Type büS
Bürkert System Bus

Design Guideline
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1 SYMBOLS USED

- Trunk line
- Stub line
- Y-connector
- Y-connector with interrupt
- Termination resistor
- Power supply
- Measurement point
- Diagnostics
2 INTRODUCTION

2.1 Preface
The aim of this Design Guideline is to provide you with practical information on how to plan your automation plant using Bürkert devices based on the Bürkert system bus (büS). The various aspects involved in the planning, assembly and operation processes are all considered. The structure of the Design Guideline helps you build knowledge and apply it through different steps based on examples.

2.2 What is the Bürkert system bus (büS/EDIP)?
The Bürkert system bus, also referred to as büS, is based on the widely spread CANopen standard and is fully downwards compatible to this standard. The büS concept does not require a master. Field devices can easily interchange process data and detailed diagnostic data. A gateway allows access to this information from a higher-level system. The Bürkert digital device platform EDIP (Efficient Device Integration Platform) opens the door to endless possibilities for a digital future.

2.3 For whom is this Design Guideline intended?
The Design Guideline is intended for engineers or plant builders who are familiar with the planning and engineering of automation plants containing fieldbuses, especially CAN-based protocols like CANopen and DeviceNet. The Design Guideline summarises the additional knowledge required to plan büS/EDIP networks. The most important steps for planning, creating and commissioning büS devices are outlined herein.

2.4 What is the purpose of the Design Guideline?
The Design Guideline aids the planning of a büS/EDIP system. In a comprehensive approach based on illustrative and practical examples, the Design Guideline walks you through the Do’s & Don’ts to ensure a fully functional system.
This Design Guideline explains in detailed individual steps how to plan a büS network.

2.5 Bürkert quality standard
All devices with a büS/EDIP interface have to obtain an internal certification which consists of a software and hardware measurement. Therefore, we can ensure that all Bürkert devices have attained the same quality standard. Currently, there are two approved CAN transceivers that meet these requirements.
3 CREATING A ROUGH PROJECT PLAN

3.1 Block diagram, devices, position, protocols

Which devices are planned?
Create an overview of the positioning of your devices.
Are the devices distributed in an equidistant or a non-equidistant manner?

![Diagram of project plan]

Fig. 1: Project plan
4 GETTING TO KNOW THE BASICS OF A büS INFRASTRUCTURE – ACCESSORIES, CABLES, PIN ASSIGNMENT

4.1 What is the purpose of the various accessories

In this chapter, the various components required for cabling are explained in detail. büS devices are widely equipped with standard M12 connectors and different accessories are available for a range of cabling tasks.

4.2 Accessories

4.2.1 Y-connector

Definition: A Y-connector has three M12 connectors in total. On one side of the connector, there is one male and one female connector. On the other side, there is one female connector.

Purpose: Since most büS devices have a single M12 büS connector, the Y-connector enables another connection option to the next device. The single connector side is connected to the device and the other two connectors may be used for the devices to the left and the right.

A Y-connector with interrupt is also available. This connector is used for segmenting power. The pin 2 connection is interrupted. It is therefore possible to use a new power supply for the next büS segment if the limit of 100 W has been reached.
4.2.2 Passive junction box

**Definition:** A passive junction box is an IP65/IP67 block with connectors for the power supply and multiple büS connectors. It is a passive module and, therefore, does not have to be configured.

**Purpose:** The passive junction box allows multiple connections to büS devices in a star form. The Y-connectors on each device become redundant when using a passive junction box, thus making cabling in the field much simpler.

![Passive junction box](image)

*Fig. 4: Passive junction box*

4.2.3 Gender changer

**Definition:** A gender changer is an IP65/67 component with two male M12 connectors.

**Purpose:** It is used to connect two female M12 connectors.

![Gender changer](image)

*Fig. 5: Gender changer*
4.2.4 Termination

**Definition:** A termination resistor is available as an M12 connector (female and male) or as a chip and has to be used twice in one network.

**Purpose:** To avoid signal reflections in the cable, the büS network always needs to be terminated with two 120 Ω resistors at the ends of the cable. One is required at the beginning of the network and one at the end.

![Termination](image)

**Fig. 6: Termination**

![Termination resistor chip](image)

**Fig. 7: Termination resistor chip**

4.3 Cable configuration

There are two types of cable: connecting cables and extension cables. All cables are available with different cable lengths. An overview can be found in the appendix.

4.3.1 Characteristic impedance and cables standards

All nodes are connected to each other through a physically conventional two-wire bus. The wires are a twisted pair with a 120 Ω (nominal) characteristic impedance. CiA 301 (CANopen application layer) is standardised as EN 50325-4.

4.3.2 Connecting cables

**Definition:** Connecting cables are equipped with a female M12 connector on one side and with open leads on the other.

**Purpose:** These cables connect a device with a terminal block to an M12 connector, e.g. gateway Type ME43.

4.3.3 Extension cables

**Definition:** Extension cables are equipped with a female M12 connector on one side and with a male M12 connector on the other.

**Purpose:** These cables are used to connect a device with an M12 connector.
4.4 Pin assignment

Various standard connectors are available for Bürkert devices with a büS interface.

4.4.1 M12 connector male, 5-pin (A-coded)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SHIELD</td>
</tr>
<tr>
<td>2</td>
<td>V+</td>
</tr>
<tr>
<td>3</td>
<td>DGND</td>
</tr>
<tr>
<td>4</td>
<td>CAN_H</td>
</tr>
<tr>
<td>5</td>
<td>CAN_L</td>
</tr>
</tbody>
</table>

Tab. 1: M12 connector male, 5-pin (A-coded)

4.4.2 M12 connector male, 8-pin (A-coded)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V+</td>
</tr>
<tr>
<td>2</td>
<td>DGND</td>
</tr>
<tr>
<td>3</td>
<td>CAN_L</td>
</tr>
<tr>
<td>4</td>
<td>CAN_H</td>
</tr>
<tr>
<td>5</td>
<td>Device specific</td>
</tr>
<tr>
<td>6</td>
<td>Device specific</td>
</tr>
<tr>
<td>7</td>
<td>Device specific</td>
</tr>
<tr>
<td>8</td>
<td>Device specific</td>
</tr>
</tbody>
</table>

Tab. 2: M12 connector male, 8-pin (A-coded)

4.4.3 Terminal block, 5-pin

<table>
<thead>
<tr>
<th>Pin (colour)</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>24V DC</td>
<td>Red</td>
</tr>
<tr>
<td>CAN_H (büS-connection)</td>
<td>White</td>
</tr>
<tr>
<td>SHIELD</td>
<td>Green</td>
</tr>
<tr>
<td>CAN_L (büS-connection)</td>
<td>Blue</td>
</tr>
<tr>
<td>GND</td>
<td>Black</td>
</tr>
</tbody>
</table>

Tab. 3: Terminal block, 5-pin
### 4.4.4 Terminal block, 4-pin

<table>
<thead>
<tr>
<th>Terminal block, 4-pin</th>
<th>Pin</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DGND</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CAN_L</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CAN_H</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>+24 V DC</td>
<td></td>
</tr>
</tbody>
</table>

*Tab. 4: Terminal block, 4-pin*
5  GETTING TO KNOW THE BÜS TOPOLOGIES

5.1  What is a bus topology and why do you need it?
The arrangement of different devices on the bus defines the topology. Different topologies influence the
quality of communication and certain topologies are, therefore, recommended to achieve a good network
design.

5.2  Common terms of bus topology

5.2.1  Trunk line
A trunk line is the main part of a CANopen cabling solution. All devices and junction boxes are connected to
it.

5.2.2  Stub line
A stub line is a branch of the trunk line and allows connection to a device that is not located close to the
trunk line. The use of stub lines must be avoided as much as possible. However, there are several limita-
tions depending on the baud rate of the network.

5.2.3  Overview of cable lengths
Overview of maximum cable lengths in the CANopen specification:

<table>
<thead>
<tr>
<th>Baud rate</th>
<th>max. trunk length</th>
<th>max. stub line length</th>
<th>max. length all stubs</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kbit/s</td>
<td>1000 m</td>
<td>50 m</td>
<td>250 m</td>
</tr>
<tr>
<td>125 kbit/s</td>
<td>500 m</td>
<td>20 m</td>
<td>100 m</td>
</tr>
<tr>
<td>250 kbit/s</td>
<td>250 m</td>
<td>10 m</td>
<td>50 m</td>
</tr>
<tr>
<td>500 kbit/s</td>
<td>100 m</td>
<td>5 m</td>
<td>25 m</td>
</tr>
<tr>
<td>1 Mbit/s</td>
<td>20 m</td>
<td>1 m</td>
<td>5 m</td>
</tr>
</tbody>
</table>

Tab. 5: Cable lengths
This table shows an overview of theoretical values for an ideal network. Nevertheless, there are more de-
pendencies regarding the trunk line length, the stub line length, the amount of process data and the baud
rate.

5.2.4  Example

![Diagram of a bus topology example](image)
5.3 Which topologies are recommended?
The following topologies achieve the best results with regard to signal quality.

5.3.1 Line topology (daisy chain)
All devices are connected in single row without a stub line.

![Line topology diagram]

Fig. 9: Line topology

5.3.2 Line topology with stub lines
The trunk line of the network is connected directly to the next device. If this is not possible, use a stub line. Avoid stub lines as much as possible and keep them short. Please note the maximum stub line length that depends on the baud rate.

![Line topology with stub lines diagram]

Fig. 10: Line topology with stub lines
### 5.3.3 Star topology

A star topology is used to interconnect devices when space is limited and a setup with a daisy chain topology is not possible.

![Star topology diagram](image)

**Fig. 11: Star topology**

### 5.4 Which topologies are NOT recommended?

The topologies in this chapter are possible, but various criteria have to be observed to ensure the network works properly.

#### 5.4.1 Tree topology

For signal quality, it is not recommended to use a tree topology. Cascading of the passive junction boxes is restricted to three. If more devices are needed, it is necessary to interconnect the trunk lines of the passive junction boxes and to not cascade more than three devices. Otherwise, the maximum stub line length is exceeded and errors may occur.

![Tree topology diagram](image)

**Fig. 12: Tree topology**
5.5 Which topologies are NOT permitted
The topologies described in this section are not permitted. Never use them in a büS or CANopen network.

5.5.1 Ring topology
A ring topology is not permitted in a CANopen network. Choose another topology for the network.

Fig. 13: Ring topology
6 DETAILED PROJECT PLAN 1

6.1 Floor plan
Create a detailed project plan using the aforesaid information about devices, cables lengths, topology, junction boxes and Y-connectors.

Are the devices close to each other?
YES: plan the network with a passive junction box
NO: plan the network with Y-connectors

Rules:
• Connect all the accessories on the trunk line
• Connect the accessories directly to the device
  – Use stub lines to connect the devices
  – Avoid long stub line lengths

6.1.1 Network with a junction box
In a network with one passive junction box, all the cables will be viewed as stub lines since there is no trunk line. Keep the stub lines as short as possible.

![Network with a junction box](image)

Fig. 14: Network with a junction box

6.1.2 Network with Y-connectors
A network with Y-connectors without stub lines (directly connected to the M12 connector of the device)

![Network with Y-connectors without stub lines](image)

Fig. 15: Network with Y-connectors without stub lines
Network with Y-connectors and stub lines

Fig. 16: Network with Y-connectors and stub lines

6.1.3 Mixed network
In a mixed network, it is important to indicate the total length of the cables. This includes the length of all trunk lines and stub lines.

Fig. 17: Mixed network
7  TECHNICAL KNOW-HOW

7.1  Termination resistors
Termination resistors are located on each side of the trunk line. The impedance is approximately 60 Ω between CAN-HIGH and CAN-LOW.

Exception: In a large network with long stub lines, the longest distance between two devices should be estimated. It is also recommended to choose the longest distance in a network that consists of more than one passive junction box.

![Fig. 18: Termination resistors](image)

7.2  Connection for diagnostics
We recommend providing a free connection for diagnostics. A port of the junction box or an extra Y-connector in the network can be used. This access is important for fast diagnostics with büS stick and the Bürkert Communicator software.

Furthermore, it can be used for measurements with external tools, e.g. GEMAC CANBUS Tester 2. In this case, a measurement connection at both ends is recommended.
8 DETAILED PROJECT PLAN 2

8.1 Completion – floor plan
A cabling plan using the accessories, cables lengths, topology, junction box, Y-connector, termination resistor and a diagnostics port must be created.

8.1.1 Network with a junction box

![Network with a junction box diagram]

In a network with a passive junction box, the termination resistors are connected to the devices with the longest distance to each other.

8.1.2 Network with Y-connectors

![Network with Y-connectors diagram]

Network without stub lines. The Y-connector is connected directly to the device.
8.1.3 Mixed network

Fig. 21: Mixed network

For good signal quality, it is important to determine the longest distance between two devices in the entire network. Place the termination resistors close to these devices. This helps to reduce the signal reflections. Please do not exceed the maximum stub line length.
9 NETWORK POWER SUPPLY

9.1 Power segments
Calculate the overall power consumption of all the devices in the network. Build power segments with a maximum load of 100 W. This refers to the M12 connector (A-coded). This component has a current limit of approx. 4 A.

9.1.1 One power segment
In a network with one power supply, overall power consumption is limited to 100 W.

![Diagram of one power segment]

Fig. 22: One power segment

9.1.2 Additional power supply
For higher power consumption, use additional power supplies and Y-connectors with interrupt to utilise power from a second power supply.

![Diagram of additional power supply]

Fig. 23: Additional power supply

9.2 Rule of thumb
The rule of thumb is that 1 W load per metre results in a voltage drop of 1 mV. A maximum voltage drop of 5 V is allowed. Some devices will shut down if the supply voltage is lower than 19 V. Therefore, refer to the respective data sheet for more information.
10 DETAILED PROJECT PLAN 3

10.1 Cabling plan
Rough cabling plan, topology, rules of cabling (table).
Place your power supply (power < 100W) close to the load.
Y-connector, passive junction box, external power supply, galvanically isolated switched-mode power supplies (recognised UL Class 2).

10.1.1 Network with junction box

![Diagram of network with junction box](image)

Fig. 24: Network with junction box

10.1.2 Network with Y-connectors

![Diagram of network with Y-connectors](image)

Fig. 25: Network with Y-connectors
10.1.3 Mixed network

Fig. 26: Mixed network
11  büS NETWORK SHIELDING

11.1 Shielding of EDIP devices

Detailed shielding information for each device can be found in pin assignment of technical data sheet and operating instructions. There are three types of device-internal shieldings:

<table>
<thead>
<tr>
<th>Direct: Direct connection of shield to FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>büS cable shield</td>
</tr>
<tr>
<td>Functional earth (FE)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RC: Parallel connection of resistor and capacitor to FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>büS cable shield</td>
</tr>
<tr>
<td>Functional earth (FE)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>None: No shield connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>büS cable shield</td>
</tr>
<tr>
<td>Shield end is floating!</td>
</tr>
<tr>
<td>Device has no functional earth (FE) to connect!</td>
</tr>
</tbody>
</table>

Tab. 6: büS network shielding

11.2 Comparison of shieldings

<table>
<thead>
<tr>
<th>Shielding</th>
<th>Reasons for/when using</th>
<th>Restrictions for installation or disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIRECT</td>
<td>• Best shielding effect</td>
<td>Equipotential FE grounding system in plant is mandatory.</td>
</tr>
<tr>
<td></td>
<td>• Metal housing (e.g. stainless steel for “clean design”)</td>
<td></td>
</tr>
<tr>
<td>Connection of shield to FE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>• Second best shielding effect</td>
<td>Shielding effect may not be sufficient in very rough H-field emitting environments.</td>
</tr>
<tr>
<td></td>
<td>• Also practicable when FE quality is poor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Recommended shielding for safety applications to prevent compensation currents</td>
<td></td>
</tr>
<tr>
<td>NONE</td>
<td>No FE on device available (e.g. due to customer requirement)</td>
<td>To have any shielding effect, cable shield must always led near by device with no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>significant stiches (stubs). The shielding is carried out on subsequent or adjacent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>devices.</td>
</tr>
</tbody>
</table>

Tab. 7: Comparison
11.3 Network with direct shielded devices

Shield is grounded at multiple points to FE. Direct shield connection on both cable ends or at multiple devices to FE has shielding effects against E and H fields. But take care for equipotential FE grounding area to prevent compensation currents over shield!

If equipotential FE area is not feasible, e.g. between two buildings, there are some measures to improve; e.g. add bypass conductor or a grounded cable duct nearby büS cable.

Explanation of graphic elements:

- Each device-internal shielding (None, Direct, RC) is said in brackets.
- Green line represents büS cable shield.
11.4 Network with RC shielded devices

In a network with RC shielded devices, shield must be only on one point directly connected to FE. This shielding set-up only shields E-Fields, but it is usually preferred, when FE area connection is poor.

- Either by using one direct shielded device.

![Diagram of network with RC shielded devices](image)

*Fig. 29: RC shielded*

- Or by grounding the cable shield directly anywhere in network, e.g. in the middle or near a source of EMC disturbance for immediate derivation.

In general, a distance between H-Field emitting machines and büS network is recommended. If not possible, use grounded metal duct for additional shielding the büS cable in whole.

![Diagram of network with grounded metal duct](image)

*Fig. 30: RC shielded*
11.5 Network with none shield connected devices

Not recommended to have “None” shield connected devices only. Network shield would be floating at all and this is equal to unshielded.

When using devices without an internally connected shield, take care that one end of büS shield must be connected directly to FE. Either a direct or RC shield connection can be used at the other shield end. The devices of the shielding type “None” are located in between with minimal stitches (e.g. with T-piece).

- For this, use either devices at the ends of network.

**Fig. 31: büS network with devices without internal shield connection (shielding “None”)**
- Or connect cable shield directly to FE on both ends (example).

**Fig. 32: büS network with devices without internal shield connection (shielding “None”)**
11.6 Mixed network with various shieldings

A planned büS network (a) is revised, some issues were identified (b) and finally some solutions are found (c).

a) Initial network

![Initial network diagram]

Identified issues:
- FE with potential differences between building A and B
- FE with potential differences between building A and outside
- Long büS line with open shield to device 7 with no shield connection.

b) Problem identification

![Problem identification diagram]
c) Modifications (possible solutions)

**Building A:** Equipotential, clean FE

- Gateway
- Device 1 (Direct)
- Device 2 (RC)
- Device 3 (Direct)
- Device 4 (Direct)
- Outside building A
  FE medium quality

**Building B:** Equipotential, clean FE

- Device 5 (Direct)
- Device 6 (Direct)
- Device 7 (None)

**Applied solutions:**

1. Add both-end FE grounded and low-impedance metal duct or bypass conductor between building A and B.
2. Add both-end FE grounded and low-impedance metal duct or bypass conductor, led as near as possible to device 4.
3. Reduce unshielded cable length, by changing trunk line: Shield is led directly past device 7 (e.g. with T-piece) and grounded at device 6 afterwards.

*Fig. 35: Examples of possible modifications*
12 BEST PRACTICE INSTRUCTIONS

12.1 Termination resistor
Termination resistors are located on each side of the trunk line. Each resistor has a resistance of approx. 120 Ω. Therefore, a network with a termination resistor at both ends has an impedance of 60 Ω. Resistors are available as a male or female M12 connector. Additionally, a chip resistor for ME43 and valve island Type 8652 is available.

12.2 Signal reflections
There might be more than one reason for signal reflections in a network. This depends on the number of devices, the baud rate, the amount of process data, the position of the termination resistors and the position of the measurement port.
Massive signal reflections occur if the position of the termination resistors is not selected correctly.

12.3 Passive junction box
Passive junction boxes are used for the distribution of devices that are close to each other. In a network with a passive junction box, it is important to determine the longest distance between two devices and to place the termination resistor there. In this case, it is not recommended to place these resistors on the trunk line.

12.4 Diagnostic port
In a büS network, one diagnostic port should be placed in one plant. It is used for fast access with the Bürkert Communicator or also a third-party tool, e.g. GEMAC CAN Bus Tester 2.

12.5 Baud rate
The default baud rate of all Bürkert devices is 500 kbit/s. In the case of a poor measurement result, it is possible to reduce the baud rate to 250 kbit/s or 125 kbit/s. Therefore, longer cables can be used in the network.
Please note that the total time of a firmware update increases when the baud rate is reduced to a lower communication speed.

12.6 büS stick
The büS stick is a USB-to-CAN converter and is connected to a laptop/PC with the Bürkert Communicator. It is used for the diagnostics, start-up and parameterisation of devices.

12.7 Stub lines
The total length of stub lines in the entire network should be reduced as much as possible. It is impossible to calculate exactly the impact that a one metre stub line has on reducing the signal quality in percentage terms.

12.8 Bus load
The maximum bus load is 40%. The specific bus load of a device is specified in the communication data sheet. To calculate the total bus load, sum up the values from the communication data sheet for all devices.
12.9 Power consumption

It is important to consider the power consumption of a device as early as possible in the planning. Using the information about the total power consumption of the network, the accessories and the number of power supplies can be planned.

Furthermore, the permitted voltage ripple of a device must be considered. For devices with direct access, e.g. MFCs, it is important to have a low residual ripple. For sensors, the impact is not that significant.

12.10 Grounding power supplies

Power supplies should not be earthed, but it is important to ensure galvanic isolation. Otherwise, huge loops may develop that can have a negative impact on the entire network.

12.11 Shielding of büS network

Provide good, continuous functional earth (FE) with low impedance and noise. If this cannot be ensured in the area of the büS network, use a low-impedance metallic cable duct or bypass conductor grounded on both sides to prevent compensation currents over büS shield.

Connect devices of the internal shielding "None" directly to the büS strand (without stitch). The shielding must be on upstream or downstream devices in the network, but at least on end devices.

Connect at least one point of büS shield directly to FE (e.g. by using a device with direct FE connection to shield).

Keep a distance from H-Field emitting machines with high power consumption. If not possible, use metal duct grounded on both sides or multiple times for additional shielding of the büS cable.
13 büS NETWORKS WITH MAXIMUM NETWORK EXPANSION

Networks with varying devices, cable lengths, baud rates and topologies are tested.

The networks shown here should only serve as examples of what is possible and are intended as a reference point for your own setup. For large networks close to the limit or even above, it always makes sense to check the network quality.

13.1 Line topology

For the baud rates 500 kbit/s, 250 kbit/s and 125 kbit/s the maximum cable length and the maximum number of devices have been determined.

13.1.1 500 kbit/s

Communication of the entire büS network worked with up to 84 devices and 1 büS stick. The total cable length was 75 metres.

Measurements with a maximum cable length of 100 metres was possible with 44 devices and 1 büS stick. A length of 100 metres is defined as the limit in the CANopen specification.
13.1.2 250 kbit/s

The network was tested with 84 devices and a total cable length of 175 metres and worked without any errors.

Fig. 38: 250 kbit/s, 84 devices, cable length 175 m

The system setup consists of 41 büS devices and 1 büS stick with a total cable length of 250 metres, which is defined as the maximum.

Fig. 39: 250 kbit/s, 41 devices, cable length 250 m
13.1.3 125 kbit/s

The network can have a total cable length of 475 metres with 84 devices and 1 büS stick.

![Diagram of a network with 23, 21, 8, and 9 devices connected by 50 m, 100 m, and 50 m cables](image1)

*25 m additional cable length for wiring the devices

**Fig. 40: 125 kbit/s, 84 devices, cable length 475 m**

With 125 kbit/s, it is possible to connect up to 53 devices with a total cable length of 500 metres.

![Diagram of a network with 17, 15, 9, 3, 4, and 5 devices connected by 50 m, 100 m, 150 m, 75 m cables](image2)

*25 m additional cable length for wiring the devices

**Fig. 41: 125 kbit/s, 53 devices, cable length 500 m**
13.2 Star topology with a junction box

If a passive junction box is used, all the cables are stub lines. With a baud rate of 500 kbit/s, a total stub line length of 25 metres is permitted. The maximum length of each stub line is limited to 5 metres. If all the stub lines have the same length, the position of the termination resistor is irrelevant.

Fig. 42: Star topology with a junction box

13.3 Tree topology with a junction box

With a tree topology, a total cable length of 94 metres was measured with 23 devices in the network. The stub line length varies between 1 and 10 metres.

Fig. 43: Tree topology with a junction box
14 Troubleshooting

14.1 Sporadic disconnections

Description:
In a faulty network, it is possible to experience sporadic disconnections. Therefore, one or more devices may disappear for a few seconds. This is an indication that something has gone wrong.

Common problems:
- More or less than two termination resistors
- Total cable length is too long
- Total stub line length is too long
- Bus load is too high
- Undersized power supply

Solution:
- Measurement of the impedance between CAN-High and CAN-Low. The impedance should be approx. 60 Ω
- Reduce the cable length
- Reduce the baud rate to the next lower communication speed
- Create power segments in the network with more power supplies and Y-connectors

14.2 Red LED (failure)

Description:
The LED of a single device or the entire EDIP network lights up red.

Common problems:
- Incorrect connection to the PLC
- Device reached critical limit, e.g. power supply too low
- EDIP partner is missing

Solution:
- Check the cabling to the PLC and configure the PLC with the description files of the device
- Check the messages of the device with the PLC or Bürkert Communicator
- Check the partner name and mapping

14.3 Orange LED on the device (functional check)

Description:
The LED of a single device or the entire EDIP network lights up orange.
Common problems:
- Partner allocation is active
- PLC has “stopped”
- Simulation is active
- Manual mode

Solution:
- Wait until the device finds its partner in the network
- Set the PLC to “RUN”
- Deactivate simulation
- Set the device to “Automatic”

14.4 Yellow LED on the device (out of specification)

Description:
The LED of a single device or multiple devices in the network lights up yellow.

Common problems:
- Device has reached an internal limit, e.g. temperature
- Teach function is required
- Device cannot reach the setpoint

Solution:
- Check the limits and messages with the PLC or Bürkert Communicator
- Start the device teach function
- Check the medium pressure

14.5 Blue LED on the device (maintenance required)

Description:
The LED of a single device or multiple devices in the network lights up blue.

Common problems:
- Switching cycle counter limit has been reached
- Config-Provider/Client missing
- Damaged calibration curve

Solution:
- Reset the switching cycle counter
- Replace the missing device
- Recalibrate the device
14.6  Restarting some devices

If the LED first lights up yellow and then turns red or green, it is an indication that the power supply has reached a limit for stable operation. If one device switches an actor on, the voltage drop is so high that the power falls below the limit and a restart will be performed.
15 APPENDIX

15.1 Accessories - büS stick interface sets

<table>
<thead>
<tr>
<th>Accessories - büS stick interface sets</th>
<th>Bürkert order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB-büS interface set 1</td>
<td>00772426</td>
</tr>
<tr>
<td>USB-büS interface set 2</td>
<td>00772551</td>
</tr>
</tbody>
</table>

Tab. 8: büS stick

15.2 Accessories - connectors

<table>
<thead>
<tr>
<th>Accessories - connectors</th>
<th>Bürkert order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>büS connector, female, M12</td>
<td>00772416</td>
</tr>
<tr>
<td>büS connector, male, M12</td>
<td>00772417</td>
</tr>
<tr>
<td>büS connector, female angled, M12</td>
<td>00772418</td>
</tr>
<tr>
<td>büS connector, male angled, M12</td>
<td>00772419</td>
</tr>
<tr>
<td>büS Y-connector, M12</td>
<td>00772420</td>
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<tr>
<td>büS Y-connector, M12 with interrupt</td>
<td>00772421</td>
</tr>
<tr>
<td>büS gender changer</td>
<td>00772867</td>
</tr>
<tr>
<td>büS termination, male, M12</td>
<td>00772424</td>
</tr>
<tr>
<td>büS termination, female, M12</td>
<td>00772425</td>
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<tr>
<td>Terminal block 4 pin with termination</td>
<td>00566066</td>
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<tr>
<td>Termination chip resistor ME43</td>
<td>00303833</td>
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</table>

Tab. 9: Connectors

15.3 Accessories - cables (open leads)

<table>
<thead>
<tr>
<th>Accessories - cables (open leads)</th>
<th>Bürkert order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>büS connecting cable 0.7 m</td>
<td>00772626</td>
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<tr>
<td>büS connecting cable 1 m</td>
<td>00772409</td>
</tr>
<tr>
<td>büS connecting cable 3 m</td>
<td>00772410</td>
</tr>
<tr>
<td>büS connecting cable 5 m</td>
<td>00772411</td>
</tr>
<tr>
<td>büS connecting cable 10 m</td>
<td>00772412</td>
</tr>
<tr>
<td>büS connecting cable 50 m (cable drum)</td>
<td>00772413</td>
</tr>
<tr>
<td>büS connecting cable 100 m (cable drum)</td>
<td>00772414</td>
</tr>
<tr>
<td>büS service cable, micro-USB-to-M12</td>
<td>00773254</td>
</tr>
</tbody>
</table>

Tab. 10: Cables (open leads)
### 15.4 Accessories - extension cables

<table>
<thead>
<tr>
<th>Accessories - extension cables</th>
<th>Bürkert order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>büS extension cable 0.1 m</td>
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<tr>
<td>büS extension cable 0.2 m</td>
<td>00772402</td>
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<tr>
<td>büS extension cable 0.5 m</td>
<td>00772403</td>
</tr>
<tr>
<td>büS extension cable 1 m</td>
<td>00772404</td>
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<td>büS extension cable 3 m</td>
<td>00772405</td>
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<tr>
<td>büS extension cable 5 m</td>
<td>00772406</td>
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<tr>
<td>büS extension cable 10 m</td>
<td>00772407</td>
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<tr>
<td>büS extension cable 20 m</td>
<td>00772408</td>
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</tbody>
</table>

Tab. 11: Extension cables

### 15.5 Accessories - power supplies

<table>
<thead>
<tr>
<th>Accessories - power supplies</th>
<th>Bürkert order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply, 1A, NEC Class 2</td>
<td>00772361</td>
</tr>
<tr>
<td>Power supply, 2A, NEC Class 2</td>
<td>00772362</td>
</tr>
<tr>
<td>Power supply, 3.8A, NEC Class 2</td>
<td>00772898</td>
</tr>
<tr>
<td>Power supply, 10A</td>
<td>00772698</td>
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</tbody>
</table>

Tab. 12: Power supplies

### 15.6 Accessories - power cables

<table>
<thead>
<tr>
<th>Accessories - power cables (L-coded M12 plug to M12 socket, 4-pin)</th>
<th>Bürkert order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power cable, L-coded, 1 m</td>
<td>00775061</td>
</tr>
<tr>
<td>Power cable, L-coded, 3 m</td>
<td>00775063</td>
</tr>
<tr>
<td>Power cable, L-coded, 5 m</td>
<td>00775064</td>
</tr>
<tr>
<td>Power cable, L-coded, 10 m</td>
<td>00775065</td>
</tr>
</tbody>
</table>

Tab. 13: Power cables

Further accessories available on the Bürkert homepage.