



**User Manual**

**Wiring Instructions**  
***PROFIBUS, CANopen, DeviceNet,***  
***AS-Interface, CompoNet, CC-Link***

**Hilscher Gesellschaft für Systemautomation mbH**

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# 1 Introduction

## 1.1 About the User Manual

This user manual provides the wiring instructions for the interfaces PROFIBUS, CANopen, DeviceNet, AS-Interface, CompoNet and CC-Link. This document contains information about cable characteristics, max. cable length in dependence of the baudrate as well as termination resistors.

### 1.1.1 List of Revisions

| Index | Date       | Chapter | Revisions  |
|-------|------------|---------|--|
| 1     | 2012-02-24 | All     | created  |
| 2     | 2012-07-06 | 3.3     | Section <i>Contacts</i> updated.   |
| 3     | 2014-04-09 | 2.2     | Section <i>CANopen Interface</i> max. distance for 1000 kBit/s corrected to 30 m |

Table 1: List of Revisions

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## 2 Wiring Instructions

### 2.1 PROFIBUS Interface

Please ensure that termination resistors are available at both ends of the cable. If special PROFIBUS connectors are being used, these resistors are often found inside the connector and must be switched on.

For baud rates above 1.5 Mbaud use only special connectors, which also include additional inductance.

It is not permitted to have T-stubs on PROFIBUS high baud rates. Use only a special cable which is approved for PROFIBUS DP. Make a solid connection from the cable shield to ground at every device and make sure that there is no potential difference between the grounds at the devices.

If your device or your card is linked with only one other device on the bus, both devices must be connected to the ends of the bus line. The reason is that these devices must deliver the supply voltage for the termination resistors. If three or more devices are connected to the bus, the Master device can be connected at any desired position.

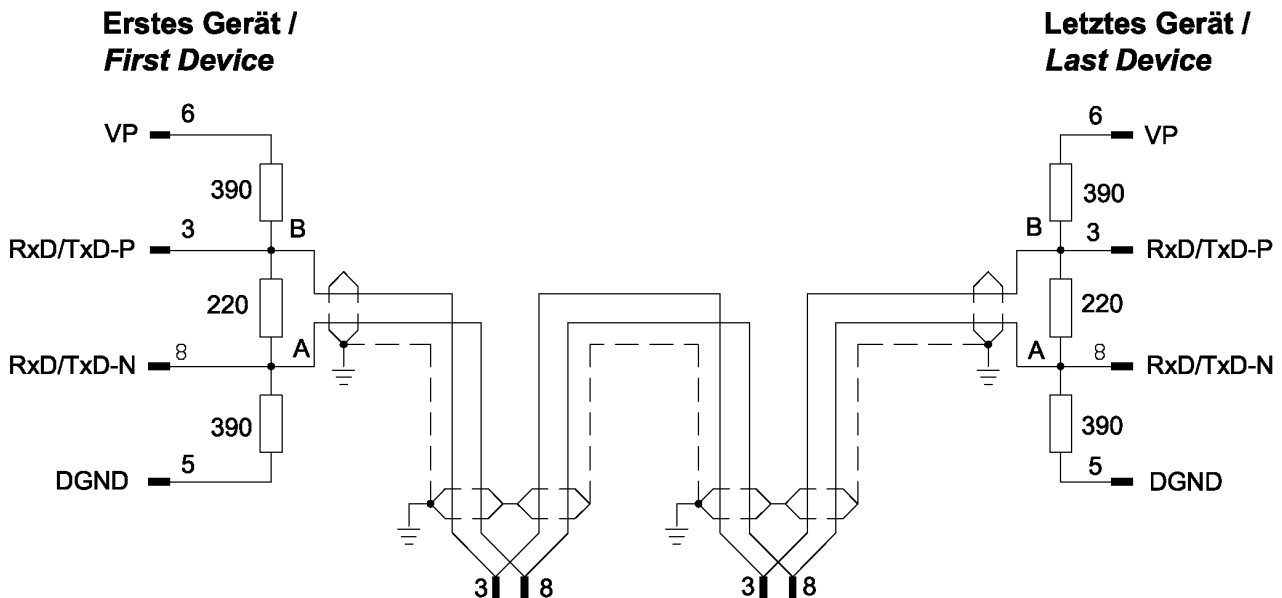


Figure 1: PROFIBUS Network

Up to 32 PROFIBUS devices can be connected to one bus segment. If several bus segments are linked to each other with repeaters, there can be up to 127 devices on the network at maximum.

The maximum permissible cable length of a PROFIBUS segment depends on the baudrate used, see the following table.

| Baud rate in kBit/s | Max. distance |
|---------------------|---------------|
| 9,6                 | 1.200 m       |
| 19,2                | 1.200 m       |
| 93,75               | 1.200 m       |
| 187,5               | 1.000 m       |
| 500                 | 400 m         |
| 1.500               | 200 m         |
| 3.000               | 100 m         |
| 6.000               | 100 m         |
| 12.000              | 100 m         |

Table 2: PROFIBUS Segment Length in dependence of the Baud rate

Only PROFIBUS certified cable, preferably the cable type A, should be used.

The following table contains the most important electrical data concerning PROFIBUS certified cable:

| Parameter                 | Value                      |
|---------------------------|----------------------------|
| Impedence                 | 150 $\Omega \pm 15 \Omega$ |
| Capacity per units length | < 30 pF/m                  |
| Loop resistance           | 110 $\Omega$ /km           |
| Wire gauge                | 0,64 mm                    |

Table 3: Characteristics of PROFIBUS certified Cable



## 2.2 CANopen Interface

Please use only CAN certified cable with the following characteristics:

| Parameter                 | Value                        |
|---------------------------|------------------------------|
| Impedance                 | $120\ \Omega \pm 12\ \Omega$ |
| Capacity per units length | $< 50\ \text{pF/m}$          |

Table 4: Characteristics of CAN certified Cable

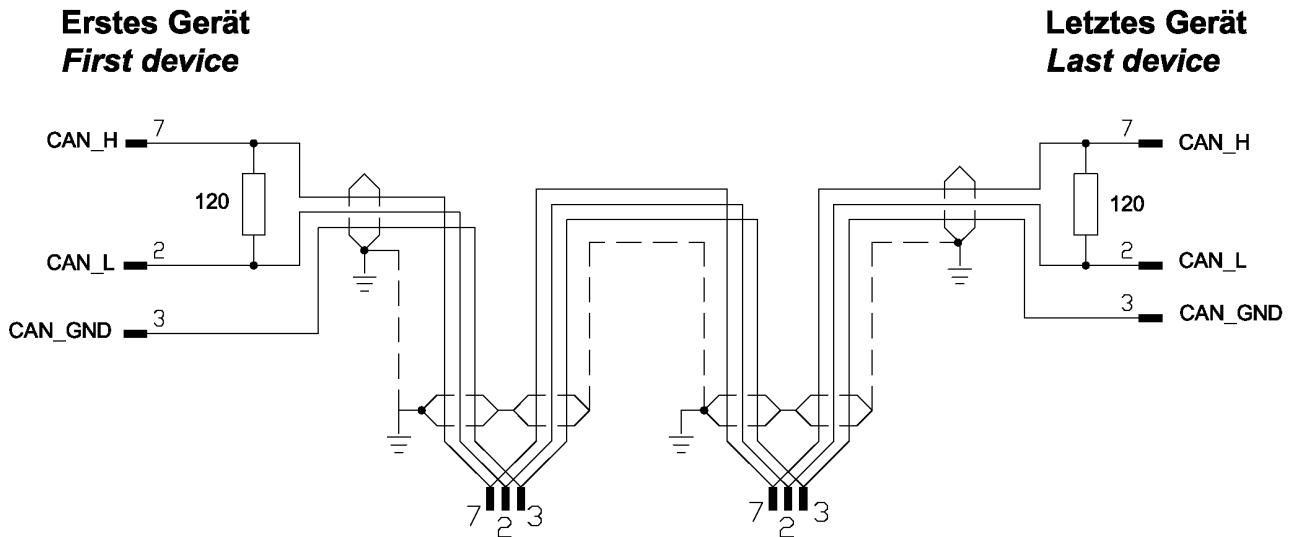


Figure 2: Termination CANopen Network

At the ends of the network there must be two resistors of  $120\ \Omega$  to terminate the cable. It is allowed to use repeaters to increase the number of nodes, which may be connected, or to increase the maximum cable length.

The CAN segment length in dependence of the Baud rate or corresponding Loop Resistance and Wire Gauge is given in the following table:

| Baud rate in kBit/s | Max. distance | Loop Resistance          | Wire Gauge                     |
|---------------------|---------------|--------------------------|--------------------------------|
| 10                  | 1000 m        | $< 26\ \Omega/\text{km}$ | $0,75 \dots 0,80\ \text{mm}^2$ |
| 20                  | 1000 m        | $< 26\ \Omega/\text{km}$ | $0,75 \dots 0,80\ \text{mm}^2$ |
| 50                  | 1000 m        | $< 26\ \Omega/\text{km}$ | $0,75 \dots 0,80\ \text{mm}^2$ |
| 125                 | 500 m         | $< 40\ \Omega/\text{km}$ | $0,50 \dots 0,60\ \text{mm}^2$ |
| 250                 | 250 m         | $< 40\ \Omega/\text{km}$ | $0,50 \dots 0,60\ \text{mm}^2$ |
| 500                 | 100 m         | $< 60\ \Omega/\text{km}$ | $0,34 \dots 0,60\ \text{mm}^2$ |
| 800                 | 50 m          | $< 60\ \Omega/\text{km}$ | $0,34 \dots 0,60\ \text{mm}^2$ |
| 1.000               | 30 m          | $70\ \Omega/\text{km}$   | $0,25 \dots 0,34\ \text{mm}^2$ |

Table 5: CAN Segment Length in dependence of the Baud rate or corresponding Loop Resistance and Wire Gauge

## 2.3 DeviceNet Interface

Up to 64 DeviceNet devices can be linked together over the bus. The maximum length of the bus cable depends on the used baud rate and the used cable type. Only special proved DeviceNet cable should be used.

The maximum length of the DeviceNet cable depends from the baud rate and from the chosen cable type, as listed in the following table:

| Baudrate in kbit/s | Maximum length of cable (thick cable) | Maximum length of cable (thin cable) |
|--------------------|---------------------------------------|--------------------------------------|
| 125                | 500 m                                 | 100 m                                |
| 250                | 250 m                                 | 100 m                                |
| 500                | 100 m                                 | 100 m                                |

Table 6: Maximum Cable Length in Dependence of the Baud Rate for DeviceNet Cables

The DeviceNet cable contains the data line cables and the power supply cables. The data line cables must match the following conditions:

| Parameter                 | Value (thick Cabel) | Value (thin Cabel)  |
|---------------------------|---------------------|---------------------|
| Impedance                 | 120 $\Omega$        | 120 $\Omega$        |
| Capacity per units length | < 39.4 pF/m         | < 39.4 pF/m         |
| Loop Resistance           | < 22.6 $\Omega$ /km | < 91.8 $\Omega$ /km |
| Wire Gauge (Diameter)     | 2*1,1 mm            | 2*0,6 mm            |

Table 7 Characteristics of DeviceNet Data Line Cable

The power supply cables must match the following conditions:

| Parameter             | Value (thick Cabel) | Value (thin Cabel)  |
|-----------------------|---------------------|---------------------|
| Loop Resistance       | < 11.8 $\Omega$ /km | < 57.4 $\Omega$ /km |
| Wire Gauge (Diameter) | 2*1,4 mm            | 2*0,7 mm            |

Table 8: Characteristics of DeviceNet Power Supply Cable

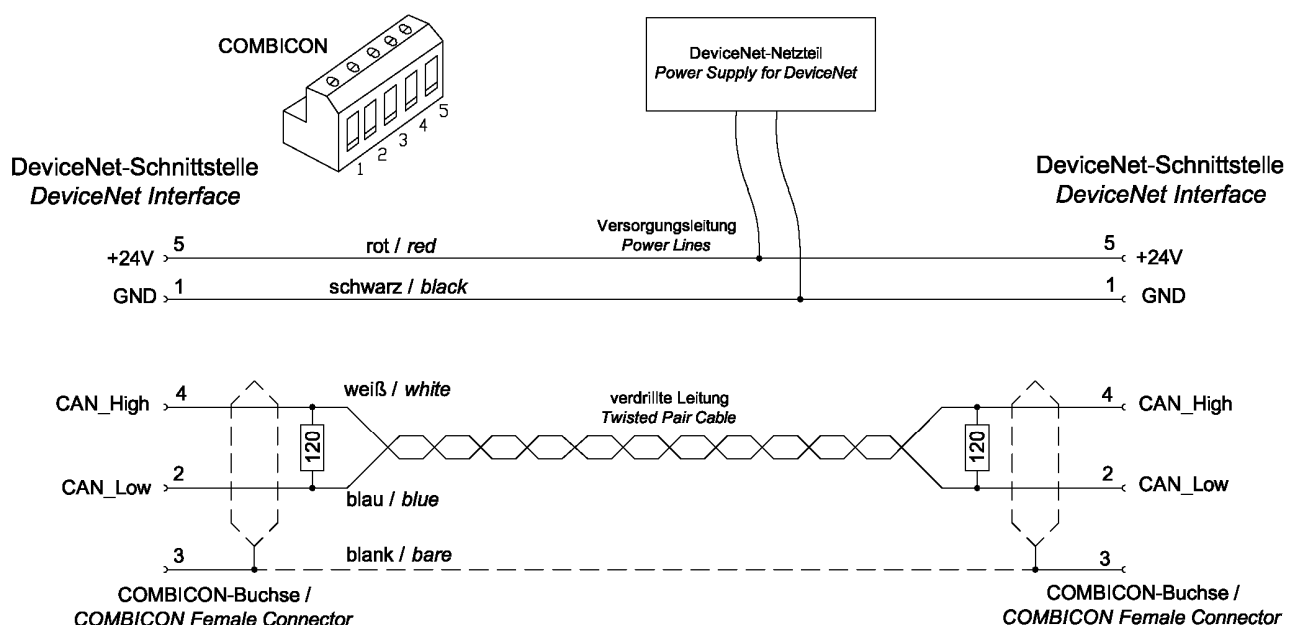


Figure 3: Termination DeviceNet Network

Please ensure that termination resistors with 120  $\Omega$  are available at both ends of the cable.

Further devices can be connected via T-stubs to the bus cable. The maximum length of all T-stubs is 6 m. The whole length of the bus cable and all T-stubs must not exceed the maximum length listed in the following table. There are two different types of cables (thick a thin). If both cables types are used within the same network, the maximum length is:

| Max. distance  | Baud rate in kBits/s |
|--|----------------------|
| $L_{\text{thick}} + 5 \times L_{\text{thin}} \leq 500 \text{ m}$   | at 125 kBaud         |
| $L_{\text{thick}} + 2,5 \times L_{\text{thin}} \leq 250 \text{ m}$ | at 250 kBaud         |
| $L_{\text{thick}} + L_{\text{thin}} \leq 100 \text{ m}$            | at 500 kBaud         |

Table 9: DeviceNet Segment Length in dependence of the Baud rate

## 2.4 AS-Interface Interface

Every cable can be used, shielded or non-shielded which meets the following characteristics (at  $f = 167 \text{ kHz}$ ):

| Parameter                       | Value                           |
|---------------------------------|---------------------------------|
| Resistance                      | $< 90 \text{ m}\Omega/\text{m}$ |
| Capacity per units length       | $< 80 \text{ pF/m}$             |
| Impedance                       | $105 \Omega \pm 35 \Omega$      |
| Inductance                      | $400 \dots 1300 \text{ nH/m}$   |
| Recommended cable cross section | $2 \times 1,5 \text{ mm}^2$     |

Table 10: Properties Cable AS-Interface

Also possible: AS-Interface standard cable according to IEC 60352-6.

The total length of the AS-Interface line shall not exceed 100 meters. This length shall be calculated inclusive the sum of all trunk lines. Termination resistors are not needed.

The total length can be increased by repeaters.

The AS-Interface topology is a tree structure. Per channel up to 31 AS-Interfaces Slaves with any profile within the lower address range can be connected. By use of Slaves with the profile x.A.y an address doubling can be achieved. The maximally possible number of 62 Slaves per channel is reached exclusively by the use of Slaves with profile x.A.y.

The recommended voltage is in range of 29.6 V to 31.6 V. The voltage drop along the AS-Interface line between power supply and any point of the network shall not exceed 3 V.



**Note:** It is strongly recommended to use a specific AS-Interface power supply in order to provide the necessary decoupling of data signals and DC power within the system.

The AS-Interface power supply can be connected at any point of the network. There shall be no connection to ground in the network apart from the port ground at the power supply.

Each channel needs its own power supply. These may not be connected with each other.

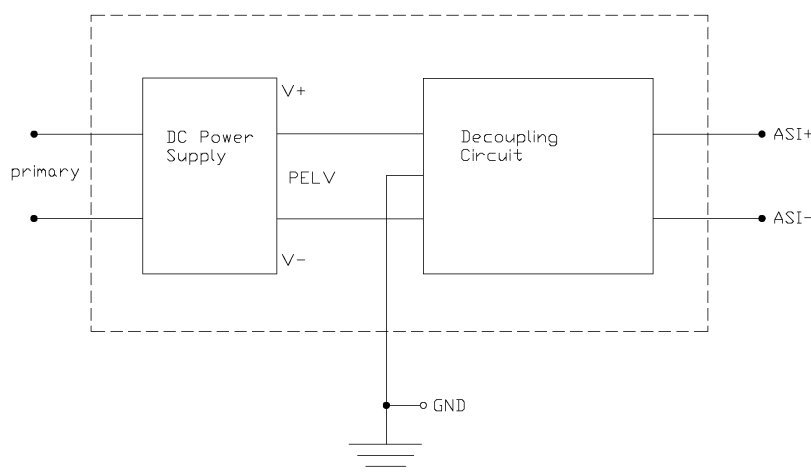


Figure 4: AS-Interface Interface Power Supply

## 2.5 CompoNet Interface

The CompoNet-Interface has been designed as interface according to the CompoNet specification *The CIP Networks Library Volume 6: CompoNet Adaptation of CIP, Chapter 8: Physical Layer*.

Up to 32 CompoNet devices can be connected to one bus segment. If several bus segments are linked to each other with repeaters, there can be up to 384 devices on the network.

At the highest CompoNet baud rate of 4.000 kBit/s no branch lines at all are allowed in the network topology.

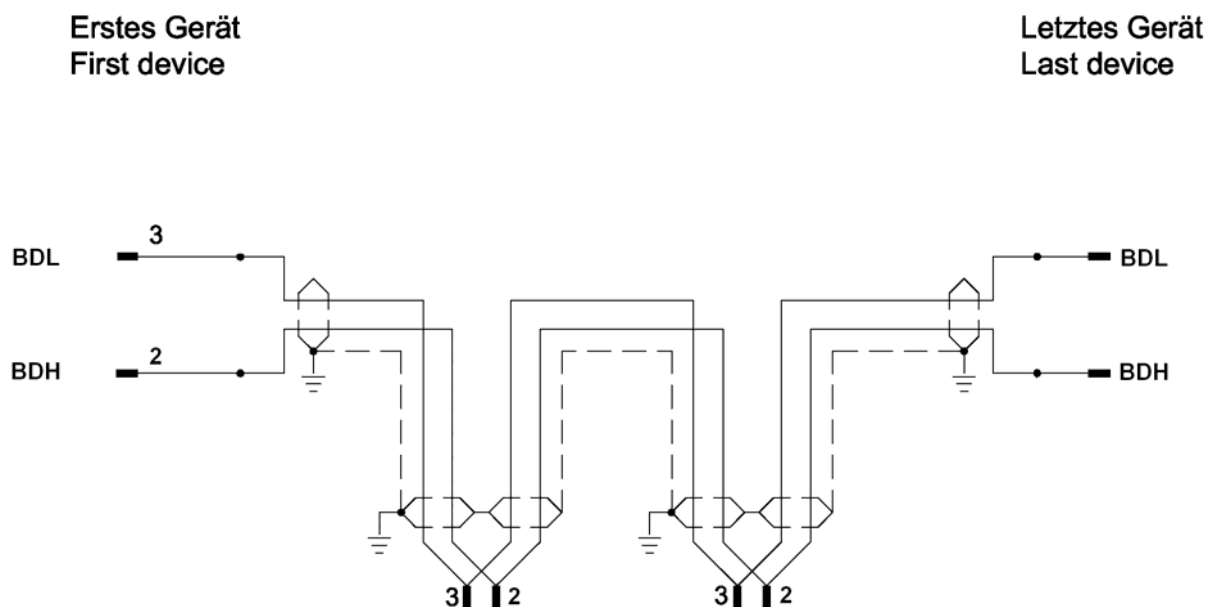


Figure 5: CompoNet Network

The maximum allowed lengths of trunk and branch lines depend from the used baud rate according to the following table:

| Baudrate in kBit/s | Max. length of trunk line<br>*without branch lines( | Max. length of a single branch line | Max. length of all branch lines altogether |
|--------------------|---|-------------------------------------|--|
| 93,75              | 500 m   | 6 m                                 | 120 m                                      |
| 1.500              | 100 m (30 m)  | 2,5 m                               | 25 m                                       |
| 3.000              | 30 m  | 0,5 m                               | 8 m  |
| 4.000              | 30m   | 0 m                                 | 0 m  |

Table 11: Maximum Segment Lengths depending on the Baud Rate for CompoNet



**Note:** At 1.500 kBit/s have the following in mind:

If no branch lines are used, the trunk line may be 100 m long. If there are any branch lines, then the length of the trunk line is limited to 30 m.

Only use special cable which is approved for CompoNet.

There are four types of such cables available:

- Round cable of type 1 (1 twisted pair of wires)
- Round cable of type 2 (4 twisted wires)
- Flat cable of type 1 (4 parallel wires)
- Flat cable of type 2 (4 parallel wires)

The data lines of these cable types must match the following specifications

The following specifications apply to the data lines of these cable types:

| Parameter                 | Round cable of type 1        | Round cable of type 2      | Flat cable of type 1       | Flat cable of type 2       |
|---------------------------|------------------------------|----------------------------|----------------------------|----------------------------|
| Impedance                 | $97 \Omega \pm 14,55 \Omega$ | $117 \Omega \pm 15 \Omega$ | $120 \Omega \pm 12 \Omega$ | $114 \Omega \pm 18 \Omega$ |
| Capacity per units length | $< 100 \text{ pF/m}$         | $< 73 \text{ pF/m}$        | $< 54,4 \text{ pF/m}$      | $< 89 \text{ pF/m}$        |
| Loop resistance           | $< 25.1 \Omega/\text{km}$    | $< 25.1 \Omega/\text{km}$  | $< 37.5 \Omega/\text{km}$  | $< 37.5 \Omega/\text{km}$  |
| Wire gauge                |                              |                            | 20*0,18 mm                 | 20*0,18 mm                 |
| Wire cross section        | $0.75\text{mm}^2 \pm 10\%$   | $0.75\text{mm}^2 \pm 10\%$ | $0.5\text{mm}^2 \pm 10\%$  | $0.5\text{mm}^2 \pm 10\%$  |

Table 12: Properties for CompoNet allowed Cables.

All cable types besides the round cable of type 1 provide integrated lines for supply voltage. These must match the following specifications:

| Parameter          | Round cable of type 2     | Flat cable of type 1      | Flat cable of type 2      |
|--------------------|---------------------------|---------------------------|---------------------------|
| Loop resistance    | $< 25.1 \Omega/\text{km}$ | $< 25.1 \Omega/\text{km}$ | $< 25.1 \Omega/\text{km}$ |
| Wire gauge         |                           | 30*0,18 mm                | 30*0,18 mm                |
| Wire cross section | $0.75\text{mm}^2$         | $0.75\text{mm}^2$         | $0.75\text{mm}^2$         |

Table 13: Specifications for lines for Supply Voltage (except of round Cable of Type 1)



**Note:** Assure, that on both ends of the trunk line and at the ends of eventual branch lines there are terminating resistors of  $121 \Omega \pm 1\%$  (1/4 W).

Master-devices already come along with integrated terminating resistors.

## 2.6 CC-Link Interface

Use only a special cable which is approved for CC-Link. CC-Link specifies several shielded three-core Twisted Pair cables. It is recommended to use only one type of cable for an installation. Please ensure that termination resistors are available at both ends of the cable. The value of the termination resistor depends on the used type of cable and can be 100  $\Omega$ , 110  $\Omega$  and respectively 130  $\Omega$ .

The following illustration displays the basic network structure.

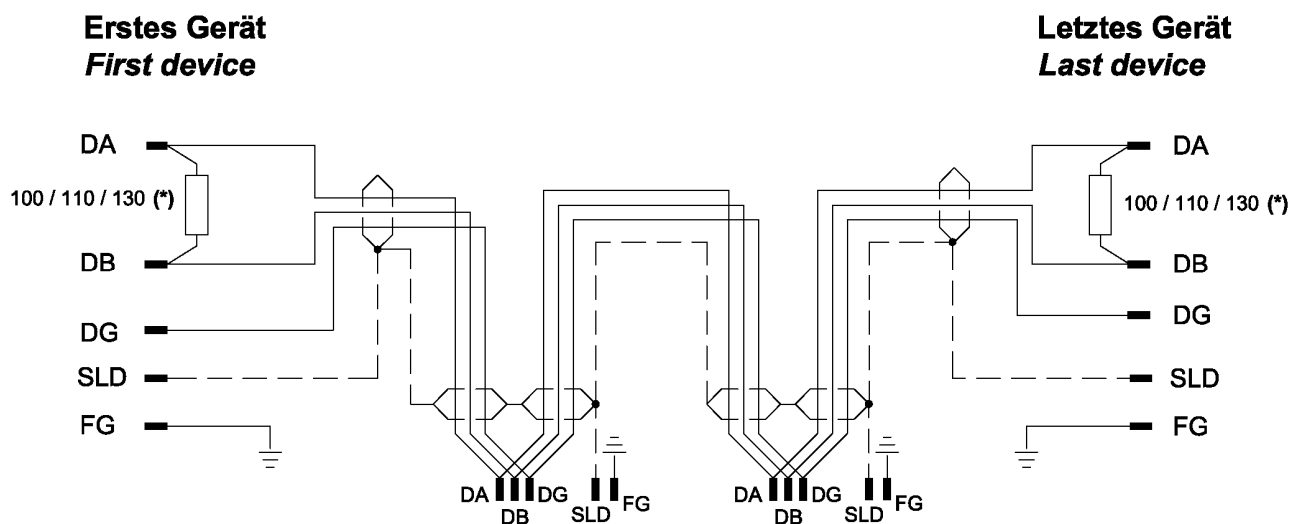


Figure 6: CC-Link Network

(\*) The termination resistor depends on the used cable type(see CC-Link Cable Wiring Manual).

The maximum length of one bus segment depends on the used baud rate. The structure of the network can be built up without or with branches. The details listed here are taken from the "CC link Cable Wiring manual" from July 2004. Also further details are contained there. The document is ready for download on [www.cc-link.org](http://www.cc-link.org).



**Note:** For CC-Link V2.00 the cable specification V1.10 has not been changed.

Depending on the baud rate with the different cable types, the following cable lengths are possible:

### Only trunk line, without branches:

| Baud rate | max. Length cable V1.00 | max. Length cable V1.10 and cable V1.00 with high performance | max. length high flexible V1.10 (Type 50%) |
|-----------|-------------------------|---|--|
| 156 kbps  | 1200 m                  | 1200 m  | 600 m                                      |
| 625 kbps  | 600 m                   | 900 m   | 450 m                                      |
| 2,5 Mbps  | 200 m                   | 400 m   | 200 m                                      |
| 5 Mbps    | 150 m                   | 160 m   | 80 m                                       |
| 10 Mbps   | 100 m                   | 100 m   | 50 m                                       |

Table 14: Maximum length



**Note:** Further cable types are available with which however lower maximum lengths can be reached.

#### **Trunk line with branch lines:**

Further devices can be connected via T-branches to the bus cable, only with the baud rates 156 kbps and 625 kbps. The maximum length of all T-stubs is 8 m. The whole length of the bus cable and all T-branches does not exceed the maximum length listed in the following table.

| baud rate                             | 156 kbps | 625 kbps |
|---------------------------------------|----------|----------|
| max. length trunk line                | 500 m    | 100 m    |
| max. number of devices in branch line | 6        | 6        |
| max. cable length of branch line      | 8 m      | 8 m      |
| max. length of all branch lines       | 200 m    | 50 m     |

Table 15: Maximum length

#### **Minimum Distance:**

Between two devices a minimum distance is to be kept.

| Distance between CC-Link devices                       | CC-Link cable V1.00 | CC-Link cable V1.10 |
|--|---------------------|---------------------|
| Remote device to next remote device                    | 0.3 m or more       | 0.2 m or more       |
| Remote device to next Master and/or intelligent device | 1 m or more         | 0.2 m or more       |

Table 16: Minimum distance between two devices



## 3 Appendix

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