

Service Guide

ECL Comfort 296 / 310 controllers Modbus networking guide



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2.0 Introduction

In smaller district heating networks lightning can be a challenge for the connected devices like ECL Comfort 296 / ECL 310 controllers.

If not protected, Modbus interfaces are subject for being burned in case of lightning.

Based on several market inputs and analysis we identified a need for information.

This has resulted in the present service guide which includes recommendations for new installations.

The document is prepared in compliance with www.modbus.org

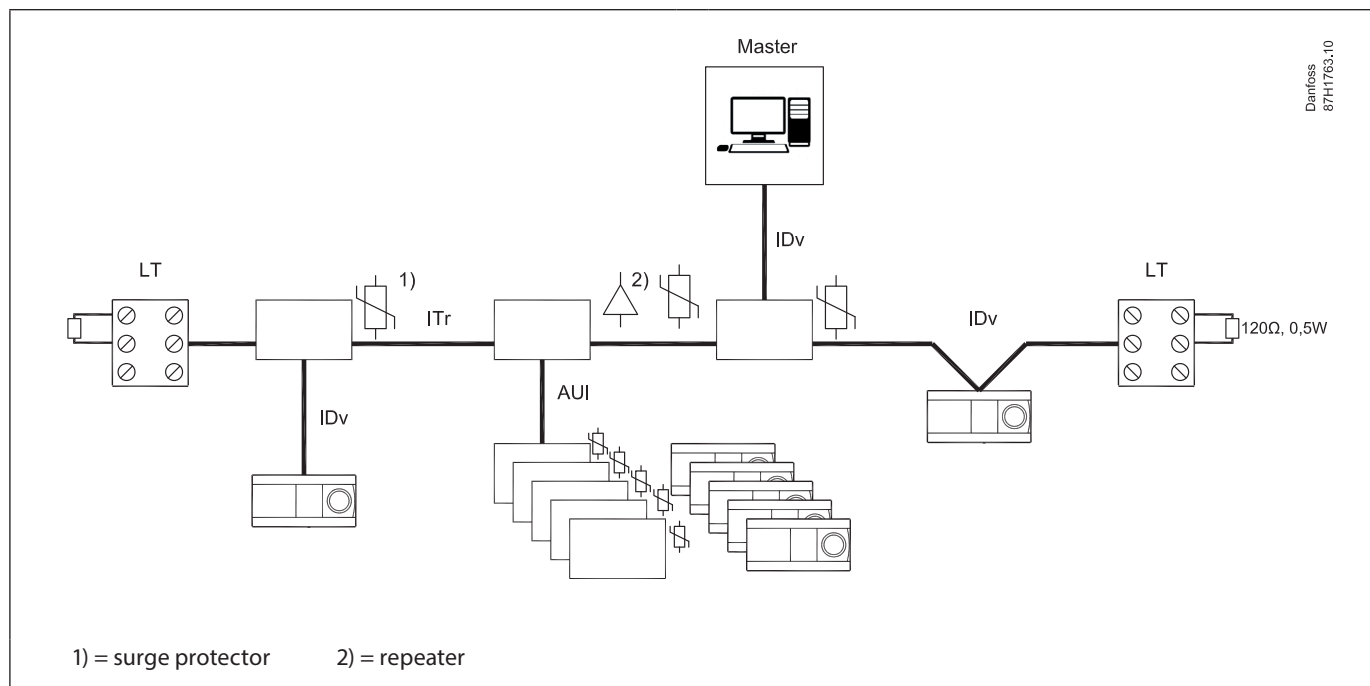
3.0 Conclusion

1. Each nodes in the "Modbus network" (central heating station, repeater station or individual house) are highly recommended to have "surge protector". It must be selected as per section 6 and installed as described in section 7.
 2. Phoenix "PT 1X2+F-BE" (or similar products from another manufacturer, as per the surge protection requirement in section 6) must be used instead of "PT 1X2-BE" in individual house installations. Refer section 8.
 3. Recommendation on Modbus reference common signal connection, shield connection, termination resistor connection may be referred in section 5, 6, 7 and 8.
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4.0 Modbus network definitions

4.1 Multipoint serial bus infrastructure

The below drawing gives a general overview of the serial bus infrastructure in a Modbus multipoint serial line system.



The following conventions are adopted in the figure above:

1. The interface with the trunk is named ITr (Trunk Interface)
2. The interface between the device (ECL 296 / 310) and the Passive Tap (surge protector) is named IDv (Derivation Interface)
3. The interface between the device (ECL 296 / 310) and the Active Tap (repeater) is named AUI (Attachment Unit Interface)
4. LT = line termination. Resistor: 120 ohm , 0,5 W or 150 ohm, 0,5 W

A multipoint Modbus serial line bus is made of a principal cable (the trunk) and possibly some derivation cables.

Line terminations are necessary at each extremity of the trunk cable for impedance adaptation.

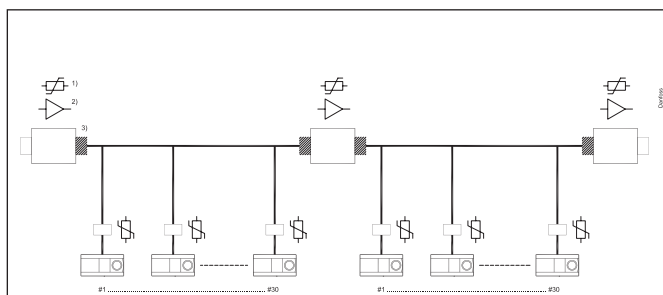
5.0 ECL 296 / 310 Modbus network specification

The ECL 296 / 310 Modbus physical layer interface is supported by the half duplex RS485 interface (A, B, common signal - i.e ref GND).

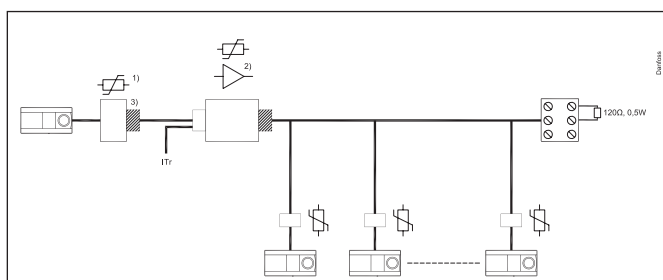
1. Maximum trunk (Bus) length = 1200 meters for AWG24 (0,51mm diameter) copper (less AWG= bigger diameter: is better).
Note: AWG= American wire gauge (AWG).
2. Maximum number of nodes in the network = 32 (including master node, ECLs and repeater node).
Note: Each repeater node is capable of driving another 32 nodes (including repeater node) of 1200 meter.
I.e. 30 ECLs between two repeater stations (or) 31 ECLs in the network connected to master node / repeater node. Refer the figure below.
3. Maximum derivation cable length per node (per ECL) = 1,25 meters (calculated based on 40 m max. derivation cable length for 32 nodes).
4. Line termination (to ensure the communication quality) = At each extremity of the trunk cable (150 ohms (or) 120 ohms, 0,5 watts resistor at both ends).

Note: Repeaters are having internal termination resistors which can be "switched on/ switched OFF" by the user.

a.
If "repeaters" are used in the extremity of the trunk cable, then switch on the repeater termination (striped block, represented by 3):



b.
If "repeaters" are used to make a branch from one of the intermediate nodes, then do **not** switch on the "repeater termination" (unstriped block connected to ITr cable).



- 1) = surge protector
- 2) = repeater
- 3) = line termination (LT)

c.
If the ECL is used in the extremity node of the trunk cable, connect an external line termination (150 ohm / 120 ohm, 0,5 watts resistor).

5. Grounding arrangements (to improve “general electrical safety” and “communication quality”) - the common signal (ref. GND) must be connected directly to the protective ground (PE= Earth), at the master device (ONE POINT ONLY).
6. Cables shield arrangements (to improve “general electrical safety”) - One end of each cable’s shield must be connected to protective ground (PE= Earth). Do not connect both ends of the shield to PE as it forms an unwanted “group loop”.

6.0 Installation class and surge / lightning protection

“To secure the Modbus electronics (ECL 296 / 310, repeater...) from surge / lightning in the network, “external protection devices” must be selected based on the installation class of the network” and rightly installed in “each site”.

Installation class 4 definitions:

Electrical environment where the interconnections are running as outdoor cables along with power cables, and cables are used for both electronic and electrical circuits.

“Surge protector requirements” for “installation class 4” (Modbus network with ECLs):

Parameter	Surge protection requirement	PT 3-PB-ST and PT 1X2+F-BE
Class 4 - surge voltage: network: 1,2uS/50uS	4KV	10KV (8uS/20uSec)
Short circuit current (42 ohm impedance)	Much higher than 95,2A	10KA. (Seems to be 2 ohm impedance tester)
Maximum continuous voltage - core to core (A, B and ref. GND in ECL)	> 3,5V and ≤ 7V	5,2Vdc
Output voltage limitation at 1 kV/μs (core-core) spike Output voltage limitation at 1 kV/μs (core-earth) spike	Much less than 1KV ≤ 700V. Note: “common signal” MUST NOT be shorted with “PE (protective earth)” in surge protector base part	≤ 55V ≤ 700V
Output voltage limitation at 1 kV/μs (core-core) static	Much less than 1KV	≤ 15V
Output voltage limitation at 1 kV/μs (core-earth) static	Much less than 1KV	≤ 30V

As per the above details, “PT 3-PB-ST and PT 1X2+F-BE” from Phoenix meet the requirements. Similar products from other suppliers can also be used.

Installation guide:

- Outer field cables (both IN and OUT field cable wires) must be connected to the “unprotected side” of the “external surge protection device)
- Indoor local cables (both IN and OUT cable wires - which are well separated from mains supply wires) used to connect combination part of electronics (repeater / ECLs) to the network, must be connected to the “protected side” of the “external surge protection device)

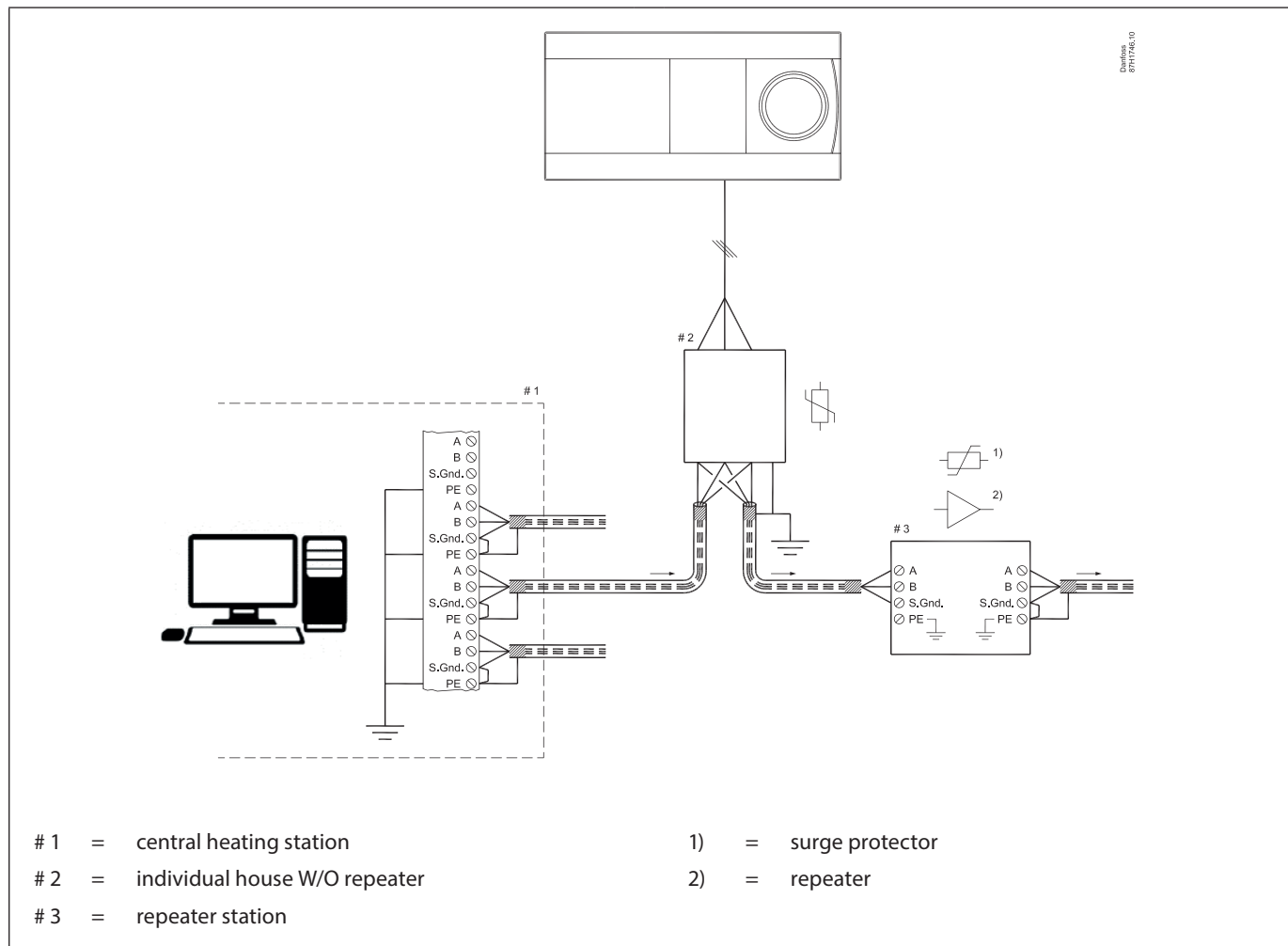
7.0 Annexure A: Modbus network wiring guidelines

Typical Modbus network consists of:

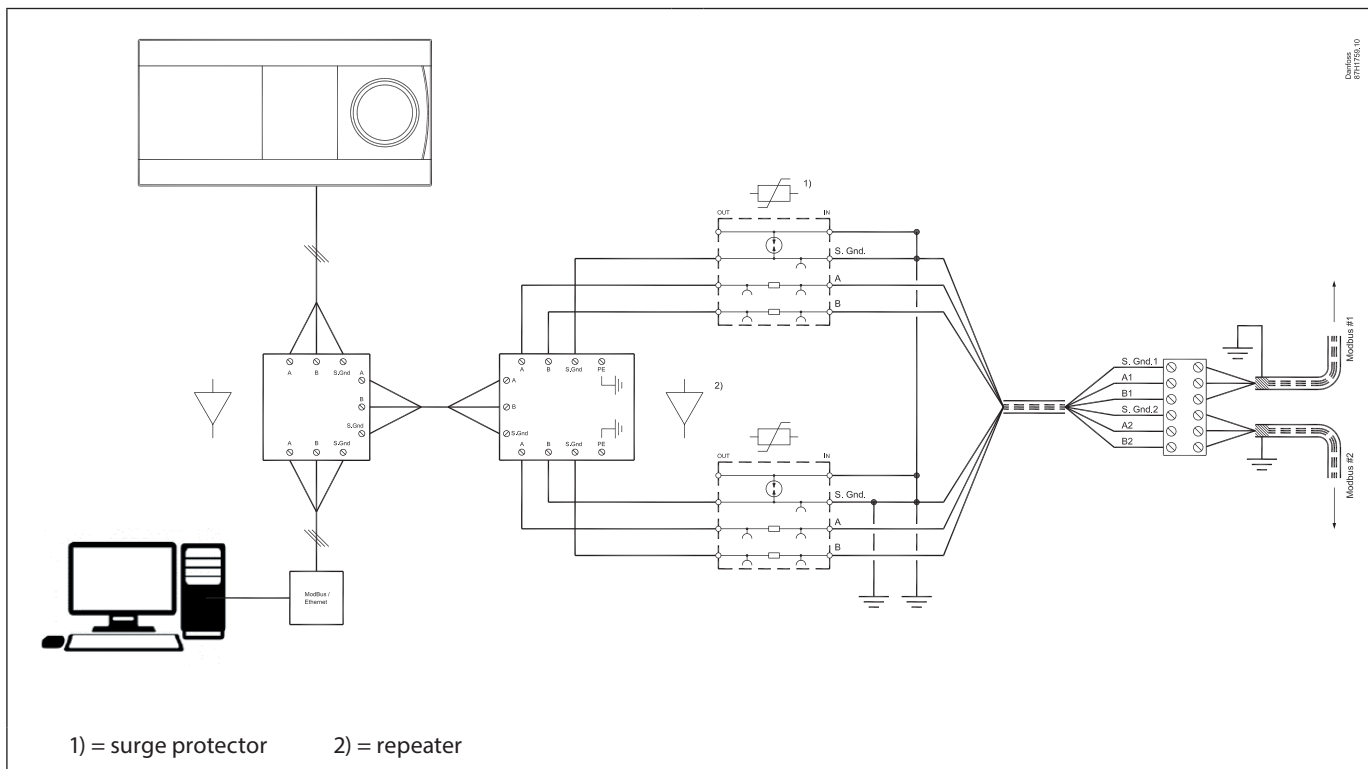
- Central heating station
 - Surge protector
 - RS485 (Modbus) repeater
 - Modbus to Ethernet converter
- Repeater stations (individual houses with repeater)
 - Surge protector
 - RS485 repeater
- Individual houses (without repeater)
 - Surge protector

Each nodes in the Modbus network (central heating station, repeater station or individual house) can have “surge protector”.

Top level logical drawing:



7.1 Central heating station



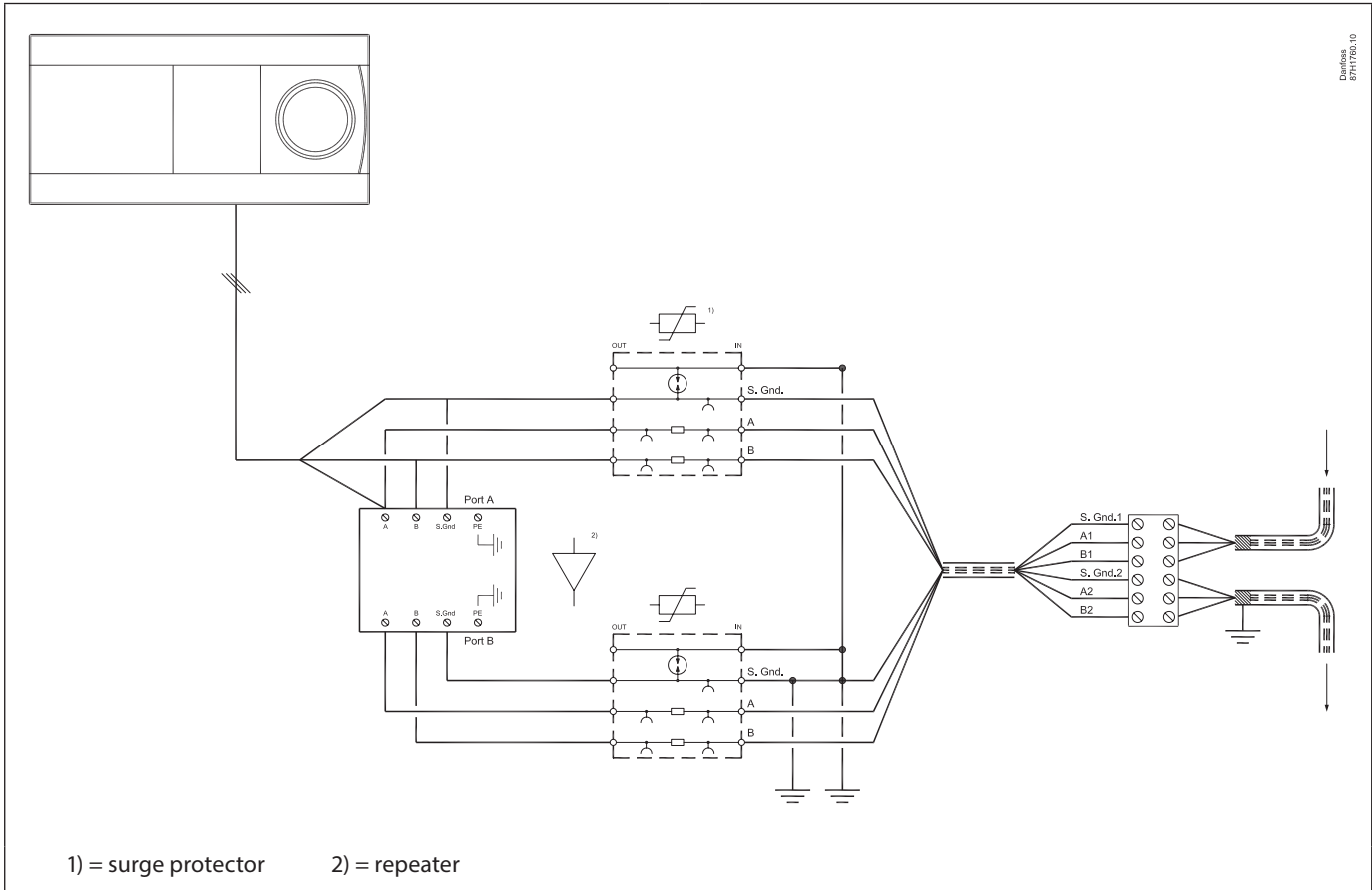
Note:

a)
 Repeater channels are isolated. Based on the central heating station architecture, more than one network (like left wing, right wing) is possible. Single point earthing on common reference signal (S.Gnd) and shield cable to be maintained (Refer section 5 point 5, 6).

Dot on the intersection lines (S.Gnd, Earth) means that those two signals are electrically shorted.

Surge suppressor connection should match as in section 8.2.

7.2 Repeater stations (individual houses with repeater)



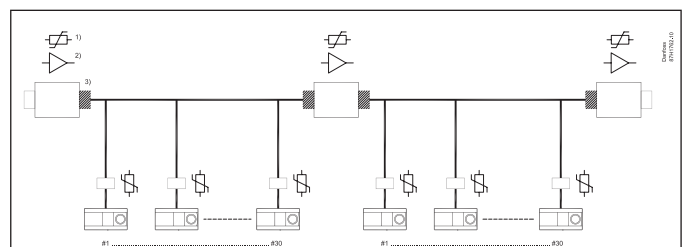
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Note:

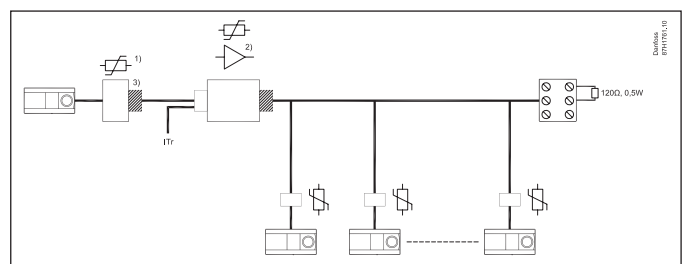
a)
Normally repeaters' inputs and outputs are isolated. Check the resistance between input common reference signal (S.Gnd1) and output common reference signal (S.Gnd2) using multimeter. If signals are having >1 Mohm, then connect the output side common reference signal to earth.

Input cable (coming from central heating station) shield MUST be floating and output cable shield is connected to earth. This is to maintain single point earthing in each network, on common reference signal (S.Gnd) and shield cable (Refer section 5 point 5, 6).
Dot on the intersection lines (S.Gnd, Earth) means that those two signals are electrically shorted.

b)
Internal termination of repeaters can be switched ON if the connection matches with section 5 point 4.a

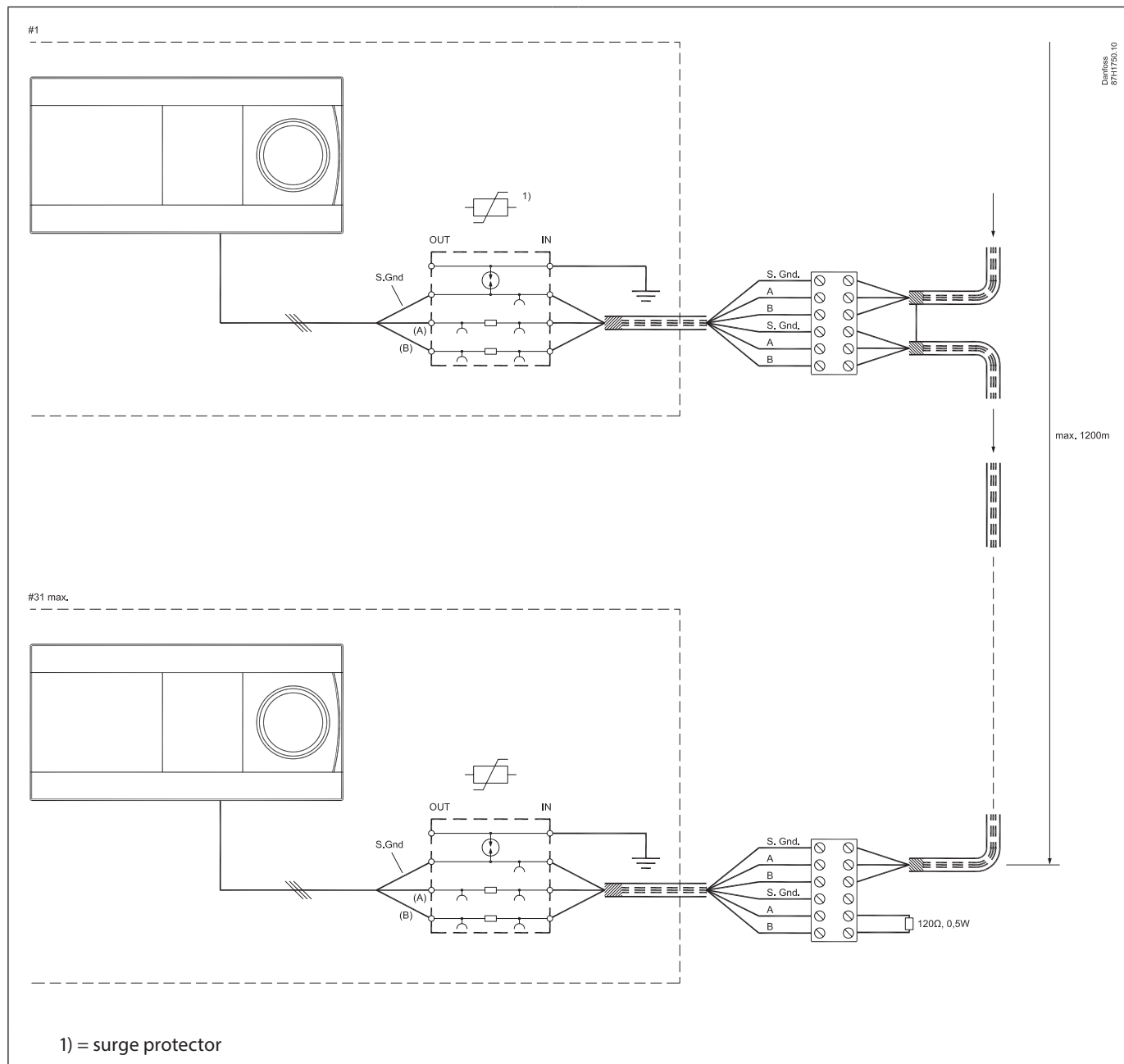


c)
Internal termination of repeaters is switched OFF if the connection matches with section 5 point 4.b



1) = surge protector
2) = repeater
3) = line termination (LT)

7.3 Individual houses (without repeater)



As there is no repeater used in this node, there is no isolated channels created. S.Gnd is not connected to earth (PE).

Input cable (coming from central heating station) shield MUST be floating and output cable shield is connected to earth. Or the input and output shield continuity is maintained and it is not connected to earth (As shown above).

This is to maintain single point earthing in each network, on common reference signal (S.Gnd) and shield cable (Refer section 5 point 5, 6).

8.0 Annexure B

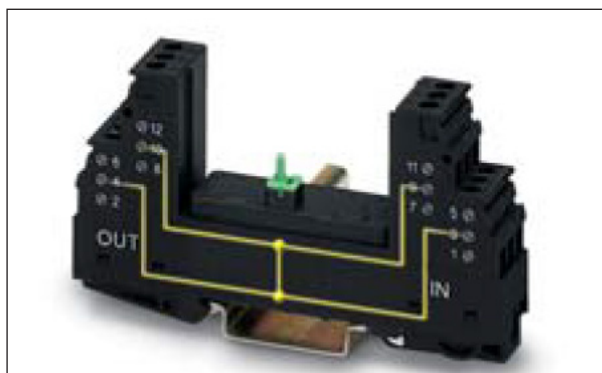
8.1 Selection of parts

There are many prebuilt connection options available on the market on "surge protector base parts", which lead to the unwanted ground looping and hence low quality / loss of communication network (section 5 point 5).

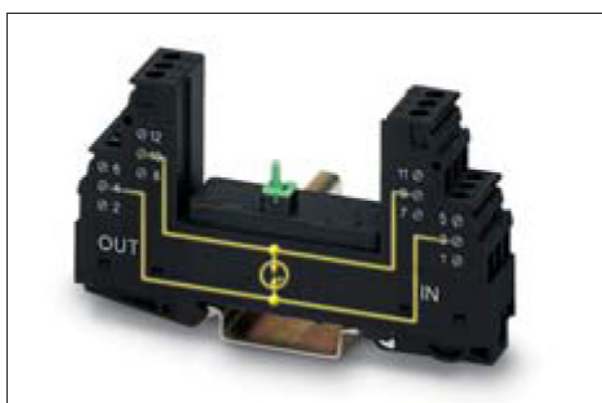
These parts look alike in part numbering system and in component outlook. So care must be taken to select the right parts. Refer the below for example:

Possibilities for grounding the base element:

- PT 1x2-BE - signal ground (pin 9/10) is shorted to PE (protective earth) (3/4)
- PT 1x2+F-BE - spark gap between signal ground (pin 9/10) to PE (protective earth) (3/4)

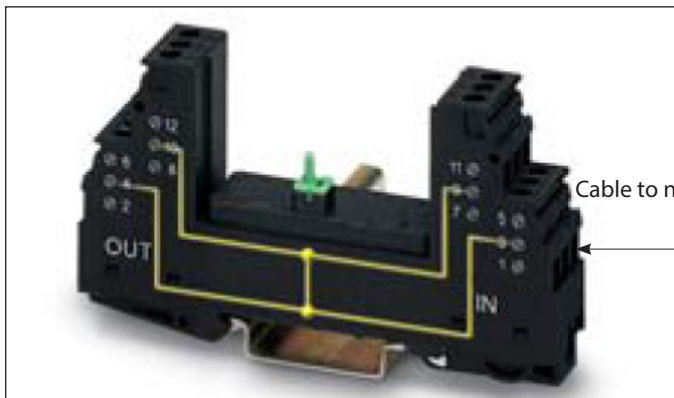


PT 1x2-BE



PT 1x2 +F-BE

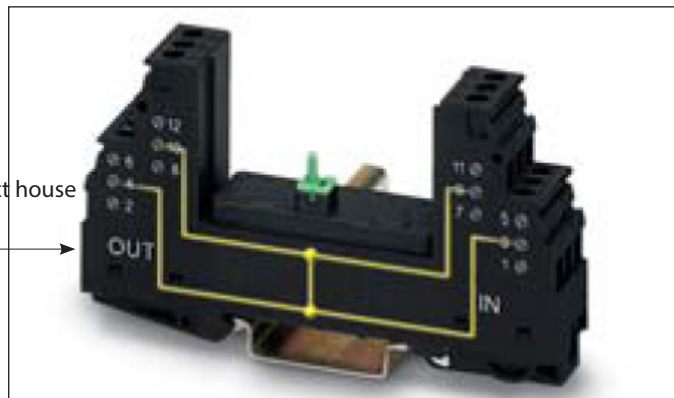
Site 1



PT 1x2-BE

Common signal shorted with PE (protective earth)

Site 2



PT 1x2-BE

Common signal shorted with PE (protective earth)

BUT common signal must be connected to earth ONLY ONE POINT (section 5 point 5). So use "PT 1X2 +F-BE" and **avoid** "PT 1x2-BE".

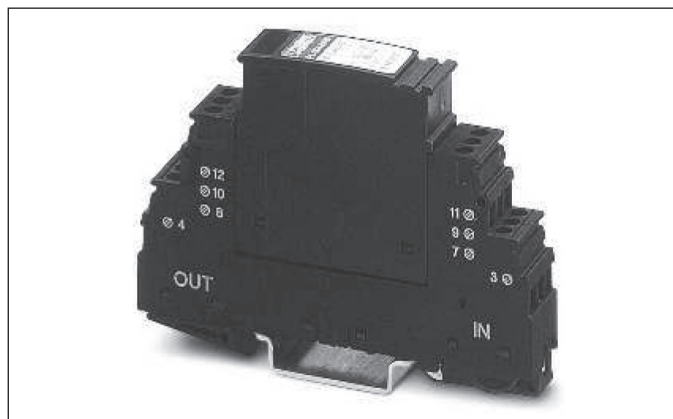
8.2 Surge protector wiring

The correct wiring is equally important to get the best "surge protection in the network level.

The "gas discharge tubes" (between pin 7, 6 to 9 in the juxtaposed example) is capable of handling higher surge current, but this device is slow responding.

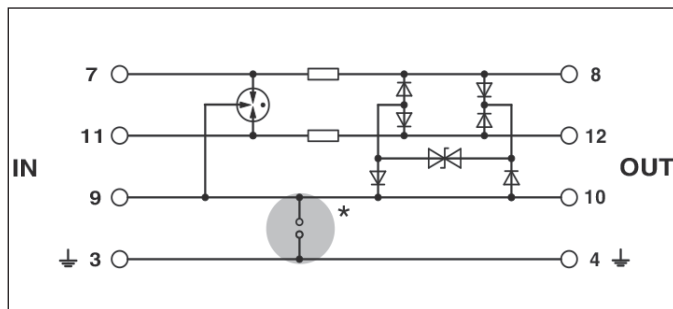
The "transils" (between pin 8 to 12 and 10) are capable of handling low surge current, but very fast responding. These two sets of components (gas discharge tubes and transils) are separated by a resistor which forces the surge to be first suppressed by the gas discharge tube and the residue will be suppressed by the transil in the proper installation ("field cables" to "gas discharge connection points" and "electronics to be protected" are connected to "transil connection points").

PT 3-PB-ST and PT 1X2+F-BE logical drawing:



3-wire, PROFIBUS (up to 12 MHz)

Total width 17.7 mm



Refer the juxtaposed drawing for example.

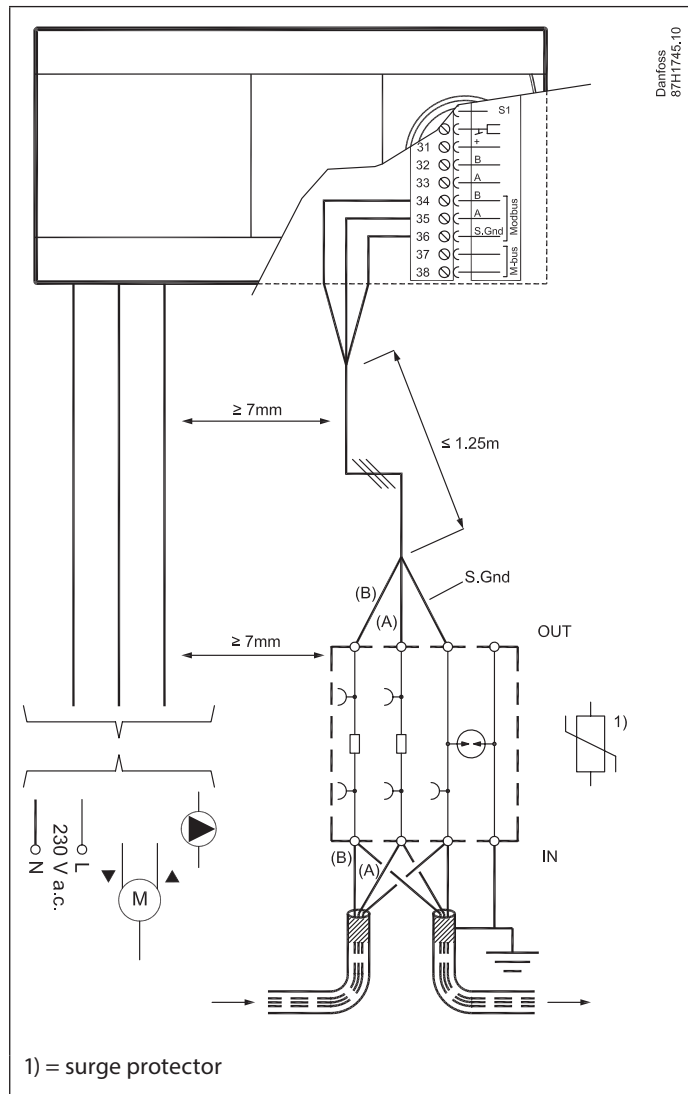
- Odd numbered connection of PT 1X2+F-BE meant for outer filed cables (both IN and OUT cable wires of field cable)
- Even numbered connection of PT 1X2+F-BE meant for repeater/ ECLs wires (both IN and OUT cable wires of ECLs / repeaters)

"Base part and surge protector data sheets must be referred before making connection".

8.3 "Modbus" to "mains" separation

The surge / lightning protected Modbus cables "must be separated from mains / switched mains signal" even for a short run. Other signals in ECL 296 / 310 (M Bus, sensor signals, RS485 signals), which are meant for indoor wiring, "must be separated from mains / switched mains signal" even for a short run. Modbus signals may be taken along with MBus, sensor signal and other RS485 signals.

Recommended:



1. Even for a short distance well separated ($\geq 7\text{mm}$) from mains signal.
2. Mains signal must be grouped separately and clear distance is maintained throughout the cable routing (from surge protected signal to ECL 296 / 310 wiring)

