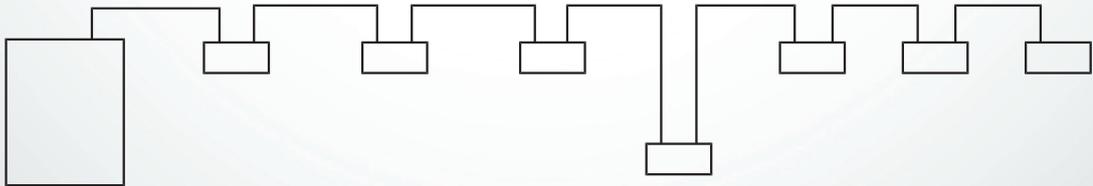ENGINEERING
TOMORROW

Danfoss

Design guide

Data communication
between ADAP-KOOL®
Refrigeration Controls

ADAP-KOOL® Refrigeration control systems

Introduction

This installation manual covers the data communication systems installed in Danfoss refrigeration control systems.

Within this guide descriptions and specifications will be shown that supports the data communication interface with Danfoss refrigeration controls systems.

The recommendations mentioned in this document are intended as instructions for the market's refrigeration engineers and electricians who install Danfoss refrigeration controls.
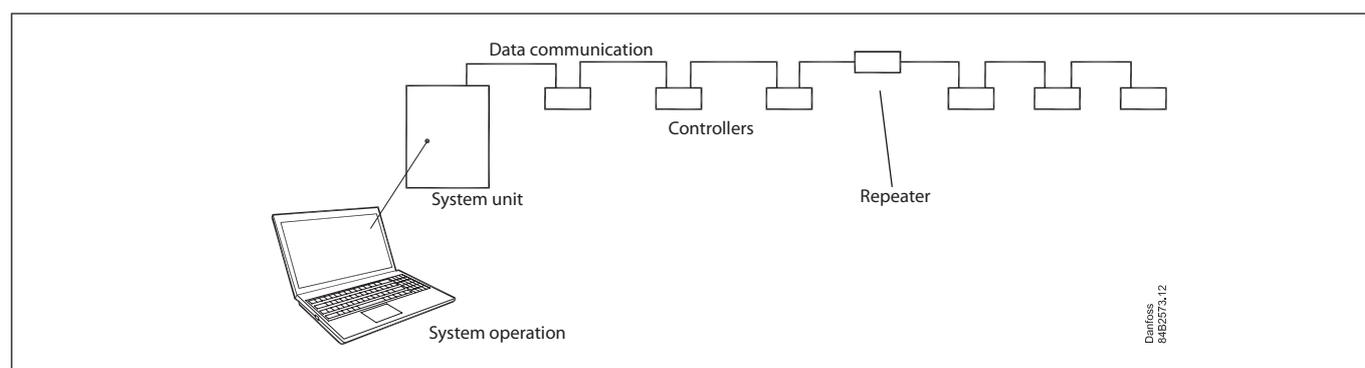
The guide describes:
- The various forms of communication
- Cable to be used
- Length of cable
- Termination of cable
- When to install a repeater

and

- How do the individual controllers become visible on the network
- What happens if a controller has to be replaced
- What happens if the gateway has to be replaced

ADAP-KOOL® only
The above communication systems are used for internal communication between ADAP-KOOL® refrigeration control systems.
The devices are not designed to communicate with equipment manufactured by other manufacturers.

IP network
In the case of controllers and system units that can be connected to an IP network, installation should be carried out on the basis of the requirements that apply to an IP network, i.e. cables must be at least category 5.

Contents

A little about controllers and system units

Communication survey

The table below shows which controllers can communicate with which system units and with what form of data communication. The summary is valid as of ultimo 2015, but the ADAP-KOOL® Refrigeration Control System is continually being extended.

System operation	System unit	Controller serie / type	Lon RS485	Mod-bus	Lon TP 78	DAN-BUSS	IP
AK-ST 500							
AK-EM 100[3]							
AK-EM 800							
AKM[1]							
	AK-SM 800 series[2]		x	x			x
		AK - controllers with extension modules AK-CC, AK-PC, AK-LM, AK-CH	x				
		EKC 3xx	x				
		EKC 202, AK-CC 210	x	x			
		EKC 302, AK-CC 250, 350, AK-PC, AK-CT		x			
		AK-CC 450, 550	(x)	x		(x)	
		AK-PI 200				x	x
		AK-CM (communication module) + AK-XM	x		x		
		DGS, SLV, Wattnote, Power meter, light control (3. party)		x			
	AK-SM 350 AK-SM 720		x	x			x
		AK - controllers with extension modules AK-CC, AK-PC, AK-LM, AK-CH	x				
		EKC 3xx	x				
		EKC 202, AK-CC 210	x	x			
		EKC 302, AK-CC 250, 350, AK-PC, AK-CT		x			
		AK-CC 450, 550	(x)	x		(x)	
		AK-PI 200				x	x
		DGS, SLV		x			
	AK-SC 255, 355		x[2]	x	x[2]		x
		AK-CM (communication module) + AK-XM	x		x		
		AK - controllers with extension modules AK-CC, AK-PC, AK-LM, AK-CH	x				
		AK-CC 750 (TP 78 version)			x		
		EKC 302, AK-CC 250, 350, 450, 550, AK-CT		x			
		EKC 202, 4xx, 5xx, AK-CC, AK-PC		x			
AKM							
EM 100	AKA 245		x			x	
		AKA, AKC, AKL				x	
		AK - controllers with extension modules AK-CC, AK-PC, AK-LM, AK-CH	x				
		EKC 202, 302, 3xx, 4xx, 5xx, AK-CC 210	x				
		AK-CC 450, 550	x			x	

1) AKM can receive alarms and logs from an AK-SM 720 and AK-SM 350. The connection is made via an analogue modem, a GPS modem or an IP network.

2) Can be delivered in two versions:
- Standard Lon-RS485
- Retro-fit Lon TP 78.

3) Together with AK-SM 350 and AK-SM 720 only.

System units

A brief summary is presented here of the communication options for the various system devices:

AK-SM 820

Up to 32 controllers can be connected, which can communicate on:
- Lon
- Modbus
- External I/O modules via AK-CM 101C
- Ethernet communication for other AK-SM or AK-SC devices
- AK-PI 200 protocol interface with DANBUSS communication

Lon RS485

Modbus   Total up to 32 devices

IP network

AK-SM 850, AK-SM 880

Up to 120 controllers can be connected, which can communicate on:
- Lon
- Modbus
- External I/O modules via AK-CM 101C
- Ethernet communication for other AK-SM or AK-SC devices
- AK-PI 200 protocol interface with DANBUSS communication

AK-SM 880 it can be delivered in a version, which can communicate in 4 x TP 78 or AK-CM 101A.

Lon RS485

Modbus   Total up to 120 devices

IP network

AK-SM 720

There are three forms of data communication:
- A Lon RS485 bus, to which up to 199 devices can be connected.
- A Modbus, to which up to 120 devices can be connected.
- Ethernet communication for other AK-SM devices, to which up to 199 addresses can be connected.

The system device can communicate with:
- AK-CC, AK-PC controllers
- EKC with either Lon RS485 or Modbus communication
- AK-PI 200 protocol interface with DANBUSS communication
- AK-PI 300 protocol interface for Daikin devices
- Other AK-SM 720 devices
- AKM and AK-EM 800 via agent.

Lon RS485 (max. 199 devices)

Modbus (max. 120 devices)

Total on bus: Lon RS 485 + Modbus: max. 199 devices

IP network (max. 199 addresses)
Total AK-SM 720 + AK-PI 200 + IP + bus: max. 200 devices.

A repeater must be added if there are more than 120 devices on the Lon RS485 communication.

AK-SM 350

This device can record up to 65 (99) readings. A reading could for example be a directly mounted temperature sensor or an external device with a temperature sensor, where the readings is loaded via data communication.
There are four forms of data communication:
- A Lon RS485
- A Modbus
- RS485 TP (Third Party) To which gas detectors, type GD, can be connected
- Ethernet communication for other AK-SM 720 or AK-SC devices.

AK-SM 350 can communicate with:
- EKC with either Lon RS485 or Modbus communication
- AK-CC, AK-PC controllers
- Gas detectors type GD
- AK-PI 200 protocol interface with DANBUSS communication
- Ethernet communication for other AK-SM or AK-SC devices.

Lon RS485

Modbus   Total up to 65 (99) devices

RS 485 TP

IP network
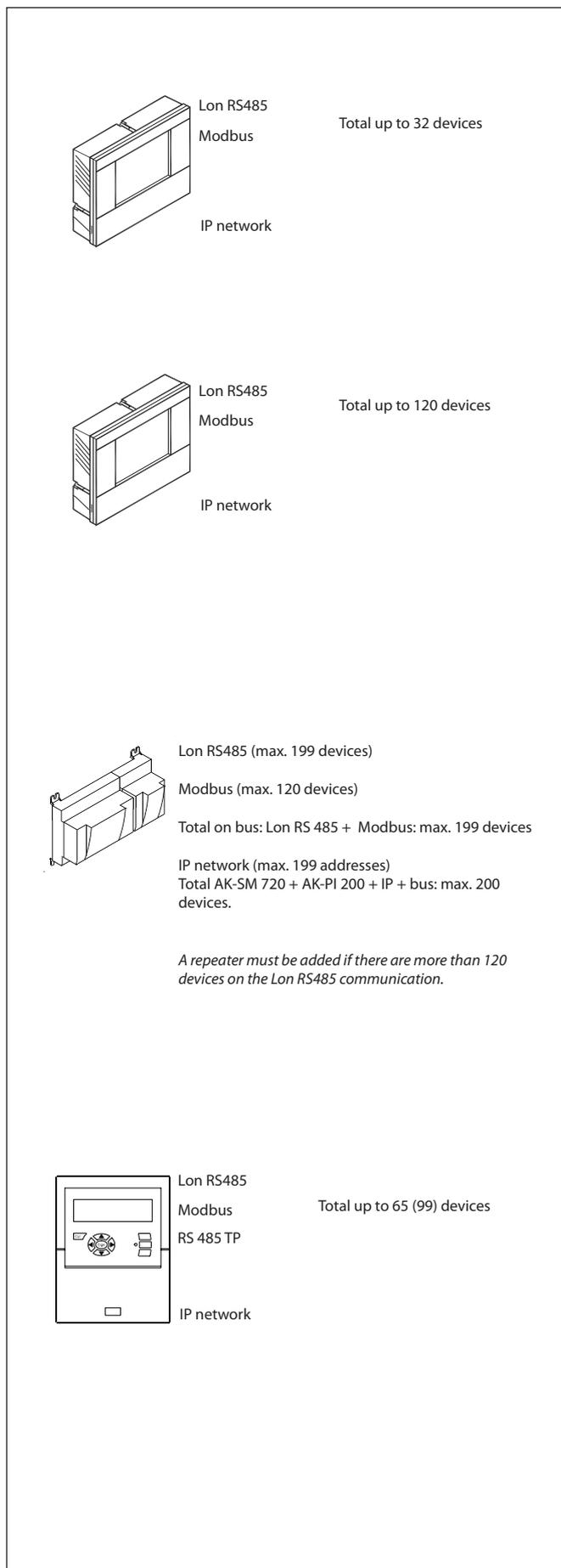
AK-SC 255 / AK-SC 355

AK-SC 255 and 355 are available in 2 versions:
- Modbus + Lon TP 78 communication
- Modbus + Lon RS485 communication

- Ethernet communication for other AK-SC or AK-SM devices.

The system device can communicate with:
- External I/O modules via AK-CM 101C or 101A (depending on model)
- All controllers where the communication is supported by: Modbus, Lon, TP78).

Gateway type AKA 245

This system device is equipped with DANBUSS data communication and Lon RS485 data communication. It can control the communication of up to 120 controllers. The controllers can be distributed between Lon and DANBUSS by setting a continuous Lon address range of up to 119 addresses.
The system device can create communication for type AKM system software.
The system device can communicate with:
- AKC controllers
- EKC controllers with a Lon RS 485 communication
- AK-CC, AK-PC controllers
- AK-EM 800 via Agent

Modbus
Lon RS485 / TP 78

IP network

DANBUSS
Lon RS485

Total up to 120 devices
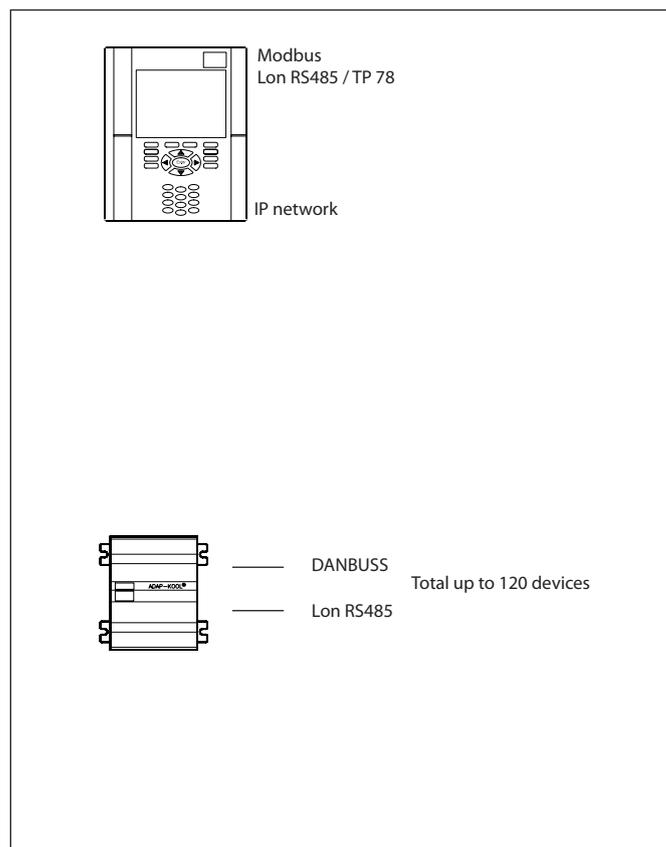
Addressing of controllers in the network

1. Connect voltage
2. Set the address in the respective controllers
   If you should inadvertently give two or more controllers the same address, only the first controller will be visible from the system device.
3. The system device must know the controllers.
   The following will occur depending on the communication type:

Lon RS485
Or better: The system device can scan the network and find all connected controllers. This scan function must be started manually in the system device.

Modbus, TP78

Here, the system device **must** scan the network.
The service PIN function on each controller **cannot** send the address to the system device.

DANBUSS
On DANBUSS, the addresses must be set before the power is switched on.
The system device will find the controllers on the network itself.

Replacement of controllers in the network

Settings
The system operation includes functions to copy a controller's settings. This function can be used where a controller is to be replaced with the same software version. After swapping, the settings are copied back onto the controller.

Address
Remember to reset the address of the controller with the same address and get the controller to notify the system device again. (You should also do this yourself if you are retaining the existing LON module).
Here, the controller can send a service PIN to the system device.

Modbus, TP78
The system device will scan the network and find the controllers that have been replaced. This scan function must be started manually in the system device.

Lon RS485
 • *AK-SC 255, 355, SM 850*
   The system device will scan the network and find the controllers that have been replaced. This scan function must be started manually in the system device.
 • *AK-SM 350, 720, AKA 245*
   Here, the controller will send a service PIN to the system device.

DANBUSS
On DANBUSS the system device will find the controllers on the network itself.

Replacement of system units in the network

If you replace the system device, all settings and data can be retrieved and reloaded with a backup function. See user Guide for the respective system device, so you can see how the setup and the collected data is retained.
• Terminate data communication inputs as previously
• Set the system device address
• Load the controller addresses up to the system device.

AK-SM 820, 850, 880
Set the address to the same value as on the previous system device. Then start the Rescan function.

AK-SM 350
No address needs to be set on AK-SM 350.
Start the scan function to find all connected controllers.

AK-SM 720
Set the address to the same value as on the previous system device. The scan function can then be started to find all connected controllers.

AK-SC 255, 355
Set the address to the same value as on the previous system device. Then start the Rescan function.

Gateway type AKA 245
Set the system address using the AKA 21 operating device.
On the DANBUSS communication, the Gateway will find the controllers itself.
On Lon RS485 the scan function can be activated from the AKA 21 operating module. This function is called "Press Enter to scan LON bus".
NB! When the scan function is used, all alarm priorities in **all** connected EKC controllers will be deleted and returned to their factory settings.

Requirement 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.
• Examples
  For Lon RS485, Modbus, RS485 Third party - General 'EIA 485' recommendation:
  - Belden 9841, 24 AWG, 1 pair with screen
  - Belden 3107A, 22 AWG, 2 pairs with screen
  - Smartwire 043006AL, 22 AWG, 1 pair with screen
  - Alpha wire 6453, 22 AWG, 1 pair with screen
  - Carol C4841A, 24 AWG, 1 pair with screen
  - Dätwyler Uninet 3002 4P 4 pairs with screen(CAT5 cable)
  For Lon TP78 communication - Level 4 cable general recommendation:
  - Belden 7703NH, 22 AWG, 1 pair with screen
  - Belden 7704NH, 22 AWG, 2 pair with screen
  - Smartwire 106500, 22 AWG, 1 pair with screen

Wires with larger cross-section than AWG 22 is not recommended. (Eg. AWG 20 and 19).

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, i.e. 2 and 2, and you must use a pair that is twisted **around each other.**

If there are several "vacant" wires in the cable, they must be used for nothing else than data communication.

Cable length
A cable length must not exceed 1200 m.
A repeater must be used for longer lengths than 1200 m.

See the additional requirements for the respective communication forms.
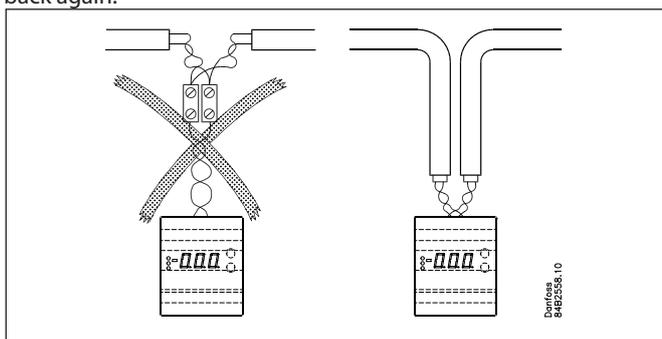
Important!

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. 3-4 cm. 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 10-15 cm will be sufficient.
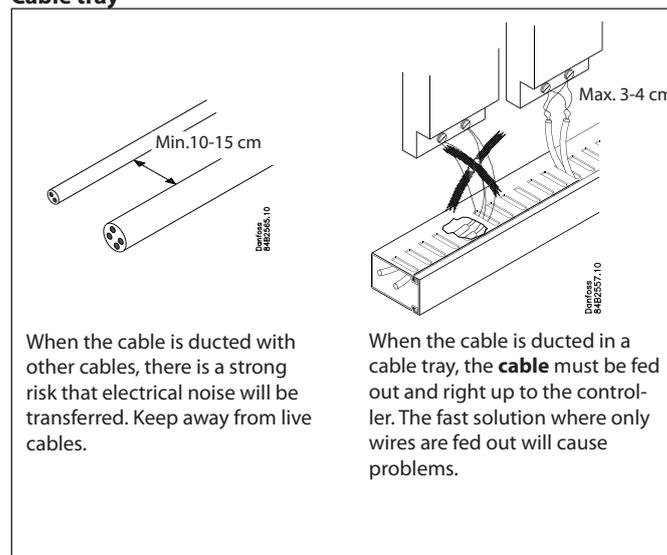
Cable length extremities
Each section of data communication must be terminated correctly. See the relevant communication form on the following pages. Termination with a resistance of 120 Ω. Either directly on the terminals or with a switch.

Screen
See the respective communication forms.

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.
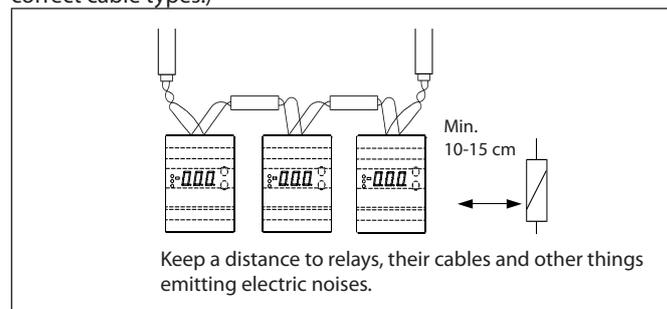
When controllers are fitted in a cabinet door, the cables are usually kept together in bundles of cables. Here the bundle with data communication, display and digital input signals must be kept separate from other cables that emit noise.
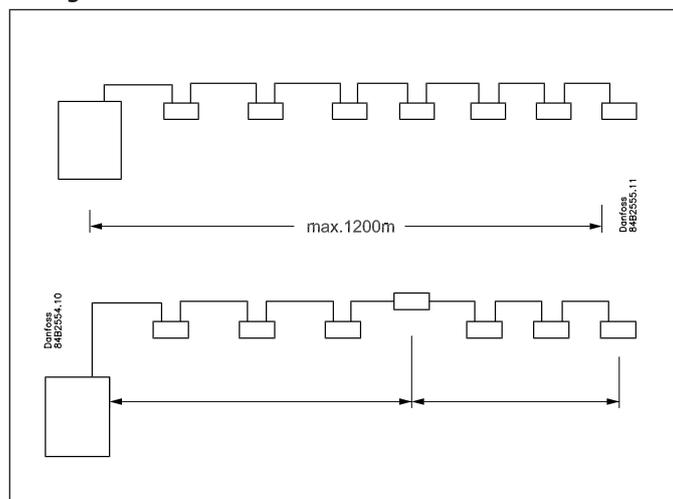
Lon RS 485 - bus
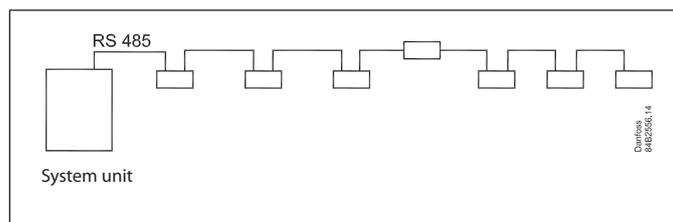
This data communication is primarily used in controllers in the series:
• EKC..
• AK-CC, AK-PC...

The system devices must be:
• System manager from the serie AK-SM
• System manager from the serie AK-SC
• Gateway type AKA 245

Wiring

The cable is connected from controller to controller, and **no** branches are allowed on the cable.
The System Manager can be inserted in middle of network. (However, not AK-SC 255 and 355, which have a fixed termination = ON.) See page 9 for drawing.

If the cable length exceeds 1200 m a repeater must be inserted

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.
The repeater is placed so that the length of the cable is evenly distributed.

See page 17 for more information on repeaters.

Number of controllers
The total number of controllers on an LON RS485 connection is determined by the system device and can vary between 32 and 200. See the summary of system options on page 4.

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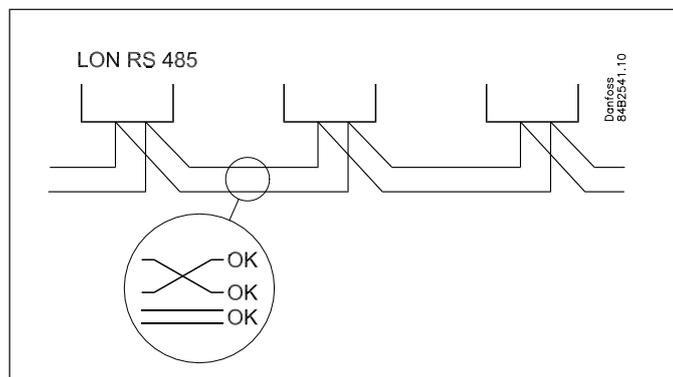
The two wires are looped from device to device. There are no polarisation requirements.
(On some controllers, the clamps are designated A and B. On others there is no designation. Otherwise the connections are identical.)
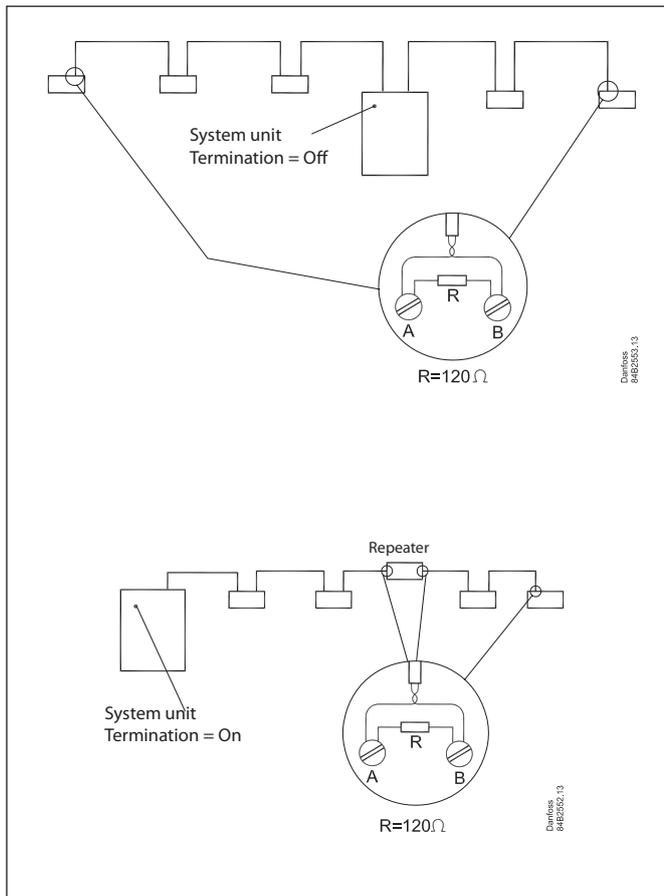
If a screen is used, ensure screen is connected to system device and any repeaters.
A screen **must always be looped** from device to device.
The screen must **not** be connected to anything else.
(The screen is earthed inside the system device and must not be earthed in any other way.)

Cable sections/termination

System unit
Termination = Off

A

B

R=120Ω

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84B2553_13

Repeater

System unit
Termination = On

A

B

R=120Ω

Danfoss
84B2552_13

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 either an external resistor or a contact. Please see the relevant device.
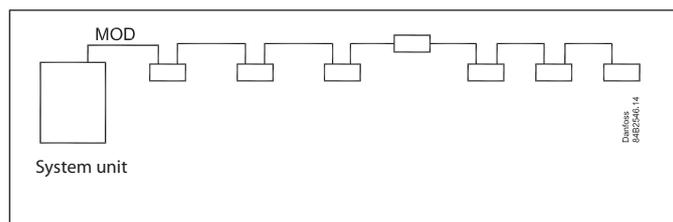
A repeater will normally terminate two cable sections.

The termination should be made with a 120-ohm resistor. (The resistor can be in the range 100 to 130 ohms.)

A repeater will always terminate two cable sections.

MOD - bus

System unit

This data communication can be used in the serie:
• EKC..
• AK-CC
• AK-CT

The system device must be:
• System manager type AK-SM
• System manager type AK-SC

Wiring

max.1200m
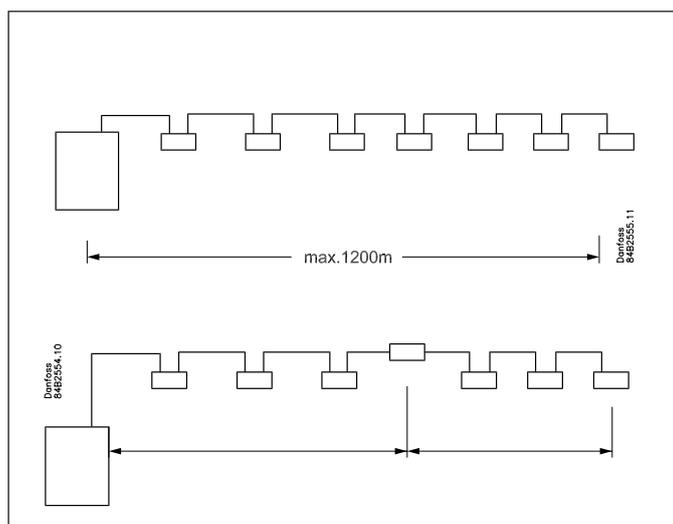
The cable must be with screen.

The cable is connected from controller to controller, and **no** branches are allowed on the cable.
The System Manager can be inserted in middle of network. (However, not AK-SC 255 and 355, which have a fixed termination = ON.) See page 11 for drawing.

If the cable length exceeds 1200 m a repeater must be inserted

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.
The repeater is placed so that the length of the cable is evenly distributed.

See page 17 for more information on repeaters.

Number of controllers
The total number of controllers on MOD bus connection can be up to 120. See the summary of system options on page 4.

Conductors

MOD

A^+ B^- A^+ B^- A^+ B^-
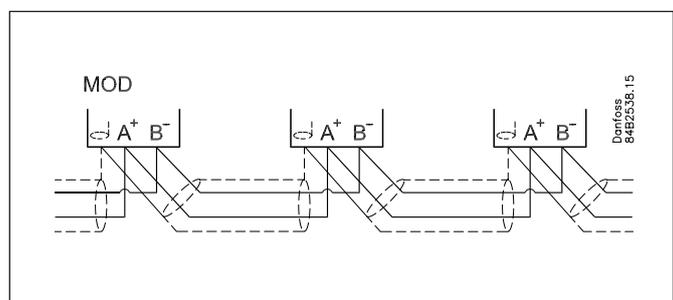
The wires are looped from device to device.
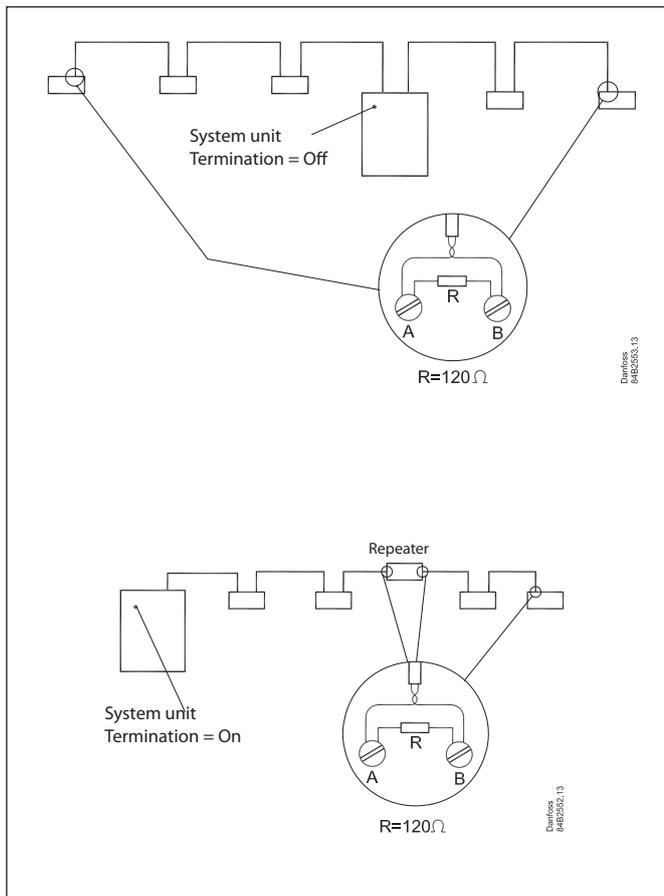A is connected to A
B is connected to B.

The screen **must** be connected to the system device, all controllers and any repeaters.
A screen **must always be looped** 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.)

Cable sections / termination

Danfoss
84B2553.13

When all cables have been mounted on the different devices, the cable must be terminated.
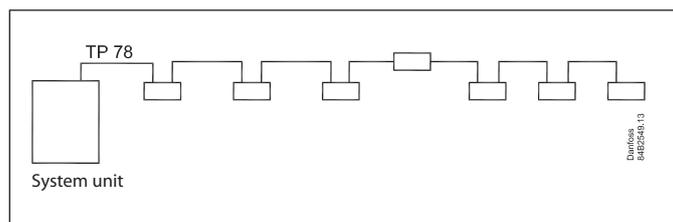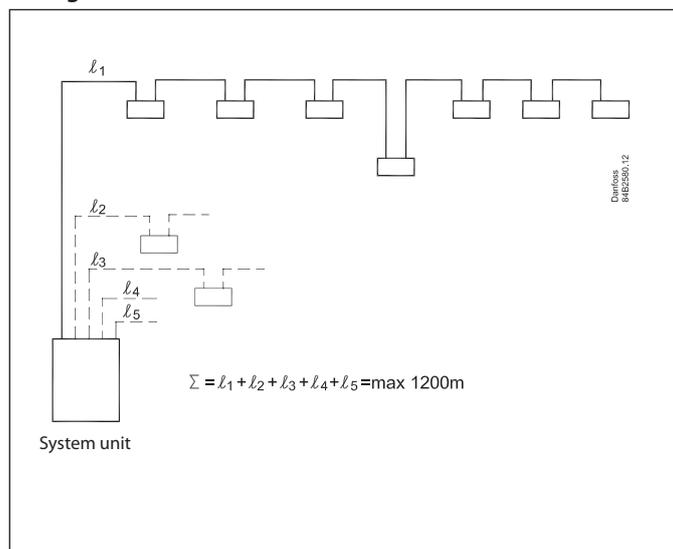
A section **must** be terminated at both ends. The section must be terminated using either an external resistor or a contact. Please see the relevant device.

A repeater will always terminate two cable sections.

The termination should be made with a 120-ohm resistor. (The resistor can be in the range 100 to 130 ohms.)

Lon TP 78 - bus

TP 78

System unit

Danfoss
84B2549.13

This data communication is no longer recommended for new installation, Danfoss can provide units for retro-fit:
• System controller type AK-SC 255, 355 and AK-SM 8xx
• AK-CM - communication modules
• AK-CC - Case control (TP 78 version)

Wiring

ℓ_1

ℓ_2

ℓ_3

ℓ_4
ℓ_5

$\Sigma = \ell_1 + \ell_2 + \ell_3 + \ell_4 + \ell_5 = $ max 1200m

System unit

Danfoss
84B2580.12

Cables with screen must be used.

The cable is connected from controller to controller, and **no** branches are allowed on the cable.
System Manager AK-SM 8xx can be inserted in middle of network. (However, not AK-SC 255 and 355, which have a fixed termination = ON.) See page 13 for drawing.

A cable section must not be longer than 1200m.
A repeater must be used for longer sections.

The sum of all sections must not exceed 1200m.
A repeater must be used if the sum is greater.

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.
The repeater is placed so that the length of the cable is evenly distributed.

See page 17 for more information on repeaters.

Number of controllers
The total number of controllers on a TP 78 connection is determined by the controlling unit and can be up to 120. See the summary of system options on page 4.

Conductors

LON TP 78

OK
OK
OK

Danfoss
84B2559.10
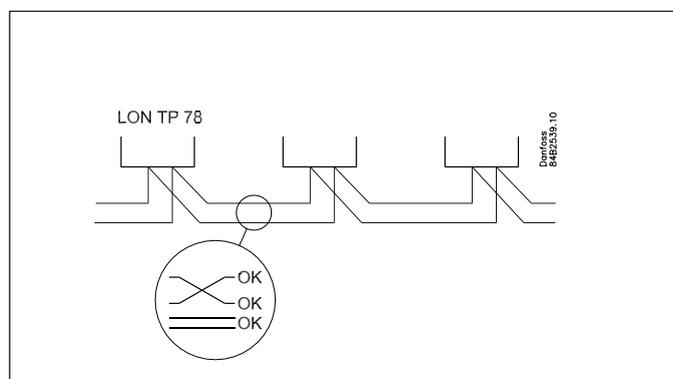
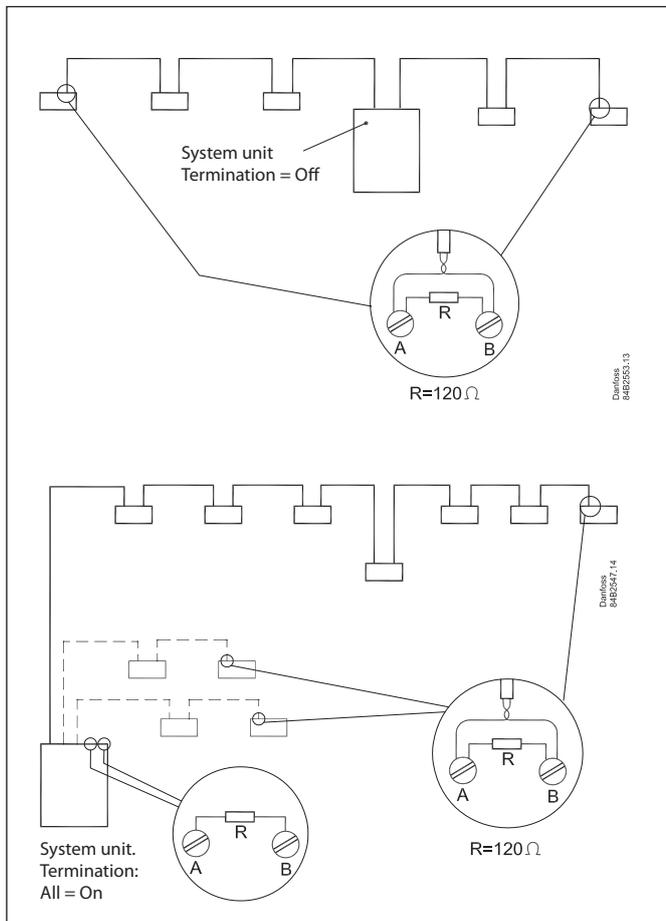The two wires are looped from device to device. There are no polarisation requirements.

The screen **must** be connected to the system manager and any repeaters.
A screen **must always be looped** from device to device.
The screen must **not** be connected to anything else.
(The screen is earthed inside the device and must not be earthed in any other way.)

Cable sections / termination

System unit
Termination = Off

R
A   B

R=120 Ω

Danfoss
84B2553.13

System unit.
Termination:
All = On

R
A   B

R
A   B

R=120 Ω

Danfoss
84B2547.14

When all cables have been mounted on the different devices, the cable must be terminated.

A section **must** be terminated at the end of each sections. Termination is performed with the resistors (terminations) supplied.
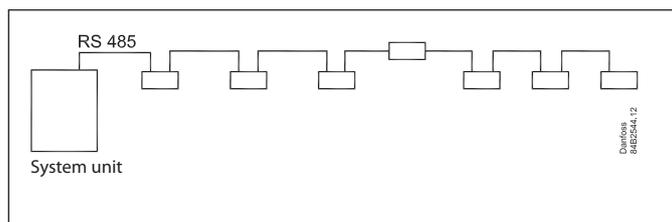If one or more of the sections is not used, the termination on the clamp row should be retained.

A repeater will always terminate two cable sections.
A section after a repeater must be terminated at both ends.

DANBUSS

This data communication is no longer recommended for new installation, Danfoss can provide units for retro-fit:
• AK-CC.

The system device must be a gateway type:
• AKA 245 or
• Interface module AK-PI 200 + a AK-SM unit

Wiring
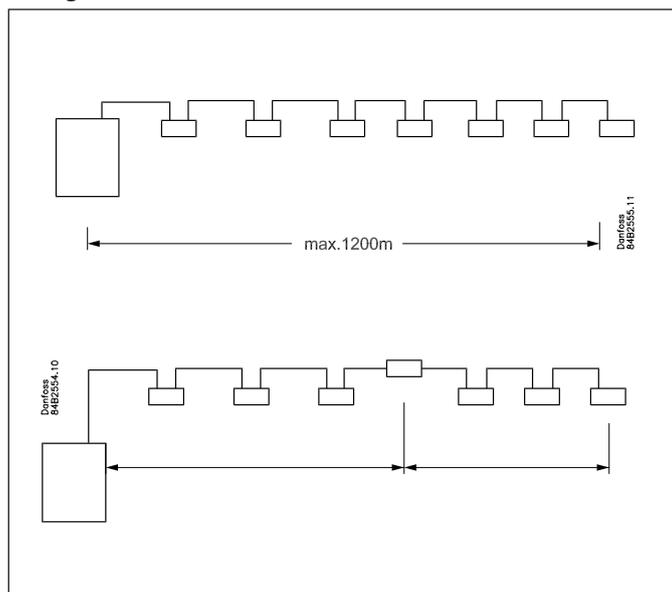
Cable must be with screen.

The cable is connected from controller to controller, and **no** branches are allowed on the cable.

If the cable length exceeds 1200 m a repeater must be inserted.

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.
The repeater is placed so that the length of the cable is evenly distributed.

See page 17 for more information on repeaters.

Nubmer of controllers

The total number of controllers on an Danbuss connection is determined by the controlling device and can vary between 60 and 120. See the summary of system options on page 4.

Conductors
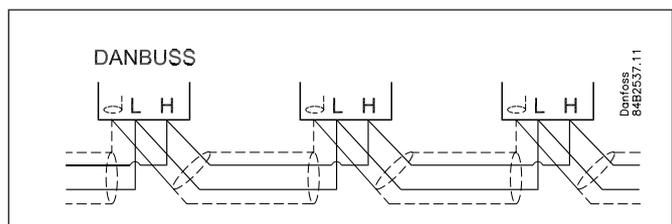
The wires are looped from device to device. L (K3) is connected to L (K3) and H (K4) to H (K4).

The screen must be connected to screen (k1) on all controllers and any repeaters. 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.)

Cable sections / termination

System unit.
Termination = On

System unit.
Termination = On
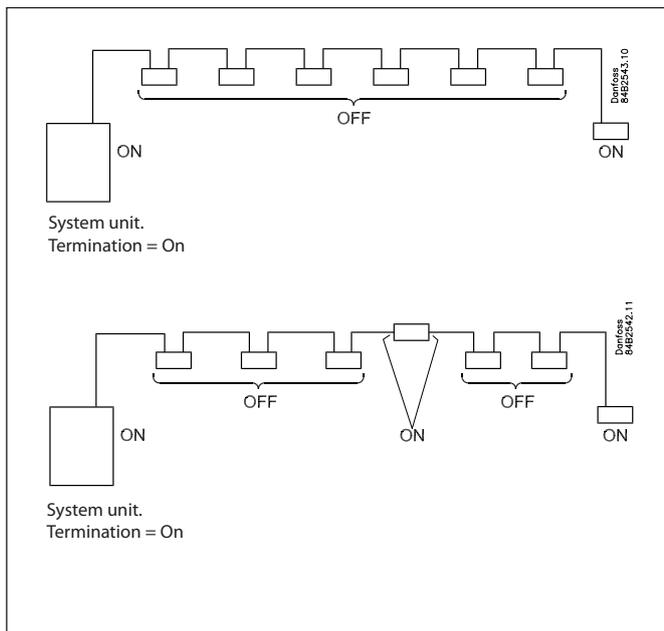
When all cables have been mounted on the different units, the cable must be terminated.
The termination is made using changeover switches and bow contacts.

A section **must** be terminated at both ends. The section must be terminated using either an external resistor or a contact. Please see the relevant device.

A repeater will always terminate two cable sections.

The termination should be made with a 120-ohm resistor. (The resistor can be in the range 100 to 130 ohms.)

Combinations of net

Bridge

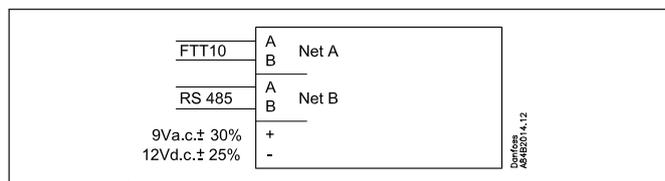A bridge is a signal transition from one type of data communication to a different type.
A bridge has no address.
Multiple bridges and bridge types can be mixed on a common loop.

Lon FTT 10 to Lon RS 485 and reverse
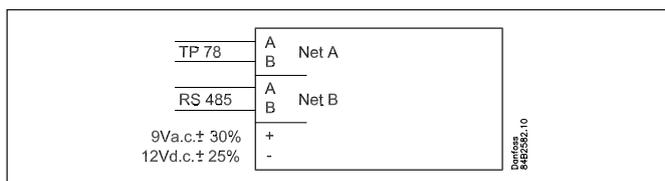A bridge type **TP78-05** can be used.
Code no. = 084B22 55.

Lon TP 78 to Lon RS 485 and reverse
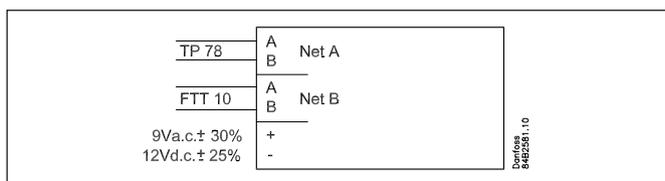A bridge type **TP78-04** can be used.
Code no. = 084B2254.

Lon TP 78 to Lon FTT10 and reverse
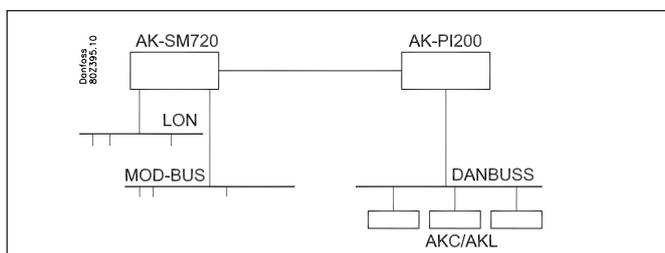A bridge type **TP78-02** can be used.
Code no. = 084B2252.

DANBUSS to AK-SM 720
Protocol interface **AK-PI 200** can be used.
Literature no. = RS8EX.

Repeater

A repeater is a device that refreshes the signal so that the signal can be read further out on the communication line.
Location-recommended to be in middle of loop so distance is split in half.
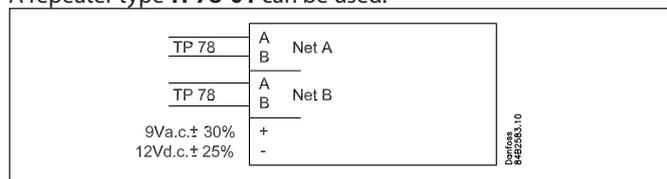A repeater has no address.

Lon RS 485

A repeater from the company "Phoenix" can be used:
Danfoss code no = 084B2241 (type AKA 223)
On Lon RS485 the communication speed is set to 78.1 kbps on the repeater.

MOD-bus

A repeater from the company "Phoenix" can be used:
Danfoss code no. = 084B2240 (type AKA 222).
On Modbus the communication speed is set to 38.4 kbps on the repeater. (A cable section with SLV must be set to **19.2 kbps**.)

Lon TP 78

A repeater type **TP78-01** can be used.

DANBUSS

A repeater from the company "Phoenix" can be used:
Danfoss code no. = 084B2240 (type AKA 222).
On DANBUSS the communication speed is set to 4.8 kbps on the repeater.
A on the repeater must be connected to DANBUSS-terminal L.
B on the repeater must be connected to DANBUSS-terminal H.

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