MAKING MODERN LIVING POSSIBLE

Electronic Controls
Fitter's Notes



www.danfoss.com

Contents

Measuring 4
- Measuring a temperature 4
- Temperature sensor type EKS 111 5
- Temperature sensor type EKS 211 5
- Positioning sensors 6
- Evaporator positions 6
- S1 and S2 sensors 7
- How to mount S2 sensor on a vertical pipe 7
- How to mount S2 sensor on a horizontal pipe 7
- Measuring a pressure 8
- Positioning sensors 11
- Pressure transmitter in liquid line with pulse snubber 12

Electrical connections 13
- Pulse width modulation electronically operated expansion valve type AKV 13
- Stepper motor electronically operated expansion valve type ETS 13
- Digital Input (DI) / Digital Output (DO) 14
- No power 14
- Split sensors and AKV 14
- External Start/Stop of regulation 14

Controlling 15
- Input and output 15
- Operation 15
- Evaporator controls 16
- Parameters 16
- What is the controller doing...? 17
- Quick start 17
- What is wrong....? 18

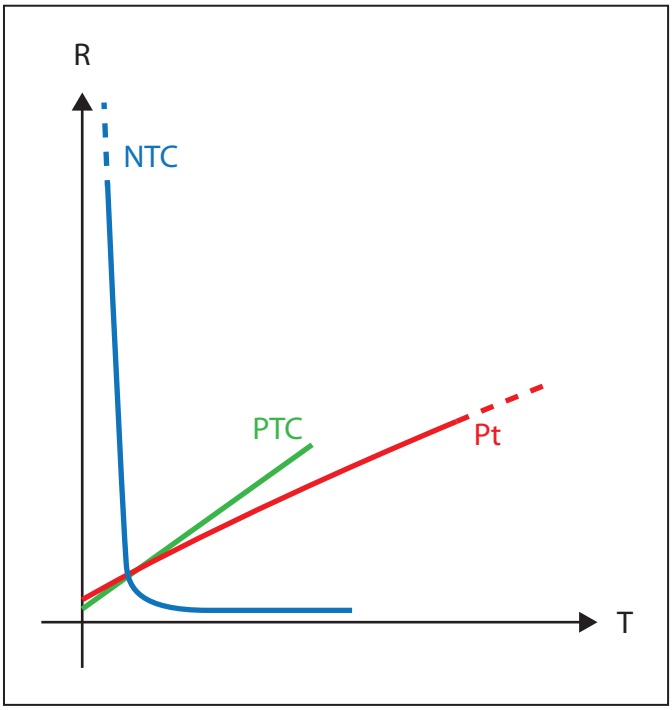
Communication 19
- Why...? 19
- How…? 19
- Cable selection / termination 20
- Requirement to installation 20
- Cable 21
- Addressing 24
- Trouble shooting 24

Measuring

Measuring a temperature

Pressure temperature inputs
With the use of electronic controllers such as Danfoss ADAP-KOOL® products the installation requirements must be followed to ensure the electrical connections, pressure and temperature sensors and any communication network connections are correct so that the unit operates as intended.
The following are some general guidelines:

- **Pressure temperature inputs**
  It is very important that the correct type of temperature sensor is used for the temperature range, sensing application, and the temperature sensor signal is compatible with the electronic refrigeration controller, (*please see the technical manual for the controller to ensure the correct temperature sensor is used*).
- **Sensor types**
  The product programme of temperature sensors for refrigeration consists of two main families: AKS and EKS. These sensor elements are based on the three technologies: Pt, PTC and NTC.



Temperature sensor type: AKS11, AKS12, AKS21, AK-HS 1000

Pt sensor
These sensors are also known as RTD´s, **Resistance Temperature Detectors**. The sensing elements is made of platinum, example PT1000, where the number describes the nominal resistance at **0°C**, here **1.000Ω**. The resistance increases 4Ω per 1°C. The sensor characteristic is linear. In Danfoss these sensors are the type AKS. The tolerance of a **Pt1000** sensor is less than ± (0.3 + 0.005 T). This translates into a temperature error of less than 0.5 degree for refrigeration control.
The **Pt1000** sensor must be used for food safety logs and regulation of superheat as they conform to the tolerance requirements of EN 60751 Class B and therefore satisfy the HACCP requirements of EN 12830, EN 13485.

Extension of sensor cables
When extending a sensor cable, the new resistance value of the longer cable may give rise to indication error. It is recommended that the total cable resistance should not exceed 2Ω corresponding to an indication error of 0.5°C (Pt1000Ω).

Note

Up to 50m use 0.75mm²
Up to 100m use 1.5mm²
Up to 150m use 2.5mm²

The typical resistance values for cables are:

- -2.4Ω/100m for core cross-sectional area of 0.75mm².
- -1.2Ω/100m for core cross-sectional area of 1.5mm².
- -0.7Ω/100m for core cross-sectional area of 2.5mm² .

AKS 11, AKS 12, AKS 21, AK-HS 1000

°C	ohm	°C	ohma
0	1000.0		1000.0
1	1003.9	-1	996.1
2	1007.8	-2	992.2
3	1011.7	-3	988.3
4	1015.6	-4	984.4
5	1019.5	-5	980.4
6	1023.4	-6	976.5
7	1027.3	-7	972.6
8	1031.2	-8	968.7
9	10.35.1	-9	964.8
10	1039.0	-10	960.9
11	1042.9	-11	956.9
12	1046.8	-12	953.0
13	1050.7	-13	949.1
14	1054.6	-14	945.2
15	1058.5	-15	941.2
16	1062.4	-16	937.3
17	1066.3	-17	933.4
18	1070.2	-18	929.5
19	1074.0	-19	925.5
20	1077.9	-20	921.6
21	1081.8	-21	917.7
22	1085.7	-22	913.7
23	1089.6	-23	909.8
24	1093.5	-24	905.9
25	1097.3	-25	901.9
26	1101.2	-26	898.0
27	1105.1	-27	894.0
28	1109.0	-28	890.1
29	1112.8	-29	886.2
30	1116.7	-30	882.2
31	1120.6	-31	878.3
32	1124.5	-32	874.3
33	1128.3	-33	870.4
34	1132	-34	866.4
34	1132.2	-34	866.4
35	1136.1	-35	862.5
36	1139	-36	858.5
37	1143.8	-37	854.6
38	1147.7	-38	850.6
39	1151.5	-39	846.7
40	1155.4	-40	842.7
41	1159.3	-41	838.8
42	1163.1	-42	835.0
43	1167.0	-43	830.8
44	1170.8	-44	826.9
45	1174.7	-45	822.9
46	1178.5	-46	818.9
47	1182.4	-47	815.0
48	1186.3	-48	811.0
49	1190.1	-49	807.0
50	1194.0	-50	803.1

approx 3.9 ohm/K

Temperature sensor type EKS 111

PTC sensor
The PTC sensor got their name as the sensing element has a **positive temperature coefficient**.
The sensing element is a semi conductor, example **PTC1000** where the number describes the nominal resistance at **25°C**.
The sensor characteristic is almost linear but is not standardized, the manufacturer can define their own characteristics.

In Danfoss the EKS111 is a PTC1000 type.
The PTC temperature sensor type EKS111 must not be used for food safety logs as they do not conform to the requirements EN 12830, EN 13485 or regulation of superheat because they do not have the needed accuracy of +/- 0.5K.

R (typ.) Ohm	Temp. °C	Error K	Temp °F
1679	100	+/-3.5	212
1575	90		194
1475	80		176
1378	70		158
1286	60		140
1196	50		122
1111	40		104
1029	30		86
990	25	+/-1.3	77
951	20		68
877	10		50
807	0		32
740	-10		14
677	-20		-4
617	-30		-22
562	-40		-40
510	-50		-58
485	-55	+/-3.0	-67

Temperature sensor type EKS 211

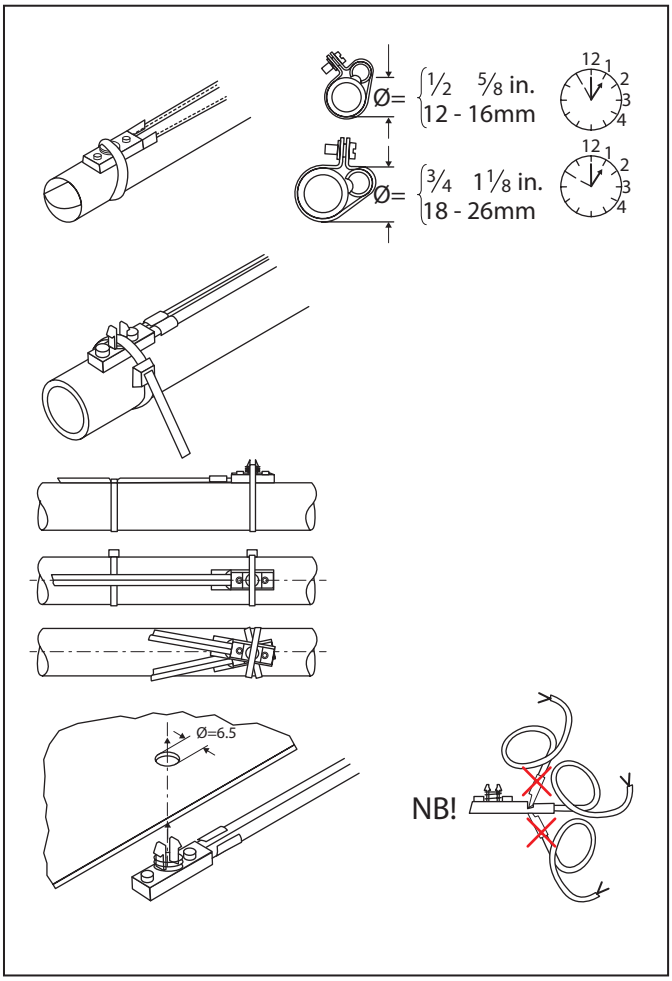
NTC sensor
The sensing element in NTC´s is a thermistor having a **negative temperature coefficient.**
The sensor characteristic is described by a number, that as with PTC´s, indicates the nominal resistance at **25°C**, and by a β-value which defines the curve characteristic.
Due to the variety of characteristics it is not possible to develop a standard NTC sensor that can be used for all controller types.
Hence, when making service you must install an "*original*" NTC sensor to ensure the controller to work properly.

Temperature sensor type EKS 211
NTC characteristic matches controllers type EKC and AK-CC.
The NTC temperature sensor type EKS211 must not be used for food safety logs as they do not conform to the requirements EN 12830, EN 13485 or regulation of superheat because they do not have the needed accuracy of +/- 0.5K.

R_nom Ohm	Temp. °C	Temp °F
631.0	80	176
743.2	75	167
878.9	70	158
1044	65	149
1247	60	140
1495	55	131
1803	50	122
2186	45	113
2665	40	104
3266	35	95
4029	30	86
5000	25	77
6246	20	68
7855	15	59
9951	10	50
12696	5	41
16330	0	32
21166	-5	23
27681	-10	14
36503	-15	5
48614	-20	-4
65333	-25	-13
88766	-30	-22
121795	-35	-31
169157	-40	-40

Positioning sensors

It is very important that during the installation process and also during maintenance schedules the correct position and mounting of all temperature sensors is in line with the recommendations. Incorrect mounting can cause faulty temperature signals to be used by the controller which will result in, in-correct operation of the refrigeration application.



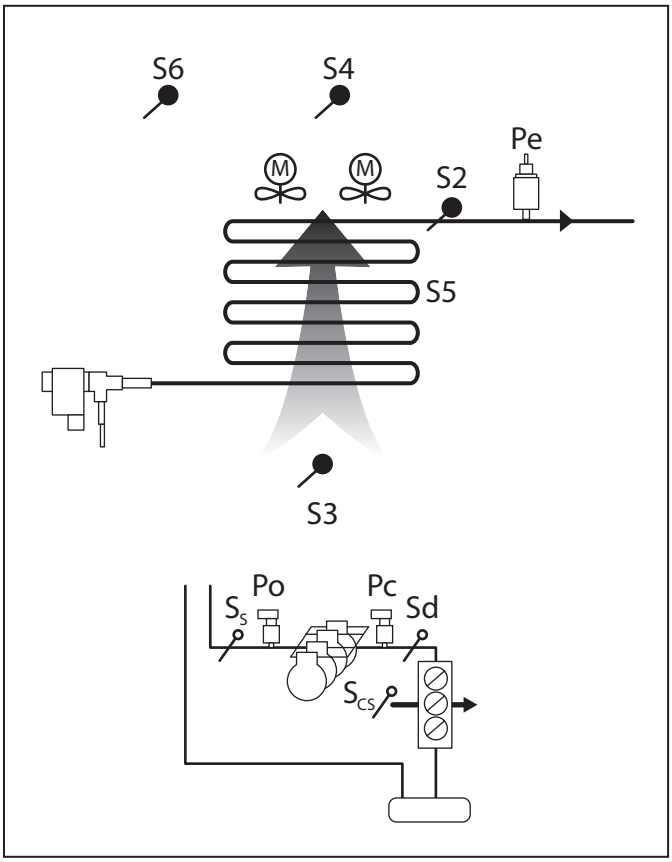
Evaporator positions

Nomenclature of temperature tensors & pressure transmitters in Danfoss controllers

- **S1:** Temperature sensor measuring evaporating temperature (Can be used as a less accurate measurement of evaporating temperature without the need for a pressure transmitter)
- **Pe:** Pressure transmitter measuring true evaporating pressure (preferred method)
- **S2:** Suction temperature outlet of the evaporator
- **S3:** Air entering the evaporator
- **S4:** Air leaving the evaporator
- **S5:** Defrost termination temperature sensor when defrost is being used
- **S6:** Is used as a product sensor (type AK-HS1000,HACCP compliance for food safety)

Pack positions

- **Po:** Pressure transmitter - Suction pressure
- **Pc:** Pressure transmitter - Discharge pressure
- **Ss:** Temperature sensor - Suction temperature to work out suction superheat in connection with suction pressure Po
- **Sd:** Temperature sensor - Discharge temperature
- **Sc3:** Temperature sensor - Ambient temperature of the air entering the condenser

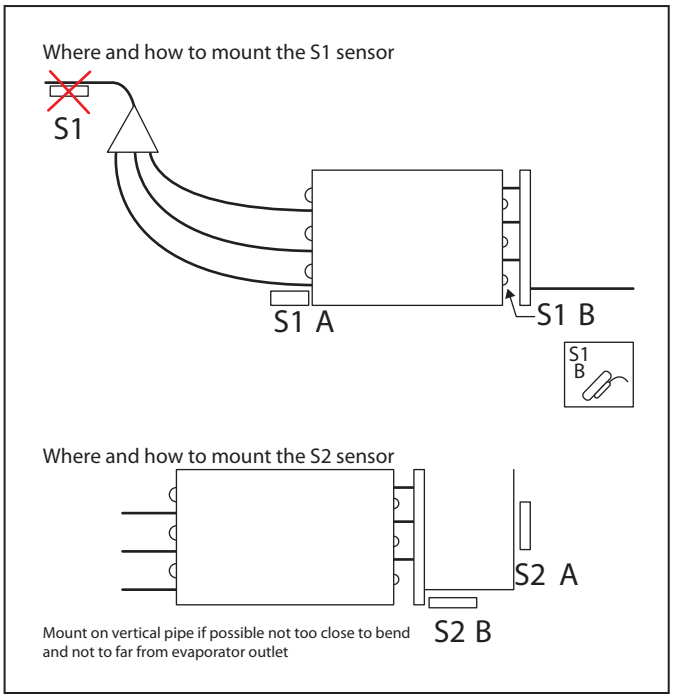


S1 and S2 sensors

S1 and S2 sensors measuring saturation temperature and temperature of superheat gasses.

- **S1**: This sensor is measuring the evaporating temperature of the evaporator and therefore must be mounted on the coldest point on the evaporator, normally the first return bend.
  The reading should be checked against the suction gauge pressure to confirm that the pressure and temperature relationship is correct otherwise the control of superheat will be incorrect.

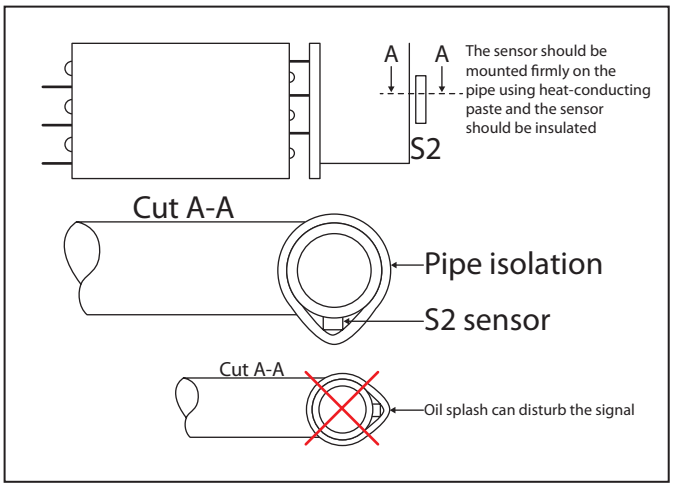
- **S2**: Sensor function is to measure the temperature of the refrigerant exiting at the evaporator's pipe outlet and, has thus, the same goal as a thermostatic expansion valve's bulb and should be placed exactly according to the same rules.
  Only a Pt1000 AKS11 type sensor must be used, as it is the only type providing the necessary accuracy needed for this purpose.



How to mount S2 sensor on a vertical pipe

Steel pipes
If steel pipes are used on the evaporator outlet the superheat signal it must be measured using a pocket sensor "*S2*" to get a correct signal. This is absolutely necessary to get a good injection control.

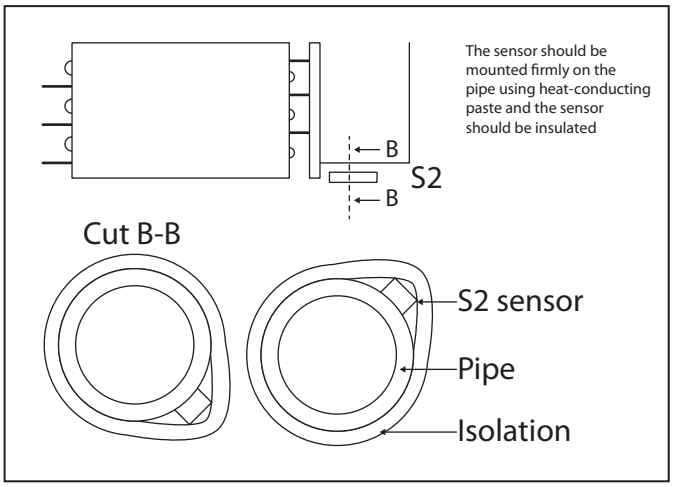
Copper pipes (exceeding 50mm)
When pipe dimensions go up so does the material thickness. Bigger thickness also means greater temperature difference between inner and outer temperatures. You should use immersion pocket sensors here also.



How to mount S2 sensor on a horizontal pipe

When mounted on horizontal pipe the position depends on the size of the pipe.

- Mount at 1 o'clock when diameter is between 1/2 and 5/8inch (12-16mm).
- Mount at 2 o'clock when diameter is between 3/4 and 1- 1/8inch (18-26mm).
- Mount at 4 o'clock when diameter is over 1- 1/2inch (38mm).
- Use immerse pocket sensor if you want to measure on steel pipe.



Measuring a pressure

It is very important that the correct type of pressure transmitter is used for the pressure range, sensing application, and the pressure transmitter signal is compatible with the electronic refrigeration controller, (*please see the technical manual for the controller to ensure correct pressure transmitter is used*).

AKS ratiometric

Type	Operating range [bar]	Permissible working pressure PB [bar]
AKS 2050	**-1 to 59**	**100**
	-1 to 99	**150**
	-1 to 159	**250**

AKS 32, version 1-5V		
	Operating range	Max working pressure PB
LP	-1 --> 6 [bar]	33 [bar]
	-1 --> 12 [bar]	33 [bar]
HP	-1 --> 20 [bar]	40 [bar]
	-1 --> 34 [bar]	55 [bar]
AKS 32, version 0-10V		
	Operating range	Max working pressure PB
LP	-1 --> 5 [bar]	33 [bar]
	-1 --> 9 [bar]	33 [bar]
HP	-1 --> 21 [bar]	10 [bar]
	-1 --> 39 [bar]	60 [bar]
AKS 33, version 4-20mA		
	Operating range	Max working pressure PB
LP	-1 --> 5 [bar]	33 [bar]
	-1 --> 6 [bar]	33 [bar]
	-1 --> 9 [bar]	33 [bar]
	-1 --> 12 [bar]	33 [bar]
	-1 --> 20 [bar]	40 [bar]
HP	-1 --> 34 [bar]	55 [bar]
	0 --> 16 [bar]	40 [bar]
	0 --> 25 [bar]	40 [bar]

Pressure transmitter
Range and types of signals

A pressure transmitter will measure the pressure and this measurement will be conditioned in the form of a defined electrical signal that will allow it to be "*transmitted*" on a further distance.
A pressure transmitter needs a power supply, most of the time this is going to be provided from the controller it is connected to.
Don't forget that sensors, in general, are the "eyes" of a controller. The better they are selected and positioned, the better the controller is able to do its job!

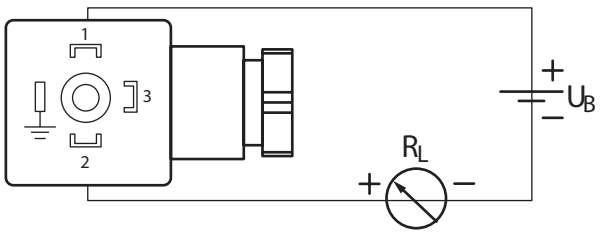
Two main data will be needed to define a pressure transmitter:

1. **The pressure range**, depending on the application where the pressure transmitter is needed.
   In traditional refrigeration system, mostly two different ranges of pressures will be found, the evaporating pressure (LP) and the condensing pressure (HP).
   This is happening at rather different pressure levels so the pressure range of the pressure transmitter for the low pressure side will be different than the one for the high pressure side.
   Typically, a range from -1 to 12bar is used for the low pressure side and a range of -1 to 34bar is used on the high pressure side. It is important, for the accuracy of the signal, that the range is properly selected according to the application.
   Example:
   If you need to measure a pressure of 5bar, a pressure transmitter of -1 to 12bar will give you a much better accuracy than one of -1 to 34bar.

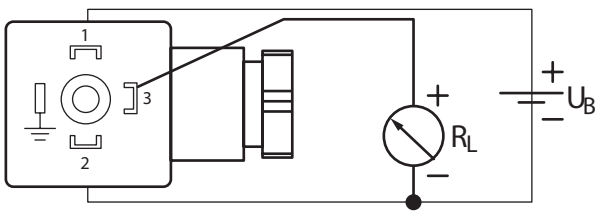
2. **The type of electrical signal**, can be either in current [mA] or voltage [V]. The two first types mentioned, the electrical signal issued is directly proportional to the pressure only.
   How to find the value of the expected signal for a known pressure?
   Example:
   A pressure transmitter with a range -1 to 12bar is used.
   The pressure in the system is 5bar. The total pressure range is thus from -1 to 12bar making a total of 13bar (+12-(-1)).

   For a 4-20mA transmitter, a signal of 4mA will be issued for a pressure of -1bar and 20mA will be for 12bar.
   The current output range is from 4 to 20mA making a total range of 16mA (20-4). We divide the 16mA by 13bar, and this will give us 1,23mA/bar. We multiply now by the number of bar starting from -1bar, thus 1+5 = 6bar by 1,23. Results = 7.38mA and we finally add the starting point of 4mA (not "0" !!) to give us the final answer of 11,38mA for a pressure of 5bar.
   This value can be easily controlled by using a ammeter in series with the sensor's wires.

   For a 0-10V transmitter, a signal of 0V will be issued for a pressure of -1bar and 10V will be for 12bar. The total pressure range is thus from -1 to 12bar making a total of 13bar (+12-(-1)).
   The voltage output range is from 0 to 10V making a total range of 10V.
   We divide the 10V by 13bar, and this will give us 0.77V/bar.
   We multiply now by the number of bar starting from -1bar, thus 1+5 = 6bar by 0.77. Results = 4.62V for a pressure of 5bar.
   This value can be easily controlled by using a voltmeter on the sensor's wires.



4-20mA output, 2 wires (+,-)

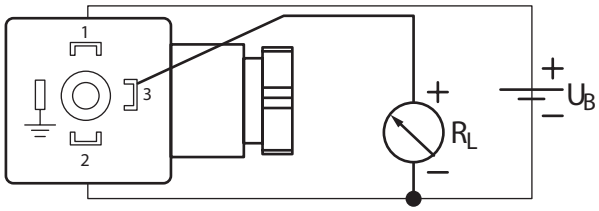


0-10V or 1-5V output, 3 wires (+, s, -)

For ratiometric transmitter, the ratio metric transmitter, the output signal is not only proportional to the pressure but is also directly depending of the voltage on the power supply.
This is the type that is commonly used on most of the controllers. The output signal of the transmitter will be presented as a percentage of the voltage of the power supply
Example: 10….90% of [V] supply.

For a ratiometric transmitter, let's take an example:
a pressure transmitter with a range -1 to 12bar is used.
The pressure in the system is 5bar and the power supply is of 5VDC. The lowest signal will be for -1bar and will correspond to 10% of the power supply, thus 0.5V.

The highest signal will be for 12bar and will correspond to 90% of the power supply, thus 4.5V.
A signal of 0.5V will be issued for a pressure of -1bar and 4.5V will be for 12bar. The total pressure range is thus from -1 to 12bar making a total of 13bar (+12-(-1)). The voltage output range is from 0.5V to 4.5V making a total range of 4V (4.5-0.5).
We divide the 4V by 13 (bar), and this will give us 0.3V/bar.
We multiply now by the number of bar starting from -1 bar, thus 1+5 = 6bar by 0.3. Results = 1.8V and we finally add the starting point of 0.5V (not "0" !!) to give us the final answer of 2.3V for a pressure of 5bar.
This value can be easily controlled by using a voltmeter on the sensor's wires but you need to measure not only the signal but also the value of the power supply to ensure a correct answer

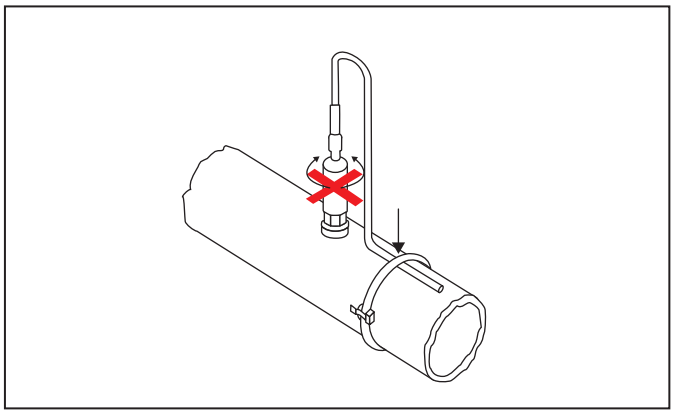


Ratio metric [V] output, 3 wires (+, s, -)

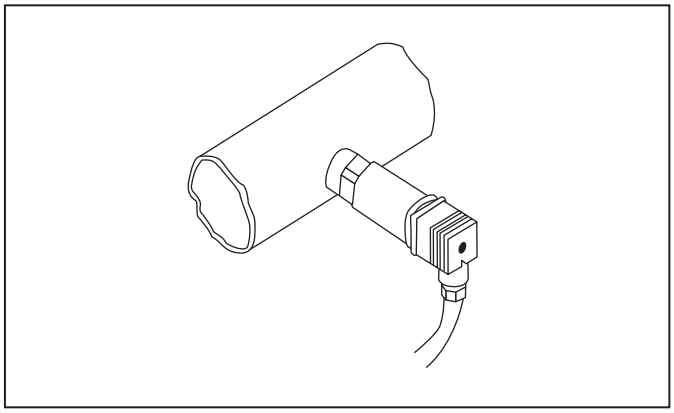
Positioning sensors

Sensor mounting
It is very important that during the installation process and also during maintenance schedules the correct position and mounting of all pressure transmitters is in line with the recommendations. Incorrect mounting can cause faulty pressure signals to be used by the controller which will result in, in-correct operation of the refrigeration application.

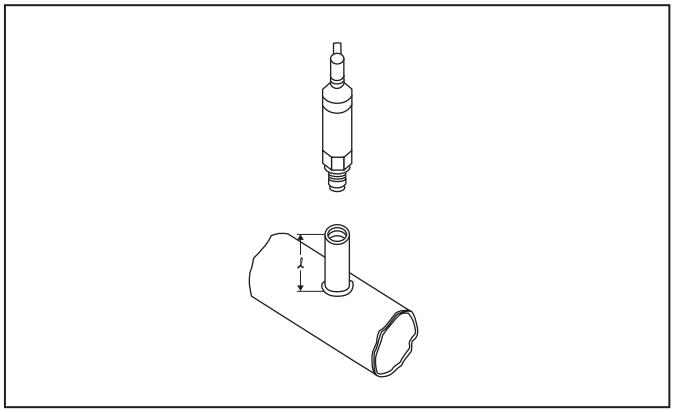
Cable version
The pressure transmitter must be mounted before the cable is fastened to avoid twisting the cable.



Orientation
Can be mounted horizontal or vertical but with the pressure connection facing downwards, example not on the bottom of the pipe to avoid oil or dirt contamination. Plug cable facing downwards prevents water collection in the cable entry.

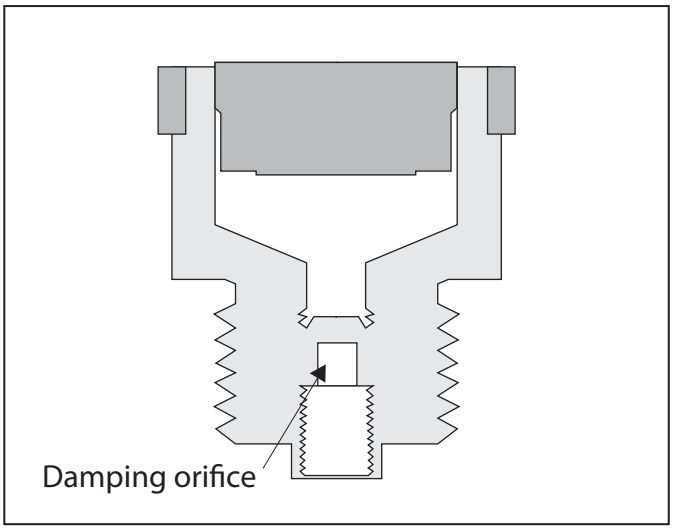


Hot gas pipe
Use a distance sleeve to reduce the temperature influence on hot gas lines to avoid overheating the pressure transmitter.

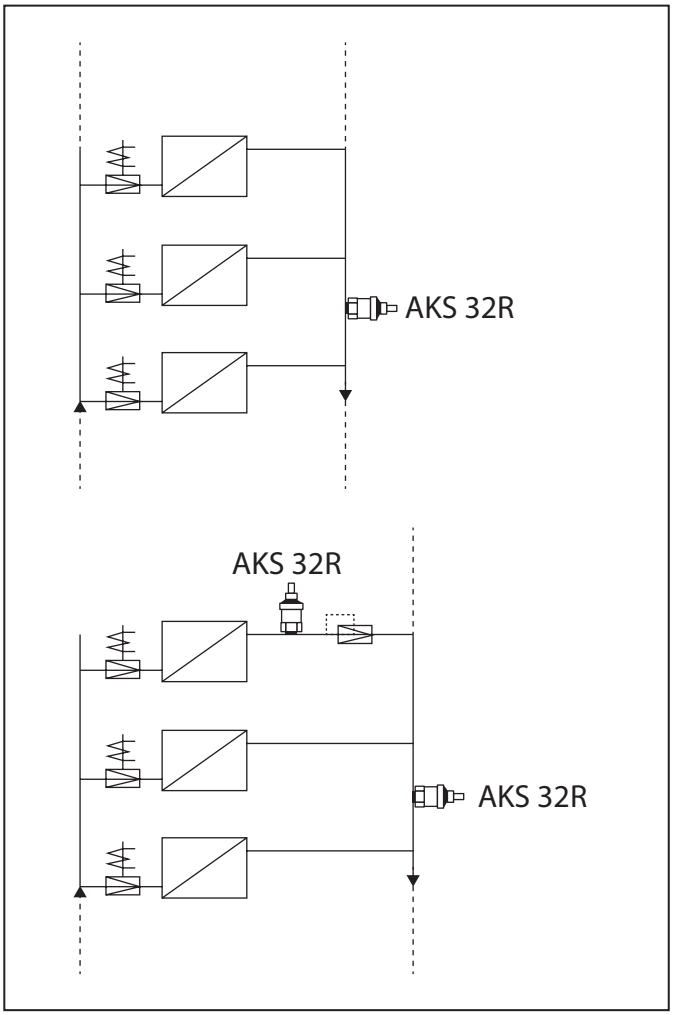


Pressure transmitter in liquid line with pulse snubber

- Cavitation, liquid hammer and pressure peaks may occur in liquid filled systems with changes in flow velocity, example fast closing of a valve or pump starts and stops. The problem may occur on the inlet and outlet side, even at rather low operating pressures.
- Pressure pulsations do not normally limit the pressure sensor lifetime, however for the sake of the controller or the pressure display equipment it may be expedient to dampen or filter the signal from the pressure sensor.
- Dampening can be performed by electronics in the controller equipment, or by means of connecting the sensor to the plant through normal damping coils (capillary tubes).
- It is also possible to order specific pressure transmitters which have a damping orifice fitted.



If a control valve is mounted on an evaporator, a separate pressure measurement will have to be made for the other controllers on the common suction if the evaporator controllers are of course using a pressure transmitter to measure the evaporating temperature.



Electrical connections

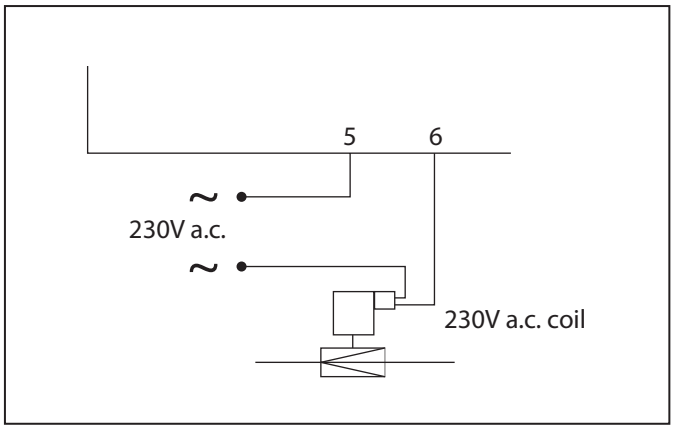
Pulse width modulation electronically operated expansion valve type AKV

Using AC coil (alternating current)
On present controllers (AK-CC) you find the electronic contact which switches the power to the AC coil.

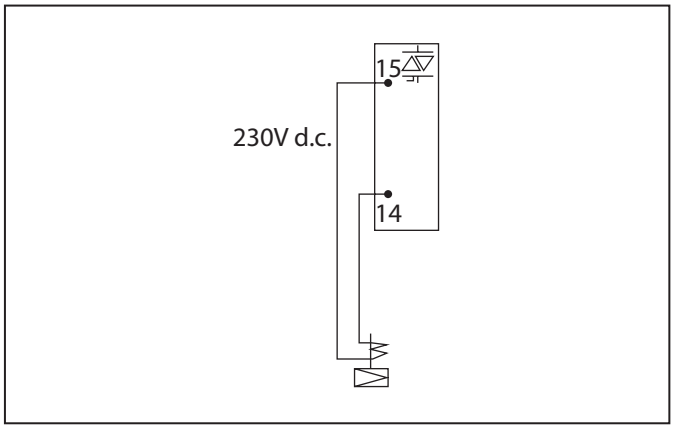


Note

Do not use a switch between the output and AKV coil.

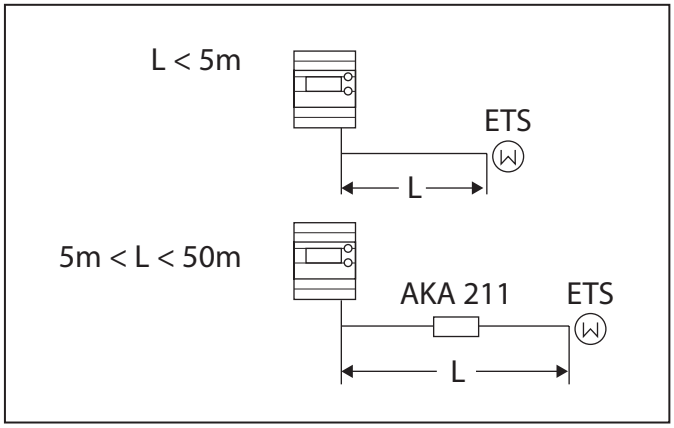


Using DC coil (direct current)
In previous controllers (AKC or EKC) the supply came directly from the controller to the DC coil.

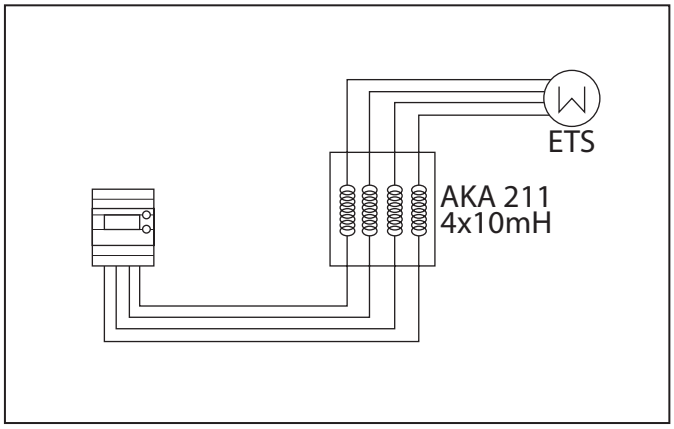


Stepper motor electronically operated expansion valve type ETS

On some controllers the length between the controller and the valve ETS have to be max 5m.
If the cable distance is greater than 5m a filter need to be used on some controllers to extend the cabling up to 50m.
Find more information in the Instruction or Manual of the specific controller.

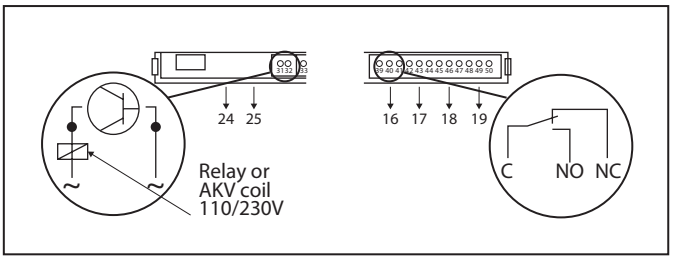


Filter
The filter has to placed beside the controller.

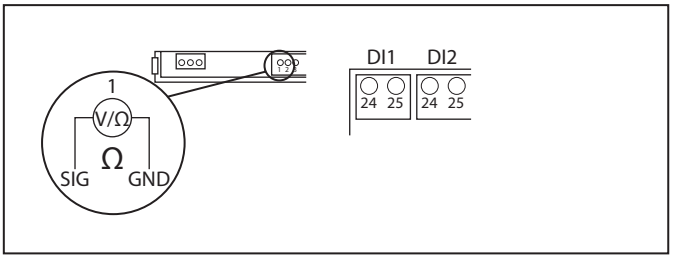


Digital Input (DI) / Digital Output (DO)

Digital Output → NC/NO
You must be aware, which type of contact do you have.

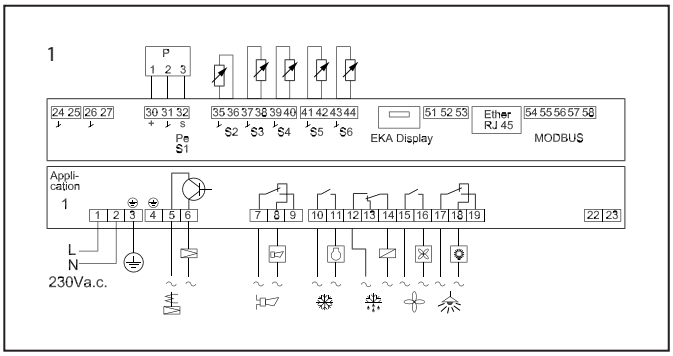


Digital Input → powerless contacts



No power

Generally
The drawings (especially the digital outputs) of the electrical connections are always shown without connected power supply.



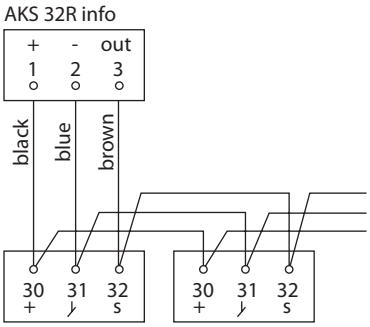
Split sensors and AKV

Temperature sensor
Each controller needs its own temperature sensor input.

Pressure transmitter
The signal from one ratiometric pressure transmitter can be received by up to 10 controllers. But only if there are no significant pressure difference between the evaporators to be controlled.

AKV
Use only one AKV coil for one solid state output.
("*Pulse width modulation electronically operated expansion valve type AKV*") on page 13.

AKS 32R info

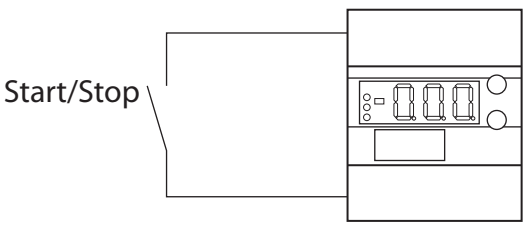


The signal from one pressure transmitter can be received by up to ten controllers

Solid State Output	**DO1 (for AKV coil)**	**Max 240V a.c. MAx 0.5 A Leak < 1mA Max 1 pcs. AKV**

External Start/Stop of regulation

Some controllers can be started and stopped externally via a contact function connected to input terminals.
The function must be used when the compressor is stopped.
The controller then closes the solenoid valve so that the evaporator is not charged with refrigerant.



Controlling

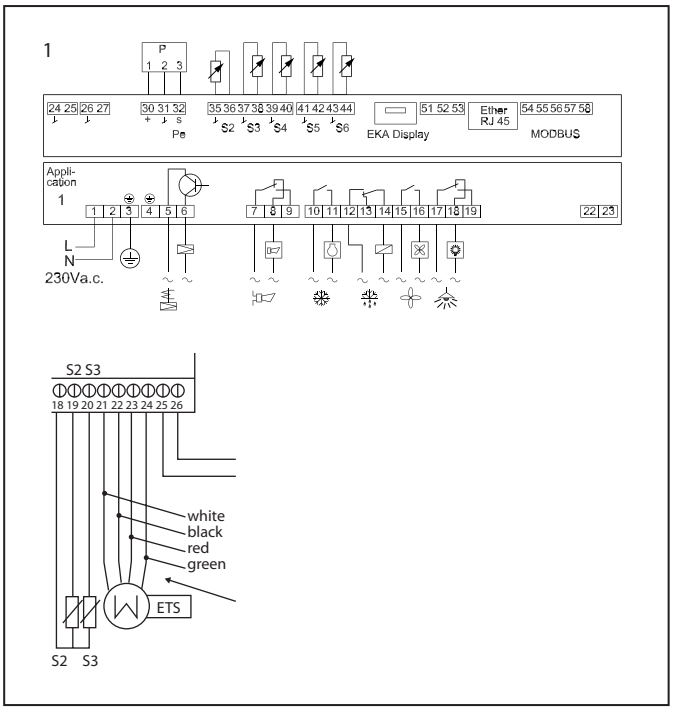
Input and output

Electronic controllers will have a number of **inputs** and **outputs** that will allow the measurement and control of several tasks related to refrigeration, mostly for evaporators and packs.

Inputs can roughly be divided in 2 types:
- **Analog inputs** that are typical for either temperature or pressure sensors, readings being °C/°F or bar/psi, (*see MEASURING*).
- **Digital inputs** that are typical for contact or voltage detection, readings being an ON/OFF results, (*see CONNECTION*).

Outputs can be divided in several types like:
- **Digital outputs** that are typically electromechanical relays.
- **Electronics outputs** generating pulses signals typically for controls of electronic expansion valves like AKV (pulse width modulation) or ETS (stepper motor).
- **Analog outputs** generating mostly a 0 to 10VDC signal available either as information or additional controls.

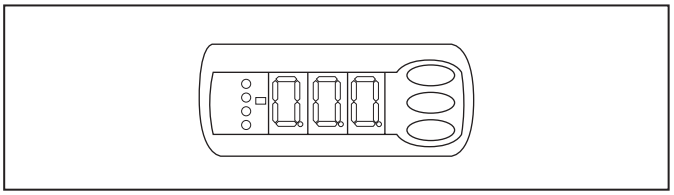
See the example beside



Operation

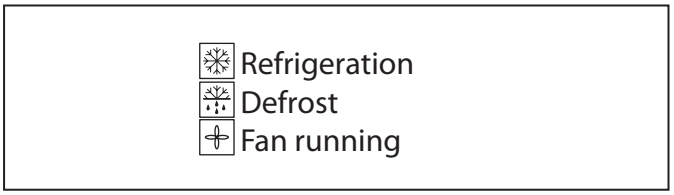
Display

The values will be shown with three digits, and with a setting you can determine whether the temperature is to be shown in °C or in °F.



Light-Emitting Diodes (LED) on front panel

The LED's on the front panel will light up when the relevant relay is activated.
The light-emitting diodes will flash when there is an alarm.
In this situation you can download the error code to the display and cancel/sign for the alarm by giving the top button a brief push.



The buttons

When you want to change a setting, the upper and the lower buttons will give you a higher or lower value depending on the button you are pushing. But before you change the value, you must have access to the menu. You obtain this by pushing the upper button for a couple of seconds, you will then enter the column with parameter codes. Find the parameter code you want to change and push the middle buttons until value for the parameter is shown. When you have changed the value, save the new value by once more pushing the middle button.

Examples:
Set menu
1. *Push the upper button until a parameter r01 is shown*
2. *Push the upper or the lower button and find that parameter you want to change*
3. *Push the middle button until the parameter value is shown*
4. *Push the upper or the lower button and select the new value*
5. *Push the middle button againt to freeze the value*

Cutout alarm relay/receipt alarm/see alarm code
- *A short press of the upper button If there are several alarm codes they are found in a rolling stack. Push the uppermost or lowermost button to scan the rolling stack.*

Set temperature
1. *Push the middle button until the temperature value is shown*
2. *Push the upper or the lower button and select the new value*
3. *Push the middle button again to conclude the setting*

Reading the temperature at defrost sensor
(Or product sensor, if selected in "o92")
- A short press of the lower button

Manuel start or stop of a defrost
(Or product sensor, if selected in "o92")
- Push the lower button for four seconds

Evaporator controls

Controllers for evaporators have built in functionalities that allow them to perform the necessary tasks for the control of the application including evaporators like cold rooms, cases, etc. Being electronic, allow them a large choice in the available functionalities under a very compact format, this is giving a lot of flexibility in their use.
Access to the functionalities is easily made through the use of a display and keys, allowing access to a list containing the different parameters. Basically, no "programming" is necessary, just setting of parameters values. An explanation on how to access parameters via display and keys is shown beside.

Parameters

Parameters are placed in "*groups*" related to their functions.
Example:
Thermostat related functions are all placed in the group of parameters starting with letter "r" followed by a number.

Access to the thermostat differential is done via parameter "*r01*" and the value is expressed in degree Kelvin (to show it's a difference). In all available controllers, "*r01*" will be referring to the differential therefore making the use of different controllers much easier. And so on for the others parameters.

- Group "*r..*" refers to thermostat related functions.
- Group "*A..*" refers to Alarms setting and functions.
- Group "*C..*" refers to Compressor management.
- Group "*D..*" refers to Defrost functions.
- Group "*F..*" refers to Fan functions.
- Group "*h..*" refers to HACCP temperature.
- Group "*n..*" refers to setting linked with the use of electronic expansion valves.
- Group "*t*" refers to the real-time clock.
- Group "*o..*" refers to miscellaneous functions like addressing, door functions, refrigerant, etc.

Beside parameters, readings are available in the "*u..*" group allowing to access sensors readings and Input/output status like opening degree of an electronic expansion valve or superheat value. These are usefully indications for the service technician, allowing him to see what the controller "*sees*" and helping drawn a fast diagnostic in case of problems.

Continued		Code	1	2	3	4	5	6	7	8	9	10
Service												
Temperature measured with S5 sensor		u09	1	1	1	1	1	1	1	1	1	1
Status on DI1 input. on/1=closed		u10	1	1	1	1	1	1	1	1	1	1
Actual defrost time (minutes)		u11	1	1	1	1	1	1	1	1	1	1
Temperature measured with S3 sensor		u12	1	1	1	1	1	1	1	1	1	1
Status on night operation (on or off) 1=on		u13	1	1	1	1	1	1	1	1	1	1
Temperature measured with S4 sensor		u16	1	1	1	1	1	1	1	1	1	1
Thermostat temperature		u17	1	1	1	1	1	1	1	1	1	1
Run time of thermostat (cooling time) in minutes		u18	1	1	1	1	1	1	1	1	1	1
Temperature of evaporator outlet temp.		u20	1	1	1	1	1	1	1	1	1	1
Superheat across evaporator		u21	1	1	1	1	1	1	1	1	1	1
Reference of superheat control		u22	1	1	1	1	1	1	1	1	1	1
Opening degree of AKV valve	**	u23	1	1	1	1	1	1	1	1	1	1
Evaporating pressure Po (relative)		u25	1	1	1	1	1	1	1	1	1	1
Evaporator temperature To (Calculated)		u26	1	1	1	1	1	1	1	1	1	1
Temperature measured with S6 sensor (product temperature)		u36	1	1	1	1	1	1	1	1		1
Status on DI2 output. on/1=closed		u37	1	1	1	1	1	1	1	1	1	1
Air temperature . Weighted S3 and S4		u56	1	1	1	1	1	1	1	1	1	1
Measured temperature for alarm thermostat		u57	1	1	1	1	1	1	1	1	1	1
Status on relay for cooling	**	u58	1	1	1		1					
Status on relay for fan	**	u59	1	1	1	1	1	1	1	1	1	1
Status on relay for defrost	**	u60	1	1	1	1	1		1	1	1	1
Status on relay for rail heat	**	u61		1	1	1	1		1		1	1
Status on relay for alarm	**	u62	1		1	1				1		1
Status on relay for light	**	u63	1	1		1		1	1	1	1	1
Status on relay for valve in suction line	**	u64						1				

What is the controller doing...?

Through status codes, the controller keeps you informed about his present behavior.
Example:
"S11" indicate that refrigeration has stopped after reaching thermostat cutout.
"S14" would indicate that a defrost is in progress.

S0	Normal regulation	**S23**	Adaptive control	**S46**	
S1	Waiting for the end of the coord def.	**S24**	Start up phase: signal reliability	**S47**	
S2	Comp. must run for at least x min	**S25**	Manual control of outputs	**S48**	
S3	Comp. must remain stop for x min	**S26**	No refrigerant selected	**S49**	
S4	Evaporator drips OFF	**S27**	Forced cooling	**S50**	
S5	Renewed cuting of relay wait x min	**S28**	Stopped regulation	**S51**	
S6	Day operation (Sout control)	**S29**	Case cleanig procedure	**S52**	
S7	Night operation (sin control)	**S30**	Forced cooling	**S53**	
S8	Next relay must not cutin until x min	**S31**	Door is oper (DI open)	**S54**	
S9	Nerxt relay must not cutout until x min	**S32**	Delay on outputs during start up	**S55**	
S10	Stopped by mainswitch *"r12"* or DI	**S33**	Heat function *"r36"* is active	**S56**	
S11	Refrig. stopped by thermostat	**S34**	Safety cutout	**S57**	
S12	Refrig. stopped due to low sair	**S35**	Cooling ON section B	**S58**	
S13	Defrost KVQ valve is closing	**S36**	Cooling OFF section B	**S59**	
S14	Defrost in progress	**S37**	Cooling ON section C	**S60**	
S15	Defrost sequence: fan delay	**S38**	Cooling OFF section C	**S61**	
S16	Refrig. stopped by ON input	**S39**	Cooling ON section D	**S62**	
S17	Door is open. DI input is open	**S40**	Cooling OFF section D	**S63**	
S18	Melt function	**S41**		**S64**	
S19	Modulating thermostat control	**S42**		**S65**	
S20	Emergency cool sensor error	**S43**		**S66**	
S21	Injection problems	**S44**		**S67**	
S22	Start up: evaporator beign charged	**S45**		**S68**	

Quick start

Before allowing the controller to start the regulation, it is important to check if the controller readings are showing the right measurements.
(*"u", see chapter "Parameters"* at page 16).

Accessing the "*u*" readings in the service group, allow you to check this.
Use the instruction sheet of the specific controller to locate the "*u*" readings corresponding to the connected sensors and contacts.

- Begin with checking that parameter "*r12*" (main switch) is set to OFF(0), that will stop the regulation.
- When done, ensure that the proper selection of the electrical diagram for the outputs has be done via the parameter "*o61*".
- An easy way would then be to use preselected settings for your application room/case/cooling/freezing via the parameter "*o62*".
- Setting parameter "*r12*" to ON(1) will then start the regulation with immediate effect.



100% tight
The buttons and the seal are imbedded in the front.
A special moulding technique unites the hard front plastic, the softer buttons and the seal, so that they become an integral part of the front panel.
There are no openings that can receive moisture or dirt.

What is wrong....?

In case of a default, Error and Alarm codes will be shown pointing directly to the problem.
Example:
"A1" will tell you that the alarm temperature has been reached.
"E8" shows that the "S4" temperature sensor wiring is short-circuited.

A1	High temperature alarm	**A24**	Compressor 6 fault	**A47**	Fan 6 fault
A2	Low temperature/P0 alarm	**A25**	Compressor 7 fault	**A48**	Fan 7 fault
A3	Alarm level limit reached	**A26**	Compressor 8 fault	**A49**	Fan 8 fault
A4	Door alarm	**A27**	Housing temperature	**A50**	Saux1 temperature
A5	Max hold time/Slv def time-out	**A28**	Digital input 1 alarm	**A51**	DO1 fault
A6	"*S4*" out high temperature	**A29**	Digital input 2 alarm	**A52**	DO2 fault
A7	"*S4*" out low temperature	**A30**	Digital input 3 alarm	**A53**	DO3 fault
A8	"*S3*" in high temperature	**A31**	Digital input 4 alarm	**A54**	DO4 fault
A9	"*S3*" in low temperature	**A32**	Digital input 5 alarm	**A55**	DO5 fault
A10	Injection problem	**A33**	Configuration change	**A56**	DO6 fault
A11	No refrigerant selected	**A34**	Fan 1 fault	**A57**	DO7 fault
A12	Digital input alarm	**A35**	Fan 2 fault	**A58**	DO8 fault
A13	High temperature "*S6*"	**A36**	Fan 3 fault	**A59**	Case cleaning (DI input)
A14	Low temperature "*S6*"	**A367**	Fan 4 fault	**A60**	HACCP alarm
A15	Digital input 1 alarm	**A38**	Fan 5 fault	**A61**	Condenser alarm
A16	Digital input 2 alarm	**A39**	Fan 6 fault	**A62**	High T1 alarm
A17	Pc high alarm	**A40**	Fan 7 fault	**A63**	Low T1 alarm
A18	Pc low alarm	**A41**	Fan 8 fault	**A64**	High T2 alarm
A19	Compressor 1 fault	**A42**	Amb. mode	**A65**	Low T2 alarm
A20	Compressor 2 fault	**A43**	Stepper motor alarm	**A66**	High T3 alarm
A21	Compressor 3 fault	**A44**	Battery alarm	**A67**	Low T3 alarm
A22	Compressor 4 fault	**A45**	Standby mode ("*r12*" or DI)	**A68**	High temperature B
A23	Compressor 5 fault	**A46**	Fan 5 fault	**A69**	Low temperature
A70	High temperature C	**E1**	Faults in the controller	**E24**	Sensor "*S2*" error
A71	Low temperature C	**E2**	Air sensor open circuit	**E25**	Sensor "*S3*" error
A72	High temperature D	**E3**	Air sensor short circuit	**E26**	Sensor "*S4*" error
A73	Low temperature D	**E4**	Defrost sensor open circuit	**E27**	Defrost sensor "*S5*" error
A74	Adaptive defrost fault	**E5**	Defrost sensor short circuit	**E28**	Product sensor "*S6*" error
A75	Adaptive defrost evaporator iced	**E6**	Realtime clock error (battery)	**E29**	Sensor Sair error
A76	Adaptive Defrost not defrosted	**E7**	"*S4*" out sensor open circuit	**E30**	Sensor Saux error
A77	Pump 1 fault	**E8**	"*S4*" out sensor short circuit	**E31**	T1 error
A78	Pump 2 fault	**E9**	"*S3*" in sensor open circuit	**E32**	T2 error
A79	Pump 1 & 2 fault	**E10**	"*S3*" in sensor short circuit	**E33**	T3 error
A80	Condensor blocked	**E11**	Q-actuator error	**E34**	Sensor "*S3*" error B
A81	"*S3*" in "*S4*" out switched	**E12**	AI input signal outside range	**E35**	Sensor "*S3*" error C
A82		**E13**	"*S1*" sensor open circuit	**E36**	Sensor "*S3*" error D
A83		**E14**	"*S1*" sensor short circuit	**E37**	Sensor "*S5*" error B
A84		**E15**	"*S2*" sensor open circuit	**E38**	Sensor "*S6*" error B
A85		**E16**	"*S2*" sensor short circuit	**E39**	
A86		**E17**	"*S3*" sensor open circuit	**E40**	
A87		**E18**	"*S3*" sensor short circuit	**E41**	
A88		**E19**	Analog input error	**E42**	
A89		**E20**	Po pressure input error	**E43**	
A90		**E21**	Level signal outside the range	**E44**	
A91		**E22**	Signal AKS45 outside range	**E45**	
A92		**E23**	Sensor "*S1*" error	**E46**	

Communication

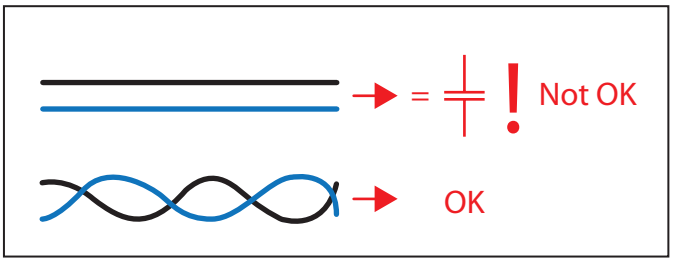
Why...?

Although controllers have their own independent control, communication between controllers and systems open up new possibilities in terms of service, commissioning, monitoring, alarming and optimization of energy on installations.
Some tasks can then be centralized in the system, allowing for example scheduled defrosts, coordinated defrosts between controllers, lighting control, scheduled stop of refrigeration and optimization of the suction pressure for energy savings.
Access to any controller connected to the system can now be done from a central point making set point and setting adaptation faster and easier.

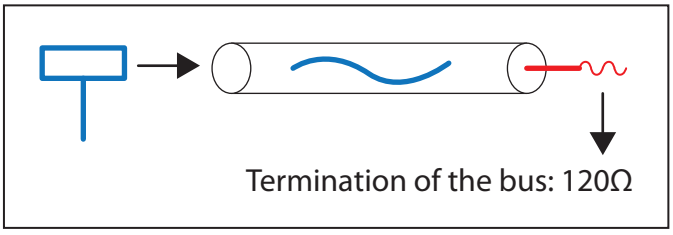
How...?

The interconnection between the controllers (and system) is done by the mean of "*bus*".
A "*bus*" is physically a specific electrical cable containing twisted wires in the form of a pair, with a shield.
The shield is protecting the signal transmitted on the pair from external disturbances, it must only be connected to the proper connection for shielding that is present on each controller.
Connection of the shied must **never** be done directly to the earth, thus bypassing internal filters presents.
This can cause serious communication problems.
Communication occurs by sending high frequency digital signals on the cable. Twisted pair is then a must to carry this signal without deforming it. Every cable has a capacitance and the effect of a capacitance is to act as a short circuit at high frequency.
So if capacitance increase, so do the losses.

The capacitance of the cable is counter balanced by the coil effect created by the twisted pair, ensuring the signal is kept in form properly across the cable. Recommended cross section of the wiring must be respected to avoid increasing the capacitance of the cable by increasing is cross section.
The bigger doesn't mean the better in this case.

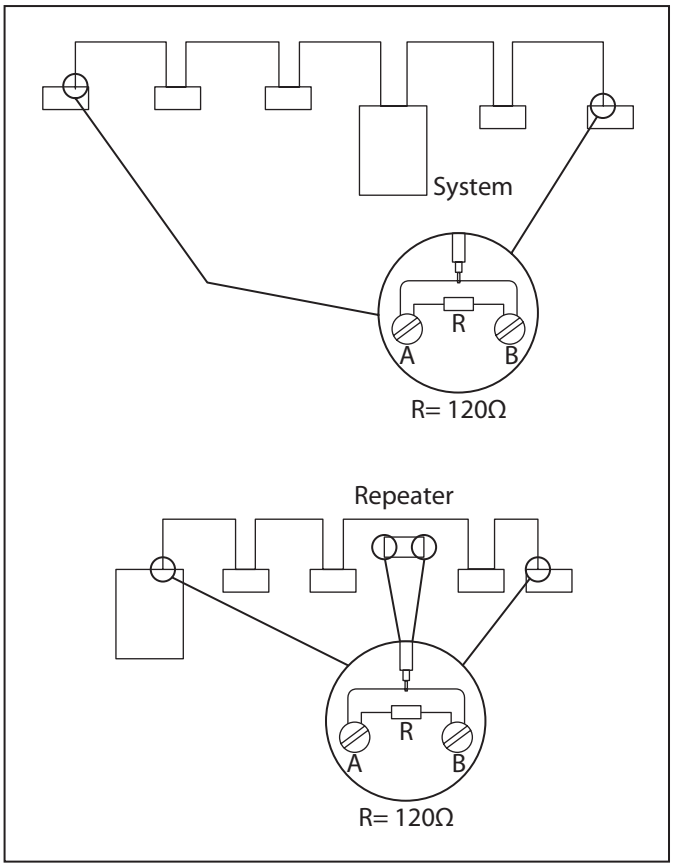


The electrical signals sent over the cable can have an analogy in the following form:
A length of pipe is filled with water and the pipe is closed at both ends. If an hammer is used on one of the ends, a pressure wave (signal) will travel through the pipe and bounce at the other end, going back to where it came from and thus mixing with the incoming wave. This deforms the signal. To avoid that, we should put a damper on both ends. This is called termination of the bus, and it's done by means of connecting resistors of 120Ω on both ends of the cable.
The resistors are supplied with the system.



Cables selection / termination

When all cables have been mounted on the different units, the cable must be terminated.
A section must be terminated at both ends.
The section must be terminated using a resistor.
A repeater will normally terminate two cable sections.
The termination should be made with 120Ω resistor (the resistor can be in the range 100 to 130Ω).
Bus standards in use with the controllers are called:
LONbus RS-485, MODbus RS-485.



Requiements to installation

Cable type
Cables twisted in pairs must be used, and they may be provided with a screen. Some types of communication require a cable with a screen to be used.
The conductor's cross section must be at least 0.60mm.
Examples of cable types:

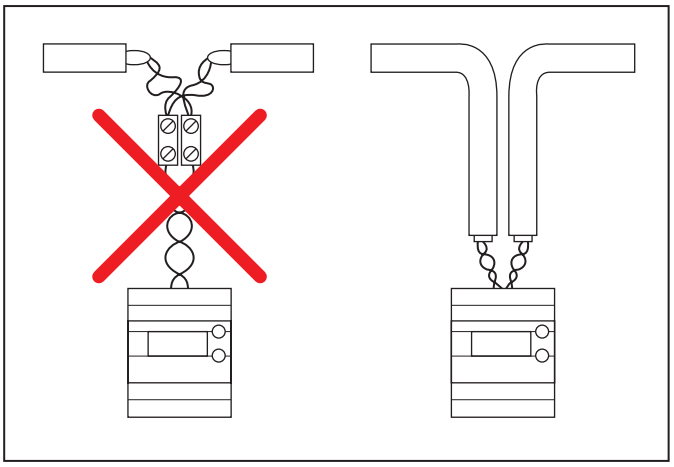
- *Belden 7703NH, single-thread 1 x 2 x 0.65mm, with screen.*
- *Belden 7704NH, single-thread 2 x 2 x 0.65mm, with screen.*
- *LAPP UNITRONIC Li2YCY (TP), multi-thread 2 x 2 x 0.65mm, with screen.*
- *Dätwyler Uninet 3002 4P, single-thread 4 x 2 x 0.6mm, with screen.*

Conductors
The wires in the cable that is connected to the controller must be correct. Although there are four wires in the cable inside the screen, you cannot simply choose colours freely. The wires are twisted in pairs, example 2 and 2, and you must use a pair that is twisted around each other.
If there are several "*vacant*" pairs in the cable, they must be used for nothing else than data communication.

Cable length
A cable length must not exceed 1200m (500m for Lon-FTT10.)
A repeater must be used for longer lengths.

See the additional requirements for the respective communication forms.

Cables



Note

Our experience indicates that problems can occur with communication due to the following weaknesses:

Long wire ends
Do not strip more of the cable insulation than strictly necessary. Max. 3-4cm. Continue the twisting of the cables right up to the terminals.

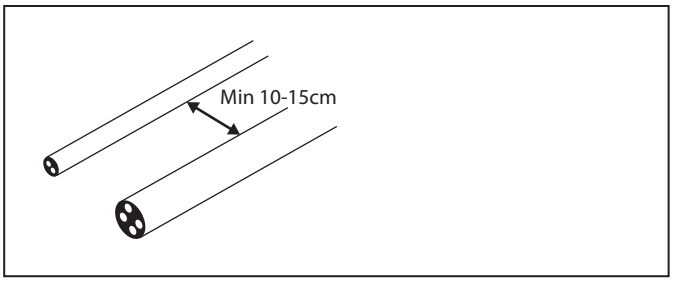
Stubs
Avoid stubs on the cable. Feed the cable right to the end and then back again.

Noise sources
Keep the cable away from electrical noise sources and power cables (relays, contactors and especially electronic ballast for strip lights are strong noise sources).
A distance of at least 10-15cm will be sufficient.

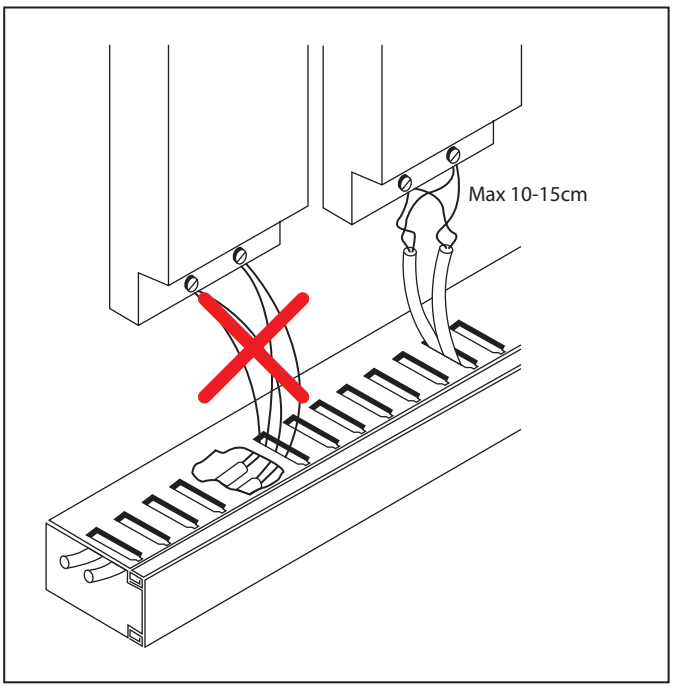
Cable length extremities
Each section of data communication must be terminated correctly.

Screen
See the respective communication forms. There should be a continuity of the screening cable up to the last controller.

Cable tray
When the cable is ducted with other cables, there is a strong risk that electrical noise will be transferred.
Keep away from live cables.

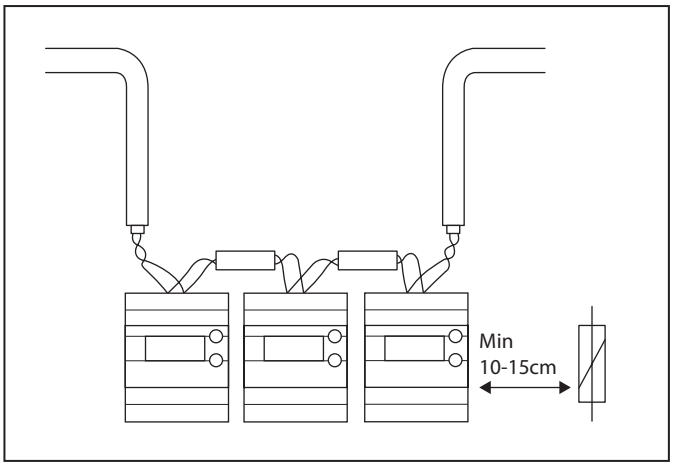


When the cable is ducted in a cable tray, the cable must be fed out and right up to the controller. The fast solution where only wires are fed out will cause problems.



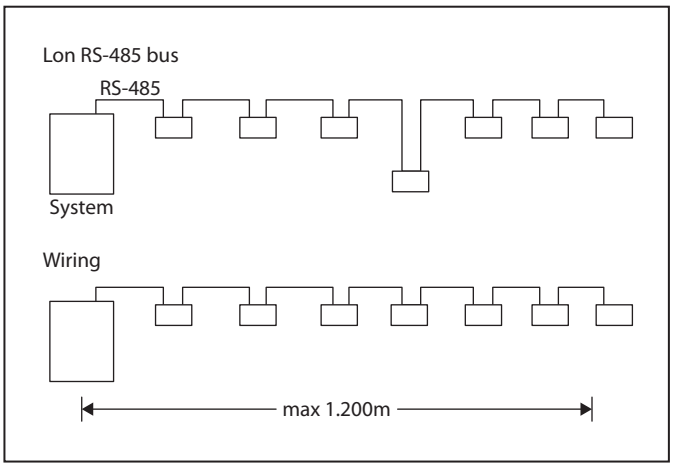
Cabinet mounting
When controllers are installed in a cabinet, internal cable ducting must also comply with the relevant requirements.
Use this cable ducting when one or more controllers are installed in a cabinet.
The short connections between controllers must also be of the correct cable types.

Keep a distance to relays, their cables and other things emitting electric noises.

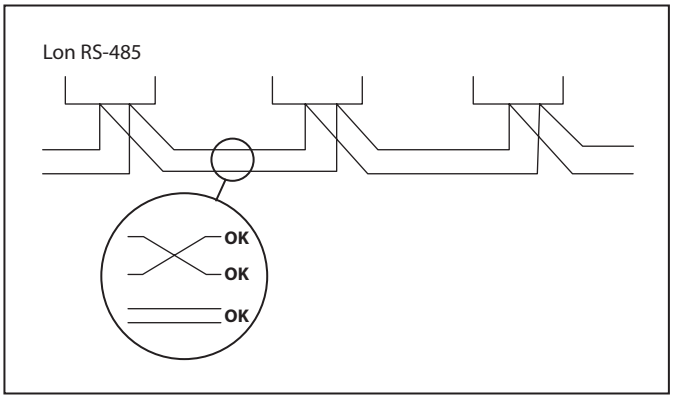


Bus standards
in use with the controllers are called:
LONbus RS-485, MODbus RS-485.
Standards define the kind of electrical signals and "*language*" used on the bus.
Signals are at a voltage level of 5V and at a speed of several thousand bits per second, but this cannot be measured by common voltmeters.
An oscilloscope is needed to visualize the presence of the signal.

Lon RS-485 bus & wiring
The cable must be with screen.
The cable is connected from controller to controller, and no branches are allowed on the cable.
If the cable length exceeds 1.200m a repeater AKA223 must be inserted.
If the data communication cable runs through an electrically noisy environment which impairs the data signal, one ore more repeaters must be added to stabilize the signal.
Every 60 controllers a repeater AKA223 needs to be placed.

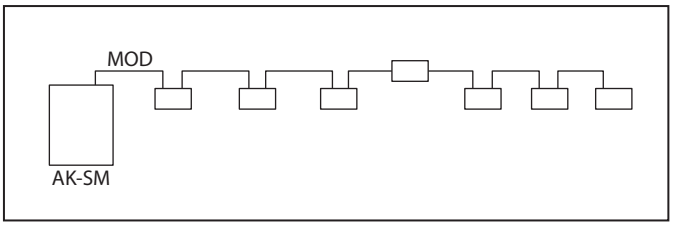


Conductors
The two wires are looped from device. There are no polarisation requirements.
On some controllers, the clamps are designated A and B.
On others there is no designation.
Otherwise the connections are identical.
If the screen used, it must be connected to the system device and any repeaters.
A screen must always be looped from device to device.
The screen must not be connected to anything else.



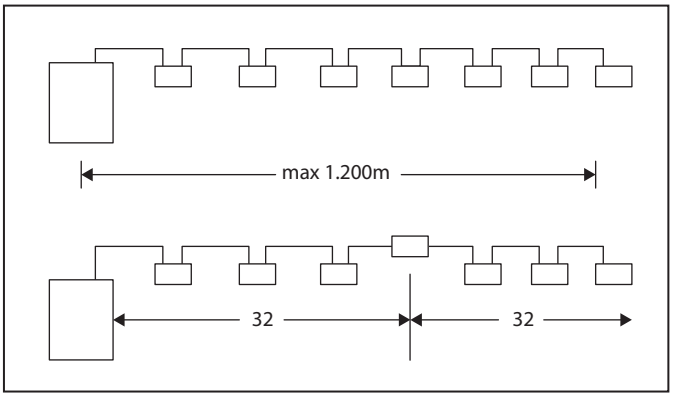
MOD-bus
This data communication can be used in the series:
- EKC...

The system device must be:
- System manager type AK2-SM.
- Monitoring unit type AK2-AM.



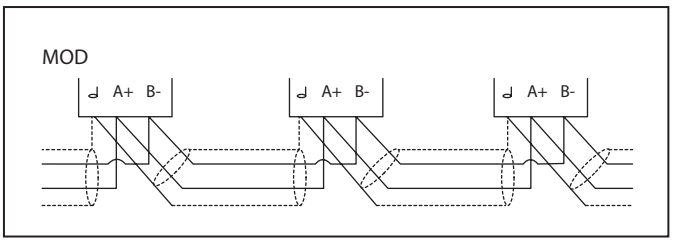
Wiring
The cable must be with screen.
The cable is connected from controller to controller, and no branches are allowed on the cable.
If the cable length exceeds 1.200m a repeater type AKA222 must be inserted.
Every 32 controllers a repeater AKA222 is to be placed.

If the data communication cable runs through an electrically noisy environment which impairs the data signal, one or more repeaters must be added to stabilise the signal.



Conductors
The wires are looked from device to device:
- A is connected to A.
- B is connected to B.

The screen must be connected to the system device, all controllers and any repeaters.
A screen must always be looked from device to device.
The screen must not be connected to anything else.
The screen is earthed inside the system device and must not be earthed in any other way.



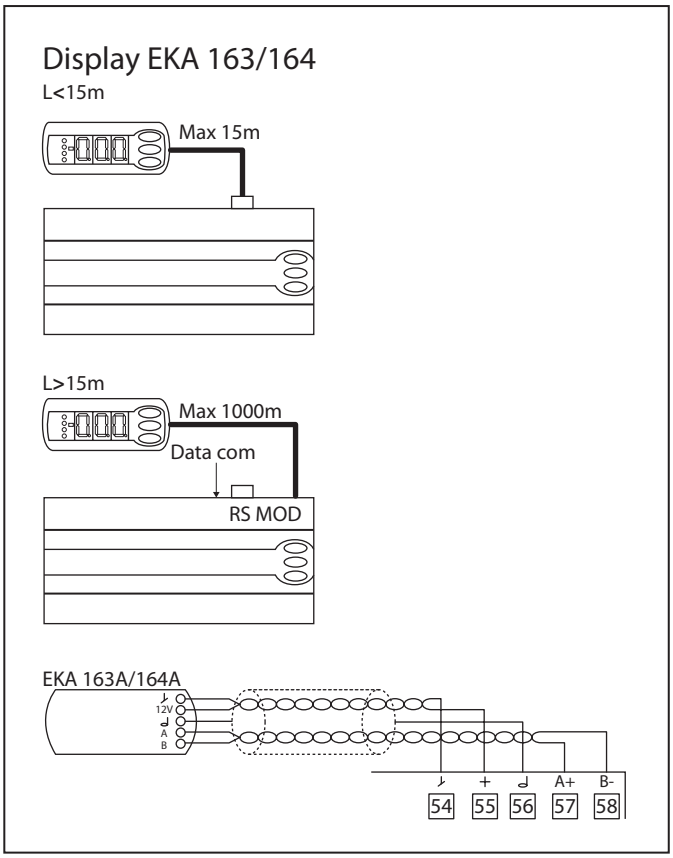
Addressing

Each controller need to have an unique address in the range of 1 to 120. This address can be set via parameter "*o03*" or by means of rotary switch, depending of the type of controller.
If parameter "*o03*" and "*o04*" are not visible, it means that the communication card is not seen as present by the controller.
Always power off the controller before inserting/extracting a communication card.
A scan can be perform by the system to discover the connected addresses. It is important that no address is used more than once!

Displays communication
Some controllers allow remote placement of display, this can be done in two ways:

- On short distances, less than 15m, connector type display can be used.
- On long distance, up to 1.000m, Modbus display must be used with communication cable.

Then, to activate the communication between the remote display and the controller, an address must be set in parameter "*o03*".



Trouble shooting

Trouble shooting communication without an oscilloscope can prove difficult but there is some basic verification that can be done:

- Are all controllers and systems properly earthed?
- Is the termination resistors in place, are they of the correct value of 120Ohm?
- Is the shield not in contact with the earth somewhere? That can be check with an ohmmeter, disconnect from the system before measuring between the shield and the Earth.
- Is the used communication cards of the proper type?
- If Modbus is in use, is the polarity respected everywhere?

Danfoss can accept no responsibility for possible errors in catalogues, brochures and other printed material. Danfoss reserves the right to alter its products without notice. This also applies to products already on order provided that such alternations can be made without subsequential changes being necessary in specifications already agreed.
All trademarks in this material are property of the respective companies. Danfoss and Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.

© Danfoss A/S (EL-MSSM/AZ), 2014-March