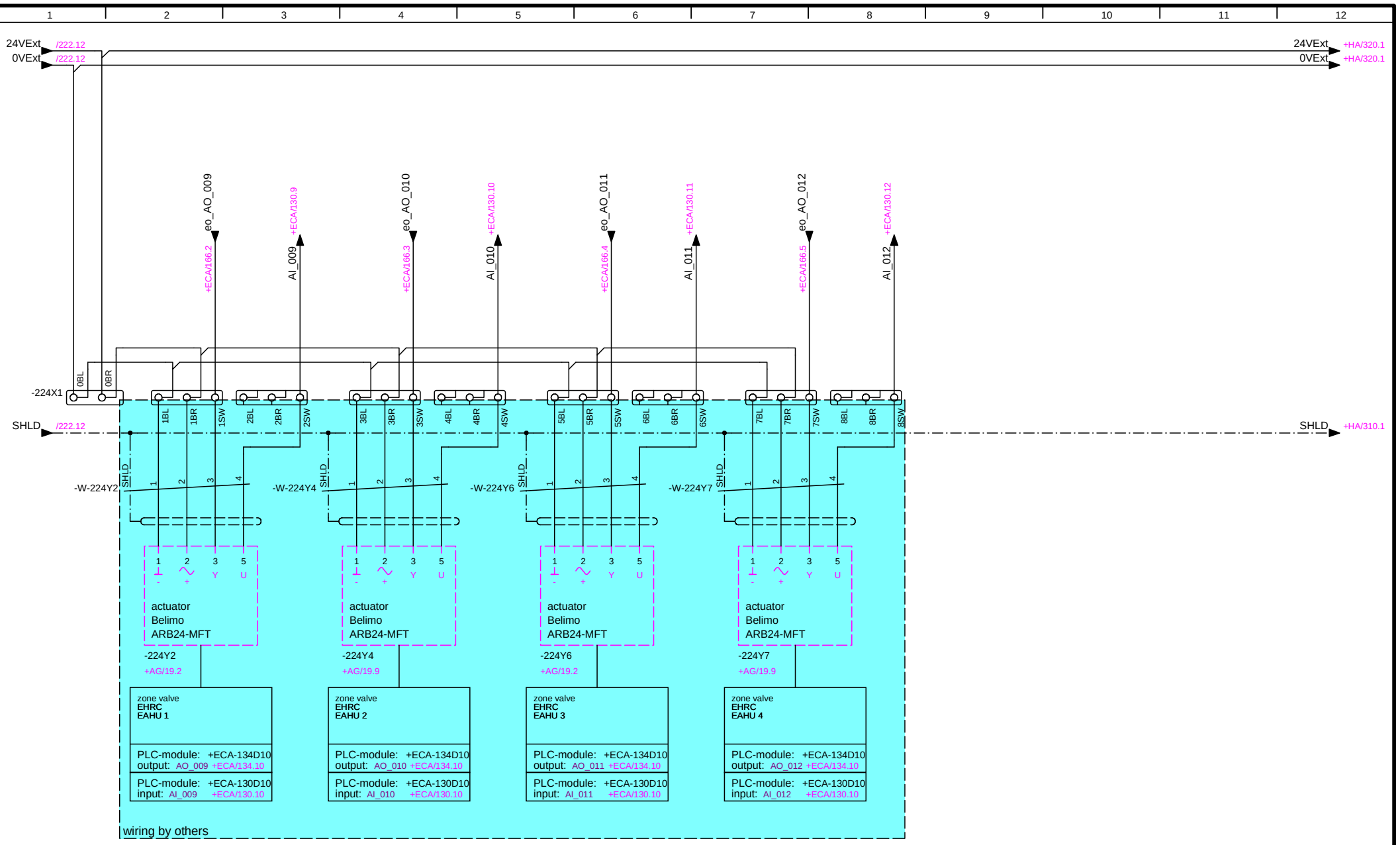


max. wiring lenght for lowvoltage valves								
cross-section								P[VA]
0.75mm2 / AWG 20		1.5mm2 / AWG 16		2.5mm2 / AWG 13		4mm2 / AWG 12		
m	ft.	m	ft.	m	ft.	m	ft.	
30	98	75	246	125	410	225	836	by 8.5
20	65	60	196	100	328	170	557	by 13
10	32	50	164	85	278	135	442	by 16
6	19	40	131	65	213	110	360	by 20
-	-	30	98	50	164	80	262	by 26
-	-	20	65	30	98	50	164	by 40
-	-	10	32	15	49	25	82	by 80
-	-	6	19	10	32	18	59	by 120

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401		
State	9/3/2018	nad		T_160823_16	control valves	location: =MA+EXT
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 220



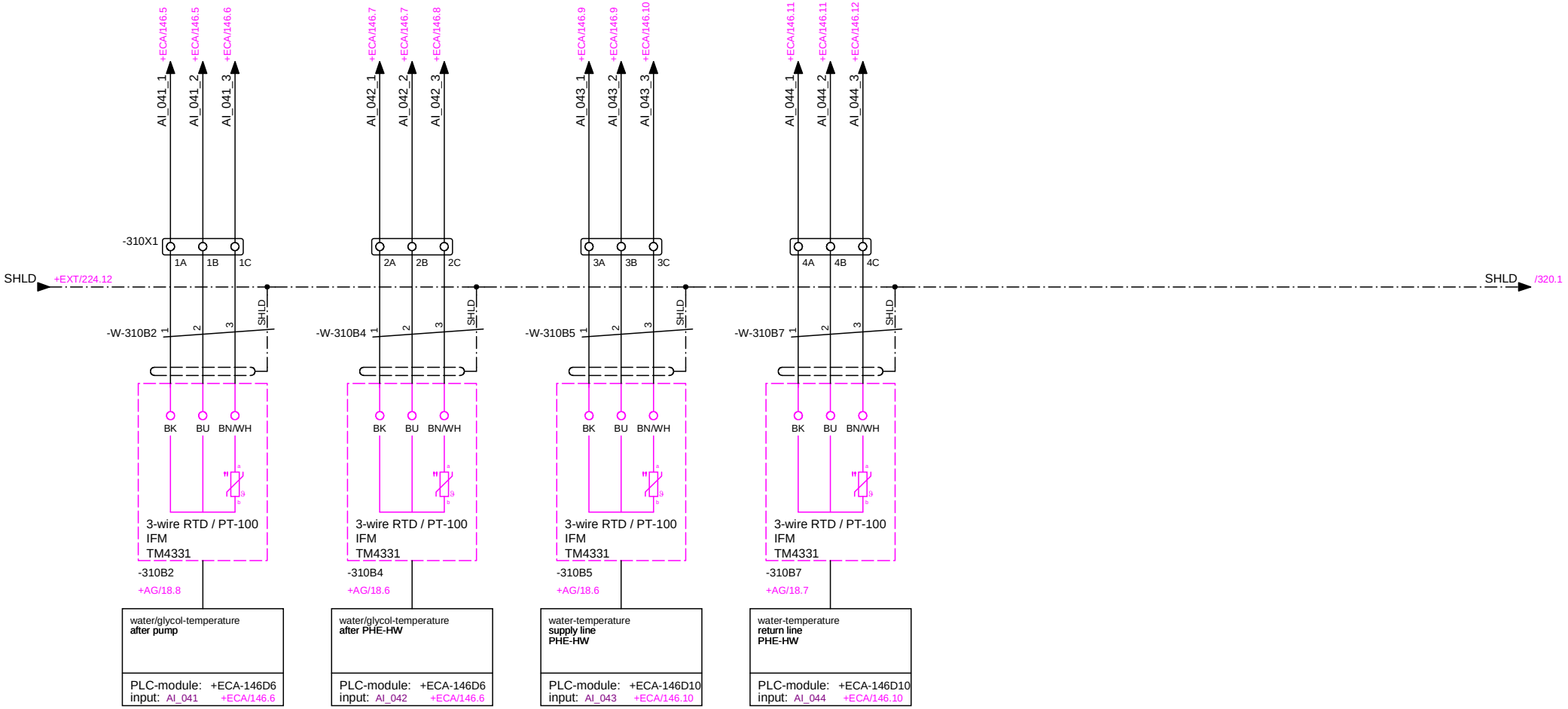
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	control valves	location: =MA+EXT
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 222



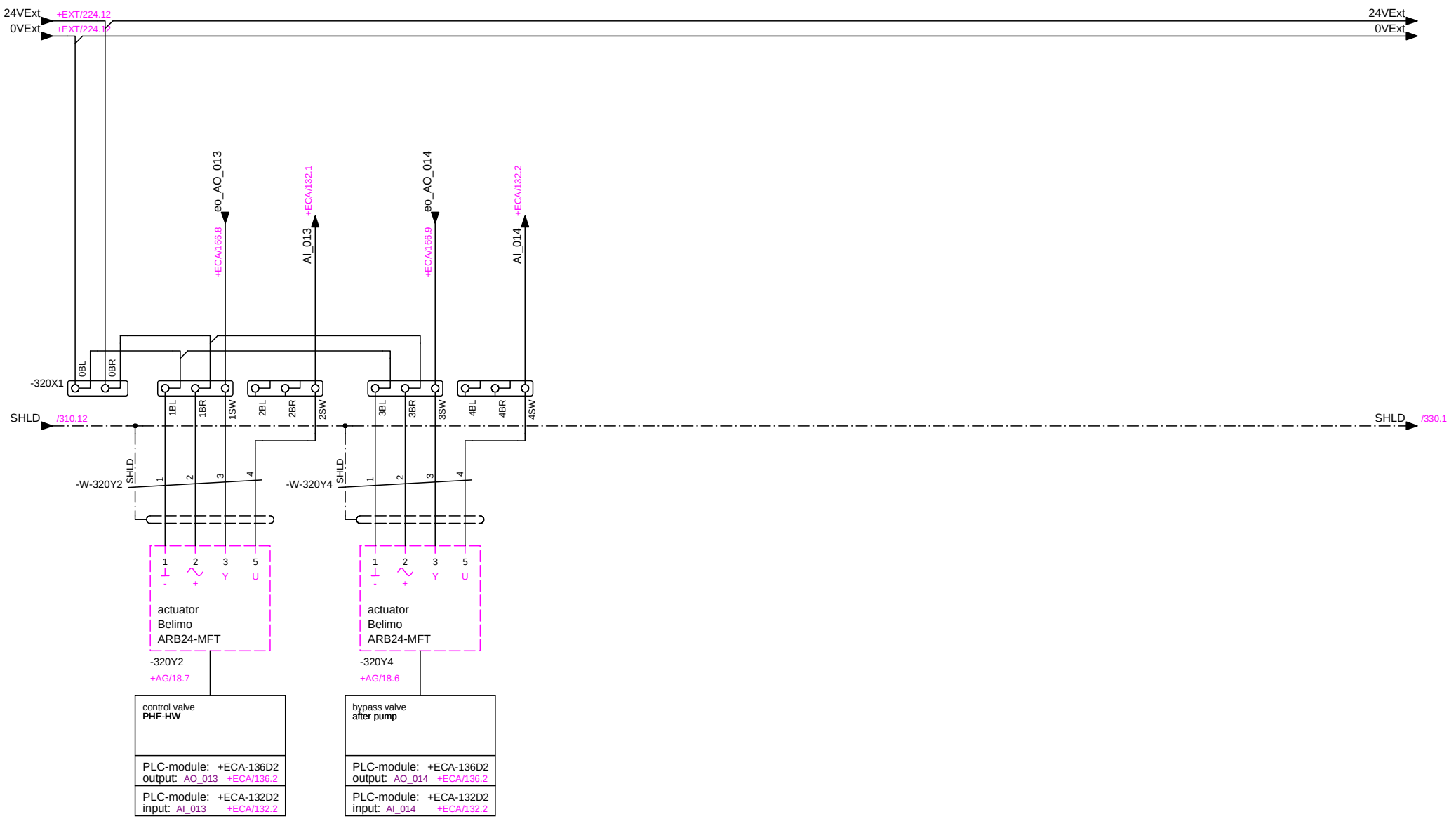
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	control valves	location: =MA+EXT
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 224

hydraulic assembly

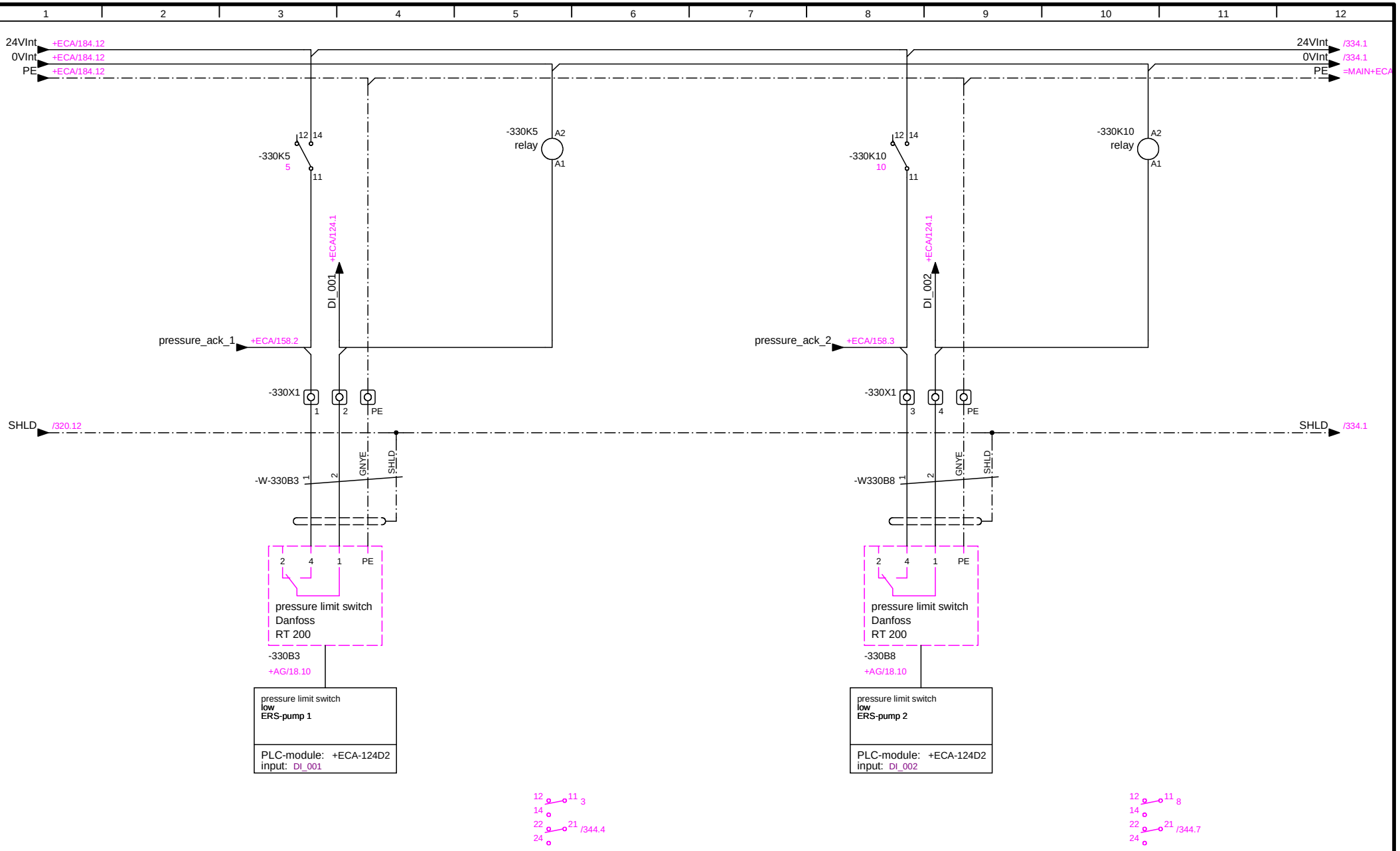
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MA+HA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 300
	Approved 12/01/2017	gei	version:	7.0	customer:		



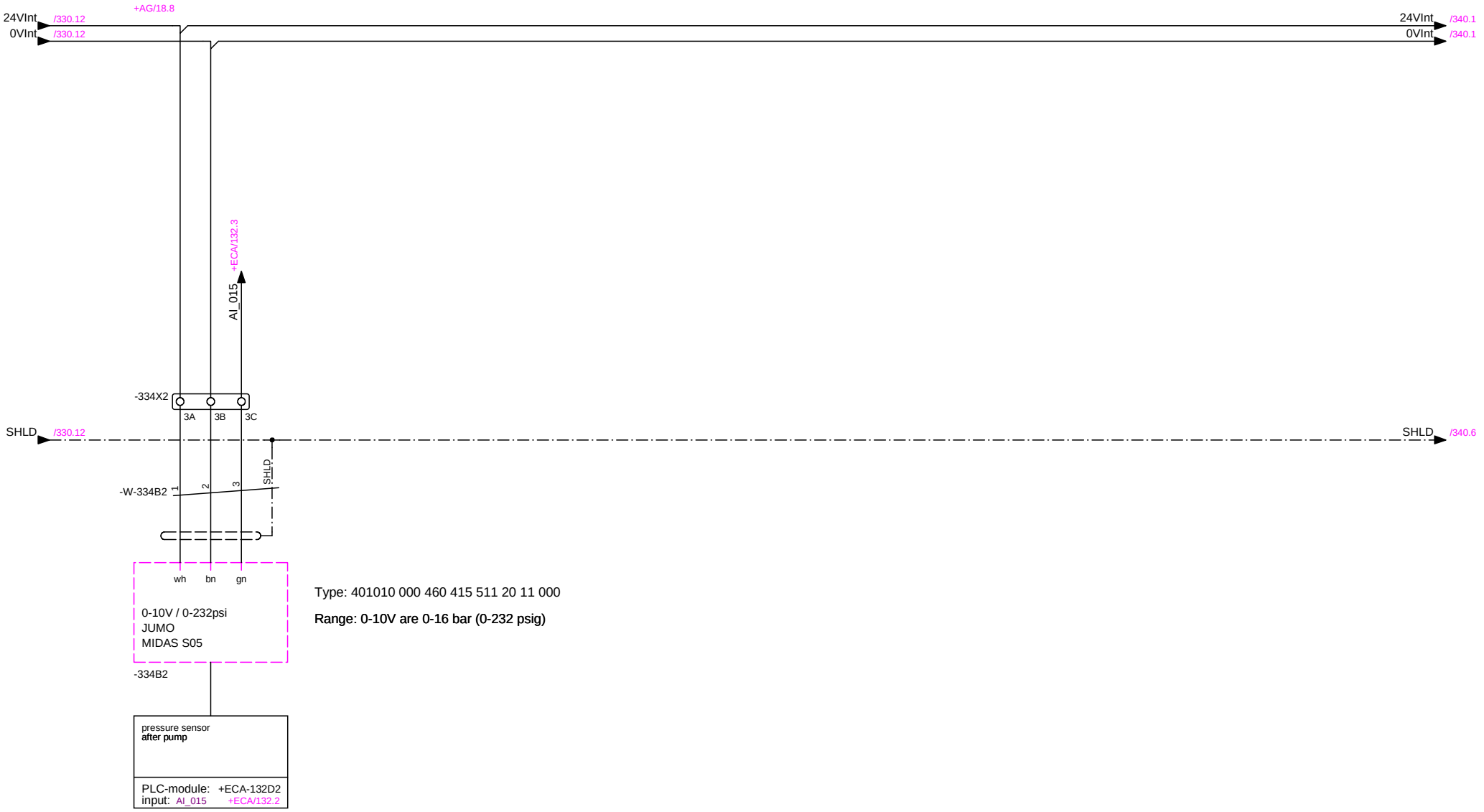
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401	temperature sensors	location: =MA+HA
State	5/8/2017	nad		T_160823_16		Sheet no. 310
Approved	12/01/2017	gei	version:	7.0	customer:	



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	control valves	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401			location: =MA+HA
State	1/17/2017	kog		T_160823_16			Sheet no. 320
Approved	12/01/2017	gei	version:	7.0	customer:		



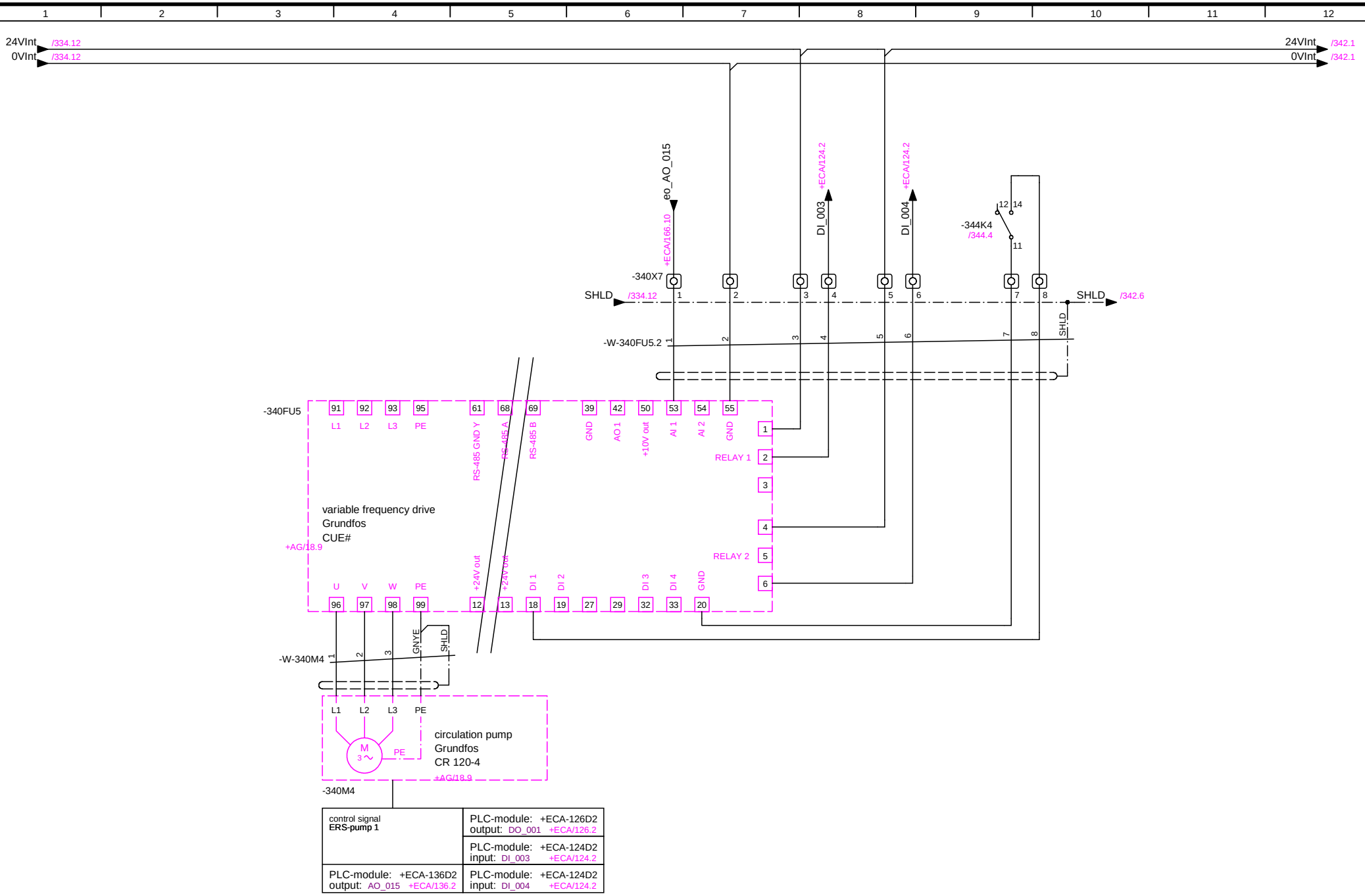
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401	pressure limit switch	location: =MA+HA
State	Edited 5/8/2017	nad		T_160823_16		Sheet no. 330
	Approved 12/01/2017	gei	version:	7.0	customer:	



Type: 401010 000 460 415 511 20 11 000

Range: 0-10V are 0-16 bar (0-232 psig)

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	pressure transmitter	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401			
State	Edited 9/3/2018	nad		T_160823_16			location: =MA+HA
	Approved 12/01/2017	gei	version:	7.0	customer:		Sheet no. 334



ECAD 3	Date	Name	commission	84160120
State	11/24/2016	kog	drawing no.:	84160120-401
State	3/31/2017	nad		T_160823_16
Approved	12/01/2017	gei	version:	7.0

University of Kentucky Research Building 2

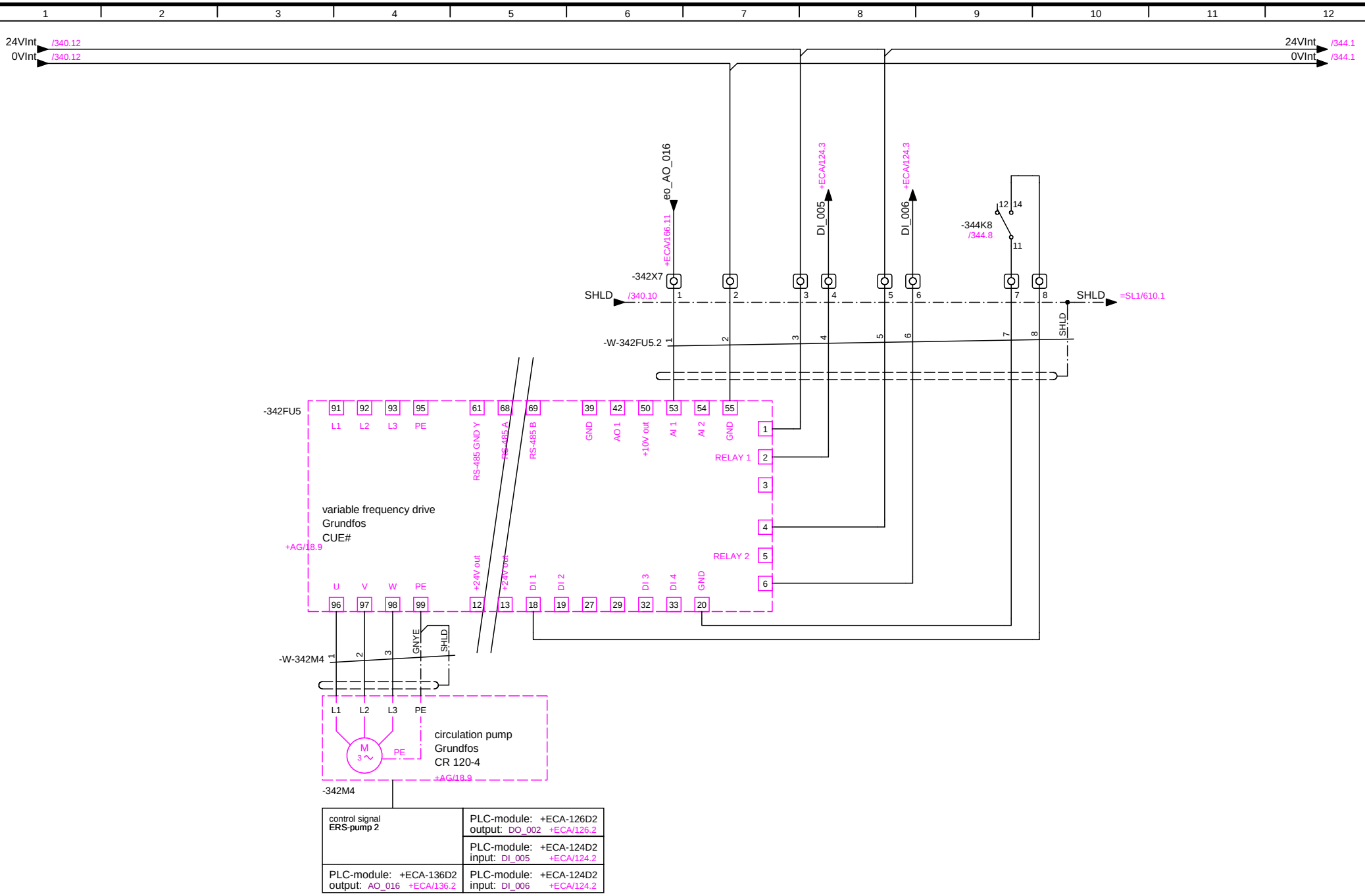
customer:

ERS-pump 1

konvekta

location: =MA+HA

Sheet no. 340



ECAD 3	Date	Name	commission	84160120
State	11/24/2016	kog	drawing no.:	84160120-401
State	Edited 3/31/2017	nad		T_160823_16
	Approved 12/01/2017	gei	version:	7.0

University of Kentucky Research Building 2

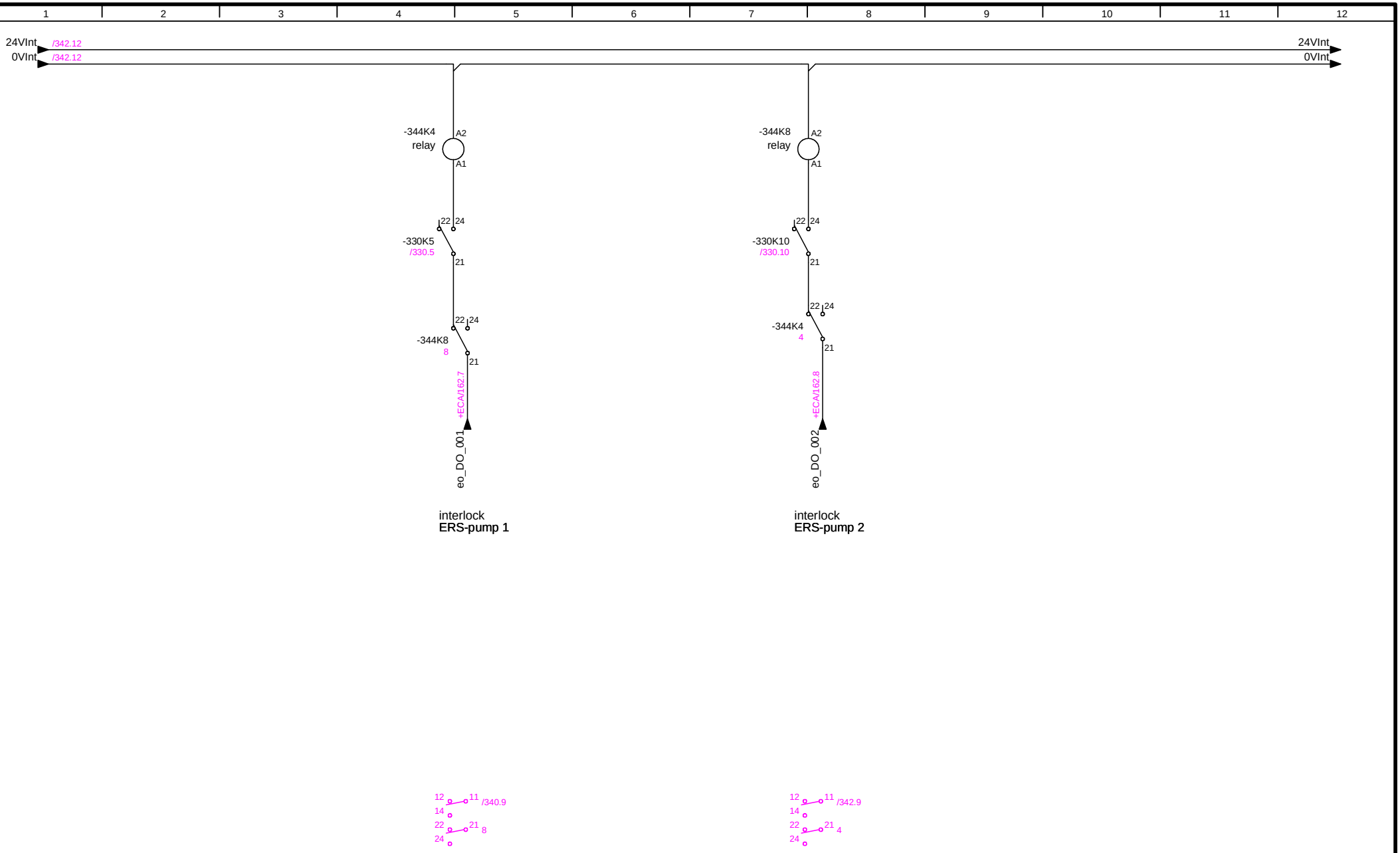
customer:

ERS-pump 2

konvekta

location: =MA+HA

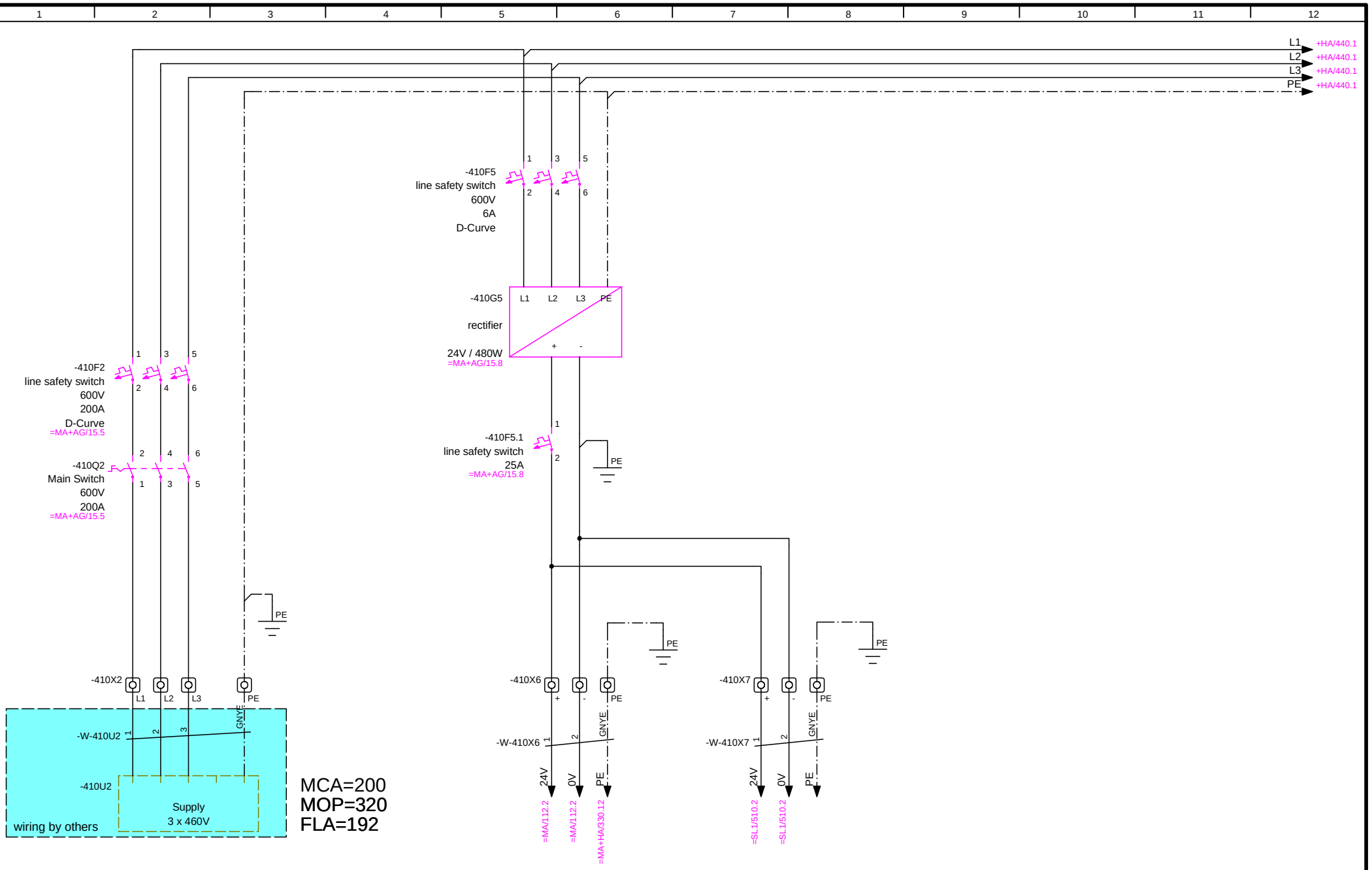
Sheet no. 342



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	pump interlock	location: =MA+HA
Approved	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 344

electrical cabinet 460V

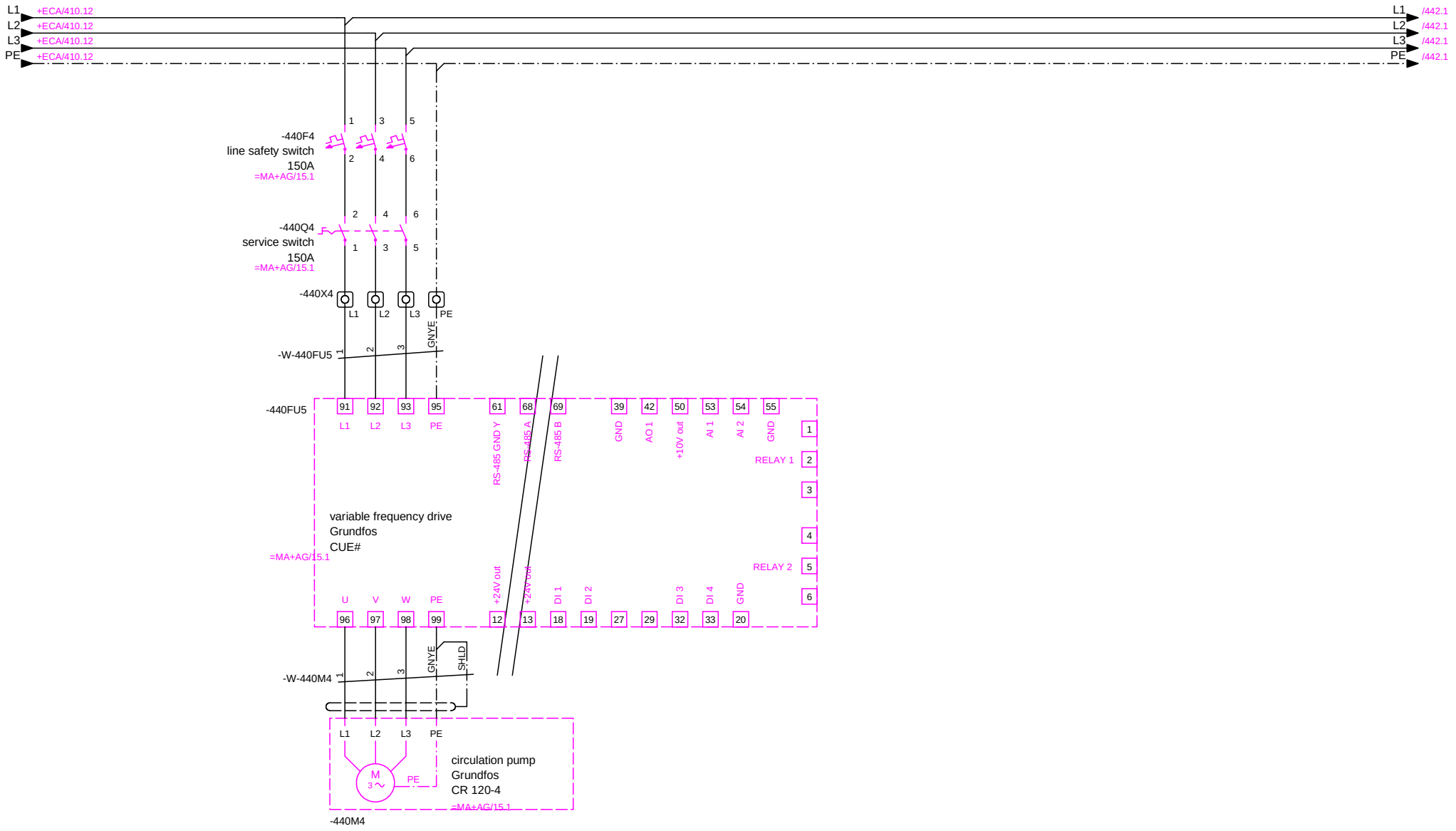
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MAIN+ECA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 400
	Approved 12/01/2017	gei	version:	7.0	customer:		



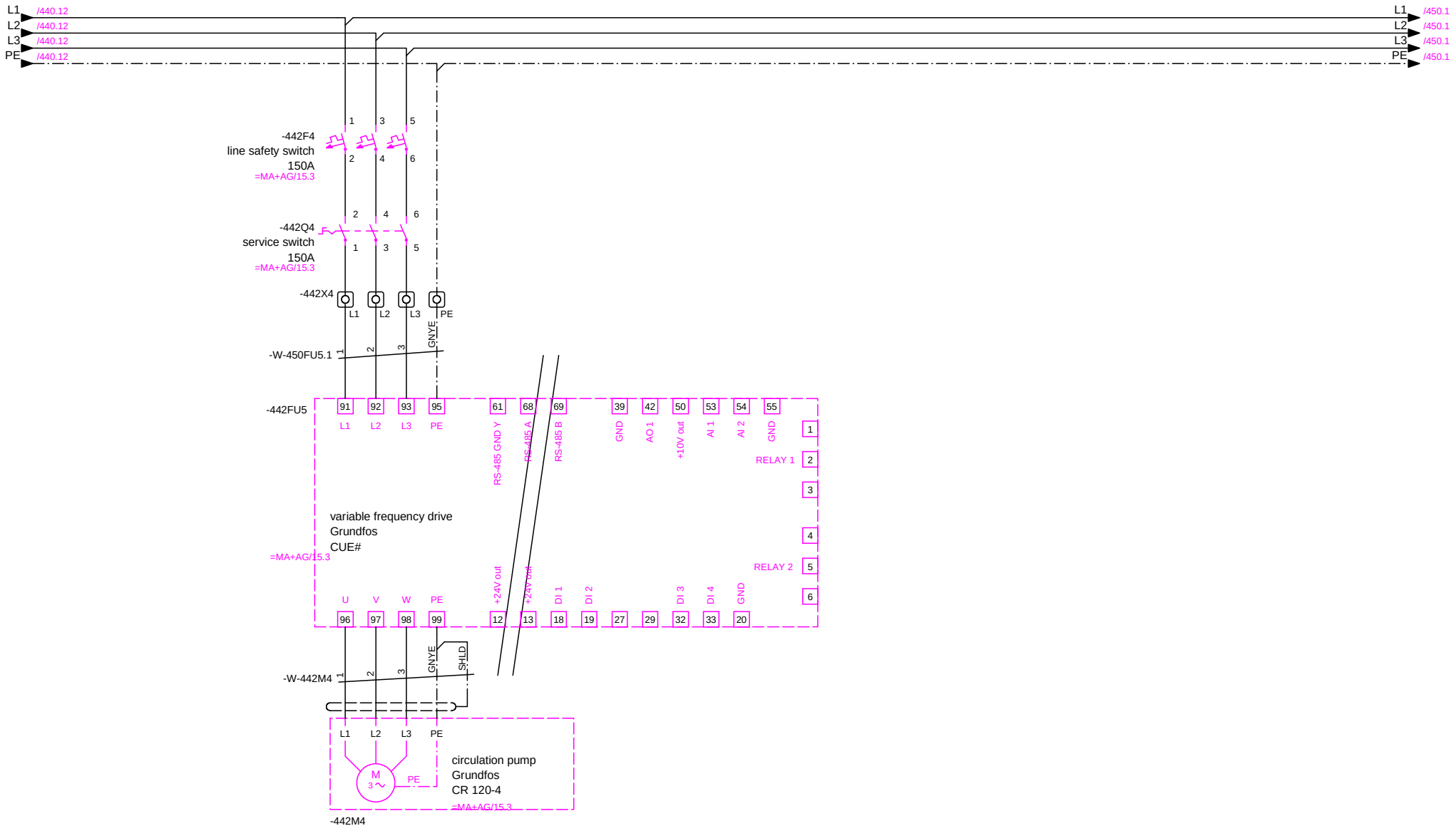
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	9/3/2018	nad		T_160823_16	Supply	location: =MAIN+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 410

hydraulic assembly

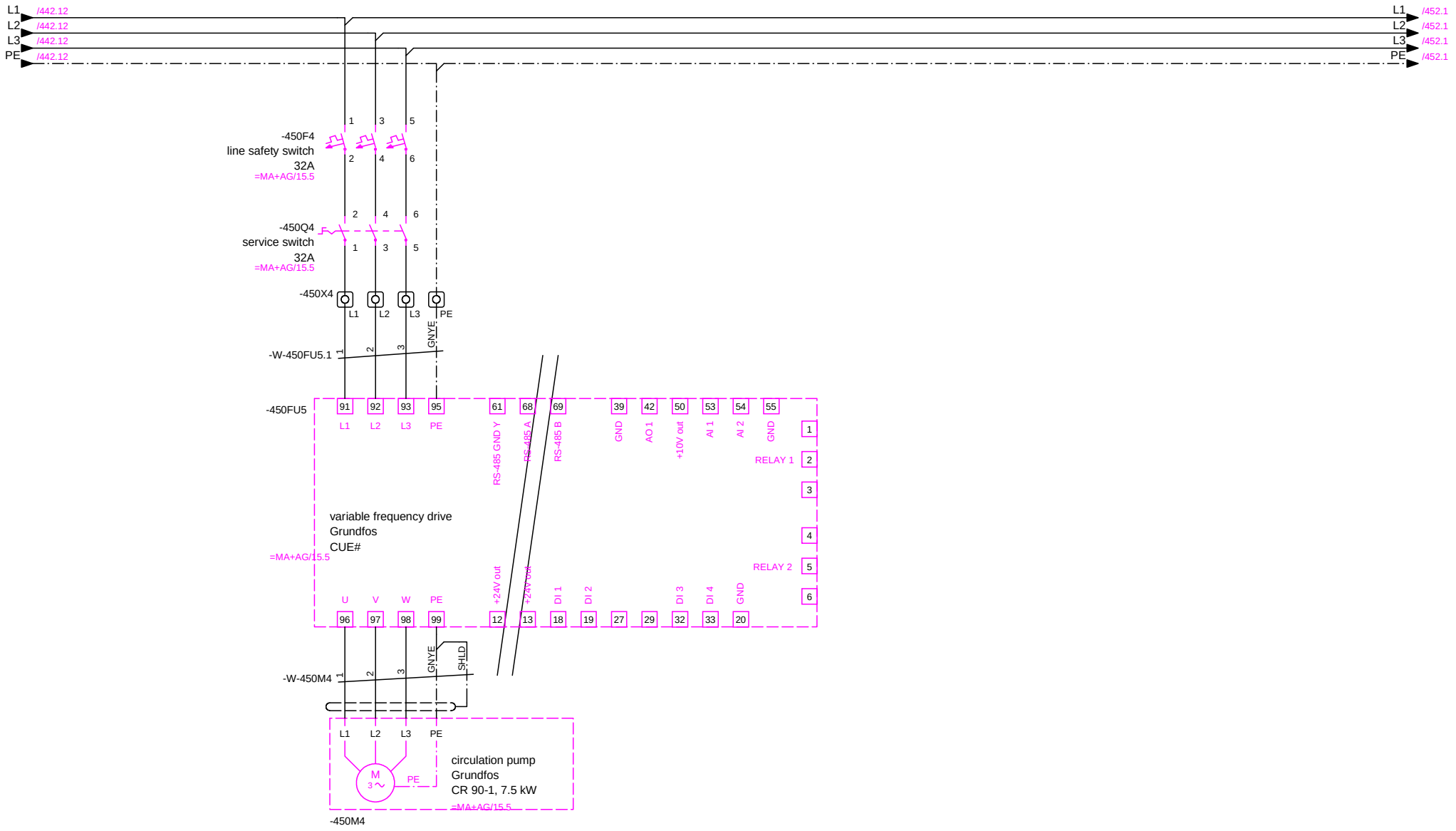
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =MAIN+HA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 420
	Approved 12/01/2017	gei	version:	7.0	customer:		



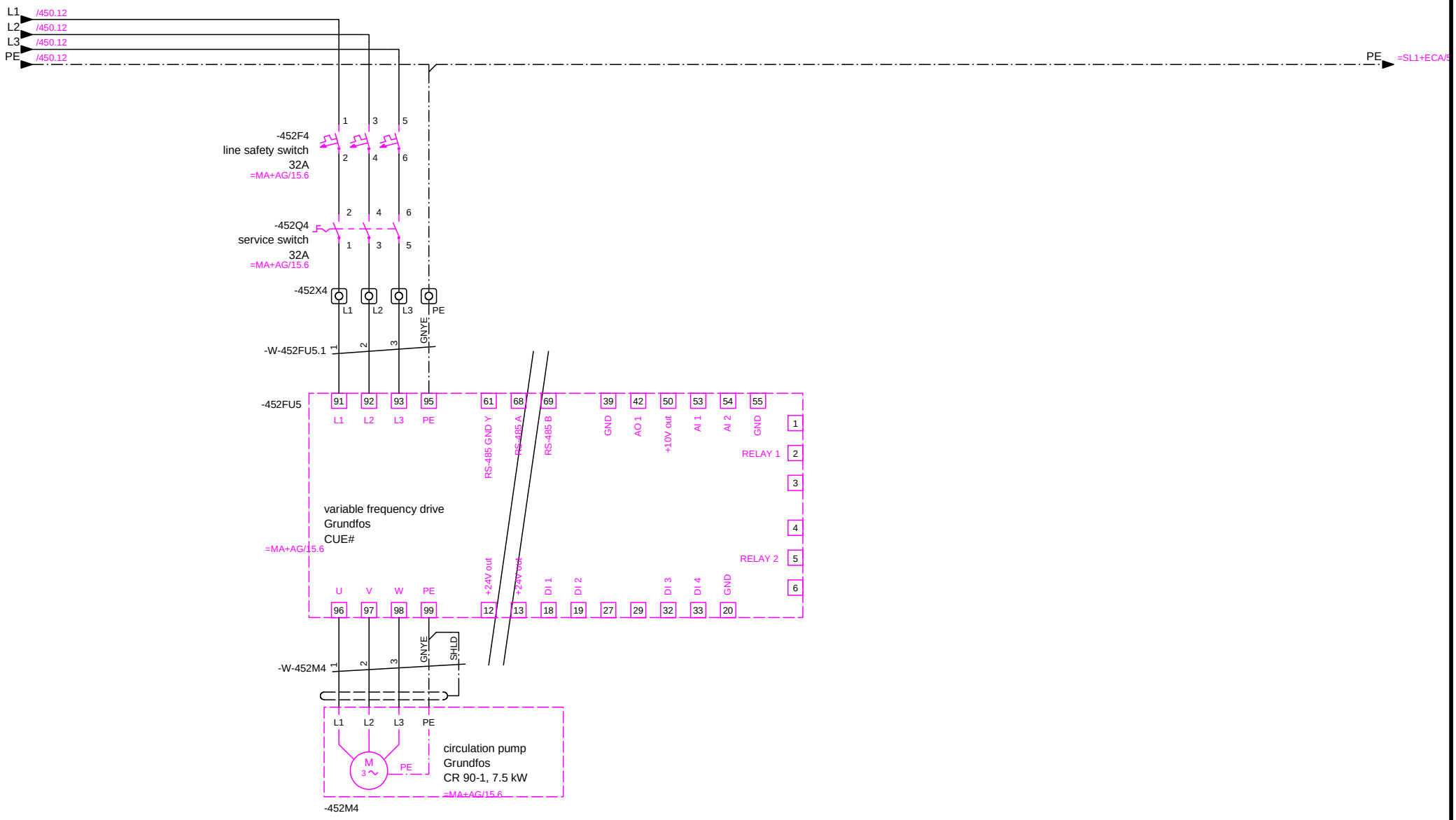
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401		
State	3/31/2017	nad		T_160823_16	ERS-pump 1	location: =MAIN+HA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 440



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	ERS-pump 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401			location: =MAIN+HA
State	Edited 3/30/2017	nad		T_160823_16			Sheet no. 442
	Approved 12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	FC-pump 1	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401			location: =MAIN+HA
State	Edited 1/17/2017	kog		T_160823_16			Sheet no. 450
	Approved 12/01/2017	gei	version:	7.0	customer:		

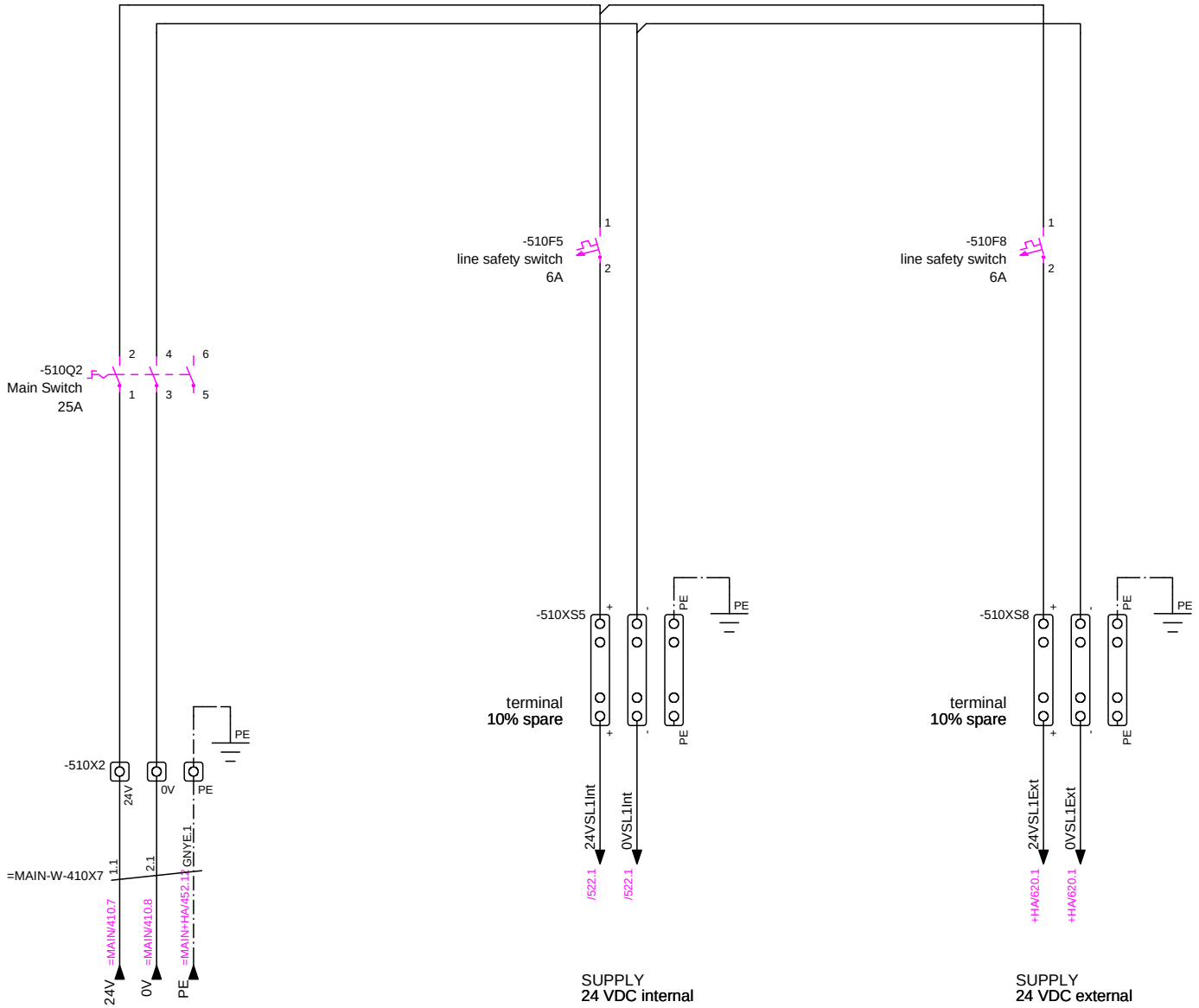


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	FC-pump 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401			location: =MAIN+HA
State	Edited 3/31/2017	nad		T_160823_16			Sheet no. 452
	Approved 12/01/2017	gei	version:	7.0	customer:		

electrical cabinet 24V

free cooling

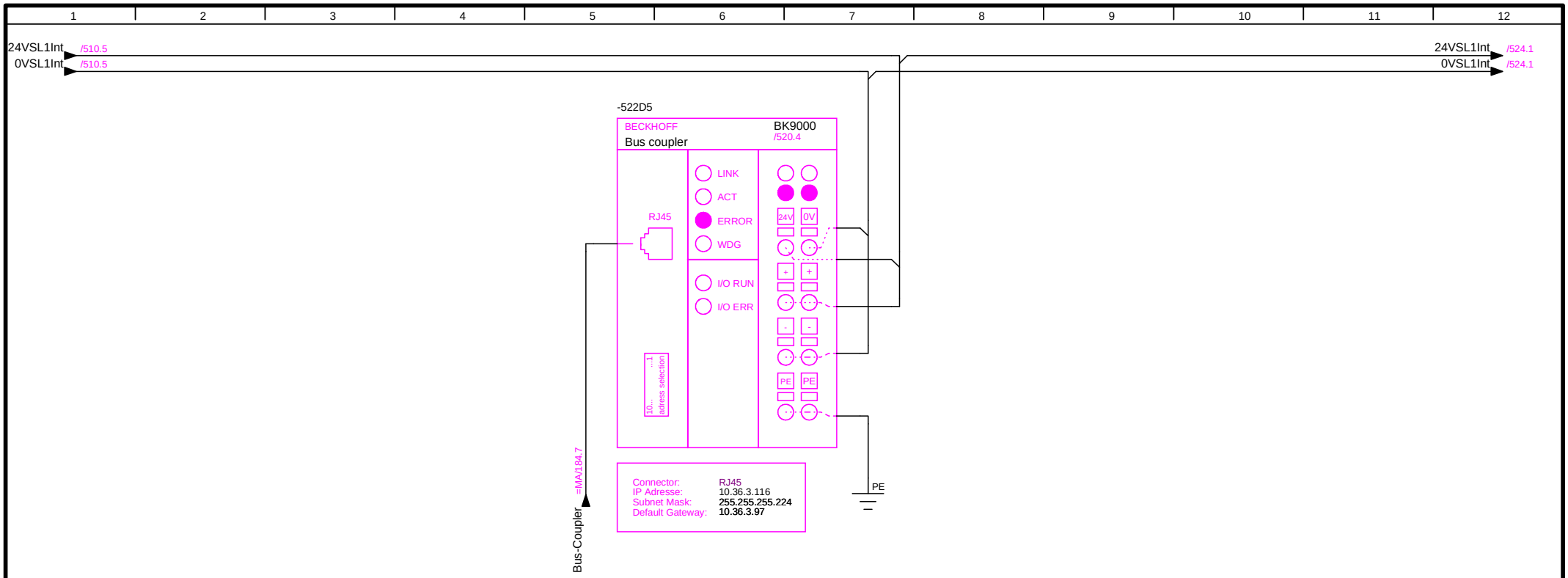
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State Edited	9/3/2018	nad		T_160823_16			Sheet no. 500
Approved	12.01.2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	Supply	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 510
	Approved 12/01/2017	gei	version:	7.0	customer:		

-522D5	-524D2	-526D2	-528D2	-530D2	-532D2	-532D6	-532D10	-534D2	-520D8
Bus coupler BK9000 522.5	8-channel digital intput terminal KL1408 524.2	8-channel digital output terminal KL2408 526.2	4-channel analog input terminal 0...10 V KL3064 528.2	4-channel analog output terminal 0...10 V KL4004 530.2	2-channel input terminal (RTD) KL3202-0028 532.2	2-channel input terminal (RTD) KL3202-0028 532.6	2-channel input terminal (RTD) KL3202-0028 532.10	2-channel input terminal (RTD) KL3202-0028 534.2	End terminal KL9010
BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF	BECKHOFF

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	PLC module overview	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State	1/17/2017	kog		T_160823_16			Sheet no. 520
Approved	12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401	bus coupler	location: =SL1+ECA
State	Edited 9/3/2018	nad		T_160823_16		Sheet no. 522
	Approved 12/01/2017	gei	version:	7.0	customer:	

1 2 3 4 5 6 7 8 9 10 11 12

24VSL1Int /522.12 — 24VSL1Int /526.1
0VSL1Int /522.12 — 0VSL1Int /526.1

-524D2

BECKHOFF
KL1408

8-channel digital intput terminal
/520.4

channel 1	channel 2	channel 3	channel 4	channel 5	channel 6	channel 7	channel 8
DI_017	DI_018	DI_019	DI_020	DI_021	DI_022	DI_023	DI_024
1-I1	5-I2	2-I3	6-I4	3-I5	7-I6	4-I7	8-I8

DI_017	DI_018	DI_019	DI_020	DI_021	DI_022	DI_023
+HA650.8	+HA650.8	+HA652.8	+HA652.8	/562.9	/564.4	+HA632.6
pump in use FC-pump 1	service FC-pump 1	pump in use FC-pump 2	service FC-pump 2	manual mode active digital modules	manual mode active analog modules	temperature switch low ahead PHE-FC

spare

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	digital inputs
State	11/11/2016	gei	drawing no.:	84160120-401		konvekta
State	Edited 1/17/2017	kog		T_160823_16		location: =SL1+ECA
	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 524

1 2 3 4 5 6 7 8 9 10 11 12

24VSL1Int /524.12 — 24VSL1Int /528.1
0VSL1Int /524.12 — 0VSL1Int /528.1

-526D2

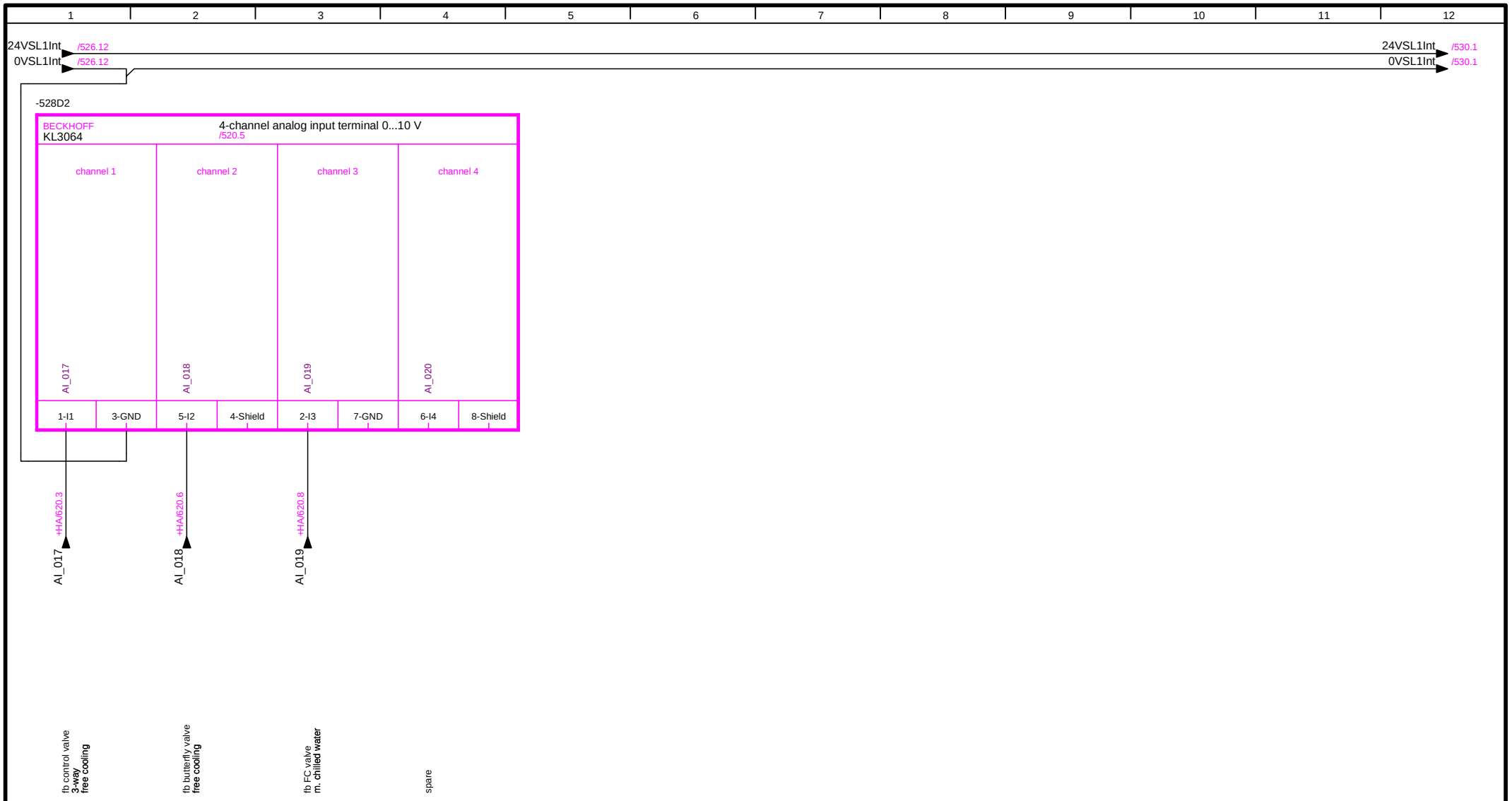
BECKHOFF
KL2408

8-channel digital output terminal
/520.5

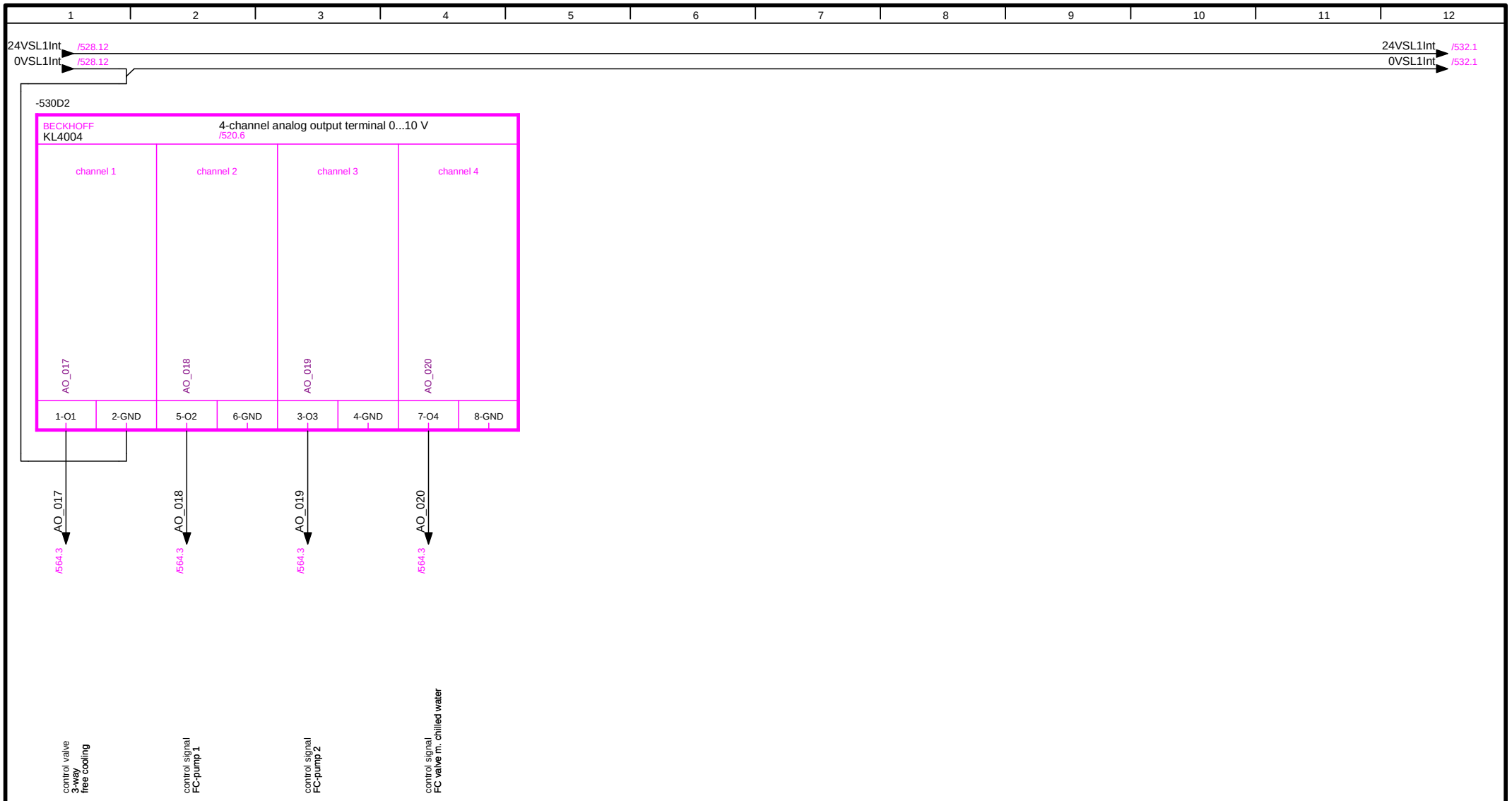
channel 1	channel 2	channel 3	channel 4	channel 5	channel 6	channel 7	channel 8
DO_009	DO_010	DO_011	DO_012	DO_013	DO_014	DO_015	DO_016
1-O1	5-O2	2-O3	6-04	3-O5	7-O6	4-O7	8-08

DO_009 /562.7 — butterfly valve free cooling
DO_010 /562.8 — request FC-pump 1
DO_011 /562.8 — request FC-pump 2
DO_012 /562.4 — watchdog emergency override modules
spare
spare
spare
spare

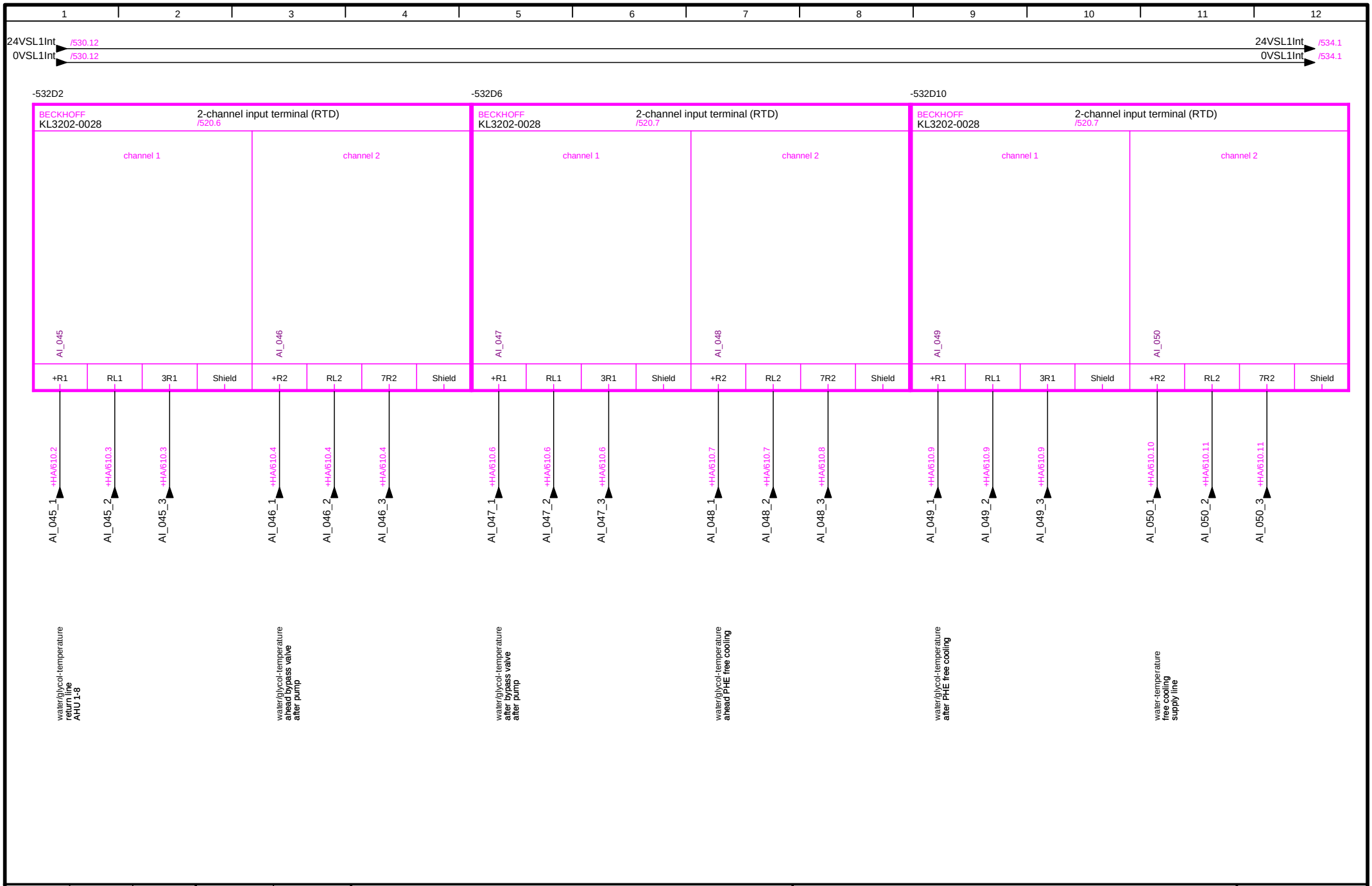
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	digital outputs	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State Edited	3/31/2017	nad		T_160823_16			Sheet no. 526
Approved	12/01/2017	gei	version:	7.0	customer:		



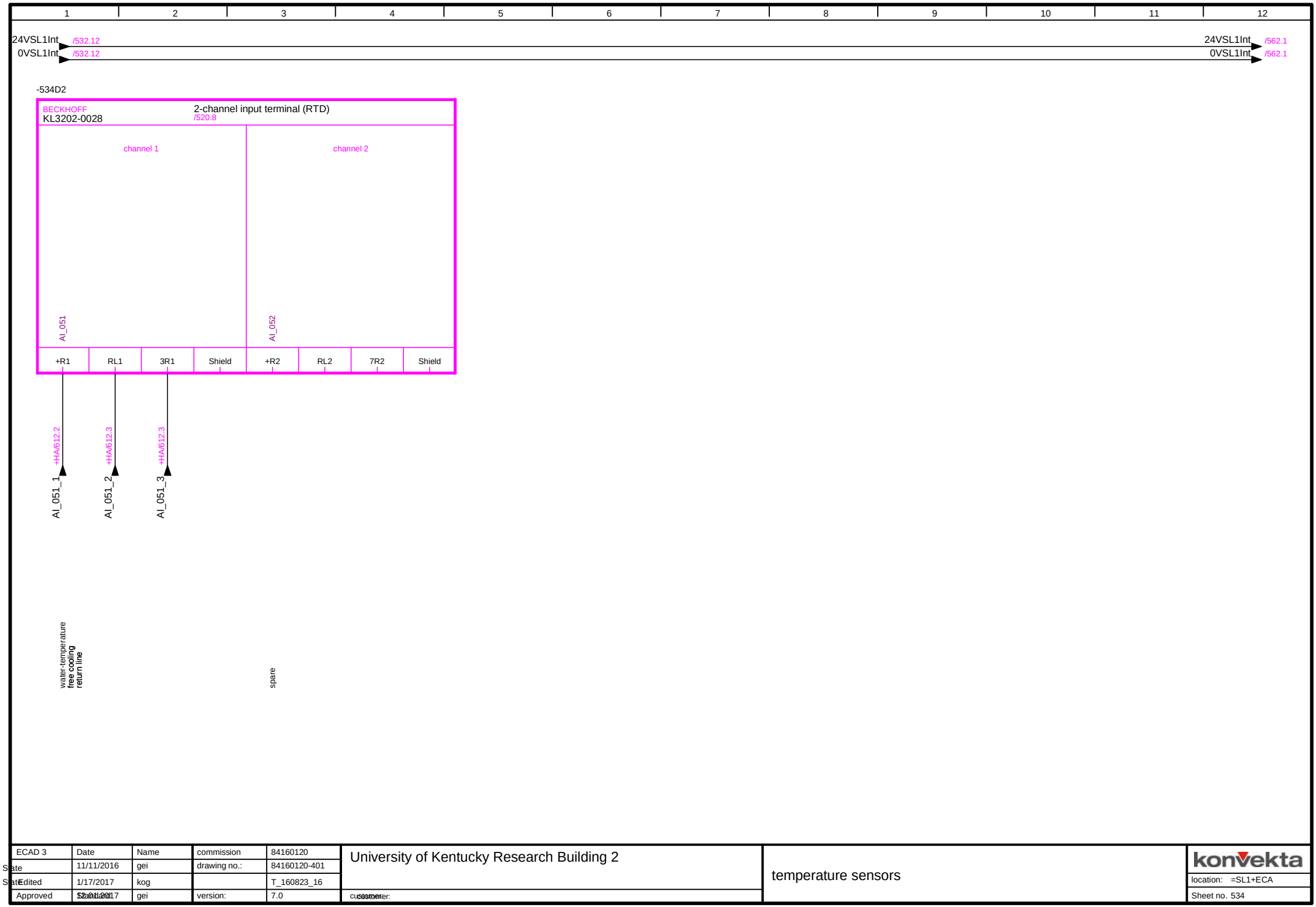
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401	analog inputs	location: =SL1+ECA
State	Edited 9/3/2018	nad		T_160823_16		Sheet no. 528
	Approved 12/01/2017	gei	version:	7.0	customer:	



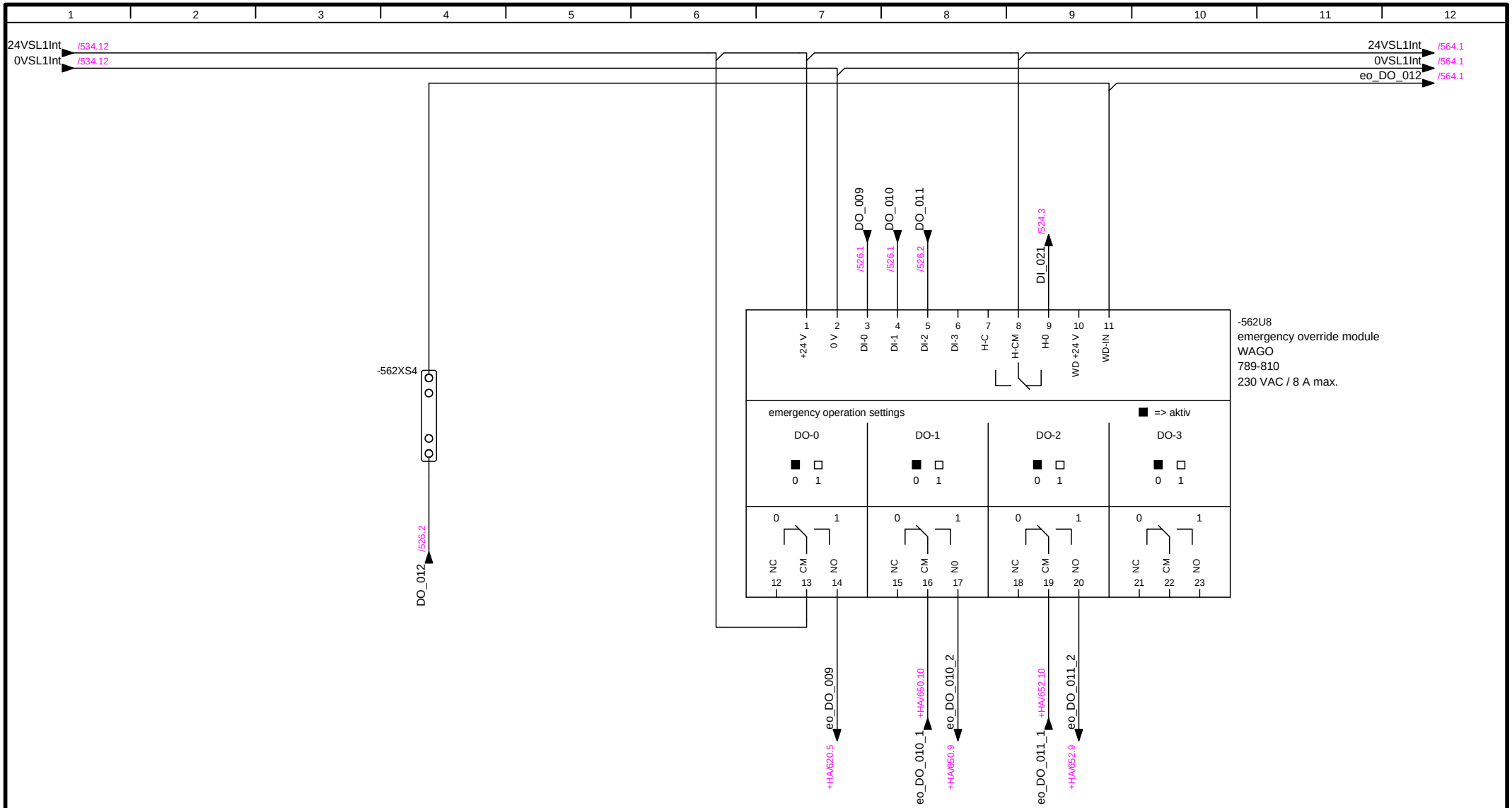
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	analog outputs	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 530
	Approved 12/01/2017	gei	version:	7.0	customer:		



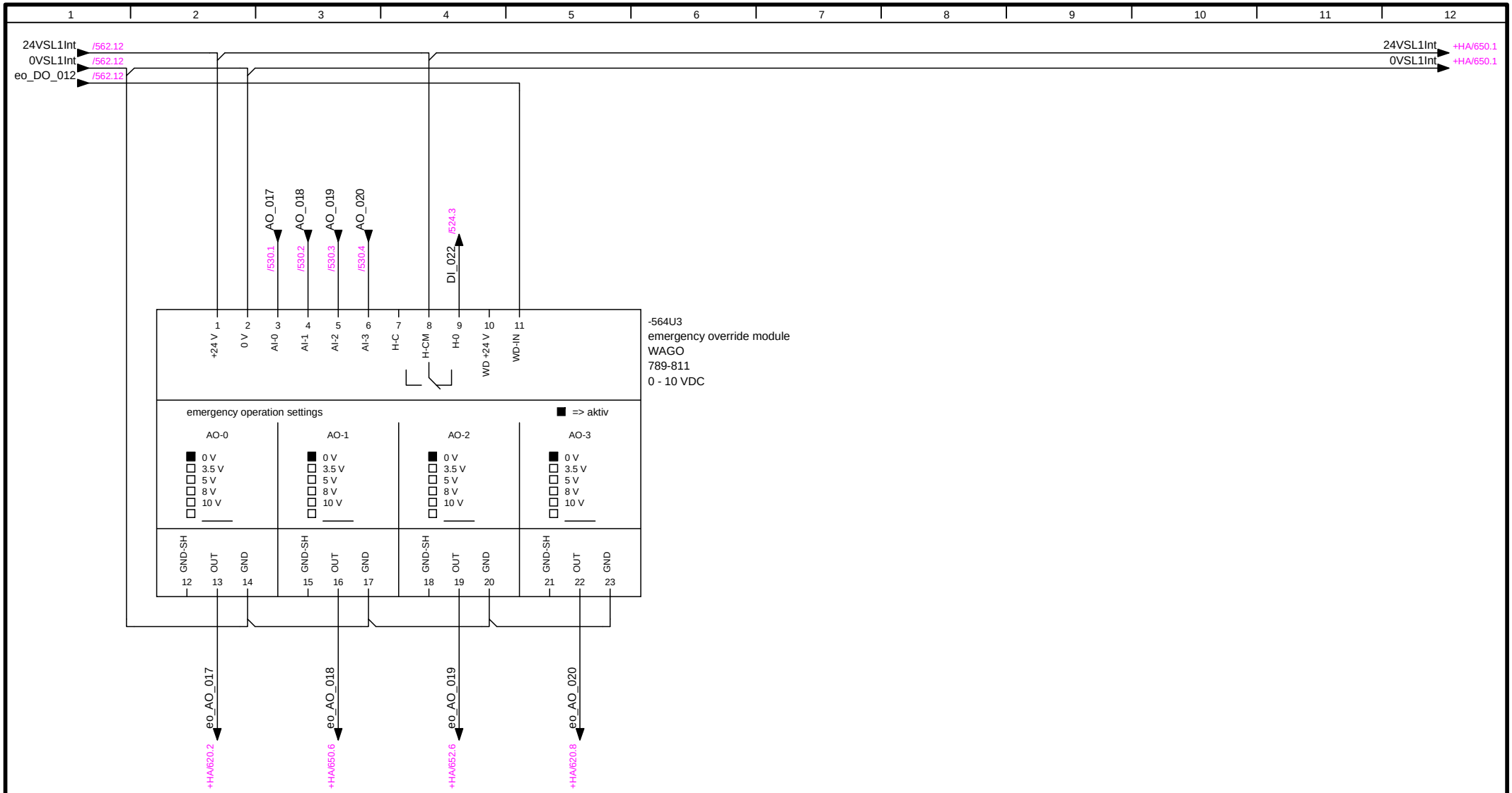
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	temperature sensors	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State	5/8/2017	nad		T_160823_16			Sheet no. 532
Approved	12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	temperature sensors	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State	Edited 1/17/2017	kog		T_160823_16			Sheet no. 534
	Approved 12/01/2017	gei	version:	7.0	customer:		



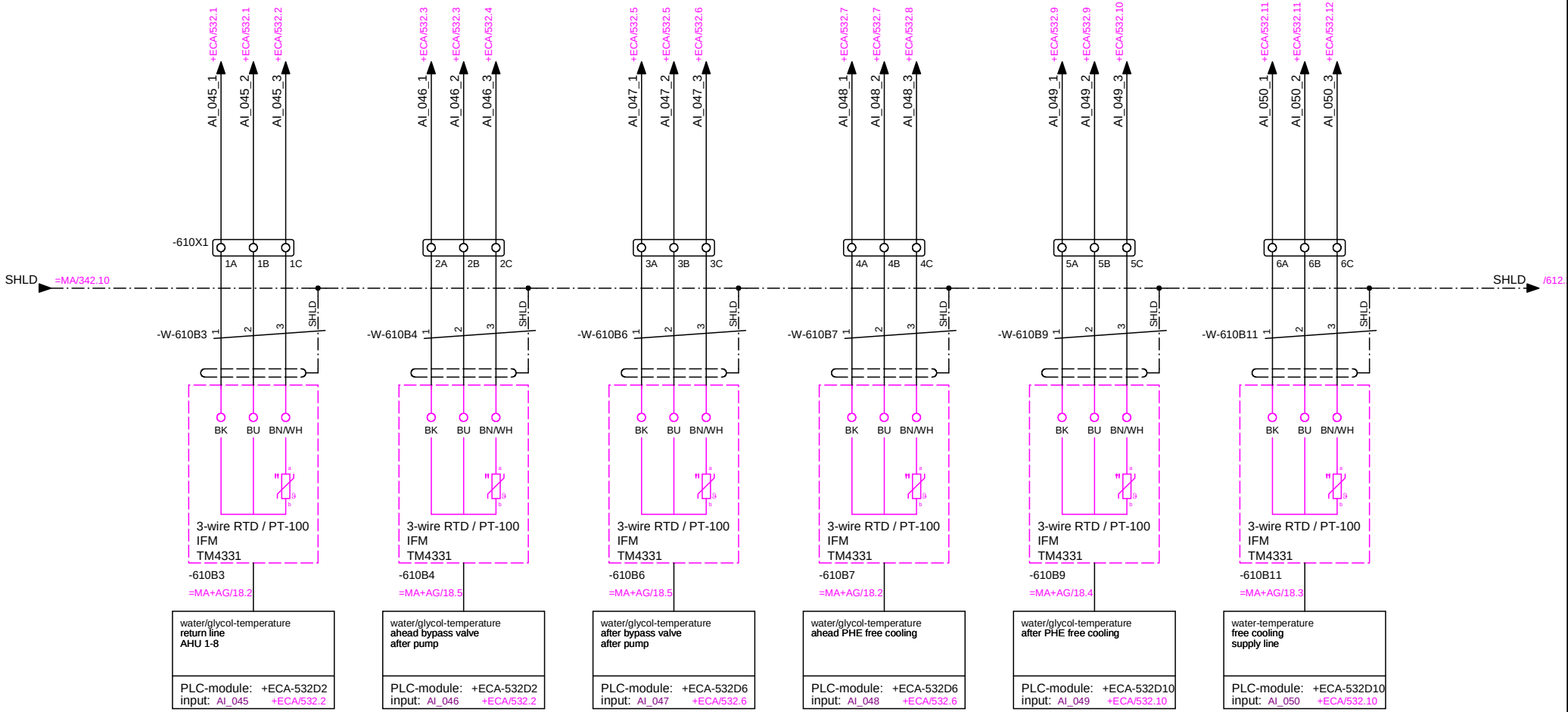
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401		
State	1/17/2017	kog		T_160823_16	emergency overwrite modules	location: =SL1+ECA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 562



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	emergency overwrite modules	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+ECA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 564
Approved	Approved 12/01/2017	gei	version:	7.0	customer:		

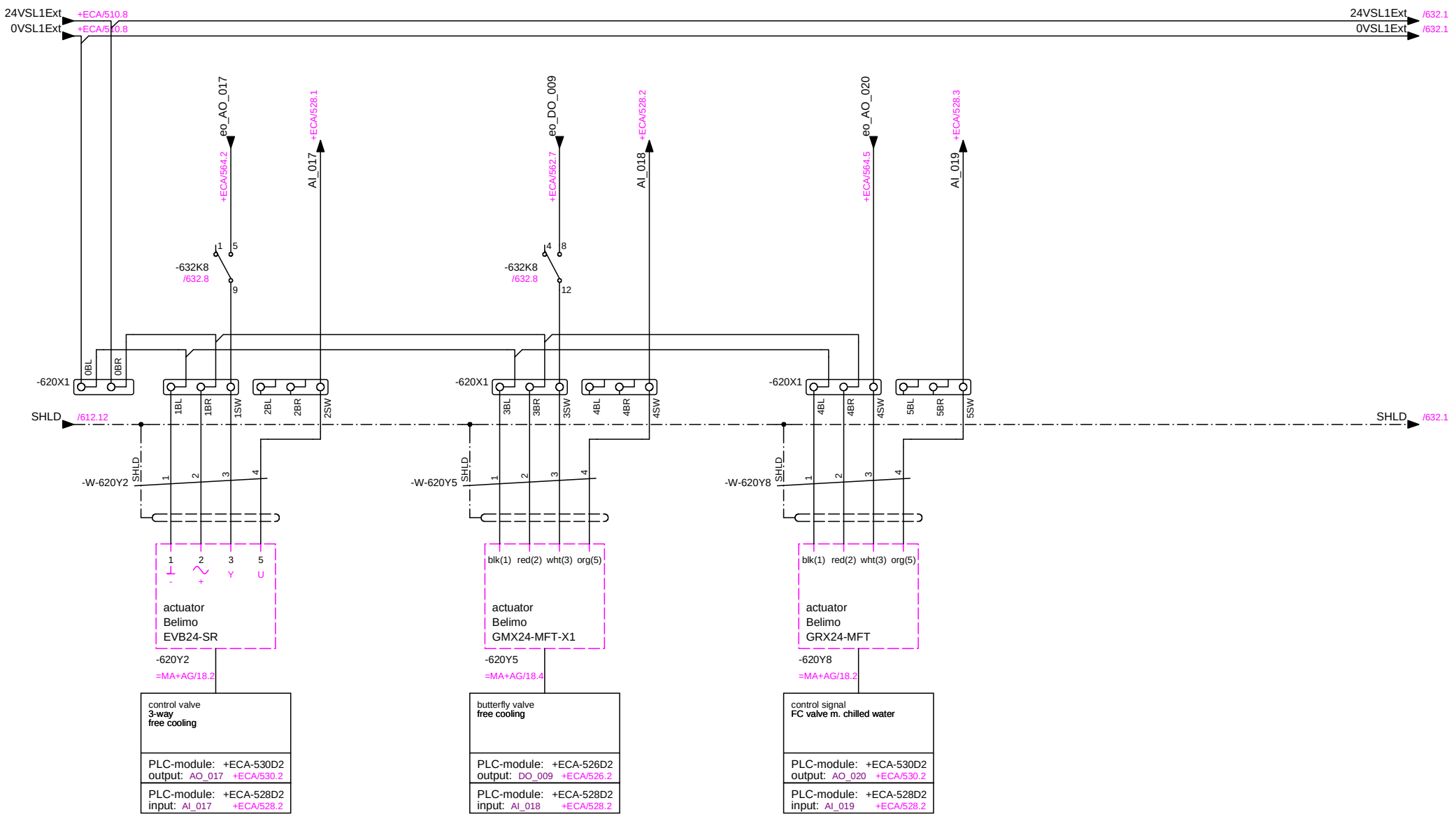
hydraulic assembly

ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	blank sheet	konvekta
State	11/11/2016	gei	drawing no.:	84160120-401			location: =SL1+HA
State	Edited 9/3/2018	nad		T_160823_16			Sheet no. 600
	Approved 12/01/2017	gei	version:	7.0	customer:		

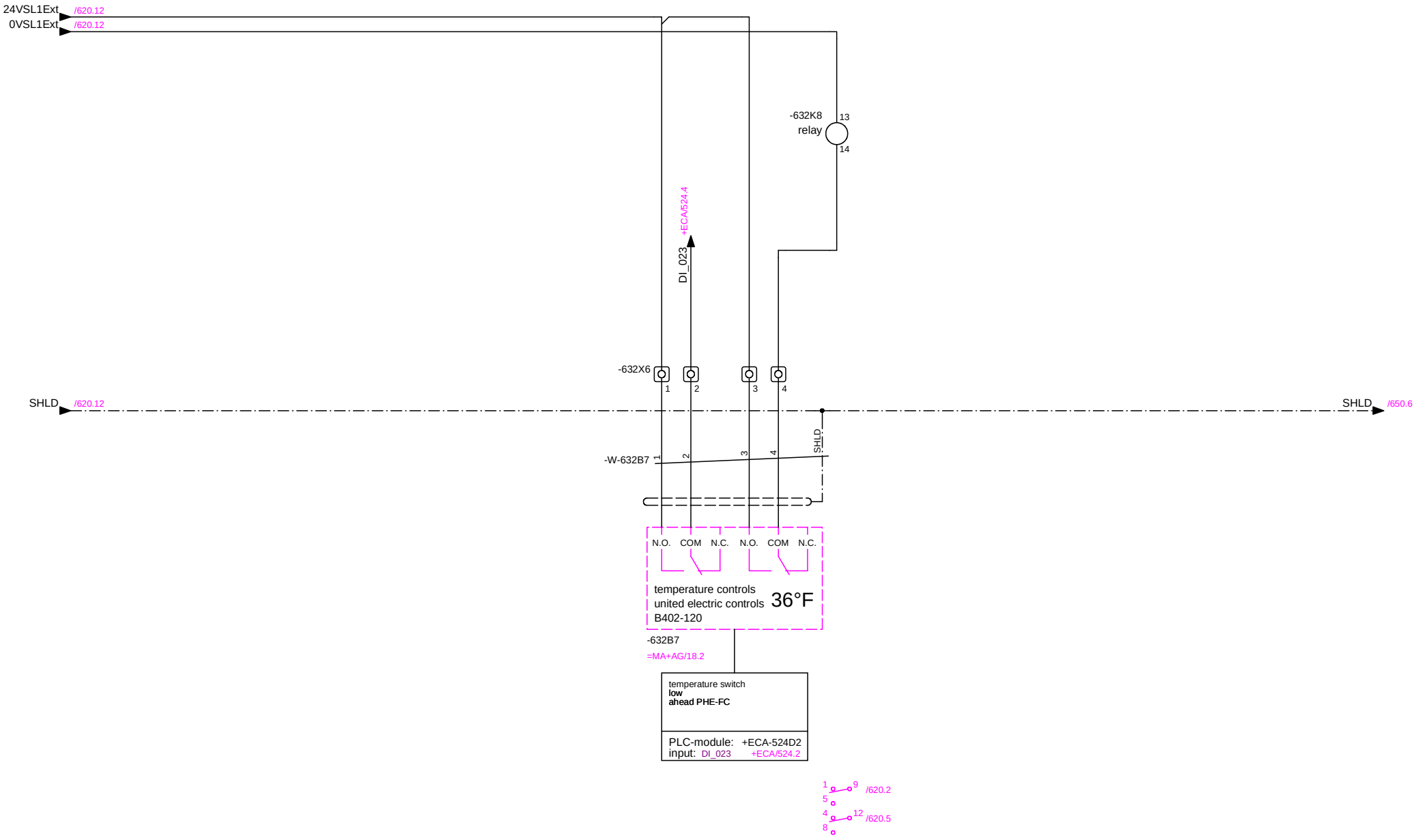


ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401		
State	Edited 5/8/2017	nad		T_160823_16	temperature sensors	location: =SL1+HA
Approved	Approved 12/01/2017	gei	version:	7.0	customer:	Sheet no. 610

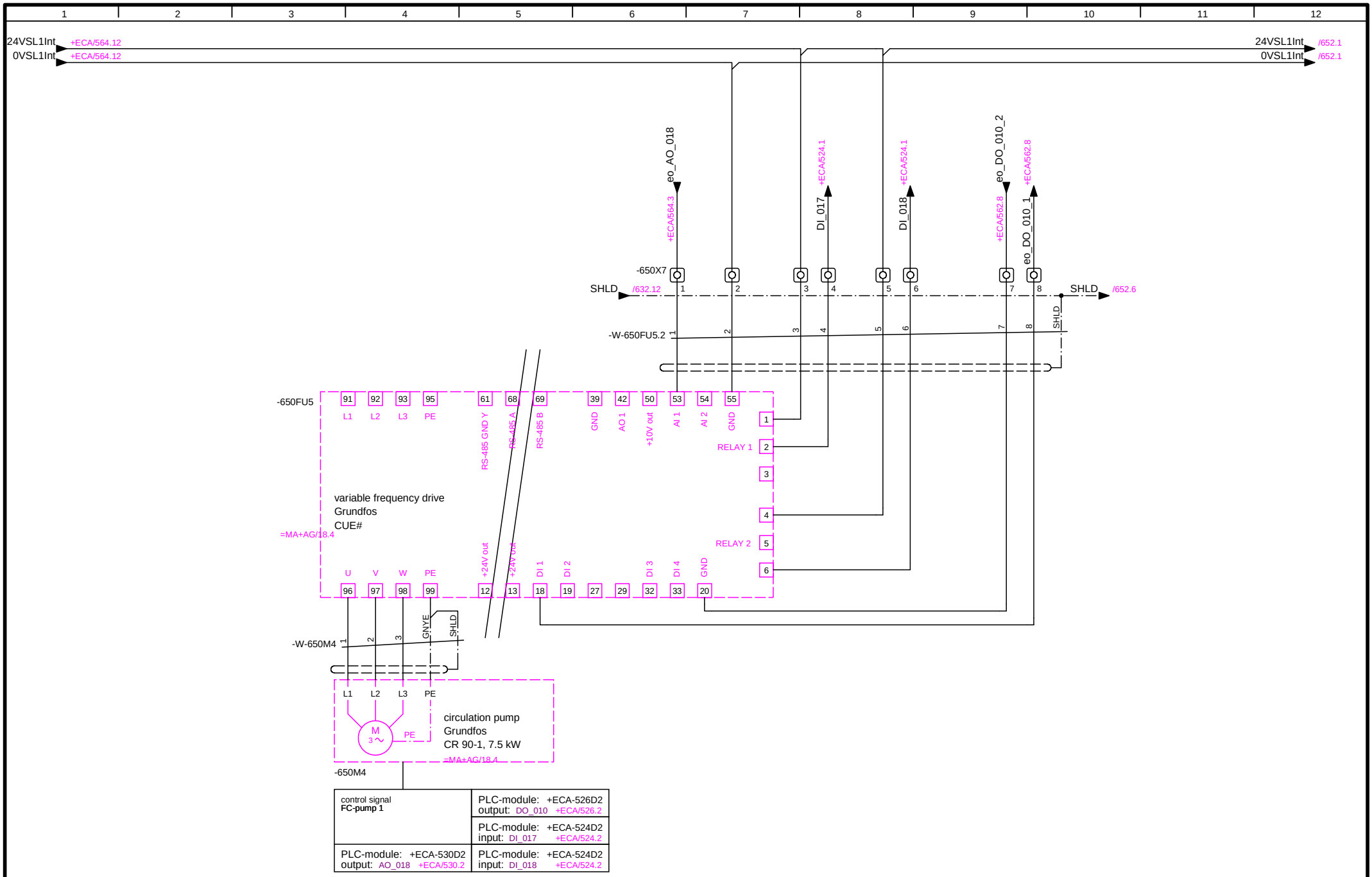
ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	temperature sensors	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401			location: =SL1+HA
State	Edited 5/8/2017	nad		T_160823_16			Sheet no. 612
Approved	Approved 12/01/2017	gei	version:	7.0	customer:		



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/28/2016	kog	drawing no.:	84160120-401	control valves	location: =SL1+HA
State	Edited 9/3/2018	nad		T_160823_16		Sheet no. 620
	Approved 12/01/2017	gei	version:	7.0	customer:	



ECAD 3	Date	Name	commission	84160120	University of Kentucky Research Building 2	konvekta
State	11/24/2016	kog	drawing no.:	84160120-401		
State	Edited 9/3/2018	nad		T_160823_16	temperature switch	location: =SL1+HA
Approved	12/01/2017	gei	version:	7.0	customer:	Sheet no. 632



ECAD 3	Date	Name	commission	84160120
State	11/24/2016	kog	drawing no.:	84160120-401
State	Edited 9/3/2018	nad		T_160823_16
	Approved 12/01/2017	gei	version:	7.0

University of Kentucky Research Building 2

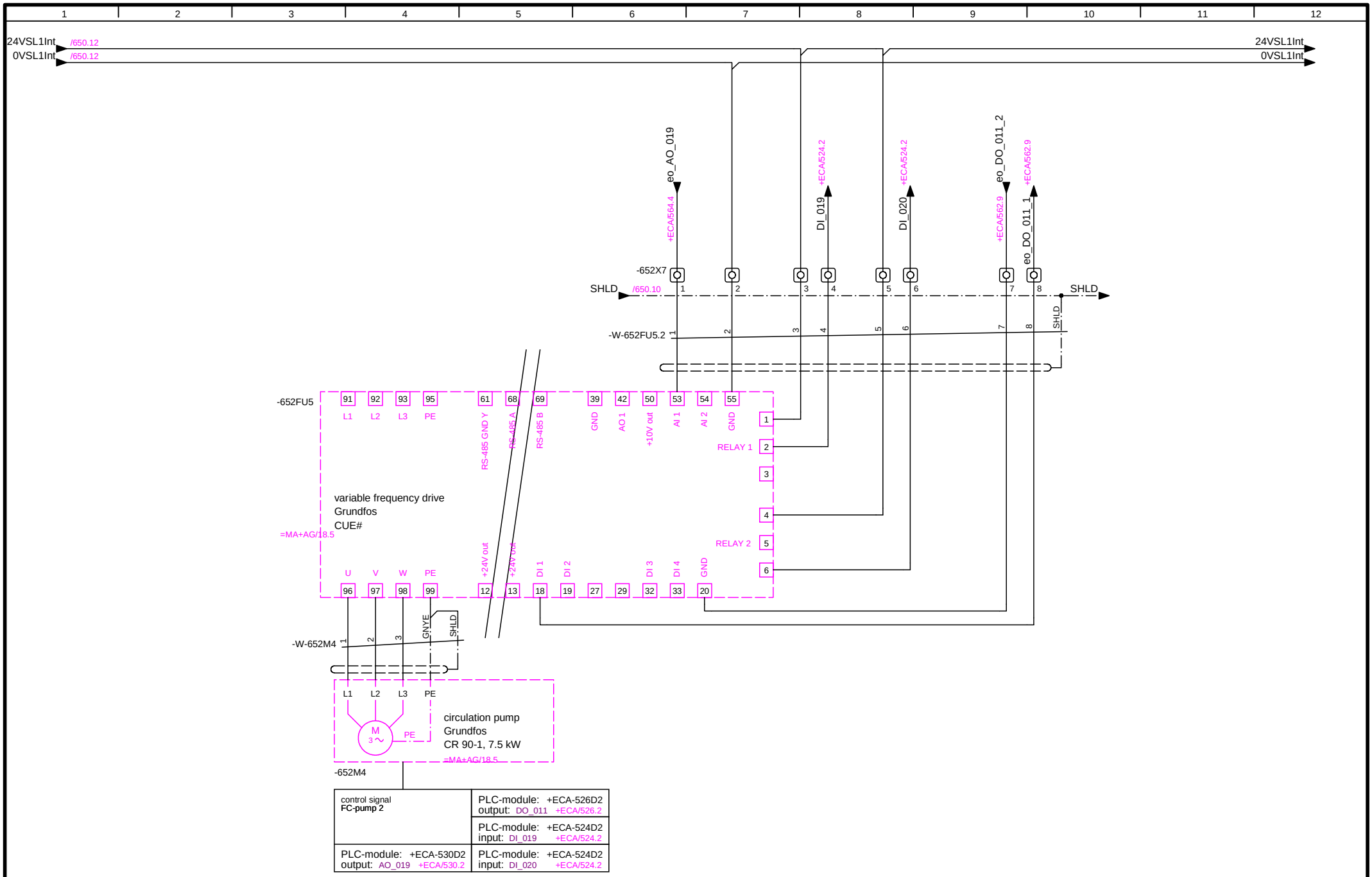
customer:

FC-pump 1

konvekta

location: =SL1+HA

Sheet no. 650



ECAD 3	Date	Name	commission	84160120
State	11/24/2016	kog	drawing no.:	84160120-401
State	Edited 9/3/2018	nad		T_160823_16
	Approved 12/01/2017	gei	version:	7.0

University of Kentucky Research Building 2

customer:

FC-pump 2

konvekta

location: =SL1+HA

Sheet no. 652

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-170GA4	3 x AWG 20 shield	SHLD		
		1	-170X4:4	-170GA4:
		2	-170X4:5	-170GA4:
		3	-170X4:6	-170GA4:
-W-184GA9	8 x AWG 22 shield	SHLD		
		1	-184GA9:	-184U6:P2
		2		
		3		
		4		
		5		
		6		
		7		
		8		

E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	konvekta
created:	9/3/2018	nad	drawing no.:	84160120-401	cable plan =MA+ECA	location: =MA+ECA
edited:	9/3/2018	nad	TAP-number:	T_160823_16		sheet no. 1
approved:	12.01.2017	gei	version:	7.0	customer:	

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-210B10	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-210X1:6A	-210B10:BK
		2	-210X1:6B	-210B10:BU
		3	-210X1:6C	-210B10:BN/WH
-W-210B3	3 x AWG 20 shield	SHLD		
		1	-210X1:1A	-210B3:gn
		2	-210X1:1B	-210B3:br
		3	-210X1:1C	-210B3:ws
-W-210B4	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-210X1:2A	-210B4:BK
		2	-210X1:2B	-210B4:BU
		3	-210X1:2C	-210B4:BN/WH
-W-210B6	3 x AWG 20 shield	SHLD		
		1	-210X1:3A	-210B6:gn
		2	-210X1:3B	-210B6:br
		3	-210X1:3C	-210B6:ws
-W-210B7	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-210X1:4A	-210B7:BK
		2	-210X1:4B	-210B7:BU
		3	-210X1:4C	-210B7:BN/WH
-W-210B9	3 x AWG 20 shield	SHLD		
		1	-210X1:5A	-210B9:gn
		2	-210X1:5B	-210B9:br
		3	-210X1:5C	-210B9:ws

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-212B10	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-212X1:6A	-212B10:BK
		2	-212X1:6B	-212B10:BU
		3	-212X1:6C	-212B10:BN/WH
-W-212B3	3 x AWG 20 shield	SHLD		
		1	-212X1:1A	-212B3:gn
		2	-212X1:1B	-212B3:br
		3	-212X1:1C	-212B3:ws
-W-212B4	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-212X1:2A	-212B4:BK
		2	-212X1:2B	-212B4:BU
		3	-212X1:2C	-212B4:BN/WH
-W-212B6	3 x AWG 20 shield	SHLD		
		1	-212X1:3A	-212B6:gn
		2	-212X1:3B	-212B6:br
		3	-212X1:3C	-212B6:ws
-W-212B7	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-212X1:4A	-212B7:BK
		2	-212X1:4B	-212B7:BU
		3	-212X1:4C	-212B7:BN/WH
-W-212B9	3 x AWG 20 shield	SHLD		
		1	-212X1:5A	-212B9:gn
		2	-212X1:5B	-212B9:br
		3	-212X1:5C	-212B9:ws

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-214B10	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-214X1:6A	-214B10:BK
		2	-214X1:6B	-214B10:BU
		3	-214X1:6C	-214B10:BN/WH
-W-214B3	3 x AWG 20 shield	SHLD		
		1	-214X1:1A	-214B3:gn
		2	-214X1:1B	-214B3:br
		3	-214X1:1C	-214B3:ws
-W-214B4	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-214X1:2A	-214B4:BK
		2	-214X1:2B	-214B4:BU
		3	-214X1:2C	-214B4:BN/WH
-W-214B6	3 x AWG 20 shield	SHLD		
		1	-214X1:3A	-214B6:gn
		2	-214X1:3B	-214B6:br
		3	-214X1:3C	-214B6:ws
-W-214B7	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-214X1:4A	-214B7:BK
		2	-214X1:4B	-214B7:BU
		3	-214X1:4C	-214B7:BN/WH
-W-214B9	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-214X1:5A	-214B9:BK
		2	-214X1:5B	-214B9:BU

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-214B9	4 x AWG 20 PE shield	3	-214X1:5C	-214B9:BN/WH
-W-216B3	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-216X1:1A	-216B3:BK
		2	-216X1:1B	-216B3:BU
		3	-216X1:1C	-216B3:BN/WH
-W-216B4	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-216X1:2A	-216B4:BK
		2	-216X1:2B	-216B4:BU
		3	-216X1:2C	-216B4:BN/WH
-W-220Y2	4 x AWG 18 shield	SHLD		
		1	-220X1:1BL	-220Y2:1
		2	-220X1:1BR	-220Y2:2
		3	-220X1:1SW	-220Y2:3
		4	-220X1:2SW	-220Y2:5
-W-220Y4	4 x AWG 18 shield	SHLD		
		1	-220X1:3BL	-220Y4:1
		2	-220X1:3BR	-220Y4:2
		3	-220X1:3SW	-220Y4:3
		4	-220X1:4SW	-220Y4:5
-W-220Y6	4 x AWG 13 shield	SHLD		
		1	-220X1:5BL	-220Y6:1
		2	-220X1:5BR	-220Y6:2
		3	-220X1:5SW	-220Y6:3
		4	-220X1:6SW	-220Y6:5
-W-220Y7	4 x AWG 13 shield	SHLD		

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-220Y7	4 x AWG 13 shield	1	-220X1:7BL	-220Y7:1
		2	-220X1:7BR	-220Y7:2
		3	-220X1:7SW	-220Y7:3
		4	-220X1:8SW	-220Y7:5
-W-222Y2	4 x AWG 18 shield	SHLD		
		1	-222X1:1BL	-222Y2:1
		2	-222X1:1BR	-222Y2:2
		3	-222X1:1SW	-222Y2:3
		4	-222X1:2SW	-222Y2:5
-W-222Y4	4 x AWG 18 shield	SHLD		
		1	-222X1:3BL	-222Y4:1
		2	-222X1:3BR	-222Y4:2
		3	-222X1:3SW	-222Y4:3
		4	-222X1:4SW	-222Y4:5
-W-222Y6	4 x AWG 18 shield	SHLD		
		1	-222X1:5BL	-222Y6:1
		2	-222X1:5BR	-222Y6:2
		3	-222X1:5SW	-222Y6:3
		4	-222X1:6SW	-222Y6:5
-W-222Y7	4 x AWG 18 shield	SHLD		
		1	-222X1:7BL	-222Y7:1
		2	-222X1:7BR	-222Y7:2
		3	-222X1:7SW	-222Y7:3
		4	-222X1:8SW	-222Y7:5
-W-224Y2	4 x AWG 18 shield	SHLD		
		1	-224X1:1BL	-224Y2:1
		2	-224X1:1BR	-224Y2:2

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-224Y2	4 x AWG 18 shield	3	-224X1:1SW	-224Y2:3
		4	-224X1:2SW	-224Y2:5
-W-224Y4	4 x AWG 18 shield	SHLD		
		1	-224X1:3BL	-224Y4:1
		2	-224X1:3BR	-224Y4:2
		3	-224X1:3SW	-224Y4:3
		4	-224X1:4SW	-224Y4:5
-W-224Y6	4 x AWG 18 shield	SHLD		
		1	-224X1:5BL	-224Y6:1
		2	-224X1:5BR	-224Y6:2
		3	-224X1:5SW	-224Y6:3
		4	-224X1:6SW	-224Y6:5
-W-224Y7	4 x AWG 18 shield	SHLD		
		1	-224X1:7BL	-224Y7:1
		2	-224X1:7BR	-224Y7:2
		3	-224X1:7SW	-224Y7:3
		4	-224X1:8SW	-224Y7:5

E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	konvekta
created:	9/3/2018	nad	drawing no.:	84160120-401	cable plan =MA+EXT	location: =MA+EXT
edited:	9/3/2018	nad	TAP-number:	T_160823_16		sheet no. 6
approved:	12.01.2017	gei	version:	7.0	customer:	

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W330B8	3 x AWG 20 PE shield	SHLD		
		GNYE	-330X1:PE	-330B8:PE
		1	-330X1:3	-330B8:4
		2	-330X1:4	-330B8:1
-W-310B2	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-310X1:1A	-310B2:BK
		2	-310X1:1B	-310B2:BU
		3	-310X1:1C	-310B2:BN/WH
-W-310B4	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-310X1:2A	-310B4:BK
		2	-310X1:2B	-310B4:BU
		3	-310X1:2C	-310B4:BN/WH
-W-310B5	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-310X1:3A	-310B5:BK
		2	-310X1:3B	-310B5:BU
		3	-310X1:3C	-310B5:BN/WH
-W-310B7	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-310X1:4A	-310B7:BK
		2	-310X1:4B	-310B7:BU
		3	-310X1:4C	-310B7:BN/WH
-W-320Y2	4 x AWG 18 shield	SHLD		
		1	-320X1:1BL	-320Y2:1
		2	-320X1:1BR	-320Y2:2

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-320Y2	4 x AWG 18 shield	3	-320X1:1SW	-320Y2:3
		4	-320X1:2SW	-320Y2:5
-W-320Y4	4 x AWG 18 shield	SHLD		
		1	-320X1:3BL	-320Y4:1
		2	-320X1:3BR	-320Y4:2
		3	-320X1:3SW	-320Y4:3
		4	-320X1:4SW	-320Y4:5
-W-330B3	3 x AWG 20 PE shield	SHLD		
		GNYE	-330X1:PE	-330B3:PE
		1	-330X1:1	-330B3:4
		2	-330X1:2	-330B3:1
-W-334B2	3 x AWG 20 shield	SHLD		
		1	-334X2:3A	-334B2:wh
		2	-334X2:3B	-334B2:bn
		3	-334X2:3C	-334B2:gn
-W-340FU5.2	12 x AWG 20 shield	SHLD		
		1	-340X7:1	-340FU5:53
		2	-340X7:2	-340FU5:55
		3	-340X7:3	-340FU5:1
		4	-340X7:4	-340FU5:2
		5	-340X7:5	-340FU5:4
		6	-340X7:6	-340FU5:6
		7	-340X7:7	-340FU5:20
		8	-340X7:8	-340FU5:18
		9		
		10		
		11		

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-340FU5.2	12 x AWG 20 shield	12		
-W-340M4	4 x AWG 6 PE shield	SHLD		-340M4:
		GNYE	-340M4:PE	-340FU5:99
		1	-340M4:L1	-340FU5:96
		2	-340M4:L2	-340FU5:97
		3	-340M4:L3	-340FU5:98
-W-342FU5.2	12 x AWG 20 shield	SHLD		
		1	-342X7:1	-342FU5:53
		2	-342X7:2	-342FU5:55
		3	-342X7:3	-342FU5:1
		4	-342X7:4	-342FU5:2
		5	-342X7:5	-342FU5:4
		6	-342X7:6	-342FU5:6
		7	-342X7:7	-342FU5:20
		8	-342X7:8	-342FU5:18
		9		
		10		
		11		
		12		
-W-342M4	4 x AWG 6 PE shield	SHLD		-342M4:
		GNYE	-342M4:PE	-342FU5:99
		1	-342M4:L1	-342FU5:96
		2	-342M4:L2	-342FU5:97
		3	-342M4:L3	-342FU5:98

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-410U2	4 x AWG 10 PE	GNYE	-410X2:PE	-410U2:
		1	-410X2:L1	-410U2:
		2	-410X2:L2	-410U2:
		3	-410X2:L3	-410U2:
-W-410X6	3 x AWG 8 PE	GNYE	-410X6:PE	-410X7:PE
		1	-410X6:+	-410X7:+
		2	-410X6:-	-410X7:-
		GNYE	=MA-112X2:PE	=MA-112XS7:PE
		1	=MA-112X2:24V	-410X6:+
		2	=MA-112X2:0V	-410X6:-
-W-410X7	3 x AWG 8 PE	GNYE	-410X7:PE	-410G5:PE
		1	=SL1-510X2:24V	-410X7:+
		2	=SL1-510X2:0V	-410X7:-
		GNYE	=SL1-510X2:PE	+HA-452X4:PE
		1	=SL1-510X2:24V	-410X7:+
		2	=SL1-510X2:0V	-410X7:-

E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	konvekta
created:	9/3/2018	nad	drawing no.:	84160120-401	cable plan =MAIN+ECA	location: =MAIN+ECA
edited:	9/3/2018	nad	TAP-number:	T_160823_16		
approved:	12.01.2017	gei	version:	7.0	customer:	sheet no. 1

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-440FU5	4 x AWG 4/0 PE	GNYE	-440X4:PE	-440FU5:95
		1	-440X4:L1	-440FU5:91
		2	-440X4:L2	-440FU5:92
		3	-440X4:L3	-440FU5:93
-W-440M4	4 x AWG 6 PE shield	SHLD	-440M4:PE	
		GNYE	-440FU5:99	-440M4:PE
		1	-440M4:L1	-440FU5:96
		2	-440M4:L2	-440FU5:97
		3	-440M4:L3	-440FU5:98
-W-442M4	4 x AWG 8 PE shield	SHLD	-442M4:PE	
		GNYE	-442FU5:99	-442M4:PE
		1	-442M4:L1	-442FU5:96
		2	-442M4:L2	-442FU5:97
		3	-442M4:L3	-442FU5:98
-W-450FU5.1	4 x AWG 4/0 PE	GNYE	-450X4:PE	-450FU5:95
		1	-450X4:L1	-450FU5:91
		2	-450X4:L2	-450FU5:92
		3	-450X4:L3	-450FU5:93
-W-450M4	4 x AWG 8 PE shield	SHLD	-450M4:PE	
		GNYE	-450FU5:99	-450M4:PE
		1	-450M4:L1	-450FU5:96
		2	-450M4:L2	-450FU5:97
		3	-450M4:L3	-450FU5:98
-W-452FU5.1	4 x AWG 8 PE	GNYE	-452X4:PE	-452FU5:95
		1	-452X4:L1	-452FU5:91
		2	-452X4:L2	-452FU5:92
		3	-452X4:L3	-452FU5:93

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-452M4	4 x AWG 8 PE shield	SHLD		-452M4:
		GNYE	-452M4:PE	-452FU5:99
		1	-452M4:L1	-452FU5:96
		2	-452M4:L2	-452FU5:97
		3	-452M4:L3	-452FU5:98

E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	konvekta
created:	9/3/2018	nad	drawing no.:	84160120-401	cable plan =MAIN+HA	location: =MAIN+HA
edited:	9/3/2018	nad	TAP-number:	T_160823_16		sheet no. 2
approved:	12.01.2017	gei	version:	7.0	customer:	

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W612B3	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-612X1:1A	-612B3:BK
		2	-612X1:1B	-612B3:BU
		3	-612X1:1C	-612B3:BN/WH
-W-610B11	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-610X1:6A	-610B11:BK
		2	-610X1:6B	-610B11:BU
		3	-610X1:6C	-610B11:BN/WH
-W-610B3	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-610X1:1A	-610B3:BK
		2	-610X1:1B	-610B3:BU
		3	-610X1:1C	-610B3:BN/WH
-W-610B4	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-610X1:2A	-610B4:BK
		2	-610X1:2B	-610B4:BU
		3	-610X1:2C	-610B4:BN/WH
-W-610B6	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-610X1:3A	-610B6:BK
		2	-610X1:3B	-610B6:BU
		3	-610X1:3C	-610B6:BN/WH
-W-610B7	4 x AWG 20 PE shield	SHLD		
		GNYE		

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-610B7	4 x AWG 20 PE shield	1	-610X1:4A	-610B7:BK
		2	-610X1:4B	-610B7:BU
		3	-610X1:4C	-610B7:BN/WH
-W-610B9	4 x AWG 20 PE shield	SHLD		
		GNYE		
		1	-610X1:5A	-610B9:BK
		2	-610X1:5B	-610B9:BU
		3	-610X1:5C	-610B9:BN/WH
-W-620Y2	4 x AWG 18 shield	SHLD		
		1	-620X1:1BL	-620Y2:1
		2	-620X1:1BR	-620Y2:2
		3	-620X1:1SW	-620Y2:3
		4	-620X1:2SW	-620Y2:5
-W-620Y5	5 x AWG 18 shield	SHLD		
		1	-620X1:3BL	-620Y5:blk(1)
		2	-620X1:3BR	-620Y5:red(2)
		3	-620X1:3SW	-620Y5:wht(3)
		4	-620X1:4SW	-620Y5:org(5)
		5		
-W-620Y8	4 x AWG 20 shield	SHLD		
		1	-620X1:4BL	-620Y8:blk(1)
		2	-620X1:4BR	-620Y8:red(2)
		3	-620X1:4SW	-620Y8:wht(3)
		4	-620X1:5SW	-620Y8:org(5)
-W-632B7	5 x AWG 20 shield	SHLD		
		1	-632X6:1	-632B7:N.O.
		2	-632X6:2	-632B7:COM

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-632B7	5 x AWG 20 shield	3	-632X6:3	-632B7:N.O.
		4	-632X6:4	-632B7:COM
		5		
-W-650FU5.2	12 x AWG 20 shield	SHLD		
		1	-650X7:1	-650FU5:53
		2	-650X7:2	-650FU5:55
		3	-650X7:3	-650FU5:1
		4	-650X7:4	-650FU5:2
		5	-650X7:5	-650FU5:4
		6	-650X7:6	-650FU5:6
		7	-650X7:7	-650FU5:20
		8	-650X7:8	-650FU5:18
		9		
		10		
		11		
		12		
-W-650M4	4 x AWG 12 PE shield	SHLD		-650M4:
		GNYE	-650M4:PE	-650FU5:99
		1	-650M4:L1	-650FU5:96
		2	-650M4:L2	-650FU5:97
		3	-650M4:L3	-650FU5:98
-W-652FU5.2	12 x AWG 20 shield	SHLD		
		1	-652X7:1	-652FU5:53
		2	-652X7:2	-652FU5:55
		3	-652X7:3	-652FU5:1
		4	-652X7:4	-652FU5:2
		5	-652X7:5	-652FU5:4

Note: the specifications on the wiring diagram are only minimum requirements.The named cable types are examples. Take regard to local requirements and the effective conditions on site. (cable lenght, laying, ...)

cable	cable type	wire	well	drain
-W-652FU5.2	12 x AWG 20 shield	6	-652X7:6	-652FU5:6
		7	-652X7:7	-652FU5:20
		8	-652X7:8	-652FU5:18
		9		
		10		
		11		
		12		
-W-652M4	4 x AWG 12 PE shield	SHLD		-652M4:
		GNYE	-652M4:PE	-652FU5:99
		1	-652M4:L1	-652FU5:96
		2	-652M4:L2	-652FU5:97
		3	-652M4:L3	-652FU5:98

E-CAD V3	date	name	commission	84160120	University of Kentucky Research Building 2	konvekta
created:	9/3/2018	nad	drawing no.:	84160120-401	cable plan =SL1+HA	location: =SL1+HA
edited:	9/3/2018	nad	TAP-number:	T_160823_16		
approved:	12.01.2017	gei	version:	7.0	customer:	sheet no. 4

Sequence of Operation

Heat Recovery System
84160120-401
University of Kentucky RB 2

Created

Company:	Name:	Date:
Konvekta AG	Neu	08.08.2011

Checked:

Company:	Name:	Date:
Konvekta AG	Bue	22.10.2014

Approved

Company:	Name:	Date:	Sign:
		Klicken Sie hier, um ein Datum einzugeben.	
		Klicken Sie hier, um ein Datum einzugeben.	

DOCUMENTATION HISTORY:

Version:	Changes:	changed by	valid date	replaced version
1	created	Kog	01.12.2016	-

Content

1 Introduction

1.1 Objective

This guide describes the components of the heat recovery system. The document also contains the necessary information for installation and operation. It is also used for the care and maintenance of heat recovery systems as a reference.

1.2 Audience

This guide is intended for operators, maintenance personnel and installers of heat recovery systems.

1.3 Special Notes

Danger of injury! If instructions are not followed and correctly executed it may result in injury.

Caution! Risk of damage to the equipment! If instructions are not followed and executed correctly, it may cause damage to the equipment.

Important: Indicates important information which will ensure a trouble-free and optimal operation.

1.4 Objective

This functional specification defines how the automatic control system of the Heat Recovery System with air handling units operates.

1.5 Scope

The functional specification with attachments applies to the project University of Kentucky RB 2.

1.6 Abbreviations

Abbr.	Description	Explanation
AF	**A**ir **F**ilter	An air filter is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mold, and bacteria from the air.
AHU	**A**ir **H**andling **U**nit	An air handler, or air handling unit is a device used to condition and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system.
	Air **V**olume	Rate of airflow, normally expressed in cubic feet per minute (cfm) or cubic meter per hour (m^3/h).
BAS	**B**uilding **A**utomation **S**ystem	A computer-based control system installed in buildings System that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems.
BCS	**B**uilding **C**ontrol **S**ystem	A computer-based control system installed in buildings System that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems.
BMS	**B**uilding **M**anagement **S**ystem	A computer-based control system installed in buildings System that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems.
	Bypass	A pipe used to convey fluid to or around another pipe.
CC	**C**ooling **C**oil	A heat exchanger for efficient heat transfer from one medium to another. The cooling coil is supplied by chilled water to cool down the air.
CPU	**C**entral **P**rocessing **U**nit	The part of a computer that interprets and executes instructions.
CW	**C**ooling **W**ater	Energy contained in cold water used to supplement energy recovery.
DB	**D**ry **B**ulb Temperature	The temperature of air measured by a thermometer freely exposed to the air but shielded from radiation of moisture.
	Diabatic **c**ooling	The process of cooling air by adding humidification.
	Dehumidification	The process to remove atmospheric moisture.
DP	**D**ew **P**oint	The atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can from.
DU	**D**emister **U**nit	Device for separating/removing liquid droplets from gases or vapors.
EA	**E**xhaust **A**ir	Commonly known as return air. The air mechanically removed from a building.
ECA	**E**lectrical **Ca**binet	An electrical cabinet is an enclosure for electrical or electronic equipment.
EHRC	**E**xhaust **H**eat **R**ecovery **C**oil	A heat exchanger in the exhaust air handling unit for efficient heat transfer from one medium to another.
ERC	**E**nergy **R**ecovery **C**oil	Energy Recovery Heat Exchanger
ERS	**E**nergy **R**ecovery **S**ystem	A system to reclaim and recycle waste heat from other sources, such as building exhaust air, in order to reduce the need for the primary energy source.
FA	**Fa**n	A fan is a machine used to create flow within a fluid, typically a gas such as air.

FC	**F**ree **C**ooling	An economical method of using low external air temperatures to assist in chilling water that can be used in mechanical processes.
FL	**Fl**ap	A flap is used to shut off air handling units or parts of it
HC	**H**eating **C**oil	A heat exchanger for efficient heat transfer from one medium to another. The heating coil is supplied by hot water to warm up the air.
HM	**H**ydronic **M**odule	Prefabricated unit containing mechanical equipment, controls, valves and sensors.
HRC	**H**eat **R**ecovery **C**oil	A heat exchanger in the air handling unit for efficient heat transfer from one medium to another.
HRS	**H**eat **R**ecovery **S**ystem	A system to reclaim and recycle waste heat from other sources, such as building exhaust air, in order to reduce the need for the primary energy source.
HVAC	**H**eating, **v**entilation and **a**ir **c**onditioning	
HW	**H**eating **W**ater	
% r.H.	**H**umidity **r**elative	The ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature.
LED	**L**ight-**E**mitting **D**iode	A device that lights up and displays information when electricity passes through it.
	Latent **H**eat	The quantity of heat absorbed or released by a substance undergoing a change of state.
n.r.	**n**ot **r**elevant	
OA	**O**utside **A**ir	Air taken from the external atmosphere not previously circulated through the building.
PHE	**P**late **H**eat **E**xchanger	A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids
PHE-HW	**P**late **H**eat **E**xchanger **H**eating **W**ater	A plate heat exchanger supplied by hot water
PHE-CW	**P**late **H**eat **E**xchanger **C**ooling **W**ater	A plate heat exchanger supplied by chilled water
PHx	**P**late & Frame **H**eat Exchanger	A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids.
RA	**R**eturn **A**ir	Describes the air leaving a room. It may be recycled or purged to the environment.
RA-HUM	**R**eturn **A**ir **H**umidifier	A device, which increases humidity in the exhaust air
RA-SP	**R**eturn **A**ir **S**prinkler	A device, which is sprinkling water over the EHRC
RARS	**R**unning **A**round **R**ecovery **S**ystem	A very efficient type of energy recovery system that consists of heat exchangers in the supply and exhaust air streams, piping (containing a heat transfer fluid) between the heat exchangers and a pump. Sophisticated systems communicate with the BMS and include controls and monitoring equipment.
RCA	**Rec**irculating **A**ir	Air recirculation is when a circulation device moves air in a closed space around more than once
RHC	**R**e-**H**eat **C**oil	A heat exchanger for efficient heat transfer from one medium to another.
SA	**S**upply **A**ir	Air that has been conditioned entering a space.
SA-HUM	**S**upply **A**ir **H**umidifier	A humidifier is a HVAC appliance that increases humidity (moisture).
	Sensible **H**eat	Heat exchanged by a body or thermodynamic system that has as its sole effect a change of temperature.

SHRC	**S**upply **H**eat **R**ecovery **C**oil	A heat exchanger in the supply air handling unit for efficient heat transfer from one medium to another.
SHRC-PH	**SHRC p**re-**h**eater	A heat exchanger in the supply air handling unit for efficient heat transfer from one medium to another. Typically located in front of the air filter to reduce relative humidity.
SHRC-SH	**SHRC s**upplementary **h**eater	A heat exchanger in the supply air handling unit for efficient heat transfer from one medium to another.
UPS	**U**ninterruptable **P**ower **S**upply	A device that supplies power on a short term basis when a primary power source is lost.
	Ventilation	The process of "changing" or replacing air in a space to provide high indoor air quality.
VFD	**V**ariable **F**requency **D**rive	Power control conversion devise for 3 phases motors.
VPN	**V**irtual **P**rivate **N**etwork	A network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization's network.
WD	**W**atch**d**og	Watchdog unit which detects malfunctions of an intelligent device such as a CPU.
WB	**W**et **B**ulb Temperature	The temperature at which water, by evaporating into air, can bring the air to saturation at the same temperature.
WDT	**W**atch**d**og **T**imer	An electronic timer that is used to detect and recover from computer malfunctions.
WHR	**W**aste **H**eat **R**ecovery	Waste heat recovery is to recover energy from hot streams with potential high energy content, such as waste water from different cooling processes.

2 Overview

2.1 Introduction

The Konvekta Run Around Recovery System (RARS) is an Intelligent Run Around Recovery System. The Konvekta system recovers energy from multiple exhaust airstreams and optimizes the energy distribution to multiple supply airstreams. Konvekta utilizes high efficiency coils to capture the energy in the air stream and transfer that energy into the glycol. Variable speed pumps and control valves are used to distribute the glycol to between the coils. The Konvekta Heat Recovery System (HRS) Controller is an industrial controller developed to optimize the energy recovery. The Konvekta HRS Controllers is responsible for the overall system operation. The HRS controller monitors the temperatures of the glycol and the air streams in order to optimize the flow of glycol by adjustments to pump speed and valve positions.

2.2 Basic operation of a Standard Energy Recovery System[1]

In a standard run around glycol system, there is one supply coil, one exhaust coil and a pump. The pump moves the heated glycol from the exhaust air handling unit to the supply air handling unit. The warm glycol is used to heat the supply air. In the example in figure 1, return air enters the exhaust unit at 70°F/21°C. The return air heats the glycol from 35°F/1.5°C to 68°F/20°C. The 68°F/20°C glycol is pumped to the supply air handling unit and used to heat the outside air from 32°F/0°C to 65°F/18°C. The glycol transfers it's heat into the supply air stream and cools from 68°F/20°C to 35°F/1.5°C. The pump moves the 35°F/1.5°C glycol back to the exhaust unit where it is warmed by the return air from 35°F/1.5°C back to 68°F/20°C.

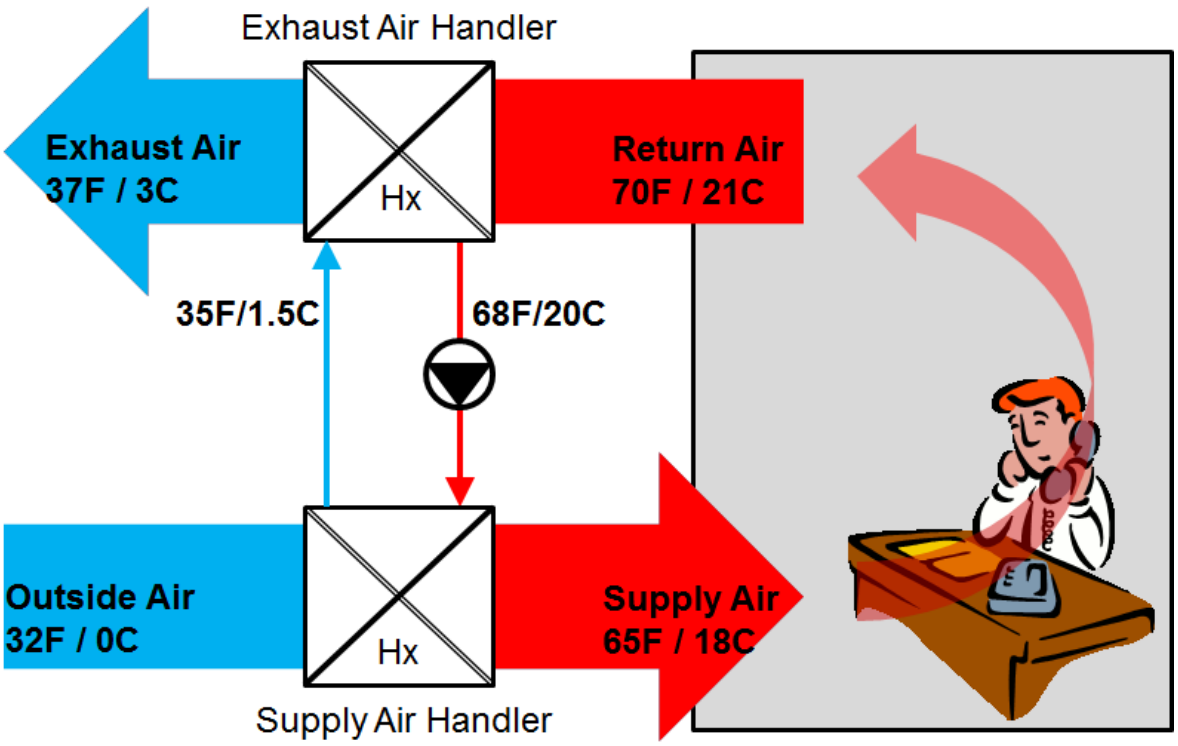


figure 1 – standard glycol system

[1] Example based on a general concept

2.3 Basic operation of a Standard Run Around Energy Recovery System[2]

The Konvekta system utilizes the same concept as a standard system, however Konvekta has the ability to recovery from multiple exhaust air streams and control the distribution of the glycol to multiple supply sources based on their demand for heating or cooling.

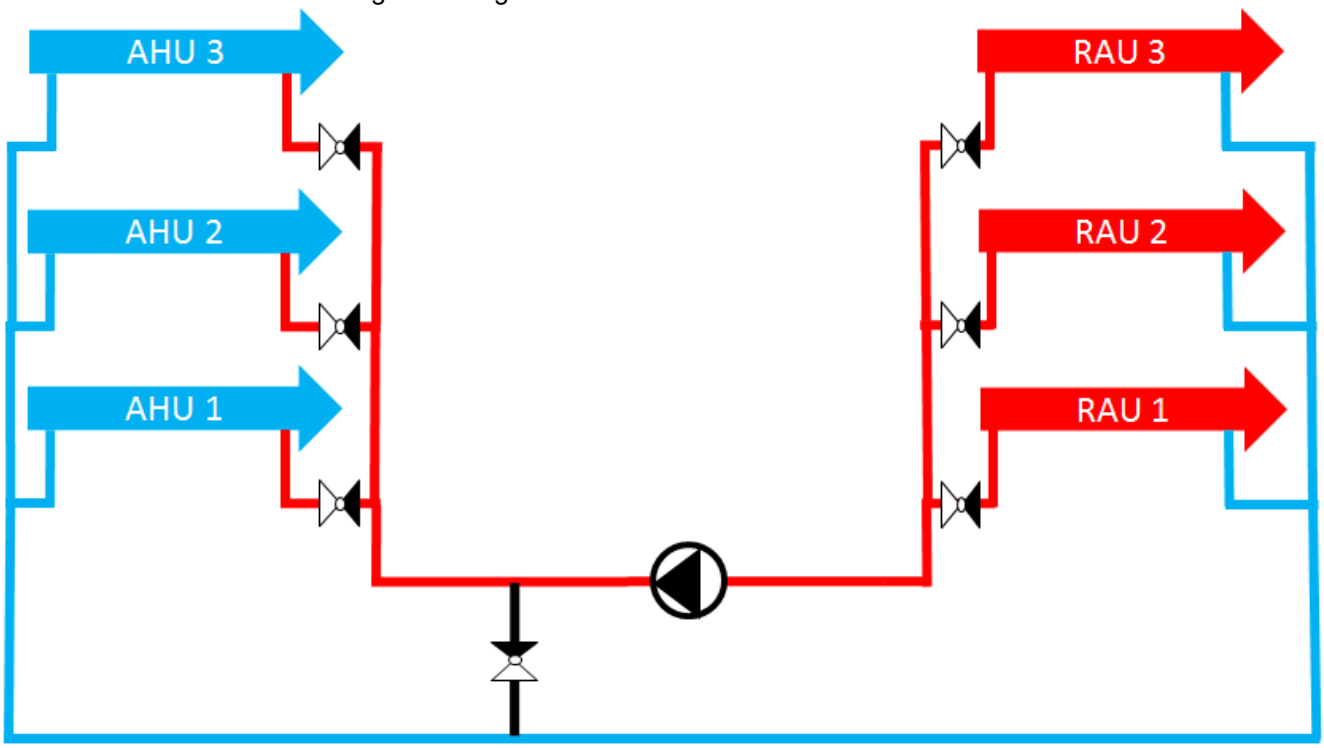


figure 2 - multiple air streams

In figure 2 each coil is equipped with a two way control valve, these are utilized to direct glycol flow thru the coils. As heating and cooling loads change the Konvekta HRS controller modulates the position of these valves to direct the energy in the glycol from where it is recovered to where it is needed.
Bypass - The black line in Figure 2 represents a bypass line. The bypass control valve is used to warm the glycol returning to the exhaust system to prevent condensation from freezing on the exhaust coils. Konvekta optimizes the glycol return temperature to eliminate the risk of freezing on the exhaust coils.

[2] Example based on a general concept

2.4 Additional Heating for a Standard Energy Recovery System[3]

When the outside air temperatures (OAT) are significantly low, the RARS will not be able to recover enough heat to heat the OAT to the supply air set point. For these conditions the Konvekta system adds heat via a hot water plate and frame heat exchangers (PHE-HW). The PHE-HX allows additional heat to be added to the glycol from an outside source (boiler hot water, chiller, etc.)

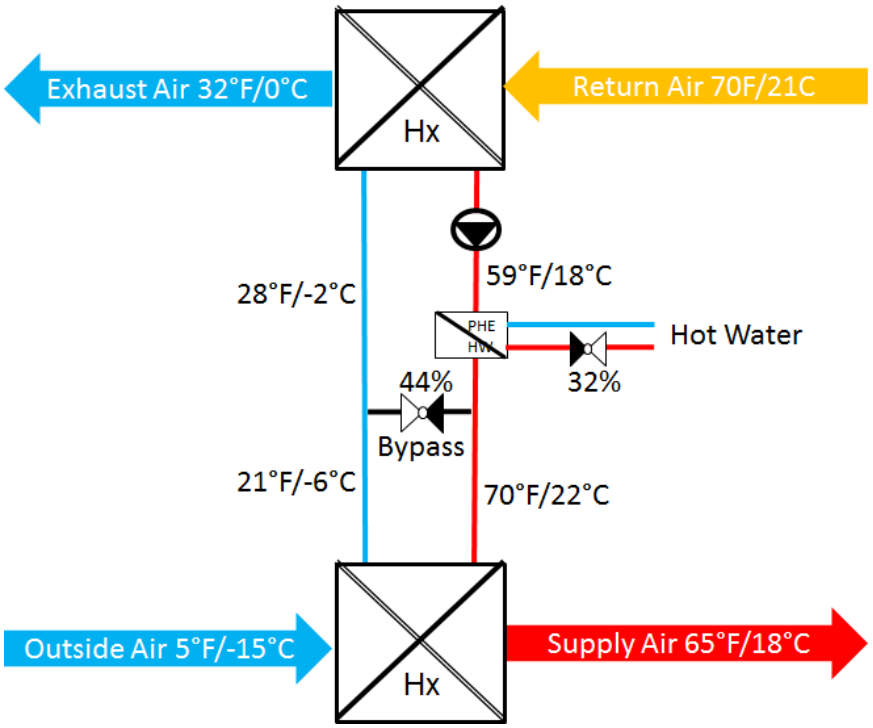


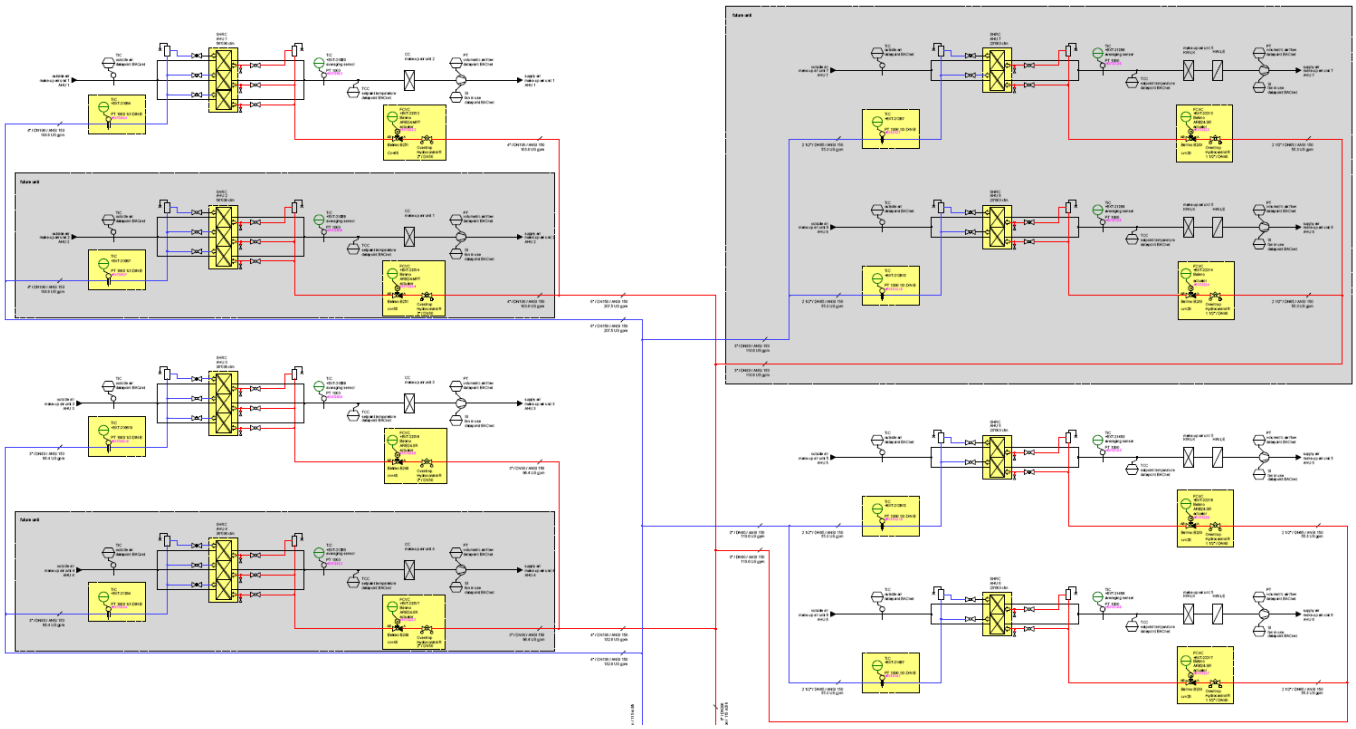
figure 3 - adding heat

In figure 3 - adding heat, the Konvekta system has added a hot water plate and frame heat exchanger to the glycol supply line to the AHU coil. PHX-HW receives hot water from a boiler. The PHX-HW is used to heat the recovered glycol from 59°F/18°C to 70°F/22°C. The 70°F/22°C glycol is warm enough to heat the OAT from 5°F/-15°C to 65°F/18°C. If the heat exchanger was not provided, the 59°F/18°C would not be adequate to heat the OAT to the desired set point. An additional hot water coil would be required in the supply AHU. The additional coil would add air pressure drop all year and increase the fan energy usage.
The bypass is shown in Figure 3. In this example the supply glycol goes from 70°F/22°C to 21°F/-6°C. The heat from the glycol is transferred into the supply air stream, resulting in cold glycol. The 21°F/-6°C returning glycol has the potential to cause condensation to freeze on the EAHU coil. The Konvekta system monitors the return glycol temperature and opens the bypass to warm the glycol to 28°F/-2°C.

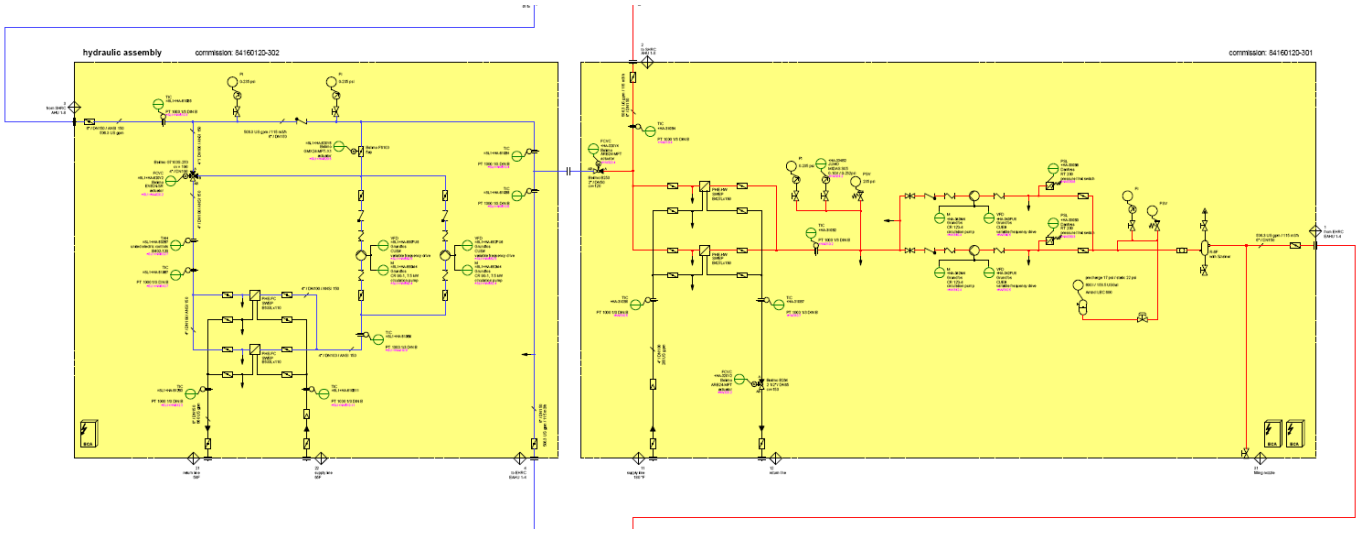
[3] Example based on a general concept

3 System Overview

AHU 1-8



Hydronic Modules



EAHU 1-4

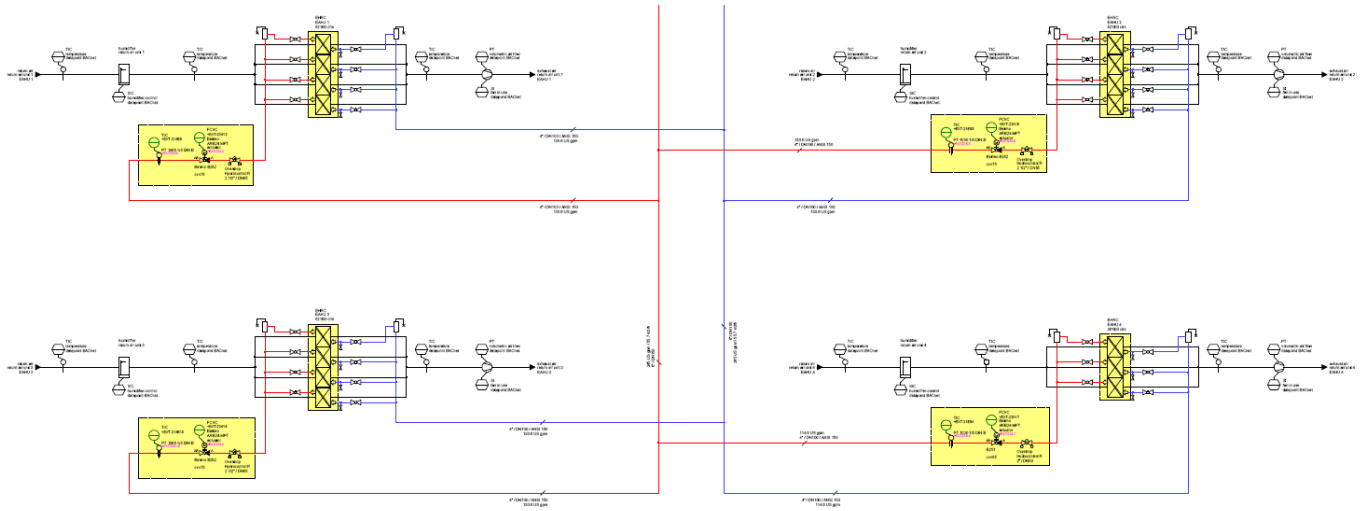


figure 4 - system overview: AHU 1-8, hydronic module with free cooling, EAHU 1-4

The Heat Recovery System is designed as a network system: the water/glycol circuits for both the supply air and the exhaust air heat exchanger banks are fed by the hydronic module. The heat exchangers serve to recover heat during the heating season and recover cooling energy during the cooling season. The recovered energy is fed to the heat exchanger bank in the supply air to heat/cool the outside air. The hydronic module with glycol/water pump, redundancy pump and control system serves the supply and exhaust air handling units of the building's HVAC system. The attached P&ID Schematics depicts the hydraulic design of the Heat Recovery System.

3.1 Supply Air Handling Units

With the future units, there are eight supply air handling. Seven will be used and one will be solely for redundancy reasons. Each AHU is equipped with its own individual control valve which is used to regulate Discharge Air Temperature (DAT).

3.2 Exhaust Air Handling Units

There are four exhaust air handling units. Each EAHU is equipped with its own individual control valve which is used to modulate the flow of glycol to the supply AHUs. This allows the system to adjust glycol flow to air flow even if the EAHU's aren't run as per design.

3.2.1 Additional EAHU-SP

If an additional exhaust air sprinkler is installed, it will be enabled for generating an additional cooling effect.

3.3 Hydronic Module

3.3.1 Pumps and VFDs

The hydronic module is equipped with two (2) Grundfos circulation pumps. Each pump is powered via a VFD. The Pump VFD is used to modulate the speed of the pump in response to load conditions on the system. The Konvekta HRS optimizes the speed of the pump to maximize the energy efficiency of the system.

3.3.2 Plate and Frame Heat Exchangers PHE-HW

In case the recovered energy doesn't suffice to heat the outside air to the supply air set temperature, additional heat is introduced into the glycol/water circuit through a separate heat source.

The 2 parallel (no n+1 redundancy) plate and frame heat exchangers are located on the hydronic module. Hot water flow through the plate-heat exchangers is modulated by a control-valve.

3.3.3 Plate and Frame Heat Exchangers PHE-FC

In case the outside air temperature is low enough, process cold water can be pre-cooled or even completely provided by the PHE-FC (n+1 redundancy).

3.3.4 Bypass-valve

The bypass valve is located on the skid. There is a bypass line and control valve between the supply and return lines. The by-pass is used to prevent freezing at the EAHU coils.

3.3.5 Relief-valves

Two relief valves are installed. The discharge valve is set at 235 PSI and the suction valve is set at 125 PSI.

3.3.6 Expansion Tank

A glycol expansion tank is skid mounted to regulate expansion and contraction of the glycol. Find the system pressure on the P&ID or on a sticker on the skid.

3.3.7 System Controller / Electrical

Three electrical cabinets are mounted on the hydronic module, one for 460VAC components, one 24VDC for the module with the main pumps and field components and the third serves the part of the hydronic module with the free cooling on it. The Konvekta HRS controller and all electrical components are cabinet mounted.

4 Architecture

4.1 Automation Concept

The Heat Recovery System is designed as a network system. The automatic control of the Heat Recovery System is governed by the HRS-Controller. The Hydronic Module combines the supply air handler and the exhaust air handlers in one Heat Recovery System.
The Electrical Cabinet contains a network access that serves Konvekta to remotely monitor, optimize and analyze the system in case of a malfunction.

For remote access the following device is used:
☐Modem ☒network router (VPN)

4.2 System Overview

System	commission	manual overwrite modules
ERS University of Kentucky RB 2	84160120-401	yes

5 Electrical

5.1.1 Electrical Cabinet (ECA)

Electrical power feed is industrial standard 3 x 460VAC. For closer details see the electrical schematic. The main disconnect switch is lockable and is located in the sidewall of the electrical cabinet. The service switches of the pumps are also lockable and located in the sidewall of the ECA.

5.1.1.1 Electrical Cabinet 460VAC

The 460VAC power supply is landed into this cabinet, also the power feed for the pumps. The main disconnect and the individual pump service switches are located on the side of the cabinet. A 460VAC to 24VDC rectifier is placed in this cabinet, it power feeds the 24VDC cabinet. All components are equipped with circuit breakers.

5.1.1.2 Electrical Cabinet 24VDC

The 24VDC electrical cabinet contains all controlling components, such as PLC, network devices, emergency override modules (EOM), relays and circuit breakers. The user interface is on the exterior door of the cabinet. A cabinet disconnect is located on the side of the cabinet.
Internal to the cabinet is the pump pressure alarm reset button to manually reset this alarm.

5.1.2 Energy Measurement

The electrical power consumption is not being measured.

5.1.3 Circuit Breaker

The automatic circuit breakers are not monitored.

5.1.4 Phase Monitoring

The power feed with its single phases is not monitored.

5.1.5 Overvoltage Protection

There is no overvoltage protection in the ECA.

6 Interfaces

6.1 Hardware-Communication

Signals that are relevant for the system controls (release HRS, differential pressure fans, etc.) can either be communicated via hardware-interface or via bus interface from and to the BMS. For detailed data points see electrical schematics and data points list.

6.1.1 I/O Interface

No hardwired contacts to the building automation.

6.2 Bus-Interface

All available data of the HRS controller can be transmitted to the BMS via a bus interface. A detailed list of data points has been provided.

Used bus interface:

- ☐ Modbus RTU by RS485
- ☐ Profibus Master
- ☒ BACnet MS/TP
- ☐ none
- ☐ LON
- ☐ Profibus Slave
- ☐ BACnet IP

6.3 Signalization on ECA

For signalization on the ECA a panel is used.

7 System Operation

7.1 Operating Hierarchy

1. **Manual Access via Emergency Overwrite Module:** all control signals for each actuator can be manually overwritten and set. Access via Emergency Overwrite Module (located in the 24VDC ECA and Free Cooling ECA) has highest priority and overwrites all other signals.
2. **Manual Access via Panel:** all actuators can be set manually by entering “manual mode”.
3. **Remote Access Konvekta**: the entire system can be operated and monitored manually via remote access by Konvekta.
4. **Automatic Mode:** the system operates in automatic mode and controls the set points as provided by the BMS.

7.2 Local Operating Device

7.2.1 Emergency Overwrite Module

The Konvekta control system includes emergency control modules built into the system. The emergency control module will operate the system in an “emergency mode" with basic functionality if the main HRS controller fails. In the emergency mode the system will function and deliver system temperatures, but will not be able to optimize the system operation, and efficiency may be reduced for the short time it requires to replace the main HRS controller. The Emergency Overwrite Modules also allow local manual operation of the HRS or of individual components of the HRS. All analog signals and the important digital signals are wired through the Emergency Overwrite Module and can be manipulated individually. The operator must ensure that the system is not operating in a non-permissible mode. Note in particular that while the automatic controller is functional, system components that are not controlled by the Emergency Overwrite Module will still be controlled by the HRS Controller.

In manual mode, all pumps, valves and control signals can be adjusted manually via the display.

CAUTION! Only trained personnel are allowed to set the system in manual mode. The system may be in harmful or dangerous operating conditions if the manual input is wrong.

7.2.1.1 Manual Overwrite Modules

Depending on the configuration of the system it is equipped with manual overwrite modules. The following chapter describes how to use the digital and analog manual overwrite modules.

Digital overwrite module **Analog overwrite module**

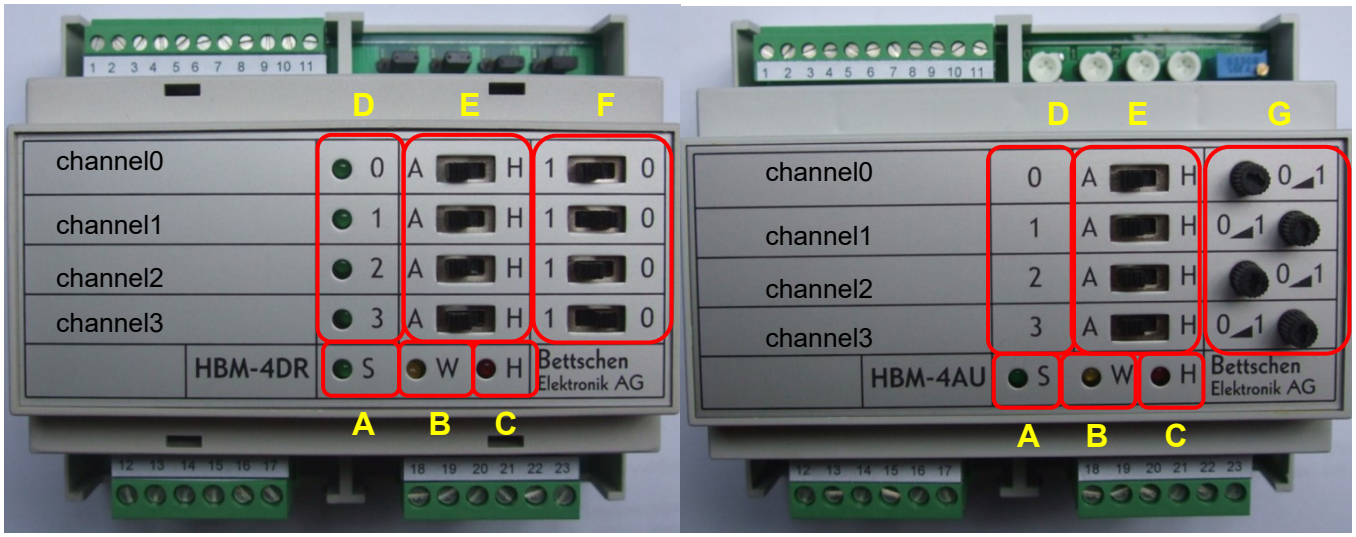


figure 5 – manual override module

A) LED supply voltage (is on, if module is supplied with +24VDC)
B) LED Watchdog (is on, if the watchdog drops)
C) LED manual (is on, if one auto/manual switch is in manual mode)
D) LED channel status (is on, if the corresponding channel is on)
E) Auto/manual switches
F) Channel on/off switches (only active if the corresponding channel is in manual mode)
G) Potentiometer (only active if the corresponding channel is in manual mode)

7.2.1.2 Automatic mode

During automatic mode (LED manual is off) the overwrite modules have no function. The input signals at the four channels are equal to the output signals. No signal will be overwritten.

7.2.1.3 Manual mode

The overwrite mode is active, if one of the four auto/manual switches is in position manual “E” (A→**H)**. The overwrite mode is indicated by the red LED at “C”. Each channel can be set in manual mode individually by the switches “E”. If a channel is in manual mode, the corresponding output signal can be overwritten by the switches “F” or the potentiometers “G”.

Only trained personnel are allowed to set the system in manual mode. The system may be in harmful or dangerous operating conditions if the manual input is wrong.

7.2.1.4 Emergency operation mode

The overwrite modules are equipped with a watchdog function which checks the state of the HRS-Controller. If the HRS-Controller is in an inoperative state the watchdog signal drops. It is signalized by the orange LED watchdog “B”. In emergency operation mode all channels are set to a predefined value. Therefore the presets of the digital channels can be set by the jumpers “H” and the analog channels by separate potentiometers “I”. The presets of all channels are set during the start-up procedure of the HR-System.

Digital overwrite module **Analog overwrite module**

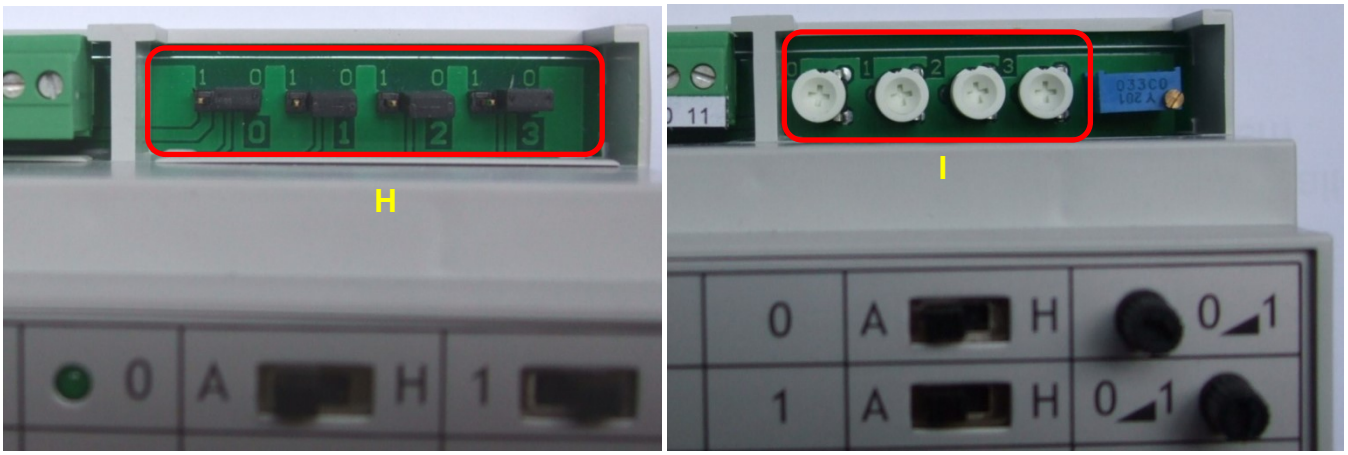


figure 6 – watchdog settings

H) Jumpers for digital channels
I) Potentiometers for analog channels

Generally in emergency operation mode pump1 will be released and runs with 80% pump speed. All zone valves are opened to 100%, bypass valve after pump is opened to 35%. For detailed watchdog settings see the following list.

The jumpers and potentiometers are not part of the user interface handling module and may be set or changed only by employees of Konvekta.

7.2.1.5 Watchdog settings

The following tables show the watchdog settings of the Emergency Override Modules. These settings apply if the CPU fails.

Emergency Override Modules ERS-pump skid

channel	module	signal name	signal type	command	preset
DO_0	170U9	eo_DO_001	digital output	ERS pump 1 request	ON
DO_1		eo_DO_002		ERS pump 2 request	OFF
DO_2		eo_DO_003		spare	OFF
DO_3		eo_DO_004		spare	OFF
AO_0	174U3	eo_AO_001	analog output	control signal zone valve SHRC AHU 1	100%
AO_1		eo_AO_002		control signal zone valve SHRC AHU 2	100%
AO_2		eo_AO_003		control signal zone valve SHRC AHU 3	100%
AO_3		eo_AO_004		control signal zone valve SHRC AHU 4	100%
AO_0	174U9	eo_AO_005	analog output	control signal zone valve SHRC AHU 5	100%
AO_1		eo_AO_006		control signal zone valve SHRC AHU 6	100%
AO_2		eo_AO_007		control signal zone valve SHRC AHU 7	100%
AO_3		eo_AO_008		control signal zone valve SHRC AHU 8	100%
AO_0	176U3	eo_AO_009	analog output	control signal zone valve EHRC EAHU 1	100%
AO_1		eo_AO_010		control signal zone valve EHRC EAHU 2	100%
AO_2		eo_AO_011		control signal zone valve EHRC EAHU 3	100%
AO_3		eo_AO_012		control signal zone valve EHRC EAHU 4	100%
AO_0	176U9	eo_AO_013	analog output	control signal control valve PHE-HW	30%
AO_1		eo_AO_014		control signal bypass valve after pump	10%
AO_2		eo_AO_015		control signal ERS pump 1	80%
AO_3		eo_AO_016		control signal ERS pump 2	0%

Emergency Override Modules free cooling skid

channel	module	signal name	signal type	command	preset
DO_0	170U9	eo_DO_001	digital output	Butterfly valve free cooling	OFF
DO_1		eo_DO_002		Free cooling pump 1 request	OFF
DO_2		eo_DO_003		Free cooling pump 2 request	OFF
DO_3		eo_DO_004		spare	OFF
AO_0	174U3	eo_AO_001	analog output	Control valve 3-way free cooling	0%
AO_1		eo_AO_002		control signal free cooling pump 1	0%
AO_2		eo_AO_003		control signal free cooling pump 2	0%
AO_3		eo_AO_004		spare	0%

7.2.2 Display/Control Panel

A display/control panel module is mounted outside on the ECA where metered values, signals and alarms are displayed. The operating mode can be switched between automatic and manual and set point for pumps and valves can be changed manually. The manual mode of the display/control panel is password protected, see below. For more details see the HIOM instructions.

In manual mode, all pumps, valves and control signals can be adjusted manually via the display.

CAUTION! Only trained personnel are allowed to set the system in manual mode. The system may be in harmful or dangerous operating conditions if the manual input is wrong.

7.2.3 Valve Activation

In case of a controller malfunction, the valves will be automatically set at a predefined status. This status can be defined in the Emergency Overwrite Module. Each valve can also be set manually with the manual drive located at the valve gear assembly.

7.2.4 Replacing the Flash Card

Under unusual circumstances, the flash card may need to be replaced. Konvekta will send a replacement flash card immediately.

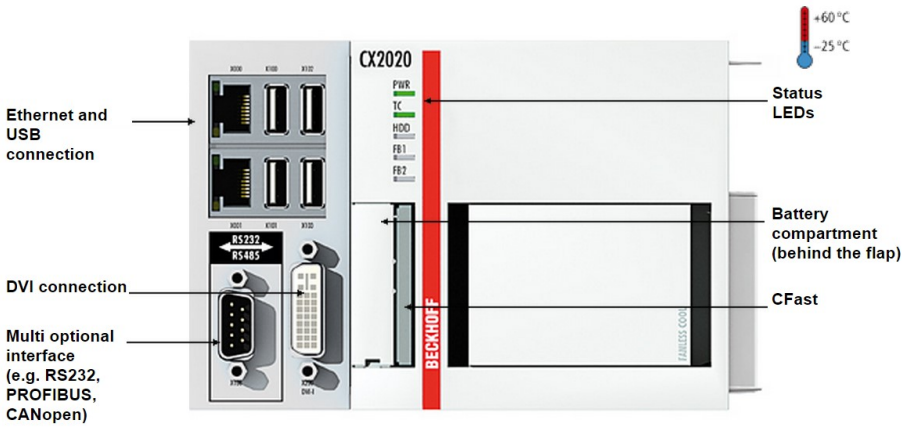


figure 7 – CPU

Replacing the Memory Card

1. Turn the controller off (main switch outside the control cabinet). The display and the LED should be off.
2. Press on the CFast card to remove it
3. Remove the memory card from the slot and replace it with the new memory card. Make sure the new card is inserted face up.
4. Turn the controller on by turning the main switch on.
5. The system starts automatically in automatic mode.

7.2.5 Main Switch and Maintenance Switch

The main electrical switch and maintenance switches of the pumps are mounted outside of the electrical cabinet.

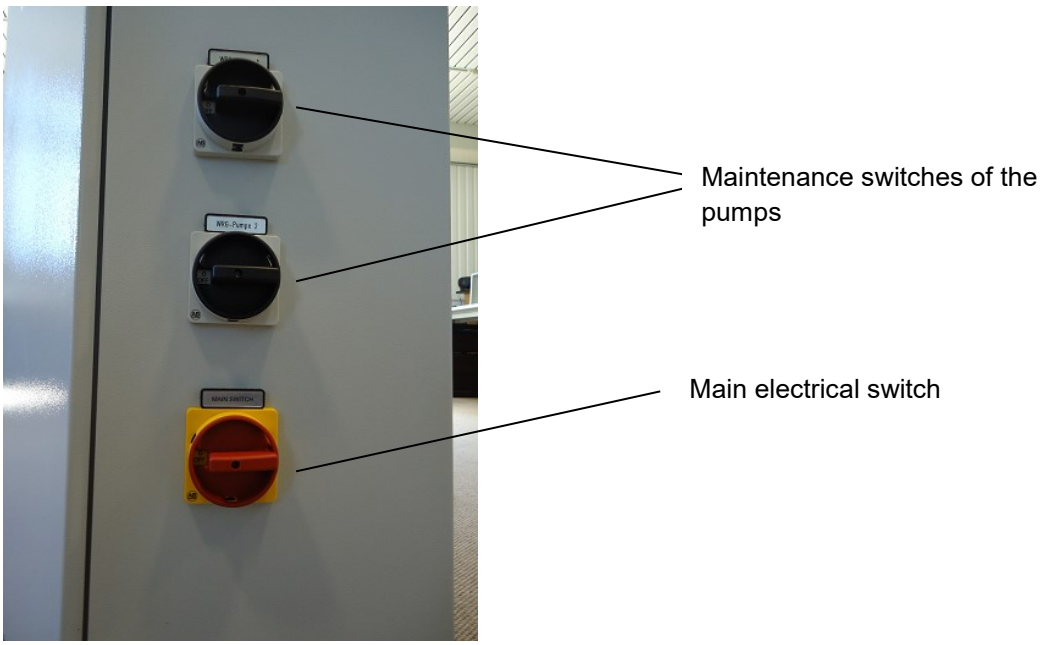


figure 8 – mains switch

8 Control Functions

This chapter describes the control functions of the entire HRS.

8.1 Control Concept

In automatic mode, the HRS-controller controls the system operation based on the release from the air handling units (supply and exhaust air handling units must be operational) and the air temperatures.

The controller utilizes:

- the measurement signals
- the HRS pumps
- all automatic valves in the glycol/water circuit
- return air sprinkler RA-SP
- temperature and/or humidity set points from BMS

The controller doesn't control:

- the air handling units
- humidification and de-humidification of the supply and exhaust air

8.2 Start-up of the HRS-Controller

Once the controller is started up, it reads all sensor signals simultaneously. The controller reads the operating mode and sends the newly calculated signals to the system components.

8.3 Operating Modes

The HRS operates depending on season and requirements in different modes. The operating mode is determined based on the following criteria:

Operating Mode	**Description**	**Requirements**		**state**		
		Temp. OA	Temp. W/Gly. after Bypass	Bypass -Valve (after pump)	HRS pumps	RA-HUM
HRS not in operation	OA temperature is equal to Supply Air Set temperature or all AHU's are off	$<T_{SA,Set}$[4] +1K and $>T_{SA,Set}$ -1K	N/A	open	disabled	disabled
HRS winter operation without freeze protection	Heating of OA, energy recovery with additional heat input if available	$< T_{SA,Set}$	> -2.0°C/ 28°F	closed	enabled	disabled
HRS winter operation with freeze protection	Heating of OA, energy recovery with additional heat input if available, control of glyc./w temperature at exhaust air heat exchanger entry at minimum	$< T_{SA,Set}$	< -2.0°C/ 28°F	0-100%	enabled	disabled
HRS transition period	Heating of OA with energy recovery only	$< T_{SA,Set}$	> -2.0°C/ 28°F	0-100%	enabled	disabled
HRS summer operation	Cooling of OA with additional cold input if available	$> T_{SA,Set}$	> -2.0°C/ 28°F	closed	enabled	enabled if OA temp >22°C/ 72°F
HRS summer operation with dehumidification	cooling and dehumidification of OA with additional cold input and RA-HUM if available	$> T_{SA,Set}$	> -2.0°C/ 28°F	closed	enabled	enabled if OA temp >22°C/ 72°F

8.3.1 Operation without exhaust unit

The operation of the heat recovery system is maintained, even when all exhaust systems are off. However, this requires a minimum of an available energy source such as hot or cold water supply, steam supply, etc.. Frost protection of the primary energy sources, the icing protection temperature is increased from -2°C/28°F to +2°C/36°F.

[4] $T_{SA,Set}$ = Supply Air Set Temperature

8.3.2 Abstract

HRS not in Operation: If the supply air set temperature of every section is within 1°C/1°F of the outside air temperature, the pumps are shut down, the bypass valve and the section valves are opened. The valves to the heat/cold plate heat exchangers are closed if available.

HRS Winter Operation without Freeze Protection: The system operates in this mode while the outside air temperature is in the band of approximately -15°C/5°F to +2°C/35°F. If the outside air temperature drops below approximately +2°C/35°F, the water/glycol pump operates depending on the air volumes and air temperatures. The system needs additional heat input to heat the outside air up to the supply air set temperature if available. Therefore the control signal to the hot water unit is enhanced to the point where the water/glycol is heated enough to heat, in turn, the outside air up to the supply air set temperature.

HRS Winter Operation with Freeze Protection: If the outside air temperature drops below approximately -15°C/5°F, the return water/glycol temperature from the supply air handler will drop below -2°C/28°F. In that case, the water/glycol bypass valve will open and is controlled such that the water/glycol temperature to the exhaust air handler doesn't drop below -2°C/28°F to prevent precipitated moisture in the exhaust air from freezing. The pump works at its maximum pump speed.

HRS Transition Period: Depending on the air volumes and exhaust air temperatures, the system is capable to heat the outside air from up to the supply air set temperature without additional heat input. If the outside air is cooling down below the supply air set temperature, the pump will be started and the pump-VFD will control the water/glycol volume at the level necessary to heat the outside air up to the supply air set temperature. If the exhaust air temperature in the exhaust air handlers is not equal, the water/glycol flow control valves to each air handler will be set such that the heat recovery required is achieved at the lowest possible water/glycol volume pumped through the system (i.e. more water/glycol volume to the air handler with the higher exhaust air temperature).

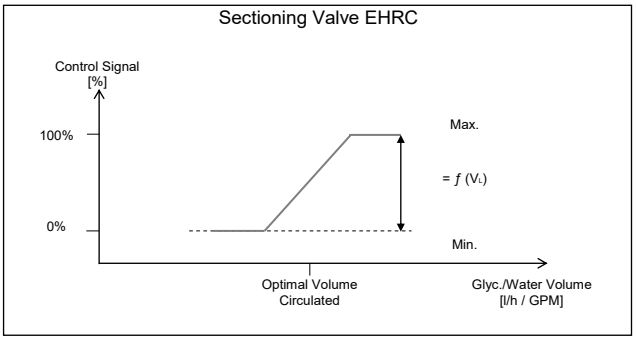
HRS Summer Operation: If the supply air set temperature is lower than the outside air temperature (and the return air temperature is higher than the supply air set temperature), the water/glycol needs additional cooling and the valve to the plate heat exchanger for cold is opened to the degree necessary to achieve the supply air set temperature. If the return water/glycol temperature from the supply air handler is lower than the exhaust air temperature, the bypass valve ahead the pump(s) is opened if available and no water/glycol will flow through the exhaust air heat exchangers.

8.3.3 Heating Mode with exhaust coil Freeze Protection

Heating up the outside air to the supply air set point given from the BMS. Freezing protection for exhaust coil is activated.

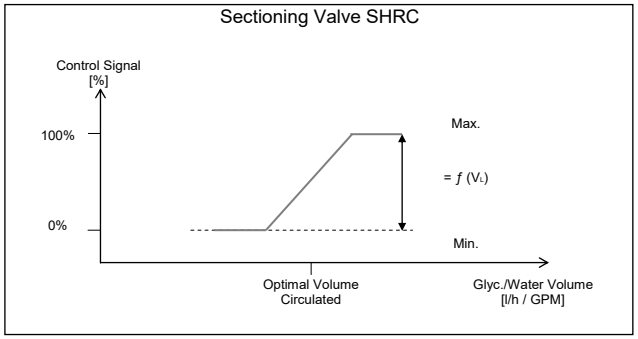
Sectioning Valve EHRC

The position of the valves depends on the actual operating conditions of the exhaust air systems, i.e. the valve position in one exhaust air system will influence the valve position of the other exhaust air system. The valve positions control the glycol/water volumes such that the energy recovered is as high as possible.



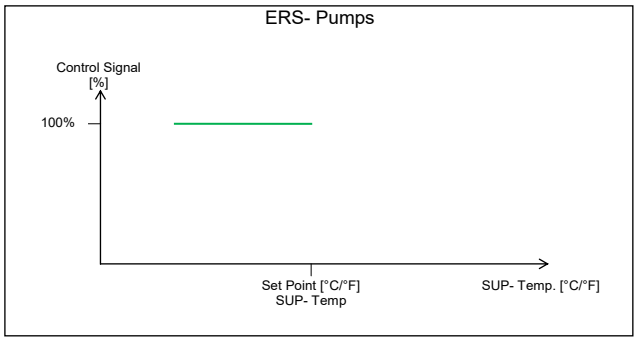
Sectioning Valve SHRC

The position of the valves depends on the actual operating conditions of the supply air systems, i.e. the valve position in one supply air system will influence the valve position of the other supply air system.



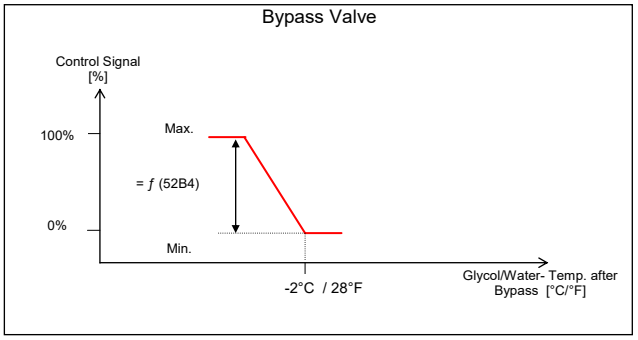
HRS- Pumps

In this operating mode, the power output of the HRS at 100% air volumes is at its peak. Even at lower OA temperatures, it cannot be increased as the pump operates at its maximum rotation speed and the maximum heat is being recovered from the RA.



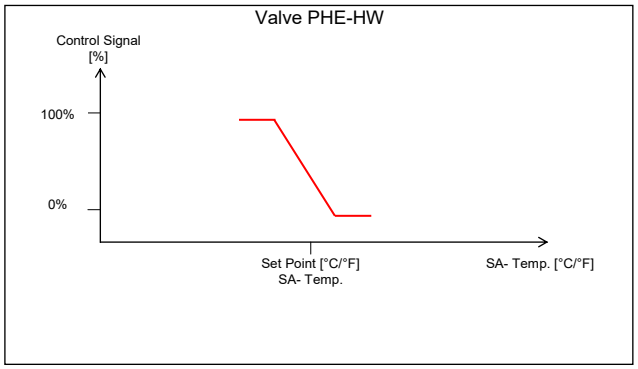
Bypass Valve after pump

With this valve, hot glycol/water is added to the cold fluid via the bypass, such that the control aim of min. -2°C / 28°F glycol/water temperature at the entry into EHRC is achieved.



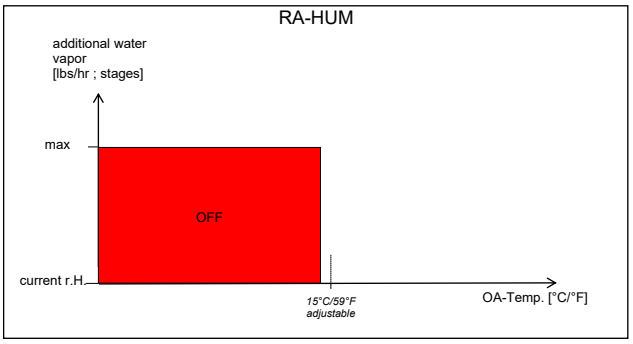
Valve PHE-HW

The PHE-HW valve's position depends on the supply air set temperature. Depending on how much heat is necessary to achieve the supply air set temperature, the valve's position is set accordingly.



Return Air Humidifier RA-HUM

In this operating mode, the RA-HUM is disabled.

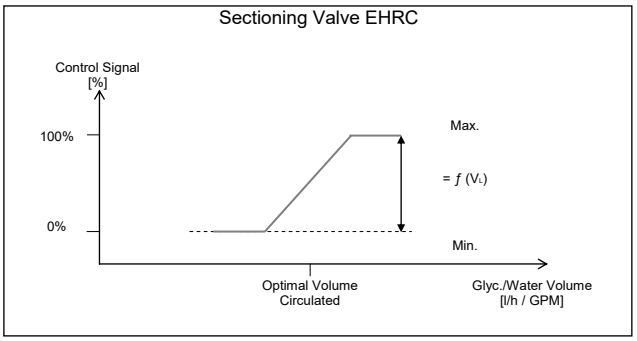


8.3.4 Heating Mode without Freeze Protection

Heating up the outside air to the supply air set point given from the BMS. Freezing protection is not activated.

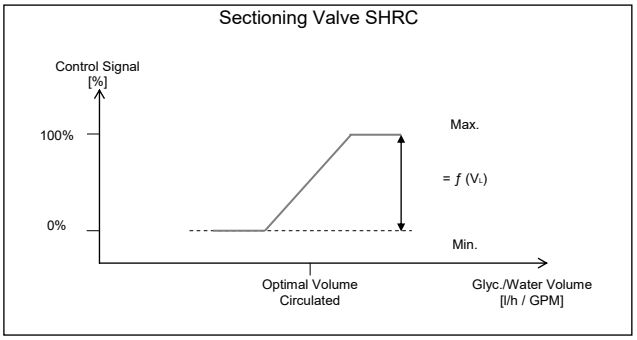
Sectioning Valve EHRC

The position of the valves depends on the actual operating conditions of the exhaust air systems, i.e. the valve position in one exhaust air system will influence the valve position of the other exhaust air system. The valve positions control the glycol/water volumes such that the energy recovered is as high as possible.



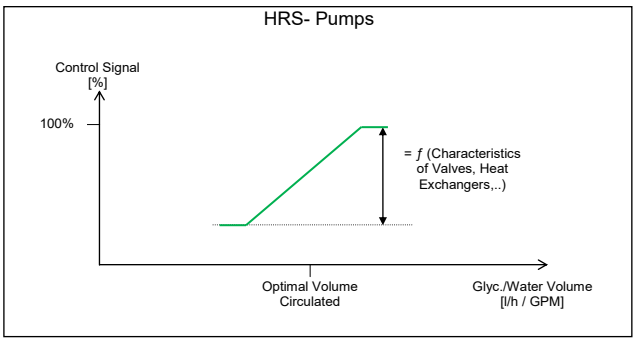
Sectioning Valve SHRC

The position of the valves depends on the actual operating conditions of the supply air systems, i.e. the valve position in one supply air system will influence the valve position of the other supply air system.



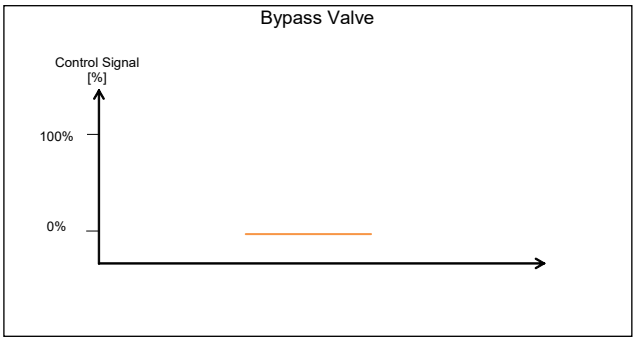
HRS- Pumps

In this operating mode, the pump speed is set according the actual temperatures and air flows for achieve the highest possible heat recovery.



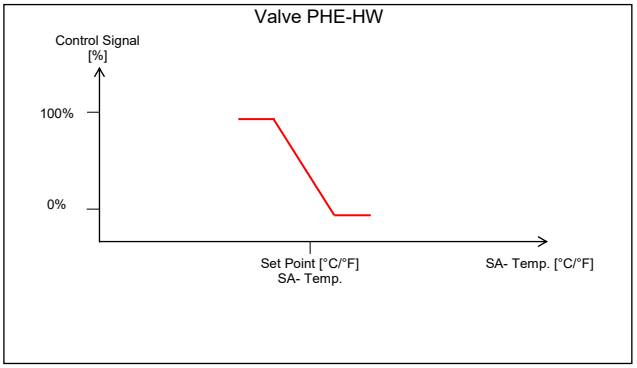
Bypass Valve after pump

In this operating mode, the valve is closed.



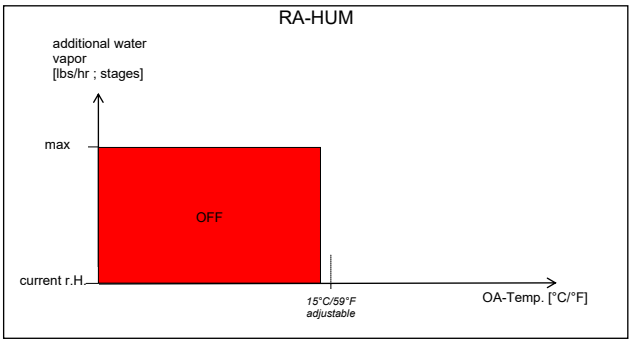
Valve PHE-HW

The PHE-HW valve's position depends on the supply air set temperature. Depending on how much heat is necessary to achieve the supply air set temperature, the valve's position is set accordingly.



Return Air Humidifier RA-HUM

In this operating mode, the RA-HUM is disabled.

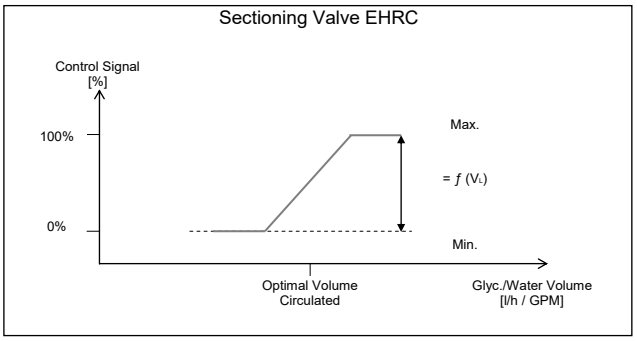


8.3.5 Transition Period

Heating of the supply air up to the supply air set temperature. Hating with recovered energy only.
This operating mode occurs during the transition period when the heat recovered from the exhaust air is sufficient to achieve the supply air set temperature.

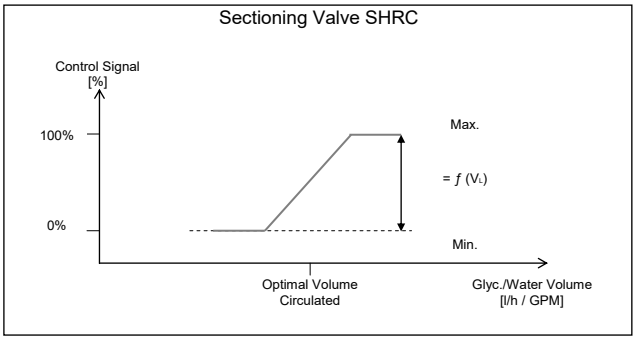
Sectioning Valve EHRC

The position of the valves depends on the actual operating conditions of the exhaust air systems, i.e. the valve position in one exhaust air system will influence the valve position of the other exhaust air system. The valve positions control the glycol/water volumes such that the energy recovered is as high as possible.



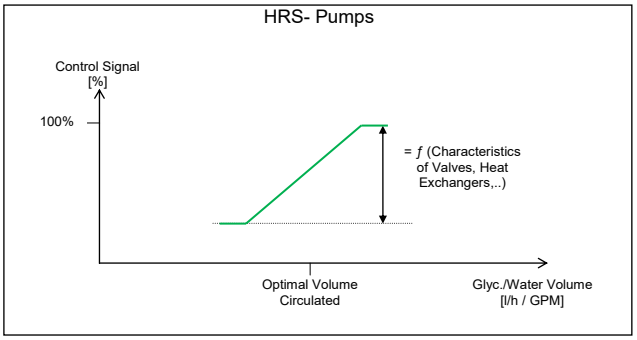
Sectioning Valve SHRC

The position of the valves depends on the actual operating conditions of the supply air systems, i.e. the valve position in one supply air system will influence the valve position of the other supply air system.



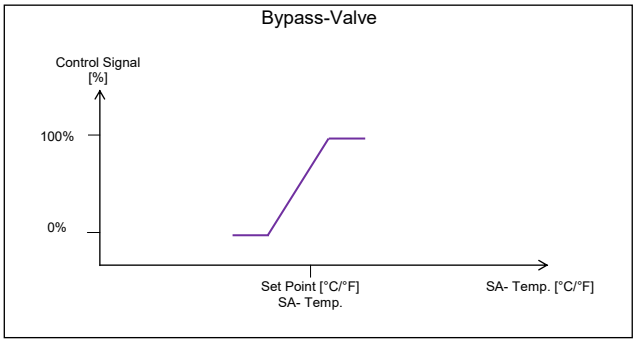
HRS- Pumps

In this operating mode, the pump speed is set according the actual temperatures and air flows for achieve the highest possible heat recovery.



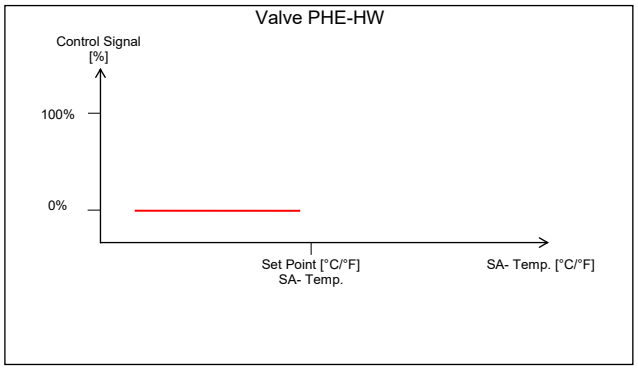
Bypass Valve after pump

As soon as the pump speed is set to its minimum and the supply air temperature is still above the set point, the bypass valve will open until the set point is achieved.



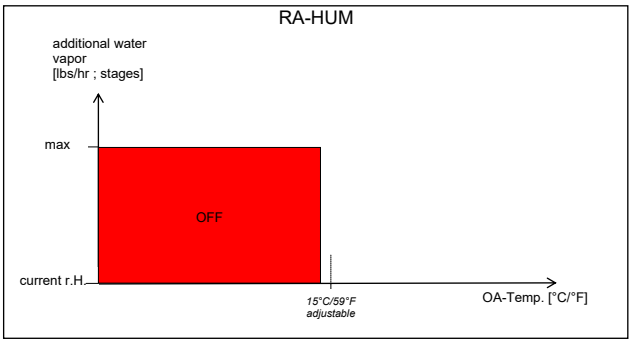
Valve PHE-HW

In this operating mode, the valve is closed.



Return Air Humidifier RA-HUM

In this operating mode, the RA-HUM is disabled.

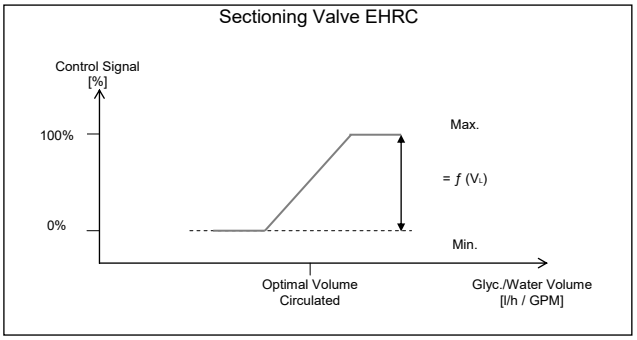


8.3.6 Summer Operation – Cooling Mode

Cooling of the outside air to the supply air set temperature. Cooling of the outside air with energy recovered and additional cold introduced into the glycol/water circuit. This operating mode occurs in summer when the outside air temperature is higher than the supply air set temperature.

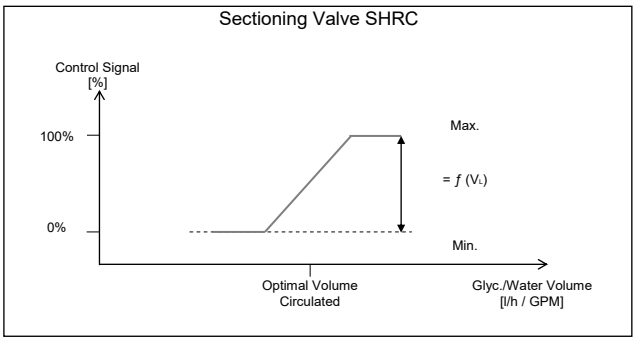
Sectioning Valve EHRC

The position of the valves depends on the actual operating conditions of the exhaust air systems, i.e. the valve position in one exhaust air system will influence the valve position of the other exhaust air system. The valve positions control the glycol/water volumes such that the energy recovered is as high as possible.



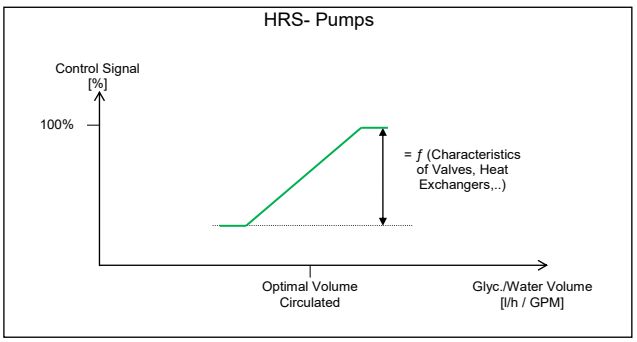
Sectioning Valve SHRC

The position of the valves depends on the actual operating conditions of the supply air systems, i.e. the valve position in one supply air system will influence the valve position of the other supply air system.



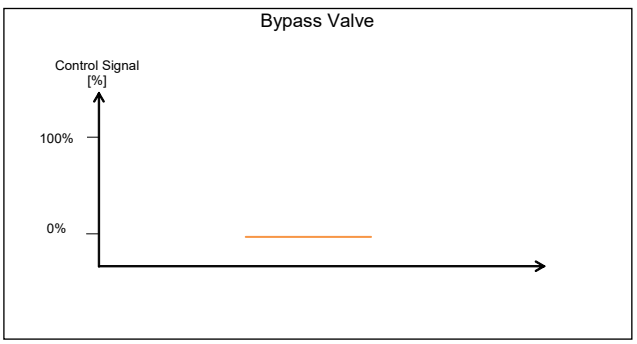
HRS- Pumps

In this operating mode, the pump speed is set according the actual temperatures and air flows for achieve the highest possible heat recovery.



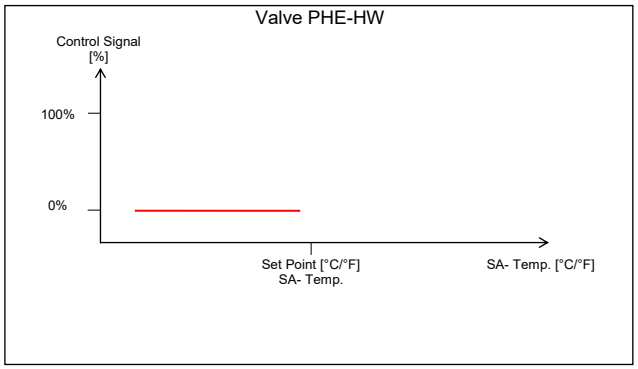
Bypass Valve after pump

In this operating mode, the valve is closed.



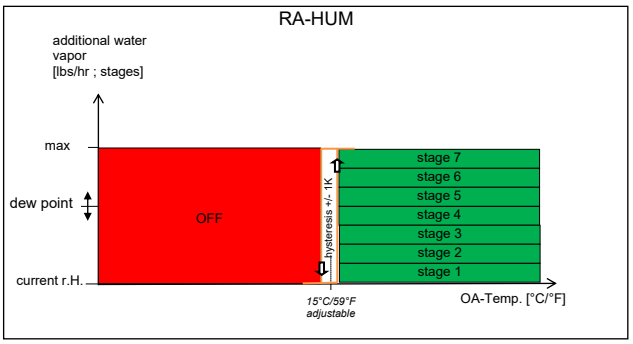
Valve PHE-HW

In this operating mode, the valve is closed.



Return Air Humidifier RA-HUM

In cooling mode the RA-HUM is enabled if the OA temperature is above 15°C / 59°F. Depending on the current relative humidity, return air temperature and dew point temperature the different stages are set accordingly.

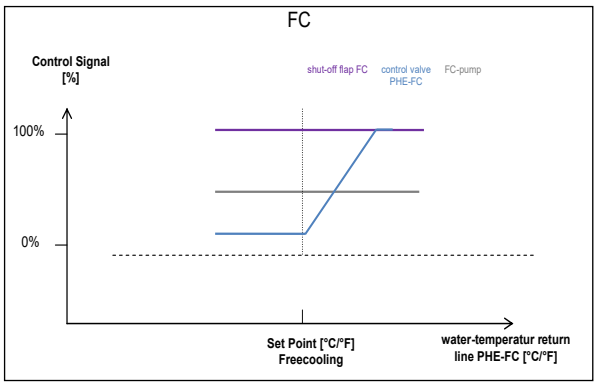


8.3.7 Free cooling

In the transitional period, the process cold water is pre-cooled by a plate heat exchanger. During winter time the process cold water can be completely produced by the PHE-FC depending on the outside air temperature.

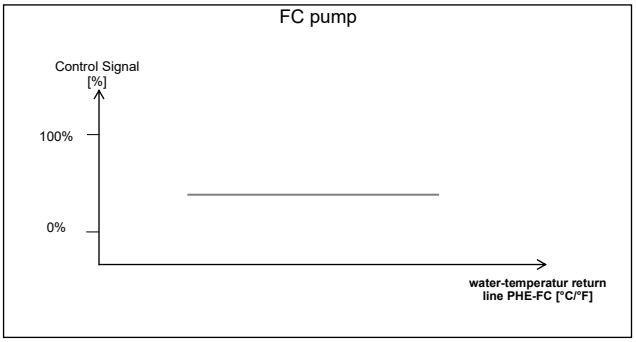
As soon as the water/glycol temperature of the return line of the SHRC coils is lower as a defined “minimum w/gl temperature”, the HRS controller will indicate this with the “notification free cooling possible” message to the BMS. Whenever the “notification free cooling possible” is present, free cooling of the process cold water is possible. By sending the request “requirement free cooling” from the BMS to the HRS controller, the free cooling is started.

A frost protection stat monitors the secondary water/glycol outlet temperature of the plate heat exchanger. In case of too low temperature, the shut off flap and the control valve will be closed until the secondary outlet temperature rises above a certain temperature level.



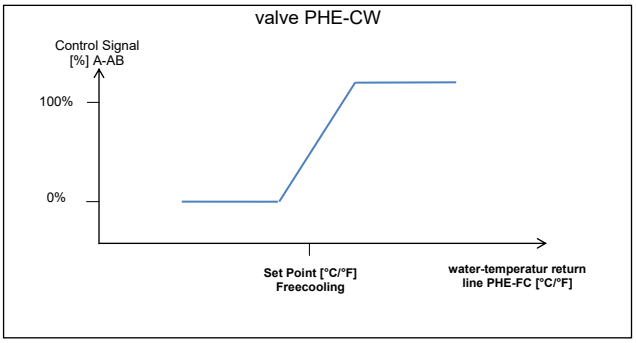
FC-pump

The FC-pump is on if the “notification free cooling possible” and the “requirement free cooling” from the BMS are both ON. At the university of Kentucky the redundant pumps will alternate from time to time.



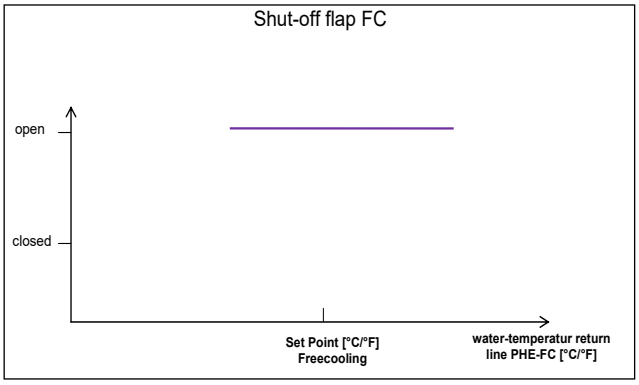
valve PHE-CW

The Position of the valve depends on the water temperature return line PHE-FC. Depending on how much cooling energy is required to achieve the freecooling set point, the valve position is opened or closed accordingly.



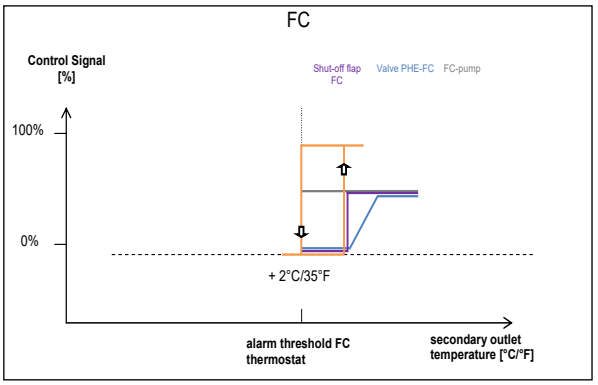
Shut-off flap FC

In normal operating mode, the flap is opened.



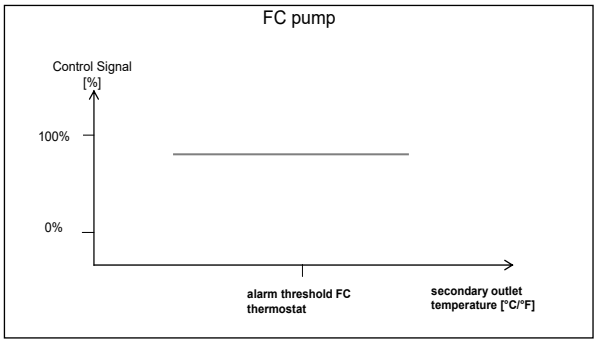
8.3.8 Freecooling Freeze Protection

To protect the plate heat exchanger FC from frost damage, the secondary water/glycol outlet temperature of the PHE is monitored with a frost stat. If the secondary outlet temperature drops below 2°C/35°F, the PHE-FC valve and the shut-off flap are closed whereas the FC-pump is still in operation. This will heat up the primary side of the PHE-FC again and protects the PHE. As soon as the secondary water/glycol outlet temperature rises above 2°C/35°F, the control circuit for the PHE-FC valve and the shut-off flap is enabled again.



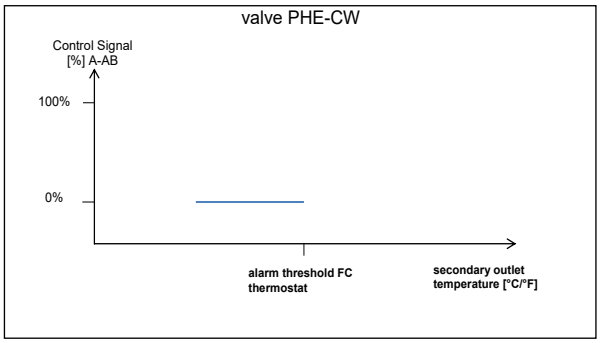
FC-pump

The FC-pump is on if the “notification free cooling possible” and the “requirement free cooling” from the BMS are both ON.



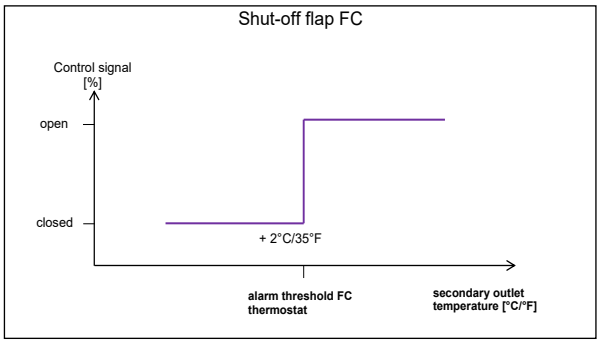
valve PHE-CW

In this operating mode, the valve is closed.



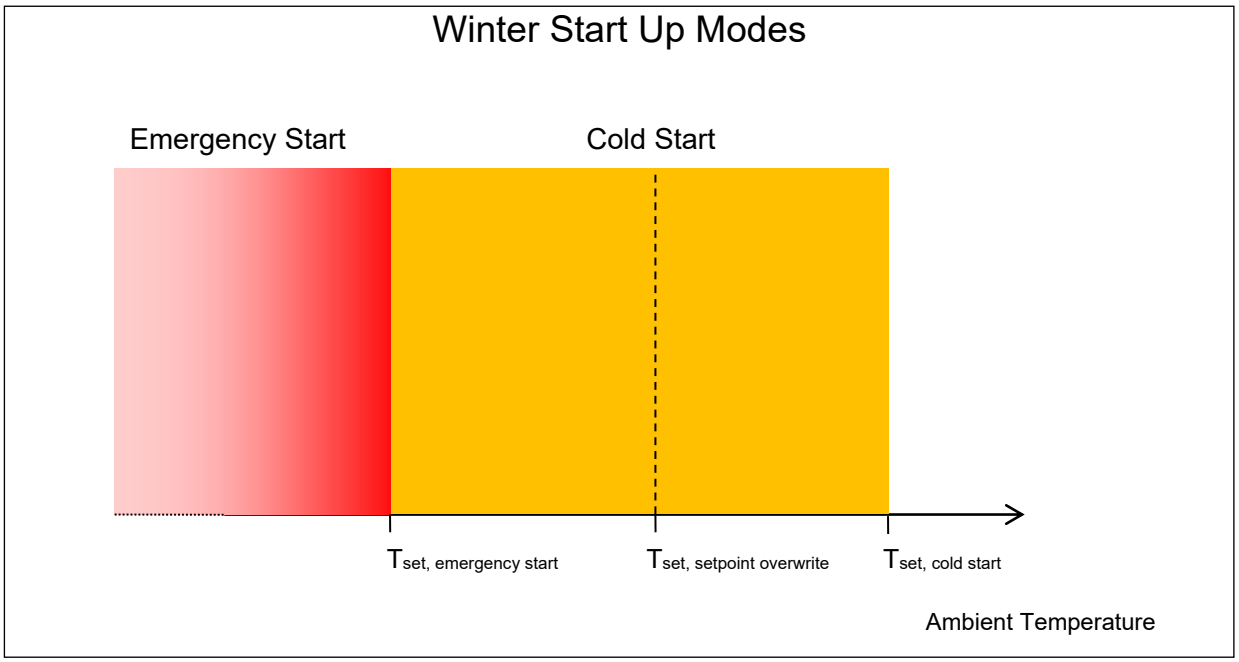
Shut-off flap FC

In this operating mode, the valve is closed.



8.3.9 HRS winter start-up

This mode is specially designed for an AHU ramp up at low outside air temperatures. In order to prevent the fans from tripping due to low temperature supply air, the heat recovery coil will be pre-heated before the corresponding AHU fan can be ramped up. This shall ensure a proper start-up even at low outside air temperatures. It will avoid a frost alarm during the fans start-up. There are two different start up sequences; emergency start and cold start. It depends on the ambient temperature which sequence is being performed.



For each supply air unit the start-up can be requested separately by the BMS. Therefore the following signals are provided:

datatyp bacnet	direction	name on BACnet
BinaryInput	IN	start-up request MAU 1
BinaryInput	IN	start-up request MAU 2
BinaryInput	IN	start-up request MAU 3
BinaryInput	IN	start-up request MAU n

When any one of these start-up requests is present, the heat recovery system for that AHU is put into operation with no respect to the fan's status. If an ambient temperature sensor is available, this value will be taken to decide which sequence is being performed. If no such sensor is available the coldest OA temperature of all running AHU's will be taken for this cause. All set temperatures can be adjusted, default values for set point emergency start is 2°C / 35.6°F, for set point overwrite during cold start is 10°C / 50°F and for set point cold start is X°C / X°F.
At the end of the cold start sequence, as well as during emergency start sequence a signal is sent to the BMS to slowly ramp up the fans. If the ambient temperature is above the set point cold start, no start up sequence is being performed and start up completed signal will be sent immediately. Therefore the following signals are provided:

datatyp bacnet	direction	name on BACnet
BinaryOutput	OUT	start-up completed MAU 1
BinaryOutput	OUT	start-up completed MAU 2
BinaryOutput	OUT	start-up completed MAU 3
BinaryOutput	OUT	start-up completed MAU n

Once the "start-up completed" is set by the heat recovery system, the cold start-up request can be removed by BMS.

8.3.9.1 Cold Start Sequence

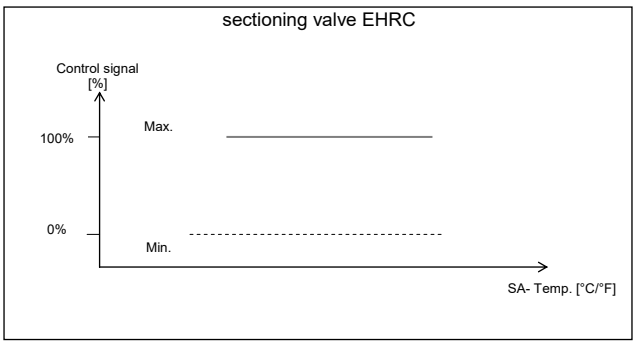
After the start up request is set and a waiting time of 5 minutes, the temperature of the corresponding SHRC return line water/glycol temperature is checked whether the default limit of 15°C/ 59°F is exceeded. Once this is satisfied, it is guaranteed that the mass of the heat recovery SHRC air coil is sufficiently preheated and the HRS-controller signals the BMS "start-up completed". If ambient temperature is below the set point “set point overwrite”, additionally the set point temperature SA (given by the BMS) is temporary being risen to prevent heating from undershooting due to overheat. The set point will slowly ramp down to the set point SA during an adjustable period (Default: 30min).

The following sequence shows the behavior of only those actuators which are affected by the start-up mode. Furthermore only for those zones, where the start-up mode is requested. All other actuators behave as defined in chapters the previous chapters.

Sectioning Valve EHRC

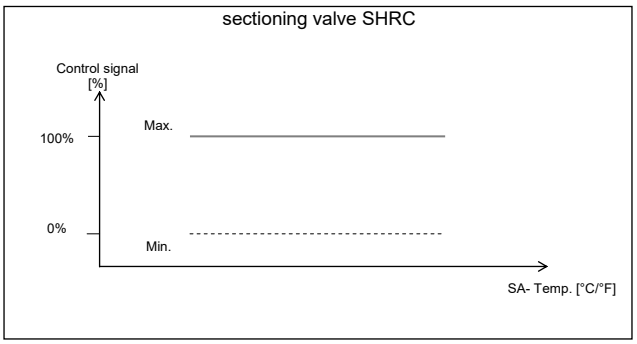
The sectioning valves are open 100%

(only if all RAU units are off)



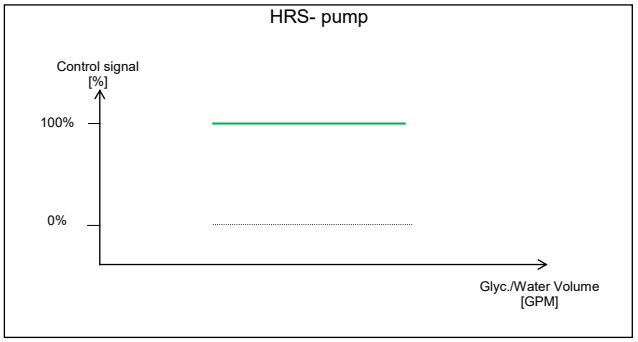
Sectioning Valve SHRC

The sectioning valves are open 100%



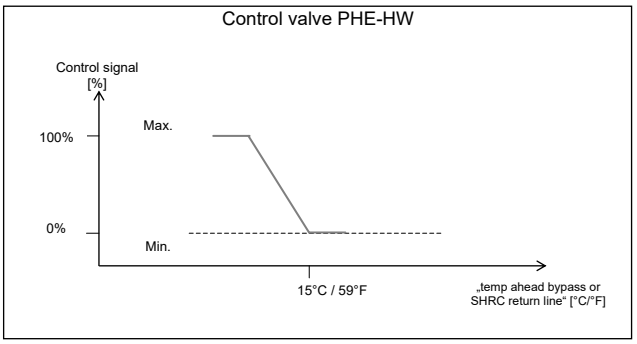
HRS-pump

The heat recovery pump is operated at a fixed speed of 100%.



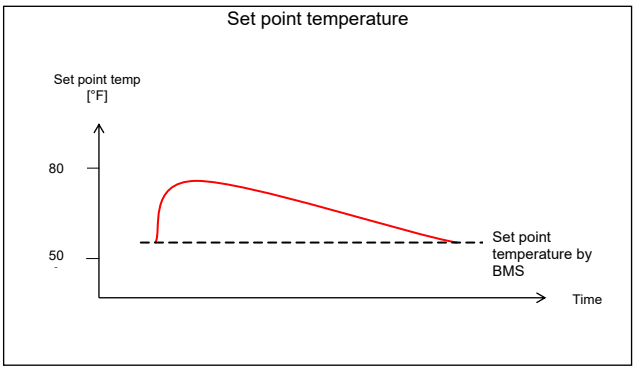
Valve PHE-HW

The position of the valve depends on the temperature ahead the bypass (bypass after pump) or the corresponding SHRC return line water/glycol temperature in composite systems respectively to maintain a temperature of 15°C/ 59°F.



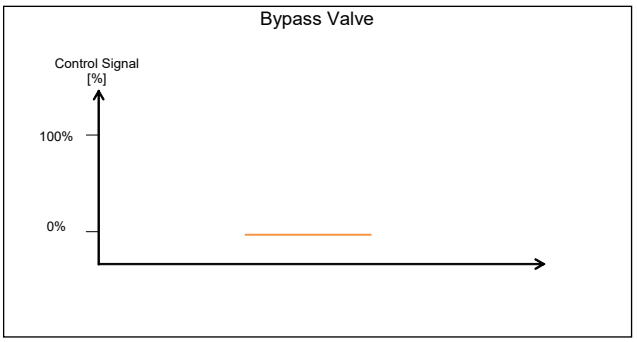
Set point temperature SA

The set point temperature supply air given by the BMS will temporary be risen. Within an adjustable period of time the set point temperature is slowly ramping down to the set point temperature given by the BMS.
This only happens if the ambient temperature is below the set point “set point overwrite”.



Bypass Valve after pump

The bypass valve after pump will be closed in this mode.



8.4 Control of Glycol/Water Temperature to Exhaust Air Heat Exchanger

The temperature of Glycol/Water at the entry into the exhaust air heat exchanger should not be below a certain minimum, as the condensate from the exhaust air can freeze otherwise. The minimal set temperature of -2°C / 28°F is programmed and fixed in the controller.

8.5 Redundancy

8.5.1 Redundant Pumps

At any given time, one pump is operational. Switching from one pump to the other is based on pump operating time intervals programmed in the controller. Typically each pump runs for appx. 2 weeks until the system switches over to the other pump. The switchover happens automatically. If the outside air temperature is below 5°C/40°F the regular switchover from one ERS-pump to the other is locked and delayed until the outside air rises back above 40°F to not risk a freeze trip on low temperature. Only if a pump is malfunctioning the switchover will be unlocked below 5°C/40°F.

If a pump doesn't acknowledge its operating status, the other pump is started-up automatically. If the second pump doesn't acknowledge its operating status either, the controller will switch back and forth between the two pumps in short intervals and an alarm signal will be sent to the operator.

Pump switchover has to happen in less than 2 minutes.

8.5.2 Redundant Heat exchangers Free Cooling

The redundant free cooling plate heat exchangers may be left open in parallel or alternated manually using the flaps.

9 Safety Functions

9.1 Voltage reduction and subsequent restoration

When restoring power supply after a power outage, the CPU will start-up and the system will resume the operating mode as before the power outage without time lag.
No acknowledgments are required.

9.2 Air Handling Unit Malfunction or Incident

There are no hardware contacts for emergency functions of the air handling unit such as fire, smoke provided in the HRS-controller.

9.3 Low Pressure Switch

A pressure monitor is installed upstream of each pump. These pressure monitors, serving to protect against dry running and cavitations. In case of pressure loss below low pressure threshold upstream of the HRS pumps by either of these sensors, a pressure loss alarm is triggered. This alarm must be acknowledged inside the electrical cabinet of the HRS to restart the system.

9.4 HRS Pressure limitation

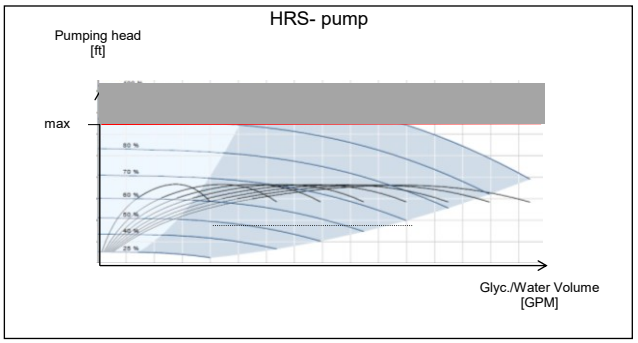
A pressure sensor is installed downstream of the pumps. This pressure sensor, serving to protect against high system pressure. In case of too high pressure downstream of the HRS pumps, the pump speed is limited before an alarm is triggered.

Targets:

- Preventing the HRS system from high pressure

HRS-pump

The heat recovery pump is limited to a defined maximum downstream pressure.



9.5 Safety Circuit Breaker

Safety circuit breaks are installed locally at each pump. The safety circuit breaks serve the safe interruption of power supply during pump maintenance.

9.6 Communication-Lost Mode

All necessary signals from the BMS are fed into the controller thru the BUS-Interface (BACnet/IP). If communication is lost for more than 60 seconds, the HRS-Controller goes into a special “communication-lost” mode. If this mode is active, the necessary signals for the system operation are set to a predefined value. The values are as follows:

9.6.1 Without future units

datapoint	direction	description	predefined value (if communication is lost)
91	IN	fan in use AHU 1	True
92	IN	fan in use AHU 2	False
93	IN	fan in use AHU 3	True
94	IN	fan in use AHU 4	False
95	IN	fan in use AHU 5	True
96	IN	fan in use AHU 6	True
97	IN	fan in use AHU 7	False
98	IN	fan in use AHU 8 (redundant)	False
99	IN	fan in use EAHU 1	True
100	IN	fan in use EAHU 2	True
101	IN	fan in use EAHU 3	True
102	IN	fan in use EAHU 4	True
103	IN	humidifier ok signal EAHU 1	False
104	IN	humidifier maintenance signal EAHU 1	False
105	IN	humidifier ok signal EAHU 2	False
106	IN	humidifier maintenance signal EAHU 2	False
107	IN	humidifier ok signal EAHU 3	False
108	IN	humidifier maintenance signal EAHU 3	False
109	IN	humidifier ok signal EAHU 4	False
110	IN	humidifier maintenance signal EAHU 4	False
111	IN	start-up request AHU 1	False
112	IN	start-up request AHU 2	False
113	IN	start-up request AHU 3	False
114	IN	start-up request AHU 4	False
115	IN	start-up request AHU 5	False
116	IN	start-up request AHU 6	False
117	IN	start-up request AHU 7	False
118	IN	start-up request AHU 8	False

119	IN	volumetric airflow AHU 1	80% of max air volume
120	IN	volumetric airflow AHU 2	80% of max air volume
121	IN	volumetric airflow AHU 3	80% of max air volume
122	IN	volumetric airflow AHU 4	80% of max air volume
123	IN	volumetric airflow AHU 5	80% of max air volume
124	IN	volumetric airflow AHU 6	80% of max air volume
125	IN	volumetric airflow AHU 7	80% of max air volume
126	IN	volumetric airflow AHU 8	80% of max air volume
127	IN	volumetric airflow EAHU 1	80% of max air volume
128	IN	volumetric airflow EAHU 2	80% of max air volume
129	IN	volumetric airflow EAHU 3	80% of max air volume
130	IN	volumetric airflow EAHU 4	80% of max air volume
131	IN	setpoint temperature after Konvekta coils AHU 1	55°F
132	IN	setpoint temperature after Konvekta coils AHU 2	55°F
133	IN	setpoint temperature after Konvekta coils AHU 3	55°F
134	IN	setpoint temperature after Konvekta coils AHU 4	55°F
135	IN	setpoint temperature after Konvekta coils AHU 5	55°F
136	IN	setpoint temperature after Konvekta coils AHU 6	55°F
137	IN	setpoint temperature after Konvekta coils AHU 7	55°F
138	IN	setpoint temperature after Konvekta coils AHU 8	55°F
139	IN	temperature entering air Konvekta coils AHU 1	-2.2°F
140	IN	temperature entering air Konvekta coils AHU 2	-2.2°F
141	IN	temperature entering air Konvekta coils AHU 3	-2.2°F
142	IN	temperature entering air Konvekta coils AHU 4	-2.2°F
143	IN	temperature entering air Konvekta coils AHU 5	-2.2°F
144	IN	temperature entering air Konvekta coils AHU 6	-2.2°F
145	IN	temperature entering air Konvekta coils AHU 7	-2.2°F
146	IN	temperature entering air Konvekta coils AHU 8	-2.2°F
147	IN	air-temperature ahead humidifier EAHU 1	74.3°F
148	IN	air-temperature ahead humidifier EAHU 2	74.3°F
149	IN	air-temperature ahead humidifier EAHU 3	74.3°F
150	IN	air-temperature ahead humidifier EAHU 4	74.3°F
151	IN	air-temperature ahead Konvekta Coils EAHU 1	74.3°F
152	IN	air-temperature ahead Konvekta Coils EAHU 2	74.3°F

153	IN	air-temperature ahead Konvekta Coils EAHU 3	74.3°F
154	IN	air-temperature ahead Konvekta Coils EAHU 4	74.3°F
155	IN	temperature leaving air EAHU 1	37.8°F
156	IN	temperature leaving air EAHU 2	37.8°F
157	IN	temperature leaving air EAHU 3	37.8°F
158	IN	temperature leaving air EAHU 4	40.1°F
159	IN	ambient temperature (sensor outside building)	-2.2°F

As soon as the communication is restored the values from the BMS are taken.

9.6.2 Changed values as soon as future units are started up

datapoint	direction	description	predefined value (if communication is lost)
91	IN	fan in use AHU 1	True
92	IN	fan in use AHU 2	True
93	IN	fan in use AHU 3	True
94	IN	fan in use AHU 4	True
95	IN	fan in use AHU 5	True
96	IN	fan in use AHU 6	True
97	IN	fan in use AHU 7	True
98	IN	fan in use AHU 8 (redundant)	False
99	IN	fan in use EAHU 1	True
100	IN	fan in use EAHU 2	True
101	IN	fan in use EAHU 3	True
102	IN	fan in use EAHU 4	True

As soon as the communication is restored the values from the BMS are taken.

10 Alarms and Warnings

All alarms and notifications are displayed on the local display panel and are transmitted to the BMS according chapter 6 Interfaces.

10.1 General system alarm

General system alarm is a general alarm which is triggered, if one of the following alarms occurs.

10.2 General system warning

General system warning is a general warning which is triggered, if one of the following warnings occurs.

10.3 Alarm Malfunction HRS-Pump

Class: warning if only one pump fails, alarm if both pumps fail at the same time

If a pump doesn't acknowledge its operating status, if the safety circuit breaker is off or if the power safety switch in the ECA is off, an individual alarm for each pump is triggered. The alarm will reset automatically if the alarm condition is not met anymore.

10.4 Alarm low pressure HRS-Pump

Class: warning if only one pump fails, alarm if both pumps fail at the same time

A pressure monitor is installed upstream of each pump. These pressure monitors, serving to protect against dry running and cavitations. In case of pressure loss below low pressure threshold upstream of the HRS pumps, a pressure loss alarm is triggered. This alarm must be acknowledged inside the electrical cabinet of the HRS. In order to prevent damage to the pumps, the system will not restart automatically. Once the reason for the malfunction is corrected, the alarm can be acknowledged in the ECA and the system will restart.

10.5 Alarm temperature sensors

Class: warning

An operating range is defined for each temperature probe and stored in the software. If the signal of a temperature probe is outside this operating range, an alarm is triggered. This alarm is triggered as well in case of a hardware deficiency. The alarm will reset automatically if the alarm condition is not met anymore.

10.6 Alarm Valve Position Signal

Class: warning

All automatic valves are monitored continuously. If a valve actual position doesn't meet the set position after a predefined time interval, an alarm is triggered. The alarm will reset automatically if the alarm condition is not met anymore.

10.7 Alarm Bypass Valve Leakage

Class: warning

A leaking bypass valve can be a reason for the system not operating at optimal performance. Should the bypass valve be closed and the temperature difference in the glycol/water before and after the bypass valve is higher than a fixed temperature differential, an alarm will be triggered with a certain time lag. The alarm will reset automatically if the alarm condition is not met anymore.

10.8 Alarm Plate Heat Exchanger

Class warning

If the Plate Heat Exchangers control valve is closed and the temperature difference in the glycol/water before and after the bypass valve is higher than a fixed temperature differential, an alarm will be triggered with a certain time lag. The alarm will reset automatically if the alarm condition is not met anymore.

10.9 Acknowledgment

In case of pressure loss below low pressure threshold upstream of the HRS pumps, a pressure loss alarm is triggered. This alarm must be acknowledged inside the electrical cabinet of the HRS.
The acknowledge button is located in the 24VDC electrical cabinet.

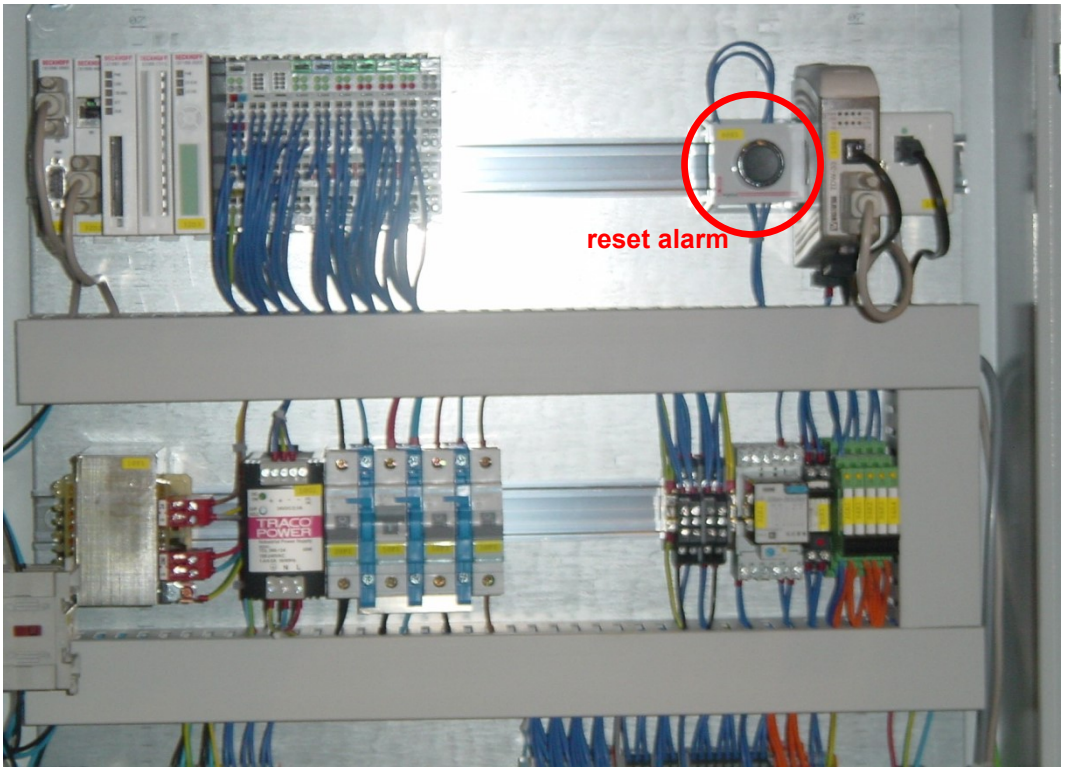


figure 9 – alarm acknowledge button

Acknowledgment of all other alarms is not mandatory as they are reset automatically.

11 Hardware Design Specification

The controller is based on a Beckhoff-SPS (Series CX2020). It includes the following components:

Hardware WRG Controller		
Beschreibung:	**Hersteller:**	**Typ:**
CPU-Modul	Beckhoff	CX2020-0111-N31
CPU-Modul BACnet	Beckhoff	CX8091-1001
bus coupler	Beckhoff	BK9000
supply unit for k-bus	Beckhoff	CX2100-0004
digital input module	Beckhoff	KL1408
digital output module	Beckhoff	KL2408
MP-Bus master module	Beckhoff	KL6771
analog input module	Beckhoff	KL3064
RS232 Modul	Beckhoff	KL6001
analog output module	Beckhoff	KL4004
PT1000-sensor module	Beckhoff	KL3202
diode array module	Beckhoff	KL9302
end terminal	Beckhoff	KL9010
display	Bachmann	OT-1200 series

Subject to modifications and amendments.

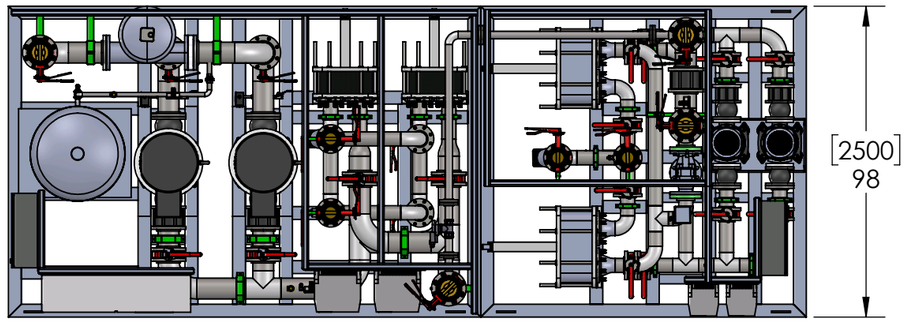
12 Software Design Specification

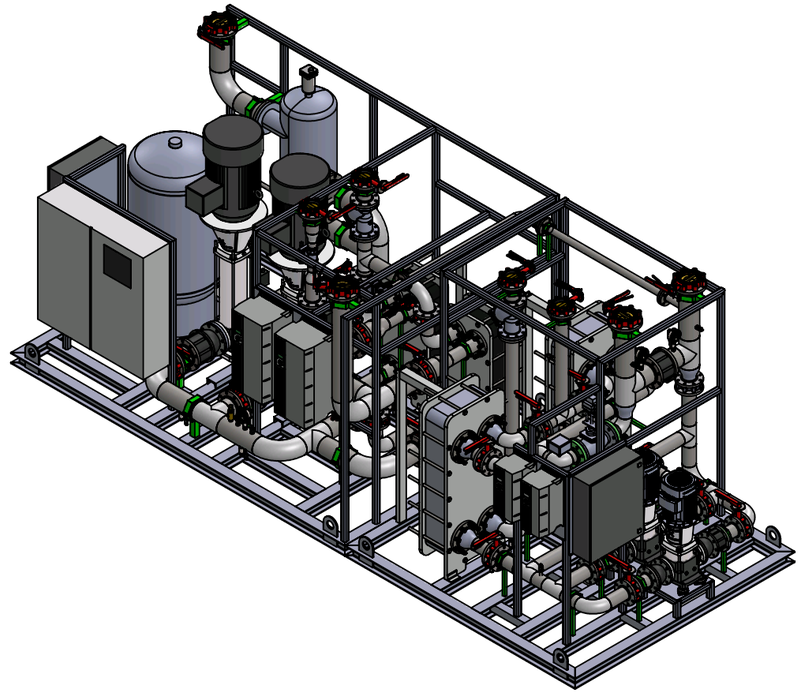
12.1 Program Software

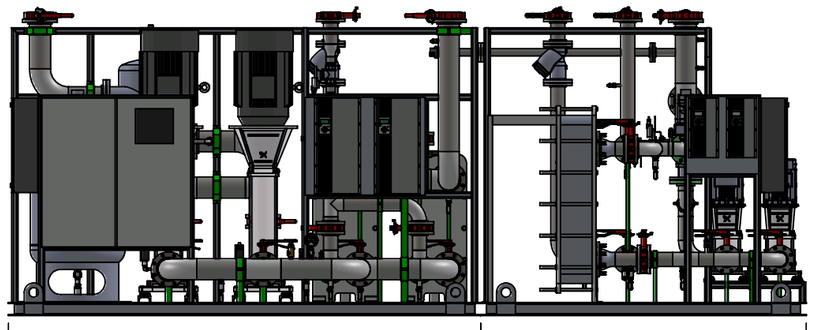
The Software of the Beckhoff-SPS is programmed in TwinCAT-Software System Version 2.11.0.

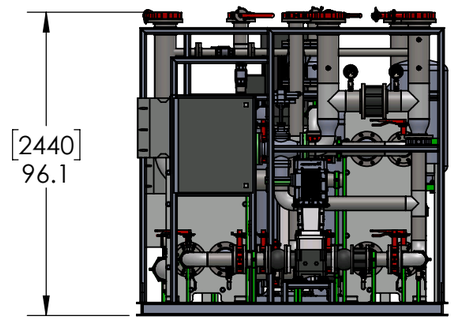
12.2 Firmware

- Microsoft Windows CE
- Version 6.0







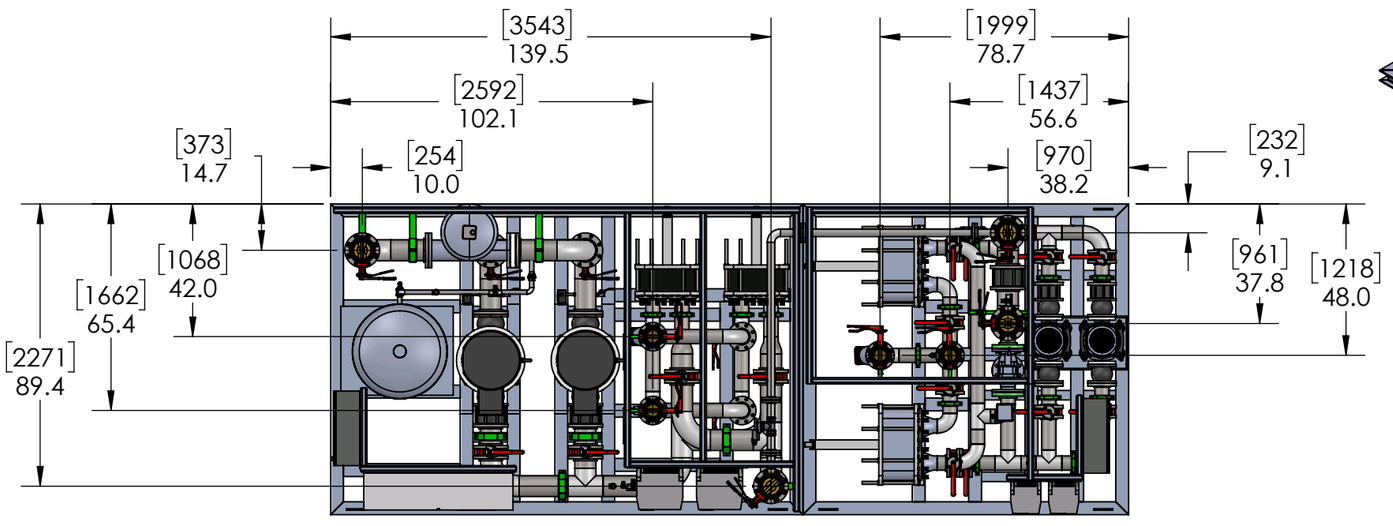


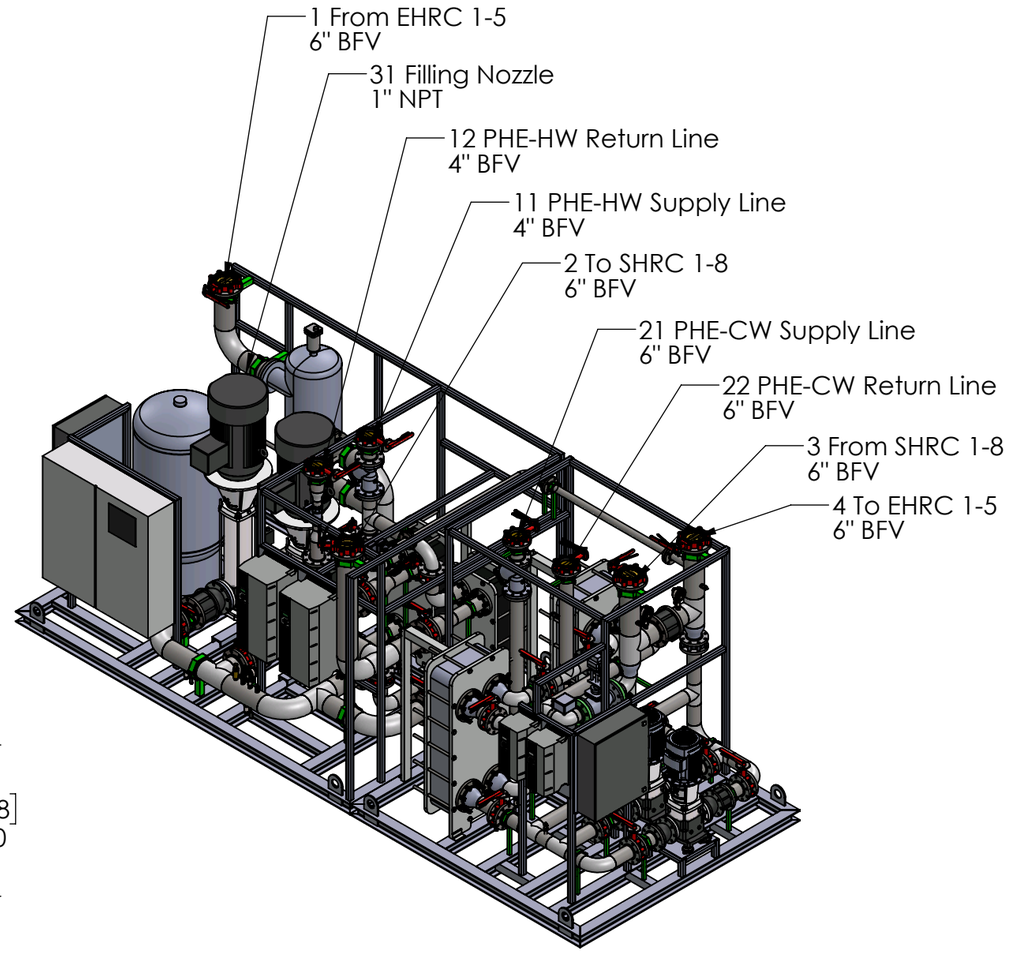
		NAME	DATE
UNLESS OTHERWISE SPECIFIED:	DRAWN	C.O.	5-17-17
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	CHECKED		
	ENG APPR.		
	MFG APPR.		
	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

ProSkid Design & Fabrication
www.ProSkid.com

TITLE:
Kentucky Asembly

SIZE	DWG. NO.	REV
B	1264-001	0
SCALE: 1:48	WEIGHT:	SHEET 1 OF 4





		NAME	DATE
UNLESS OTHERWISE SPECIFIED:	DRAWN	C.O.	5-17-17
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±1/16" ANGULAR: MACH ±1° BEND ±1° TWO PLACE DECIMAL ±0.01" THREE PLACE DECIMAL ±0.005"	CHECKED		
	ENG APPR.		
	MFG APPR.		
	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL			
FINISH DO NOT SCALE DRAWING			

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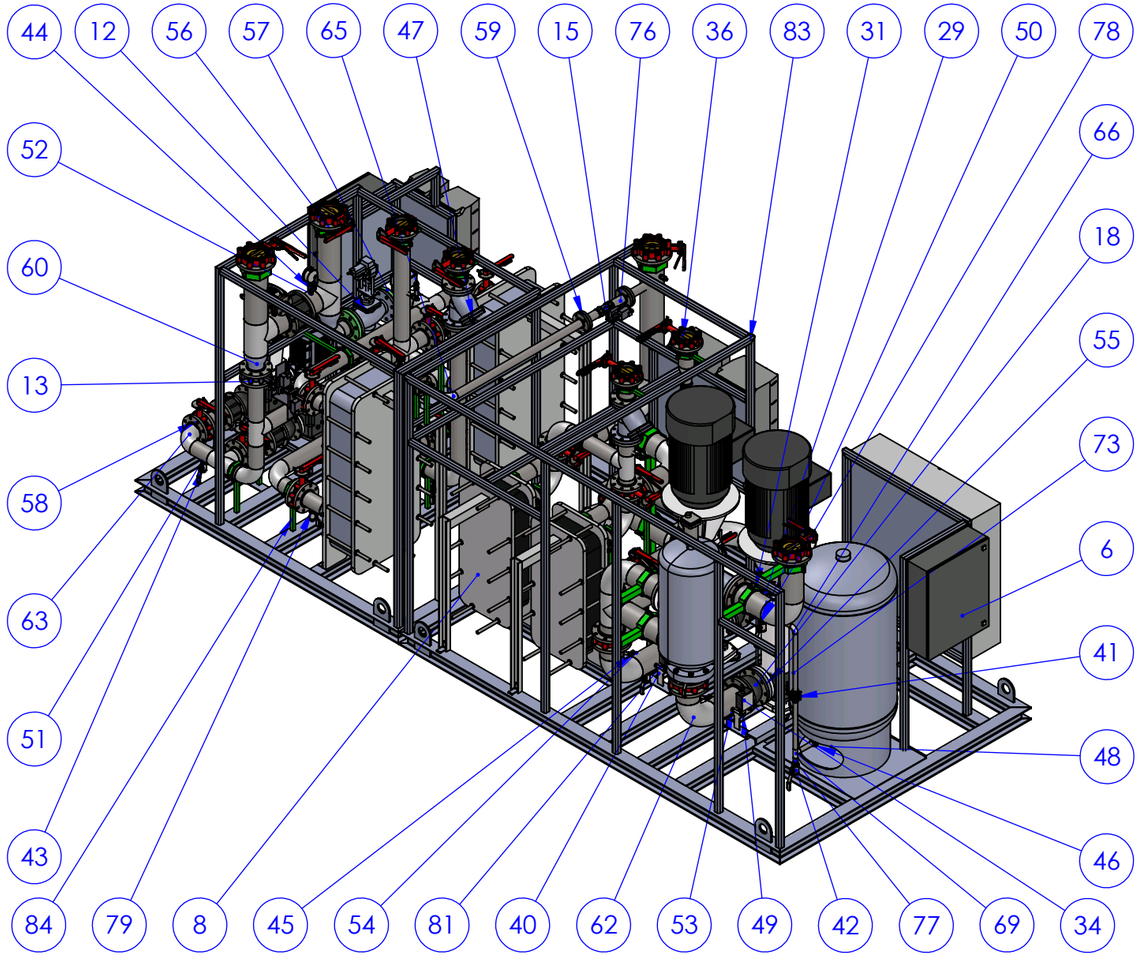
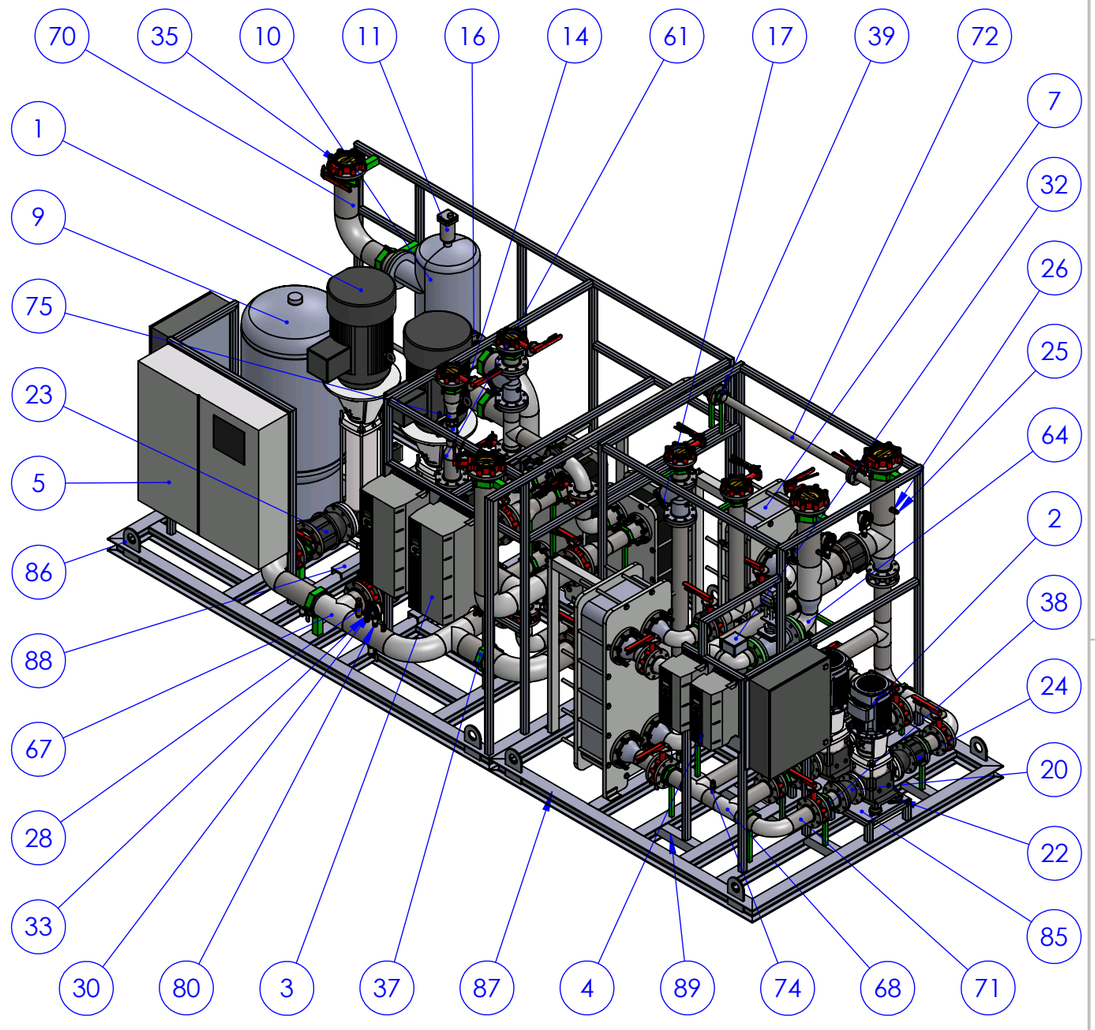
TITLE:
Kentucky Assembly

SIZE	DWG. NO.	REV
B	1264-001	0
SCALE: 1:48	WEIGHT:	SHEET 2 OF 4





		NAME	DATE
UNLESS OTHERWISE SPECIFIED:	DRAWN	C.O.	5-17-17
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±1/16" ANGULAR: MACH ±1° BEND ±1° TWO PLACE DECIMAL ±0.01" THREE PLACE DECIMAL ±0.005"	CHECKED		
	ENG APPR.		
	MFG APPR.		
	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

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TITLE:

Kentucky Assembly

SIZE	DWG. NO.	REV
B	1264-001	0
SCALE: 1:48	WEIGHT:	SHEET 3 OF 4

Item No.	Part No.	Description	QTY.
1		Grundfos Pump CR 120-4 100HP 3x460V (Supplied by Konvekta)	2
2		Grundfos Pump CR 90-1 15HP 3x460V (Supplied by Konvekta)	2
3	91136893	Grundfos VFD CUE Enclosure C2 (Supplied by Konvekta)	2
4	91136885	Grundfos VFD CUE Enclosure B1 (Supplied by Konvekta)	2
5		Control Panel 1200x1200x300mm - Bold Controls	1
6		Control Panel 760x600x210mm - Bold Controls	2
7	BY5431	Bell & Gossett GPX Gasketed Plate Heat Exchanger P 41A (Supplied by Konvekta)	2
8	BY5409	Bell & Gossett GPX Gasketed Plate Heat Exchanger P 21A (Supplied by Konvekta)	2
9	116792	Bell & Gossett 600 Liter Expansion Tank Model B-600LA	1
10	R-6F	6" Bell & Gossett Rolairtrol Strainer Flanged	1
11	107A	Bell & Gossett Model 107A Air Vent	1
12	G7100S-250-EVB24-SR	4" Belimo 3-Way Globe Valve (Supplied by Konvekta)	1
13	F6100HD+ 2GMX24-MFT-X1	4" Belimo 2-Way Butterfly Valve (Supplied by Konvekta)	1
14	B264-ARB24-MFT	2 1/2" Belimo Characterized Control Valve (Supplied by Konvekta)	1
15	B253-ARB24-MFT	2" Belimo Characterized Control Valve (Supplied by Konvekta)	1
16	HS6SGLFA	6" Sight Glass Flange -Salco	1
17		4" 125# Flanged Flat Face Y-Strainer A-7 Style Cast Iron Body Perforated 304SS Screen w Fiber Gasket	2
18		6" Expansion Coupler Single Sphere Flex Connector 6" F-F	4
19		6" Control Rods SGL Sphere	8
20		4" Expansion Coupler Single Sphere Flex Connector 6" F-F	4
21		4" Control Rods SGL Sphere	8
22		Industrial Vibration Isolator 385lb Load 60 Shore -AV Products	16
23		6" Keckley Wafer Style CW Silent Check Valve 125# Wafer Cast Iron Body 304SS Disc Spring and Seat	3
24		4" Keckley Wafer Style CW Silent Check Valve 125# Wafer Cast Iron Body 304SS Disc Spring and Seat	2
25	TM4331	RTD 4" Insertion Length- IFM	11
26	E37210	Thermowell 4" Insertion Length- IFM	11
27		RTD Cable 30'- IFM	11
28		Kunkle Pressure Relief Valve 1/2" x 3/4" Bronze Body 235psi	1
29		Kunkle Pressure Relief Valve 1/2" x 3/4" Bronze Body 125psi	1
30		4" Pressure Gauge 0-235psi 1/2" Bottom Connection Dry- Wika	3
31		4" Pressure Gauge 0-150psi 1/2" Bottom Connection Dry- Wika	1
32	B402-120	Temperature Alarm High- United Electric Controls	1
33	S05	Jumo Midas S05 0-10V/ 0-232psi	1
34	RT200	Danfoss RT200 Pressure Switch	2
35		6" Butterfly Valve Series 31H- Bray	12
36		4" Butterfly Valve Series 31H- Bray	20
37		6" PVC Bracket	12
38		4" PVC Bracket	30
39		2" PVC Bracket	2
40		6" Titty Bracket	2
41		1" 3PC Manual Ball Valve Socket Weld SS 150#	1
42		1" 2PC Manual Ball Valve Threaded w Cap & Chain Brass	5
43		3/4" 2PC Manual Ball Valve Threaded w Cap & Chain Brass	18
44		1/2" 2PC Manual Ball Valve Threaded SS 150#	5
45		1/4" 2PC Manual Ball Valve Threaded SS 150#	2
46		1" Union Socket Weld 150# SS	2
47		1 1/2" x 1" Threaded Hex Reducer 150# 304SS	2
48		1" Threaded Elbow 150# 304SS	1
49		3/8" Threaded Elbow 150# 304SS	2
50		1" Threaded Half Coupling 150# 304SS	1
51		3/4" Threaded Half Coupling 150# 304SS	18
52		1/2" Threaded Half Coupling 150# 304SS	19
53		3/8" Threaded Half Coupling 150# 304SS	2
54		1/4" Threaded Half Coupling 150# 304SS	2
55		6" 150# x 5" 300# Blind Flange 304SS	4
56		6" Slip On Weld Flange 150# 304SS	36
57		4" Slip On Weld Flange 300# 304SS	3
58		4" Slip On Weld Flange 150# 304SS	56
59		2" Slip On Weld Flange 150# 304SS	8
60		6"x4" Concentric Reducer Sch10 304SS	14
61		4"x2 1/2" Concentric Reducer Sch10 304SS	2
62		6" Elbow 90LR Sch10 304SS	10
63		4" Elbow 90LR Sch10 304SS	13
64		4" Elbow 90SR Sch10 304SS	7
65		2" Elbow 90LR Sch10 304SS	1
66		1" Elbow 90LR Sch10 304SS	2
67		6" Straight Tee Sch10 304SS	6
68		4" Straight Tee Sch10 304SS	9
69		1" Straight Tee Sch10 304SS	1
70		6" Pipe Sch10 304SS	30'
71		4" Pipe Sch10 304SS	56'
72		2" Pipe Sch10 304SS	12'
73		1" Pipe Sch10 304SS	10'
74		1/2" Pipe Sch10 304SS	3'
75		2 1/2" Threaded Nipple 8" Long 304SS	1
76		2" Threaded Nipple 14" Long 304SS	1
77		1" Threaded Nipple 14" Long 304SS	1
78		1" Closed Threaded Nipple 304SS	2
79		3/4" Closed Threaded Nipple 304SS	18
80		1/2" Closed Threaded Nipple 304SS	4
81		3/8" Threaded Nipple 4" Long 304SS	2
82		1/4" Closed Threaded Nipple 304SS	2
83		2"x2"x1/4" Square Tube CS	192'
84		1"x1"x1/4" Square Tube CS	35'
85		Plate 4'x8'x1/4" CS	2
86		ProSkid Lifting Lugs 10"x6"x1/2" CS	8
87		W Beam 4"x13lbs/ft CS	176'
88		MC Channel 4"x13.8lbs/ft CS	12'
89		L Angle 3"x3"x1/4" CS	12'
90		6" Fiber Gaskets 150#	15
91		4" Fiber Gaskets 300#	3
92		4" Fiber Gaskets 150#	17
93		2" Fiber Gaskets 150#	4
94		3/4"-10UNC x 14" Threaded Rod 304SS	4
95		3/4"-10UNC x 9" Hex Bolt 304SS	24
96		3/4"-10UNC x 5 1/2" Hex Bolt 304SS	8
97		3/4"-10UNC x 3 3/4" Hex Bolt 304SS	24
98		3/4"-10UNC x 3 1/4" Hex Bolt 304SS	24
99		3/4"-10UNC x 2" Hex Bolt 304SS	184
100		3/4"-10UNC x 1 1/2" Hex Bolt 304SS	24
101		3/4"-10UNC Hex Nut 304SS	232
102		5/8"-11UNC x 14" Threaded Rod 304SS	4
103		5/8"-11UNC x3" Hex Bolt 304SS	88
104		5/8"-11UNC x2 3/4" Hex Bolt 304SS	12
105		5/8"-11UNC x 1 7/8" Hex Bolt 304SS	288
106		5/8"-11UNC Hex Nut 304SS	248
107		3/4"-10UNC x 1 1/2" Heavy Hex Bolt Grade 5 Zinc Coated Fully Threaded	16
108		3/4"-10UNC Heavy Hex Nut Grade 5 Zinc Coated	16
109		3/4"-10UNC Lock Washer & Flat Washer	16
110		3/8"-11UNC x 1" Heavy Hex Bolt Grade 5 Zinc Coated Fully Threaded	12
111		3/8"-11UNC Heavy Hex Nut Grade 5 Zinc Coated	12
112		3/8"-11UNC Lock Washer & Flat Washer	12
113		5/16"-18UNC x 1 1/2" Heavy Hex Bolt Grade 5 Zinc Coated Fully Threaded	32
114		5/16"-18UNC x 1" Heavy Hex Bolt Grade 5 Zinc Coated Fully Threaded	8
115		5/16"-18UNC Heavy Hex Nut Grade 5 Zinc Coated	8
116		5/16"-18UNC Lock Washer & Flat Washer	8
117		M12x20 x 4" Heavy Hex Bolt Grade 5 Zinc Coated 1.5 Tooth Pitch	16
118		M12x20 Heavy Hex Nut Grade 5 Zinc Coated	16
119		M12x20 Lock Washer & Flat Washer	16

Additional Parts to Ship with Skid			
Item No.	Part No.	Description	QTY.
1	TM4331	RTD 4" Insertion Length- IFM	12
2	E37210	Thermowell 4" Insertion Length- IFM	12
3		RTD Cable 30'- IFM	12
4		2 1/2" Oventrop Hydrocontrol R Valve (Supplied by Konvekta)	3
5		2" Oventrop Hydrocontrol R Valve (Supplied by Konvekta)	5
6		1 1/2" Oventrop Hydrocontrol R Valve (Supplied by Konvekta)	4
7	B262+ARB24-MFT	Belimo Characterized Control Valve B262 CV 75 (Supplied by Konvekta)	3
8	B251+ARB24-MFT	Belimo Characterized Control Valve B251 CV 65 (Supplied by Konvekta)	3
9	B249+ARB24-SR	Belimo Characterized Control Valve B249 CV 46 (Supplied by Konvekta)	2
10	B239+ARB24-SR	Belimo Characterized Control Valve B239 CV 29 (Supplied by Konvekta)	4

	NAME	DATE
DRAWN	C.O.	5-17-17
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

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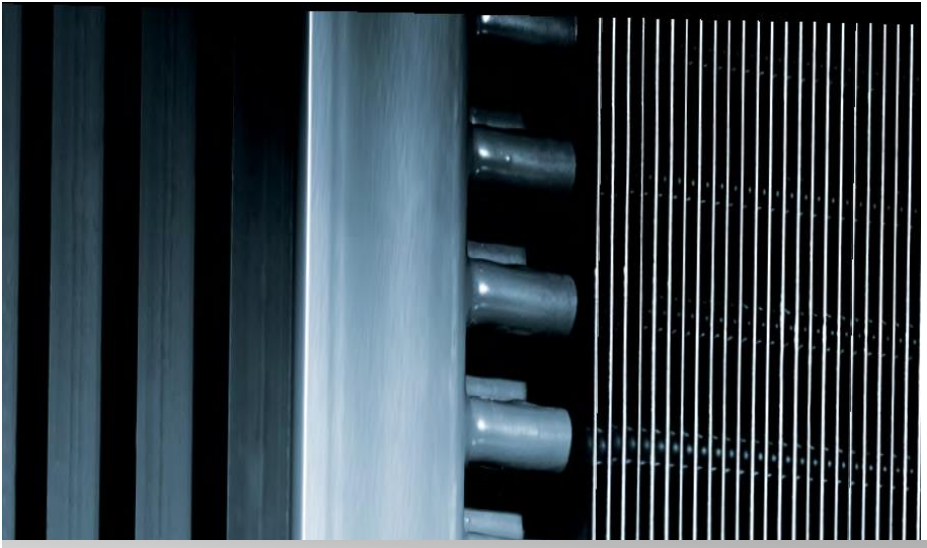
TITLE:
Kentucky Assembly

SIZE	DWG. NO.	REV
B	1264-001	0
SCALE: 1:48	WEIGHT:	SHEET 4 OF 4

konvekta



Startup Report

Startup Report Energy Recovery System

Object:	Energy Recovery System
Project:	Kentucky Research Building 2
Commission:	84160120
site:	Research Building 2
Name (of the briefed person) **:**	
Tel.-no. (of the briefed person) **:**	
E-Mail (of the briefed person) **:**	
start-up date:	08/23/2018
scope:	Second Startup
engineer:	NAD/KELJ

comments:

scope of service

The start-up procedure contains all tasks according the detailed program listed below. During start-up procedure only Konvekta components or components delivered by Konvekta's subcontractors are being checked and configured.
Hydraulic components which are necessary for the function of the ER-System but not in scope of delivery of Konvekta are only checked for their proper function. Configurations where necessary are not maintained by Konvekta due to warranty reasons.

Assembly and cleaning work are not part of the ramp-up procedure.

After completion of the start-up procedure the stuff will be briefed on the ER-System. With a short training the operation and function of the system will be shown. The briefing takes place after start-up procedure. A separate visit for the briefing by Konvekta Engineers is not included in the scope.

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Punchlist			
Pos.	**description**	**responsible**	**state**
2.5.3	Defective system pressure transducer	nad	**Replacement done**
2.5.8	Glycol concentration below specified (25%)	CJM	**Contractor to increase level**
2.5.8	Glycol in loop very dirty	CJM	**Contractor to clean/flush**

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Pos. / Scope of services	Scope	status

	--
	OK
Yes	issue
No	remark

1	**Heat-Exchangers (if within Konvekta's scope of delivery)**		
1.1	**SHRC (AHU 1)**		
1.1.1	Check for contamination and damaging, corrosion and correct sealing	**yes**	**OK**
1.1.2	Check inlet flow and return line for correctness	**Yes**	**OK**
1.1.3	Check hygienic conditions	**Yes**	**OK**
1.1.4	Check installation position and place of installation	**Yes**	**OK**
1.1.5	Check availability of drainage for condensate where necessary	**Yes**	**OK**
1.2	**SHRC (AHU 3)**		
1.2.1	Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.2.2	Check inlet flow and return line for correctness	**Yes**	**OK**
1.2.3	Check hygienic conditions	**Yes**	**OK**
1.2.4	Check installation position and place of installation	**Yes**	**OK**
1.2.5	Check availability of drainage for condensate where necessary	**Yes**	**OK**
1.3	**SHRC (AHU 5)**		
1.3.1	Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.3.2	Check inlet flow and return line for correctness	**Yes**	**OK**
1.3.3	Check hygienic conditions	**Yes**	**OK**
1.3.4	Check installation position and place of installation	**Yes**	**OK**
1.3.5	Check availability of drainage for condensate where necessary	**Yes**	**OK**
1.4	**SHRC (AHU 6)**		
1.4.1	Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.4.2	Check inlet flow and return line for correctness	**Yes**	**OK**
1.4.3	Check hygienic conditions	**Yes**	**OK**
1.4.4	Check installation position and place of installation	**Yes**	**OK**
1.4.5	Check availability of drainage for condensate where necessary	**Yes**	**OK**
1.5	**EHRC (EAHU 1)**		
1.5.1	Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.5.2	Check inlet flow and return line for correctness	**Yes**	**OK**
1.5.3	Check hygienic conditions	**Yes**	**OK**
1.5.4	Check installation position and place of installation	**Yes**	**OK**
1.5.5	Check availability of drainage for condensate where necessary	**Yes**	**OK**

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Pos. / Scope of services	Scope	status
1.6 EHRC (EAHU 2)		
1.6.1 Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.6.2 Check inlet flow and return line for correctness	**Yes**	**OK**
1.6.3 Check hygienic conditions	**Yes**	**OK**
1.6.4 Check installation position and place of installation	**Yes**	**OK**
1.6.5 Check availability of drainage for condensate where necessary	**Yes**	**OK**
1.7 EHRC (EAHU 3)		
1.7.1 Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.7.2 Check inlet flow and return line for correctness	**Yes**	**OK**
1.7.3 Check hygienic conditions	**Yes**	**OK**
1.7.4 Check installation position and place of installation	**Yes**	**OK**
1.7.5 Check availability of drainage for condensate where necessary	**Yes**	**OK**
1.8 EHRC (EAHU 4)		
1.8.1 Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
1.8.2 Check inlet flow and return line for correctness	**Yes**	**OK**
1.8.3 Check hygienic conditions	**Yes**	**OK**
1.8.4 Check installation position and place of installation	**Yes**	**OK**
1.8.5 Check availability of drainage for condensate where necessary	**Yes**	**OK**

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Pos. / Scope of services	Scope	status

2 piping (only piping of the ERS)			
2.1 ERS-Pumps			
2.1.1 Check for contamination and damaging, corrosion and correct sealing		**Yes**	**OK**
2.1.2 Check presettings of motor overload switch (where available)		**Yes**	**OK**
2.1.3 Setup pump parameters pump 1		**Yes**	**OK**
3.1 Control mode	Open loop		
3.2 Controller	N/A (Kp: 0.50 / Ti: 0.50s)		
3.3 External setpoint	active		
3.3A External setpoint	Min.: 0.00V / Max.: 10.0V		
3.4 Signal relay 1 activated during	running		
3.5 Signal relay 2 activated during	warning		
3.6 +/-, OK, On/Off buttons	Not active		
3.7 Protocol	N/A (GENIbus)		
3.8 Pump number	1		
3.9 Digital Input 2	Not active		
3.10 Digital Input 3	Not active		
3.11 Digital Input 4	Not active		
3.12 Digital flow input	N/A (0l / pulse)		
3.13 stop function	Not active		
3.15 Sensor 1	N/A		
3.16 Sensor 2	N/A		
3.17 Duty/standby	Not active		
3.18 Operating range	Min.: 25% / Max.: 100%		
3.19 Motor bearing monitoring	Active		
3.20 Motor bearings	Relubricate		
3.21 Temperature sensor 1	Not active		
3.22 Temperature sensor 2	Not active		
3.23 Standstill heating	Not active		
3.24 Ramps	Up: 10.0s / Down: 10.0 s		
3.25 switching frequency	4-12kHz (noise dependent)		
2.1.4 Setup pump parameters pump 2		**Yes**	**OK**
3.1 Control mode	Open loop		
3.2 Controller	N/A (Kp: 0.50 / Ti: 0.50s)		
3.3 External setpoint	active		
3.3A External setpoint	Min.: 0.00V / Max.: 10.0V		
3.4 Signal relay 1 activated during	running		
3.5 Signal relay 2 activated during	warning		
3.6 +/-, OK, On/Off buttons	Not active		
3.7 Protocol	N/A (GENIbus)		
3.8 Pump number	1		
3.9 Digital Input 2	Not active		
3.10 Digital Input 3	Not active		
3.11 Digital Input 4	Not active		
3.12 Digital flow input	N/A (0l / pulse)		
3.13 stop function	Not active		
3.15 Sensor 1	N/A		
3.16 Sensor 2	N/A		
3.17 Duty/standby	Not active		
3.18 Operating range	Min.: 25% / Max.: 100%		
3.19 Motor bearing monitoring	Active		
3.20 Motor bearings	Relubricate		
3.21 Temperature sensor 1	Not active		
3.22 Temperature sensor 2	Not active		
3.23 Standstill heating	Not active		
3.24 Ramps	Up: 10.0s / Down: 10.0 s		
3.25 switching frequency	4-12kHz (noise dependent)		
2.1.5 Setup pump parameters FC-pump 1		**Yes**	**OK**
3.1 Control mode	Open loop		
3.2 Controller	N/A (Kp: 0.50 / Ti: 0.50s)		
3.3 External setpoint	Active		

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Pos. / Scope of services		Scope	status
3.3A External setpoint	Min.: 0.00V / Max.: 10.0V		
3.4 Signal relay 1 activated during	Running		
3.5 Signal relay 2 activated during	Warning		
3.6 +/-, OK, On/Off buttons	Not active		
3.7 Protocol	N/A (GENIbus)		
3.8 Pump number	1		
3.9 Digital Input 2	Not active		
3.10 Digital Input 3	Not active		
3.11 Digital Input 4	Not active		
3.12 Digital flow input	N/A (0l / pulse)		
3.13 stop function	Not active		
3.15 Sensor 1	N/A		
3.16 Sensor 2	N/A		
3.17 Duty/standby	Not active		
3.18 Operating range	Min.: 25% / Max.: 100%		
3.19 Motor bearing monitoring	Active		
3.20 Motor bearings	Relubricate		
3.21 Temperature sensor 1	Not active		
3.22 Temperature sensor 2	Not active		
3.23 Standstill heating	Not active		
3.24 Ramps	Up: 10.0s / Down: 10.0 s		
3.25 switching frequency	4-12kHz (noise dependent)		
2.1.6 Setup pump parameters FC-pump 2		**Yes**	**OK**
3.1 Control mode	Open loop		
3.2 Controller	N/A (Kp: 0.50 / Ti: 0.50s)		
3.3 External setpoint	active		
3.3A External setpoint	Min.: 0.00V / Max.: 10.0V		
3.4 Signal relay 1 activated during	running		
3.5 Signal relay 2 activated during	warning		
3.6 +/-, OK, On/Off buttons	Not active		
3.7 Protocol	N/A (GENIbus)		
3.8 Pump number	1		
3.9 Digital Input 2	Not active		
3.10 Digital Input 3	Not active		
3.11 Digital Input 4	Not active		
3.12 Digital flow input	N/A (0l / pulse)		
3.13 stop function	Not active		
3.15 Sensor 1	N/A		
3.16 Sensor 2	N/A		
3.17 Duty/standby	Not active		
3.18 Operating range	Min.: 25% / Max.: 100%		
3.19 Motor bearing monitoring	Active		
3.20 Motor bearings	Relubricate		
3.21 Temperature sensor 1	Not active		
3.22 Temperature sensor 2	Not active		
3.23 Standstill heating	Not active		
3.24 Ramps	Up: 10.0s / Down: 10.0 s		
3.25 switching frequency	4-12kHz (noise dependent)		
2.1.7 Set variable ‚FUMin' in anlctr.csv to 0.25			

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Pos. / Scope of services			Scope	status
2.1.8 Check power consumption ERS-pump 1				
	@ full speed	@ OP	**Yes**	**Ok**
rotation per minutes	3510			
power consumption	52			
amperage	71			
pressure suction/discharge	5/195			
flow rate				
2.1.9 Check power consumption ERS-pump 2				
	@ full speed	@ OP	**Yes**	**Ok**
rotation per minutes	3560			
power consumption	51			
amperage	71			
pressure suction/discharge	5/195			
flow rate				
2.1.10 Check power consumption FC-pump 3				
	@ full speed	@ OP	**Yes**	**Ok**
rotation per minutes	3535			
power consumption	9.2			
amperage	13.3			
pressure suction/discharge				
flow rate				
2.2 Check for correct operation			**Yes**	**OK**
2.2.1 Check electrical connections			**Yes**	**OK**
2.2.2 Check engine smoothness and temperature rise			**Yes**	**OK**
2.2.3 Check initial pump venting			**Yes**	**OK**
2.2.4 Visual leak tightness check			**Yes**	**OK**
2.3 ERS-fittings				
2.3.1 Check for damaging and corrosion			**Yes**	**OK**
2.3.2 Visual leak tightness check			**Yes**	**OK**
2.4 Strainer				
2.4.1 Visual leak tightness check			**Yes**	**OK**
2.5 ERS-piping and expansion tank				
2.5.1 Check accessible piping for damaging, leak tightness and fixation			**Yes**	**OK**
2.5.2 Check cold and hot side insulation			**Yes**	**OK**
2.5.3 Check thermometers and pressure gauges for damaging and plausible indication			**Yes**	**issue**
2.5.4 Check availability of pressure safety valves			**Yes**	**OK**
2.5.5 Check compensators for damaging and leak tightness			**Yes**	**OK**
2.5.6 Check system pressure set pressure: 30…. psi actual pressure:30……psi			**Yes**	**OK**
2.5.7 Check pre-adjusted expansion tank pressure set pressure: 17… psi actual pressure:17……psi			**Yes**	**OK**

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Pos. / Scope of services	Scope	status
2.5.8 Check glycol concentration and frost line	**Yes**	**Issue**
2.5.9 Extract glycol specimen for chemical analysis	**Yes**	**OK**
2.5.10 Check venting of the entire piping	**Yes**	**OK**

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Pos. / Scope of services	Scope	status

2.6	**Plate heat exchanger**		
2.6.1	Check for contamination and damaging, corrosion and correct sealing	**Yes**	**OK**
2.6.2	Supply and return line	**Yes**	**OK**
2.6.3	Supply temperature PHE-HW: Supply temperature …82.8°F	**Yes**	**OK**

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Pos. / Scope of services	Scope	status
3 Electrical Cabinet ECA		
3.1 Enclosure and panel		
3.1.1 Check for contamination, damaging and corrosion	**Yes**	**OK**
3.1.2 Check for professional and suitable installation	**Yes**	**OK**
3.2 Power feed and supply		
3.2.1 Check power feed and the installation of it	**Yes**	**OK**
3.2.2 Check behavior after power outage		
3.3 Connected cables		
3.3.1 Check connected cables for completeness	**Yes**	**Ok**
3.3.2 Check for professional and suitable installation	**Yes**	**Ok**
3.4 Lighting		
3.4.1 Check for correct operation	**Yes**	**OK**

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Pos. / Scope of services	Scope	status
4 Field instruments		
4.1 Air temperature sensors		
4.1.1 Number of air temperature sensors	**20**	
4.1.2 Check for contamination, damaging and corrosion	**Yes**	**OK**
4.1.3 Check for professional and suitable installation	**Yes**	**OK**
4.1.4 Check installation position and place of installation	**Yes**	**OK**
4.1.5 Check used cable	**Yes**	**OK**
4.1.6 Check for professional and suitable electrical installation	**Yes**	**OK**
4.2 Humidity sensor		
4.2.1 Number of humidity sensors	**4**	
4.2.2 Check for contamination, damaging and corrosion	**Yes**	**OK**
4.2.3 Check for professional and suitable installation	**Yes**	**OK**
4.2.4 Check installation position and place of installation	**Yes**	**OK**
4.2.5 Check used cable	**Yes**	**OK**
4.2.6 Check for professional and suitable electrical installation	**Yes**	**OK**
4.2.7 Check measured signal 100%-check according the electrical schematic	**Yes**	**OK**

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Pos. / Scope of services			Scope	status
4.3	**Water/Glycol temperature sensors**			
4.3.1	Number of air temperature sensors		**8**	
4.3.2	Check for contamination, damaging and corrosion		**Yes**	**OK**
4.3.3	Check for professional and suitable installation		**Yes**	**OK**
4.3.4	Check installation position and place of installation		**Yes**	**OK**
4.3.5	Check used cable		**Yes**	**OK**
4.3.6	Check for professional and suitable electrical installation		**Yes**	**OK**
4.3.7	Check availability of thermal conductance paste (random test)		**Yes**	**OK**
4.3.8	Check measured signal 100%-check according the electrical schematic		**Yes**	**OK**
4.4	**Actuators**			
4.4.1	Number of 2-way valves		**8**	
4.4.2	Check for contamination, damaging and corrosion		**Yes**	**OK**
4.4.3	Check for professional and suitable installation		**Yes**	**OK**
4.4.4	Check installation position and place of installation		**Yes**	**OK**
4.4.5	Check control signal and operating range 100%-check according the electrical schematic		**Yes**	**OK**
4.4.6	Check feedback signal 100%-check according the electrical schematic		**Yes**	**OK**
4.4.7	Check safety position (if available)		**Yes**	**OK**
4.4.8	Actuator Test	Command each of the actuator dampers and valves 100% open and confirm at the unit and at the front end	220Y2	**Yes**	**OK**
			220Y4	**Yes**	**OK**
			220Y6	**Yes**	**OK**
			220Y7	**Yes**	**OK**
			222Y2	**Yes**	**OK**
			222Y4	**Yes**	**OK**
			222Y6	**Yes**	**OK**
			222Y7	**Yes**	**OK**
			320Y4	**Yes**	**OK**
			620Y4	**Yes**	**OK**

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Pos. / Scope of services	Scope	status

4.5	**Safety equipment (of ERS)**		
4.5.1	Check pre-adjusted pressure level of pressure switch 1 set: 0psi actual: 0psi …….. ……..	**Yes**	**OK**
4.5.2	Check pre-adjusted pressure level of pressure switch 2 set: 0psi actual: 0psi …….. ……..	**Yes**	**OK**
4.5.3	Check for contamination, damaging and corrosion	**Yes**	**OK**
4.5.4	Check for professional and suitable installation	**Yes**	**OK**
4.5.5	Check installation position and place of installation	**Yes**	**OK**
4.5.6	Check function and fault response	**Yes**	**OK**

5	**ERS-Controller**		
5.1	**Central Unit**		
5.1.1	Check all components for contamination, damaging and fixation	**Yes**	**OK**
5.1.2	Check display and control panel for correct operation	**Yes**	**OK**
5.1.3	Check emergency override module for correct operation	**Yes**	**OK**
5.1.4	Check watchdog settings	**Yes**	**Ok**
5.1.5	Check remote access	**Yes**	**Ok**

6	**Briefing**		
6.1.1	After completion of the start-up procedure the stuff will be briefed on the ERS. With a short training the operation and function of the system will be shown.	**Yes**	**OK**

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