# CANopen

## Hardware Setup Manual

05/2010

35010857.04

www.schneider-electric.com

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.



All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

# Table of Contents

# Safety Information

## Important Information

### NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

**⚠ DANGER**

**DANGER** indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

**⚠ WARNING**

**WARNING** indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

| ⚠ CAUTION |
| --- |
| **CAUTION** indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury. |

| CAUTION |
| --- |
| **CAUTION**, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage. |

**PLEASE NOTE**

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and the installation, and has received safety training to recognize and avoid the hazards involved.

# About the Book

## At a Glance

### Document Scope

This manual provides basic information on CANopen networks as used by Schneider Electric. It additionally describes the CANopen infrastructure components (connectors, cables, TAPs) provided by Schneider Electric for setting up a CANopen network.

### Validity Note

This documentation is valid for CANopen networks as used by Schneider Electric.

### Related Documents

| Title of Documentation | Reference Number |
|---|---|
| Electromagnetic Compatibility EMC, Practical Installation Guidelines | DEG999 |
| Machines & Installations with Industrial Communications Catalog (Part 4) | MKTED207012EN |

You can download these technical publications and other technical information from our website at www.schneider-electric.com.

### User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

# CANopen Introduction

1

## CANopen Principles

### CAN

The CAN (Controller Area Network) was originally developed for onboard automobile systems, and is now used in a wide range of areas, such as:

- transport,
- mobile equipment,
- medical equipment,
- construction,
- industrial control.

The strong points of the CAN system are:

- its bus allocation system,
- its error detection capability,
- the reliability of its data exchanges.

### CANopen

CANopen specifies the higher layer protocol and is based on CAN.

### Master/Slave Structure

The CANopen network has a master/slave bus management structure and consists of 1 master and 1 or more slaves.

The master performs the following functions:

- initialization of the slaves,
- supervision of the slaves,
- providing status information of the slaves.

### Media Access and Topology

The CAN protocol authorizes each node to start transmission of a packet when the bus is inactive. If 2 or more nodes start packet transmission at the same time, the access conflict on the bus is resolved by arbitration using the identifier included in the packet.

The sender with the highest priority identifier obtains access to the bus; the packets of other senders will be resent later on.

This arbitration uses a recessive and a dominant status on the bus, and is executed on transmission of each bit. Each sender tests the status of the bus during transmission of its bits; if a recessive bit is transmitted and the bus is in a dominant state, the sender loses place and transmission stops.

As a consequence of this, during transmission of each bit, a signal sent has the time to propagate until the farthest node, and returns to dominant state. This is why the bus has different length limitations according to the transmission rate.

### CANopen at Machine and Installation Level

According to the Schneider Electric network strategy, CANopen is mainly intended for the machine and installation level.

# CANopen Network Topologies

2

## Subject of This Chapter

This chapter describes the different types of topologies and connections possible on a CANopen bus.

## What's in this Chapter?

This chapter contains the following topics:

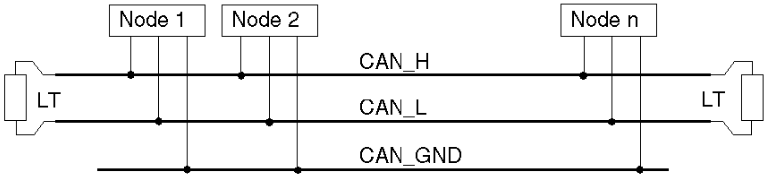
# General Architecture of a CANopen Network

### Overview

The CANopen network uses a twisted pair cable to transmit the differential signals, terminated at both physical ends with 120Ω resistors (LT in the figure below). A separate ground signal is used as a common reference for the CANopen nodes.

### Graphical Representation

The drawing below illustrates a general CANopen architecture:




Each Schneider Electric CANopen component allows interconnection of the following signals:

| **Designation** | **Description** |
|---|---|
| CAN_H | CAN_H (CAN High) bus conductor |
| CAN_L | CAN_L (CAN Low) bus conductor |
| CAN_GND | CAN bus ground |

**NOTE:** In addition to the 3 wires noted above, some Schneider Electric cables provide this feature with a fourth wire for remote power supply to devices.

# Basic Topology

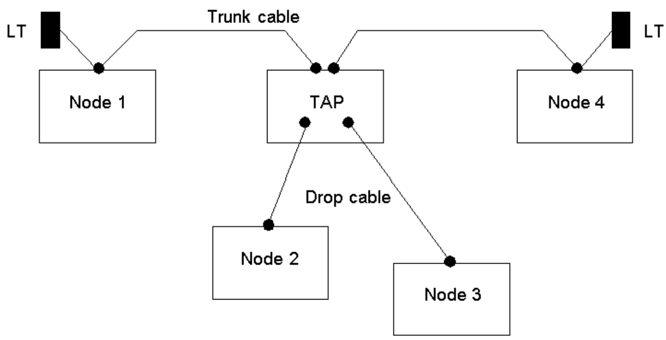
## General

The CANopen network consists of a transmission line that must be terminated at both physical ends with termination resistors.

A TAP in combination with drop cables form a partial star topology. In order to minimize reflections, keep drop cables as short as possible. The maximum length of drop cables depends on the transmission speed. For a list of the cable length allowed refer to the Maximum Cable Length table *(see page 28)*.

## Example of a Basic Topology

The diagram below provides an example of a basic topology:



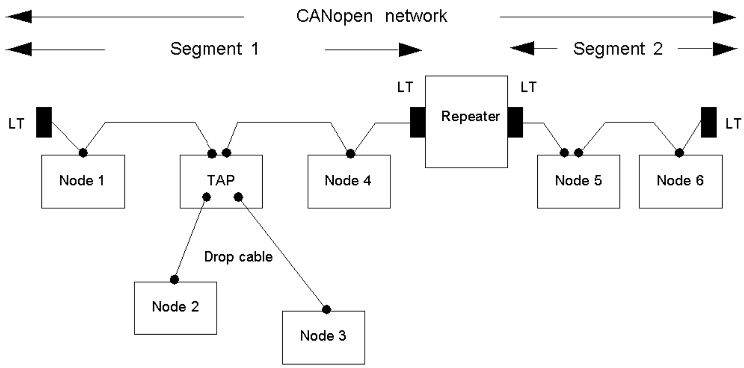
# Topology with a Repeater

### General

The CANopen network may be comprised of 1 or several segments, physically linked together via a CAN repeater.

### Example of a Topology with Repeater

The figure below provides an example of a topology including a repeater:




### Repeater Functions

A repeater:
- provides a refresh of the CAN signals, thus allowing more than 64 nodes.
- may provide isolation between the segment. Each of these segments must be terminated.
- is transparent, from the network point of view, because it simply forwards the CAN signals. This means that the devices connected to the bus participate in the same arbitration.
- does not allow to increase the total cable length. For the maximum cable lengths allowed refer to the Maximum Cable Length table *(see page 28)*.

## Chaining the Cable

The chaining of the cable from 1 node to the next is performed via the cable connectors in 2 different ways:

- by connecting 2 cables to the same cable connector. This widely used chaining technique allows to disconnect the cable connector from the device (i.e. device replacement) without disruption of the network.
- by connecting the 2 cables to individual cable connectors on devices that provide 2 cable connectors (node 5 in the above example). This chaining technique is used especially on high protection devices (i.e. IP67 devices) or for optimized cabling systems in the cabinet.

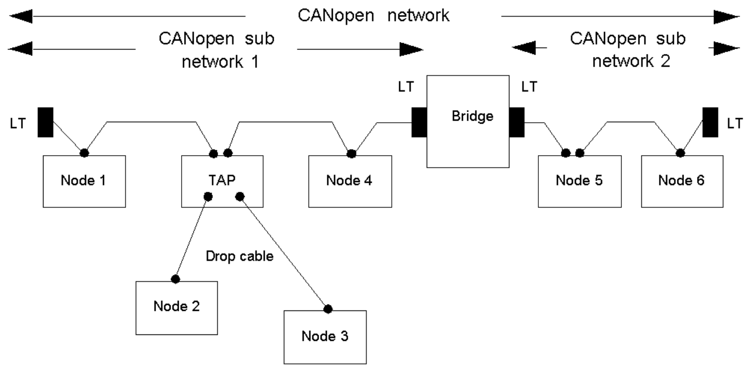
# Topology with a Bridge

## General

A CANopen overall network can be separated into more or less independent sub-networks via a CAN bridge.

## Example of a Topology with Bridge

The figure below provides an example of a topology including a bridge:




## Bridge Functions

A bridge:

- separates the overall CAN network into more or less independent sub-networks.
- provides an individual arbitration for each sub-network.
- provides the possibility for each sub-network to have its own transmission speed.
- is based on the store- and forward principle, i.e. CAN messages are received by a sub-network and are then forwarded to another sub-network.
- allows the use of translation and filter rules.
- allows a protocol adaptation to be carried out between the sub-networks.

In contrast to the CAN repeater, the CAN bridge allows to enlarge the maximum network size.

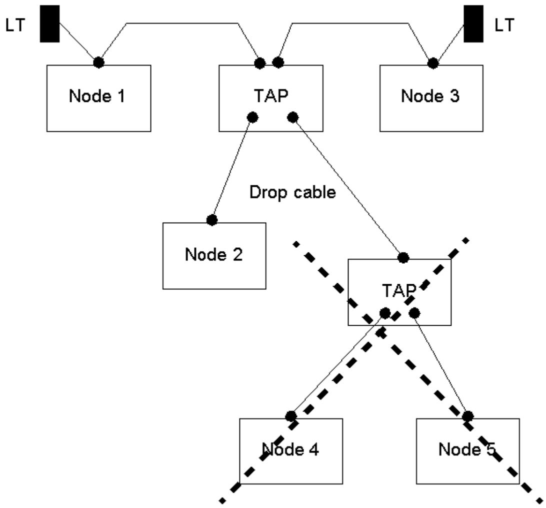
## Cascading of TAPs

### General

In CANopen networks cascading of TAPs is not allowed as this would harm the transmission line characteristic.

### Example of Cascaded TAPs

The figure below illustrates that cascaded TAPs are not allowed in CANopen networks:



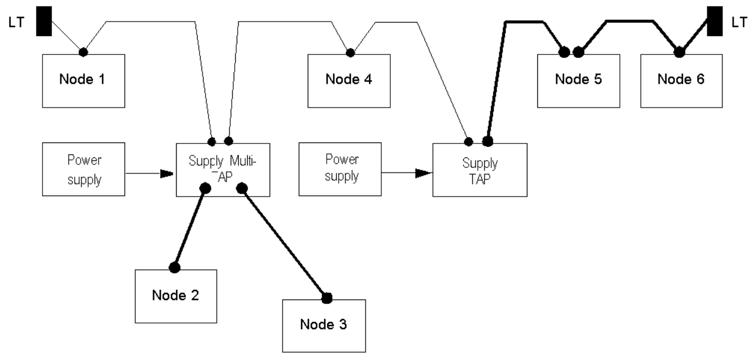
# Topology with External Power Supply

## General

To provide power to nodes of the CANopen network an external power supply can be connected to a TAP.

## Example of a Network with External Power Supply

The figure below provides an example of a topology with external power supplies:




## Supply TAPs

There are 2 types of power supply TAPs available:

| TAP Type | Function | Powered Nodes in the above Example |
|---|---|---|
| Supply Multi TAP | provides the power to the drop cables | 2 and 3 |
| Supply TAP | provides the power to the outgoing cable, thus providing power to the following nodes | 5 and 6 |

## Power Signals

Power is carried by the signals `CAN_V+` and `CAN_GND`. Since these signals are provided on standard CAN cables, no special cables are required for power supply.

### Forwarding Power through the Cable

In order to forward the power through the cable, it is required that the CAN_V+ signal is connected in the cable connector of each node, even if the respective node does not use the power itself but forwards it to a following node.

**NOTE:** Repeaters, bridges and RJ45 cables do not forward the CAN_V+ signal at all.

For more information on power distribution over the network see section Physical Layer Limitations *(see page 27)*.

# Network Design

# 3

## Subject of This Chapter

This chapter lists references to documents describing the rules of network design, it describes the relation between cable length and transmission speed, the limitations on drop cables as well as specifications applying to networks with external power supplies.

## What's in this Chapter?

This chapter contains the following sections:

# 3.1 Installation

## Overview

This section lists basic rules for CANopen networks as well as reference documents that must be considered during installation and includes precautions against EMC.

## What's in this Section?

This section contains the following topics:

# Principles

## Overview

Carefully document and record the network design with associated calculations because such documentation will be very useful when planning future changes. It will also help maintain bus performance.

## Principles of Network Design

Observe the following rules when designing the CANopen bus:
- assign each node a unique CANopen node address,
- make sure that the nodes in one network have the same transmission speed,
- verify the length of the drops and the density of these drops,
- verify that the segments have a termination resistor connected at each extremity.

In any case take the design of the network into consideration and follow the technical rules described in the following sections.

# Cable Installation

### Overview

The CANopen bus is designed for use inside buildings located in a workshop or factory environment. As for any other industrial buses you must nonetheless follow strict rules for installation to achieve full performance of the bus.

### Installation Rule References

Pay particular attention to the rules listed in the Electromagnetic Compatibility EMC, Practical Installation Guidelines *(see page 7)* document.

### Shielding and Grounding

To limit common mode disturbances and to achieve a high level of robustness against EMC, take the following precautions:

- Wire a common ground (`CAN_GND`) to the CANopen devices. Together with the electrical isolation this helps to ensure that the CANopen devices are on the same reference level.
- For devices without electrical isolation (consult the device's user manual to find out whether it is isolated) take other measures, like a separate equipotential bonding wire, to help to ensure the same reference level.

CANopen uses shielded twisted pair cables. On each device the shield is connected to functional ground. This is for example automatically achieved via the metal housing of the SUB-D 9 cable connector.

# CANopen In-Cabinet Cabling

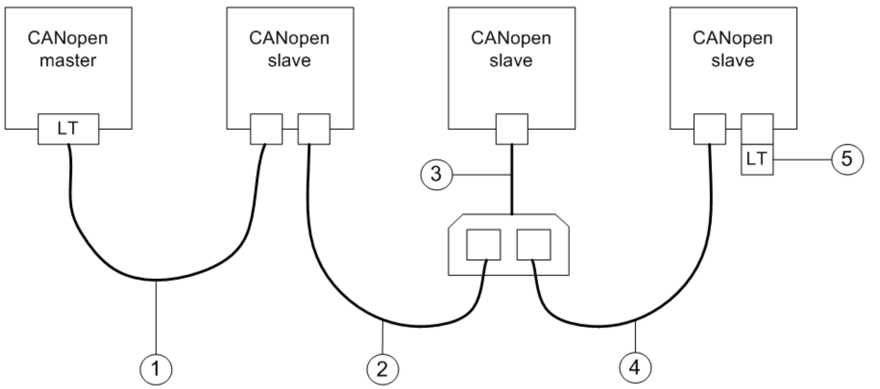
## General

Schneider Electric provides preassembled cord sets to ease the cabling of CANopen devices within a cabinet.

These cord sets, together with the daisy-chain connector, release customer from mounting connectors manually. The in-cabinet cabling is based on RJ45 connectors. If every CANopen device used in the cabinet is equipped with an RJ45 connector, the network topology is a simple daisy chain without TAPs.

## Example

The figure below provides an example of a CANopen cabling within a cabinet:




**1** VW3 M3 805R010
**2** VW3 CAN CARR03
**3** TCSCTN023F13M03
**4** VW3 CAN CARR01
**5** TCSCAR013M120

### Infrastructure Elements

The following infrastructure elements are provided for in-cabinet cabling:

| Catalog No. | Element Type | Connector Type | Cable Length |
|---|---|---|---|
| VW3 CAN CARR03 | preassembled cable | RJ45 at both ends | 0.3 m (0.98 ft) |
| VW3 CAN CARR01 | preassembled cable | RJ45 at both ends | 1.0 m (3.28 ft) |
| VW3 M3 805R010 | preassembled cable | 1 RJ45 and 1 SUB-D9 with termination resistor | 1.0 m (3.28 ft) |
| TCSCTN023F13M03 | daisy-chain connector | 1 RJ45 plug and 2 RJ45 sockets | – |
| TCSCAR013M120 | – | RJ45 termination resistor | – |
| TCS CCN 4F3 M05T | preassembled cable | 1 RJ45 and 1 SUB-D9 with termination resistor | 0.5 m (1.64 ft) |
| TCS CCN 4F3 M1T | preassembled cable | 1 RJ45 and 1 SUB-D9 | 1.0 m (3.28 ft) |
| TCS CCN 4F3 M3T | preassembled cable | 1 RJ45 and 1 SUB-D9 | 3.0 m (9.84 ft) |

### Limitations

If you use 1 of these infrastructure elements in the trunk line, the following restrictions apply:

- The maximum cable length is reduced by 50% compared to a standard CANopen cable (refer to table Maximum Cable Length *(see page 28)* and table Maximum Cable Length vs. Number of Nodes *(see page 29)*).
- Use this in-cabinet cabling infrastructure elements only inside 1 single cabinet. To spread the CANopen network over several different cabinets, use standard CANopen cable (TSXCANCA•••, TSXCANCB•••, TSXCANCD•••) for connecting the cabinets.
- RJ45 connectors do not provide CAN_V+ and thus do not provide power distribution.

# 3.2 Physical Layer Limitations

## Overview

This section lists the restrictions you must obey when setting up a CANopen network and includes a troubleshooting section to assist you in solving problems that may arise during installation.

## What's in this Section?

This section contains the following topics:

## Transmission Speed and Cable Length

### At a Glance

CANopen allows 127 devices (the bus master and 126 remote slaves). Transmission speed depends strictly on the type of used cable.

In the CAN protocol frame priority is managed by collision between dominant and recessive levels of the line. This collision must be resolved during transmission of a bit, which limits the signal propagation delay between 2 nodes.

The following tables specify the maximum trunk cable length based on the CANopen cable provided by Schneider Electric (TSXCANCA•••, TSXCANCB••• and TSXCANCD•••).

### Maximum Cable Length

Consequently, the maximum distance between the 2 most distant nodes of a CAN bus depends on the speed and is provided in the following table:

| Speed in bit/s | Maximum Cable Length |
|---|---|
| 1 Mbit/s | 20 m (65 ft) |
| 800 kbit/s | 40 m (131 ft) |
| 500 kbit/s | 100 m (328 ft) |
| 250 kbit/s | 250 m (820 ft) |
| 125 kbit/s | 500 m (1640 ft) |
| 50 kbit/s | 1000 m (3280 ft) |
| 20 kbit/s | 2500 m (8202 ft) |
| 10 kbit/s | 5000 m (16404 ft) |

According to the Schneider Electric network strategy, the speeds 1 Mbit/s, 800 kbit/s, 500 kbit/s, 250 kbit/s and 125 kbit/s are recommended for automation solutions at machine and installation level.

**NOTE:** The maximum length assumes a reasonable device internal propagation delay and bit sampling point. Devices that present long internal propagation delays will effectively reduce the maximum cable length that could otherwise be realized.

The cable lengths of the above table may include a drop cable if it is at the physical end of the trunk cable.

## Repeaters Reducing Cable Length

The above values specify the maximum cable length without any repeater. As repeaters add a propagation delay in the bus, this delay reduces the maximum length of the bus. A propagation delay of 5 ns leads to a length reduction of 1 m (3 ft).

**Example**. A repeater with a propagation delay of 150 ns reduces the maximum cable length by 30 m (98 ft).

## Maximum Cable Length vs. Number of Nodes

In addition to the length limitations based on the transmission speed, the maximum cable length is also influenced by the load resistance.

In any case, the maximum number of nodes that may be connected on the same segment is restricted to 64. To connect more nodes to 1 segment, use a repeater.

The table below shows the influence by the number of nodes on the cable length:

| Number of Nodes | Maximum Cable Length |
|---|---|
| 2 | 229 m (751.31 ft) |
| 16 | 210 m (688.97 ft) |
| 32 | 195 m (639.76 ft) |
| 64 | 170 m (557.74 ft) |

## Electrical Isolation of CANopen Devices

In documents about CANopen you will often find the value of 40 m (131 ft) maximum value at a transmission speed of 1 Mbit/s. This length is calculated without electrical isolation as used in the Schneider Electric CANopen devices.

With such electrical isolation the minimum network length calculated is 4 m (13 ft) at a transmission speed of 1 Mbit/s. However, the experience shows that 20 m (65 ft) are the practical length that could be shortened by drops or other influences.

# Drop Cable Limitations

## Overview

A drop cable creates a signal reflection on the transmission line characteristic of the trunk cable. In order to limit reflections, drop cables should be as short as possible.

## Maximum Drop Cable Length

Respect the values listed in the following table:

| **Transmission Rate** | **Lmax** | **ΣLmax** | **TAP Distance** | **ΣLGmax** |
|---|---|---|---|---|
| 1 Mbit/s | 0.3 m (0.98 ft) | 0.6 m (0.98 ft) | | 1.5 m (4.92 ft) |
| 800 kbit/s | 3 m (9.84 ft) | 6 m (19.68 ft) | 3.6 m (11.81 ft) | 15 m (49.21 ft) |
| 500 kbit/s | 5 m (16.4 ft) | 10 m (32.8 ft) | 6 m (19.68 ft) | 30 m (98.42 ft) |
| 250 kbit/s | 5 m (16.4 ft) | 10 m (32.8 ft) | 6 m (19.68 ft) | 60 m (196.84 ft) |
| 125 kbit/s | 5 m (16.4 ft) | 10 m (32.8 ft) | 6 m (19.68 ft) | 120 m (393.69 ft) |
| 50 kbit/s | 60 m (196.84 ft) | 120 m (393.69 ft) | 72 m (236.21 ft) | 300 m (984.24 ft) |
| 20 kbit/s | 150 m (492.12 ft) | 300 m (984.24 ft) | 180 m (590.54 ft) | 750 m (2460.62 ft) |
| 10 kbit/s | 300 m (984.24 ft) | 600 m (1968.49 ft) | 360 m (1181.09 ft) | 1500 m (4921.24 ft) |

**Lmax** is the maximum length of 1 drop cable.

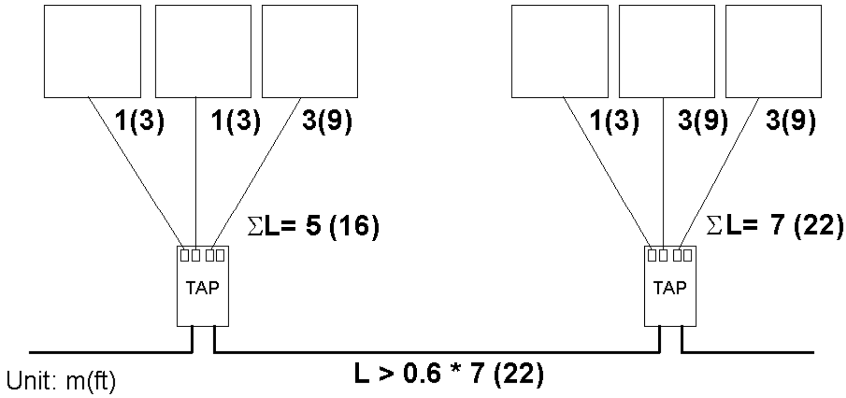
**ΣLmax** is the maximum value of the sum of drop cables on the same TAP.

**TAP distance** is the minimum distance necessary between 2 TAPs, can be calculated for each TAP (must be greater than 60% of the largest of the 2 ΣLmax).

**ΣLGmax** is the maximum value of the sum of drop cables on the network.

## Calculation Example

The figure below provides an example of a TAP distance calculation with 2 junction boxes and 6 devices:




The TAP distance in the above example is calculated as follows:

| Step | Description | Result |
|---|---|---|
| 1 | Calculating the sum of lengths of drop cables for each tap junction. | 5 m (16 ft) and 7 m (22 ft) |
| 2 | Keeping the longest length. | 7 m (22 ft) |
| 3 | Calculating the minimum cable length between the 2 TAPs. | 60% of 7 m (22 ft) |

Respect the TAP distance even if a device is in between.

## Network with External Power Supply

### Basic Characteristics

The rated voltage of the power supply shall be 24 V.

The sum current drawn by the powered devices from 1 power supply shall not exceed 1500 mA. This also applies to a single device.

### Selecting a Power Supply

The following table lists the requirements the power supply should meet:

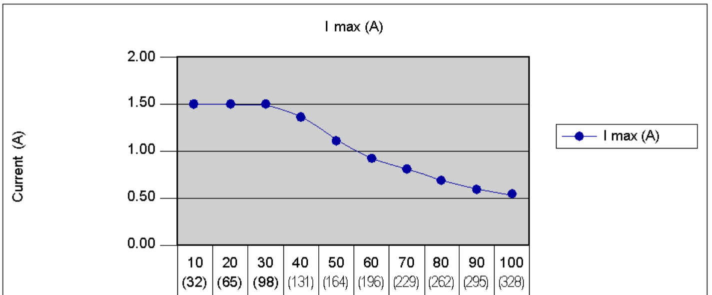
| | |
|---|---|
| Standard | IEC61131-2:2003, PELV or SELV |
| Initial tolerance | 24 V +/- 3% or better (no load voltage) |
| Line regulation | +/- 3% max |
| Load regulation | +/- 3% max |
| Output ripple | 200 mV p-p max |
| Load capacitance capability | 7000 µF max |
| Isolation | output isolated from AC and chassis ground |
| Minimum output voltage | 19.2 V at full load |
| Current limit | 2 A |

It is recommended to use Schneider Electric power supplies from the Phaseo product family such as ABL-7RE2402 or ABL-7CEM24••.

## Cable Length Limitation

Based on the amount of current, a certain voltage drop over the cable will appear. This voltage drop - and thus the cable length - needs to be limited.

The figure below illustrates the limits you must respect for the recommended cable TSXCANCA••• / TSXCANCB••• / TSXCANCD•••:




| Length m (ft) | 10 (32) | 20 (65) | 30 (98) | 40 (131) | 50 (164) | 60 (196) | 70 (229) | 80 (262) | 90 (295) | 100 (328) |
|---|---|---|---|---|---|---|---|---|---|---|
| I max (A) | 1.50 | 1.50 | 1.50 | 1.35 | 1.08 | 0.90 | 0.77 | 0.67 | 0.60 | 0.54 |

## Verifications and Troubleshooting

### Overview

For reliable CANopen network communications perform the verifications described in the following.

### Verifying the Device Configuration

Perform the following steps to verify the configuration of your devices:

| Step | Action |
|---|---|
| 1 | Verify that the connected devices are configured to the same transmission speed. |
| 2 | Verify that each device has a unique node address. |

### Verifying the Topology

Perform the following steps to verify the topology of your CANopen network:

| Step | Action |
|---|---|
| 1 | Verify the maximum cable length versus transmission speed. |
| 2 | Verify the length of the segment and the number of nodes on the segment. |
| 3 | Verify the length of drop cables and TAP distance versus transmission speed. |

### Verifying the Wiring

Perform the following steps to verify the wiring only with the devices being switched off or being disconnected from the network:

| Step | Action |
|---|---|
| 1 | Verify the resistance between CAN_L and CAN_H:<br>• if R > 65 Ω the reason may be a missing termination resistor or a broken wire<br>• if R < 50 Ω the reason may be a redundant termination resistor or a short circuit between CAN signals |
| 2 | Verify that no short circuits exist between CAN_L or CAN_H signals and CAN_GND, CAN_V+ signals and the shield. |

To perform these measurements use a standard multimeter or, more comfortably, an installation tester, e.g. CANcheck from IXXAT.

# CANopen Infrastructure Components

# 4

## Subject of This Chapter

This chapter describes the standard CANopen infrastructure components provided by Schneider Electric.

For a complete list of all infrastructure components available refer to the Schneider Electric *CANopen Catalog* (part 4 of the catalog *Machines & Installations with industrial communications*).

## What's in this Chapter?

This chapter contains the following sections:

# 4.1 CANopen Cables

## Overview

This section lists the characteristics of CANopen cables.

## What's in this Section?

This section contains the following topics:

# CANopen Cables

## Overview

Schneider Electric provides 1 cable type that performs the following functions:

- trunk
- drop
- power distribution over the network

The CANopen cable provides 2 twisted pairs. Each pair has a separate shield to reduce the disturbances from the power wires to the CANopen signal wires. Both pairs are shielded with a common tinned copper braid and an additional drain wire.

## Wire Pair Characteristics

The following table lists the characteristics of the individual wire pairs of a CANopen cable:

| Wire | Characteristic | Signal | Color |
|---|---|---|---|
| Pair A | conductor gauge: 0.34 $mm^2$ (AWG 22) | `CAN_V+` | red |
| Pair A | linear resistance: 55 Ω/km | `CAN_GND` | black |
| Pair B | conductor gauge: 0.2 $mm^2$ (AWG 24) | `CAN_H` | white |
| Pair B | linear resistance: 90 Ω/km | `CAN_L` | blue |
| Pair B | characteristic impedance: 120 Ω | – | – |

## General Cable Characteristics

The following table lists the general characteristics of CANopen cables:

| | |
|---|---|
| Shield | tinned copper braid and drain wire |
| Sheath color | Magenta RAL 4001 |
| Operating temperature | -10°–+80° C (14°–176° F) |
| Storage temperature | -25°–+80° C (-13°–176° F) |
| Overall diameter | 7.4 (0.29 in.) ± 0.2 mm (0.007 in.) |

# Cable Types

## Available Cables

Schneider Electric provides 3 different types of cable that differ in their sheath characteristic:

- TSXCANCA••• is dedicated to the European market, LSZH (low smoke zero halogen)
- TSXCANCB••• is dedicated to the American market, UL and CSA certified, fire retarding
- TSXCANCD••• is a flexible cable for severe environments, very good chemical resistance to oil and grease, LSZH and ready for mobile applications

Each cable type is available in lengths of 50 m (164 ft), 100 m (328 ft) or 300 m (984 ft).

## Specific Cable Characteristics

The Schneider Electric cables have the following characteristics:

| Characteristics | TSXCANCA | TSXCANCB | TSXCANCD |
|---|---|---|---|
| Minimum curve radius - fixed applications | 67 mm (2.63 in.) | 67 mm (2.63 in.) | 37 mm (1.45 in.) |
| Minimum curve radius - mobile applications | – | – | 74 mm (2.91 in.) |
| Fire retardant | IEC 60332-1 | IEC 60332-3 | IEC 60332-1 |
| Oil resistant | – | – | VDE 0472 part 803B |
| Low smoke | VDE 0207-24 | – | VDE 0207-24 |
| Zero halogen | EN50290-2-27 | – | EN50290-2-27 |
| Track chain application | | | |
| Maximum number of cycles | – | – | 1,000,000 |
| Maximum acceleration | – | – | 5 $m/s^2$ (16.4 $ft/s^2$) |
| Speed | – | – | 200 m/mn (656 ft/mn) |
| Alternative flection | | | |
| Bending angle | – | – | 180° |
| Maximum cycles | – | – | 30,000 |
| Maximum wheel diameter | – | – | 200 mm (7.87 in.) |

# 4.2 CANopen Cable Connectors

### Overview

This section provides an overview of the different CANopen cable connectors.

### What's in this Section?

This section contains the following topics:

# SUB-D 9 Cable Connectors

### Connector Types

Schneider Electric provides the following types of SUB-D 9 cable connectors:

| Schneider Electric Cable Connector | Characteristics |
|---|---|
| TSXCANKCDF90T | 90° cable |
| TSXCANKCDF180T | 180° cable |
| TSXCANKCDF90TP | • 90° lead<br>• male connector available for temporary connection of a diagnostic tool |

### Common Functions

The above mentioned connector types have the following functions in common:

- connection of 1 or 2 cables on screw terminals (a wire terminal)
- shield interconnection of the 2 cables and the connector's metal housing
- integrated termination resistor, switchable with an ON/OFF switch

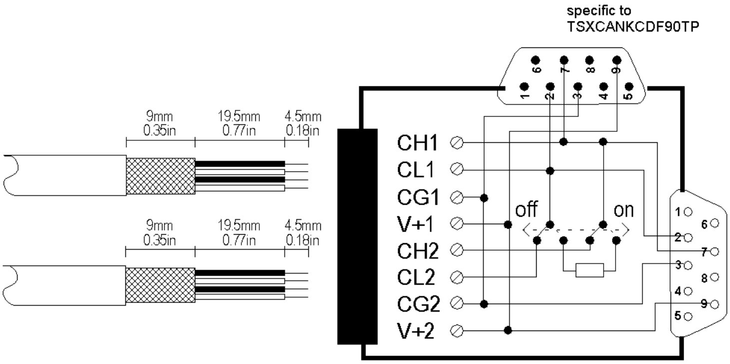
### Chaining Function

The cable connectors may be used for chaining cables between CANopen devices:

| If... | Then ... |
|---|---|
| the device is at the beginning or at the end of the network | the cable is connected on the terminal block 1 (incoming cable) and the line termination switch is ON. |
| the device is in the middle of the bus | 2 cables are interconnected in the connector and line termination switch is OFF. |

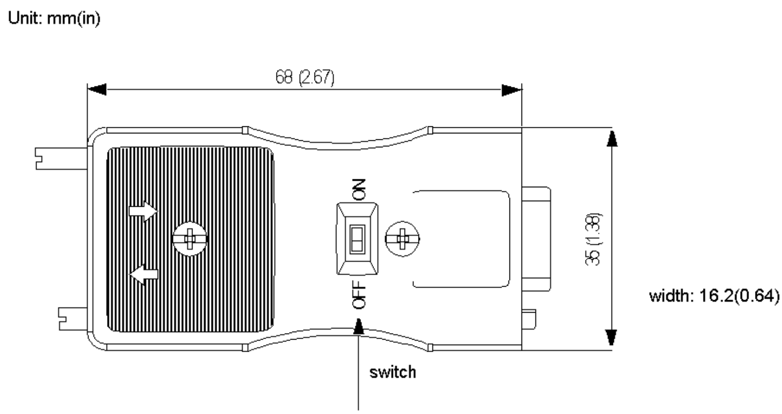
## Wiring

The figure below shows the wiring of TSXCANKCDF90T, TSXCANKCDF180T and TSXCANKCDF90TP:



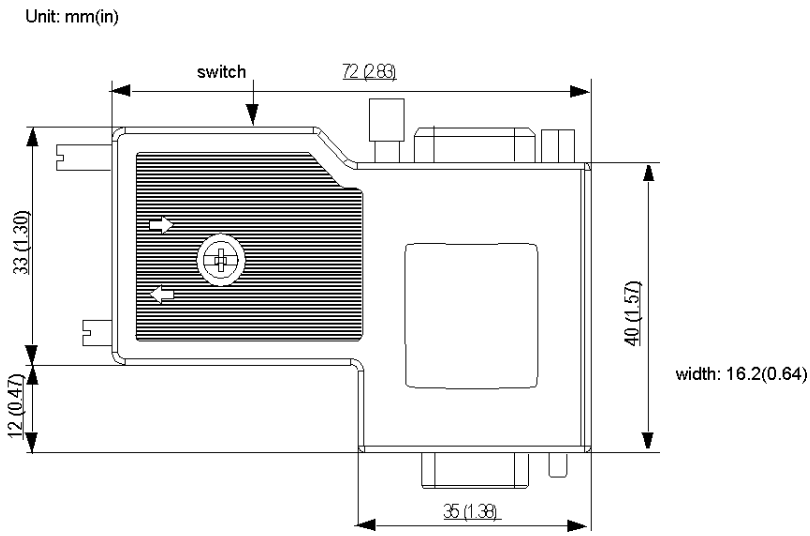

## TSXCANKCDF180T

The figure below shows the TSXCANKCDF180T cable connector:



## TSXCANKCDF90T / TSXCANKCDF90TP

The figure below shows the dimensions of the TSXCANKCDF90T / TSXCANKCDF90TP cable connector:



## Connections

**⚠ CAUTION**

**UNEXPECTED CANopen NETWORK OPERATION**

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

**Failure to follow these instructions can result in injury or equipment damage.**

When you use the Schneider Electric standard CANopen cable (TSXCANCA•••, TSXCANCB••• or TSXCANCD•••) you must comply with the wiring combinations (signal, wire color) described in the table below.

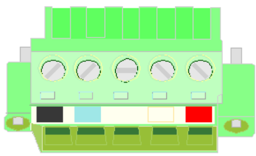
The following table shows terminal block wiring depending on the signal:

| Signal | Terminal Block 1, Incoming Cable | Terminal Block 2, Outgoing Cable | Wire Color |
|---|---|---|---|
| CAN_H | CH1 | CH2 | white |
| CAN_L | CL1 | CL2 | blue |
| CAN_GND | CG1 | CG2 | black |
| CAN_V+ | V+1 | V+2 | red |

# Open Style Cable Connectors

## Illustration

The figure below shows the open style cable connector:



## Wiring Information

**CAUTION**

**UNEXPECTED CANopen NETWORK OPERATION**

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

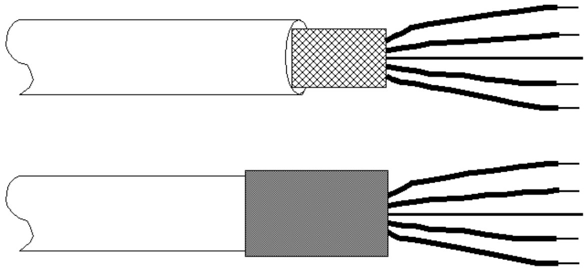
**Failure to follow these instructions can result in injury or equipment damage.**

| Pin | Signal | Connector Color Marking | Wire Color | Termination Resistor |
|---|---|---|---|---|
| 1 | CAN_GND | black | black | place a 120 Ω 0.25 W 5% resistor between CAN_H and CAN_L if this is the physical end of the trunk cable |
| 2 | CAN_L | blue | blue | |
| 3 | CAN_Shield | bare | tinned copper drain wire | |
| 4 | CAN_H | white | white | |
| 5 | CAN_V+ | red | blue | |

## Cable Preparations

Prepare your cable for connection to an open style connector as follows:

| Step | Action |
|---|---|
| 1 | Strip the sheath from the end of the cable. |
| 2 | Remove copper braided shield thereby keeping the drain wire. |
| 3 | Wrap the end of the cable with shrink wrap. |



# IP67 M12 Cable Connector

## Connector Types

Schneider Electric provides 2 types of IP67 M12 connectors:

| | |
|---|---|
| male | FTX CN 12M5 |
| female | FTX CN 12F5 |

## Chaining

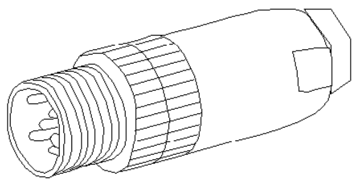
Since these connectors allow to connect only 1 cable the chaining of the cable is performed by the device. It provides specific ports for the incoming and outgoing cable.

The incoming cable is connected to the BUS IN port of the device.

The outgoing cable is connected to the BUS OUT port of the device.

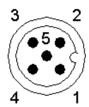
## Illustration

The figure below shows an IP 67 M12 cable connector:



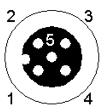
## BUS IN Connector

The figure below shows the 5-pin M12 male BUS IN connector:




## BUS OUT Connector

The figure below shows the 5-pin M12 female BUS OUT connector:



## Pin Assignment

**⚠ CAUTION**

**UNEXPECTED CANopen NETWORK OPERATION**

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

**Failure to follow these instructions can result in injury or equipment damage.**

The following table shows the pin assignments of the BUS IN and BUS OUT connector pins:

| Pin | Signal | Meaning |
|---|---|---|
| 1 | (CAN_SHLD) | optional CAN shielding |
| 2 | (CAN_V+) | optional positive power supply |
| 3 | CAN_GND | 0 V |
| 4 | CAN_H | CAN_H bus line |
| 5 | CAN_L | CAN_L bus line |

# 4.3 CANopen TAPs

## Overview

This section provides an overview of the different CANopen TAPs.

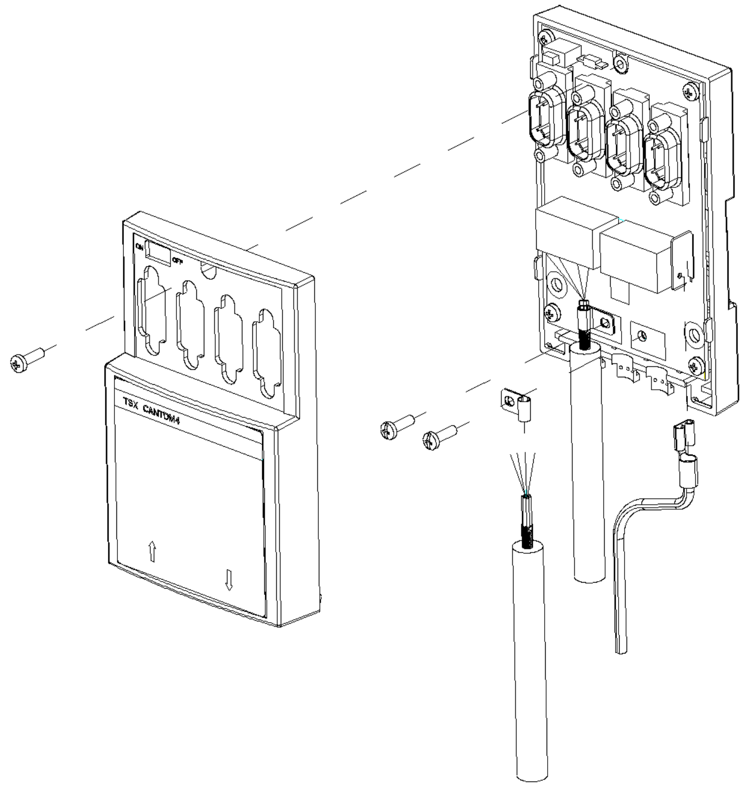
## What's in this Section?

This section contains the following topics:

## TSX CAN TDM4

### Overview

The TSX CAN TDM4 TAP allows connection of 4 devices by branching the drop cable to the four male SUB-D 9 plugs.




### Wiring

`CAN` signals (`CAN_H`, `CAN_L`, `CAN_GND`, and `CAN_V+`) from incoming and outgoing cables and the four SUB-D 9 are interconnected inside the box. Similarly, the connector shield is connected to the cable shield. Connection to the PE terminal (ground) must use the green-yellow cable.

### Attachment

The TSX CAN TDM4 TAP may be screwed onto a plate or snapped on a DIN rail.

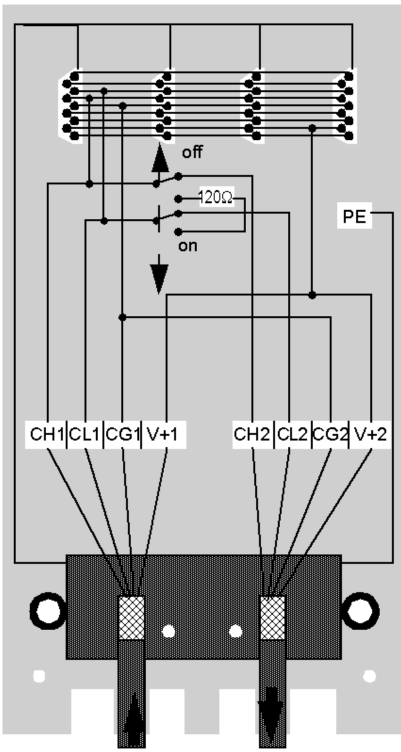
## Grounding

In addition to using the DIN rail ground, the TSX CAN TDM4 may be grounded using the terminal marked PE in the box by using a short cable (cable cross-section of 2.5 $mm^2$ (AWG13) or more).

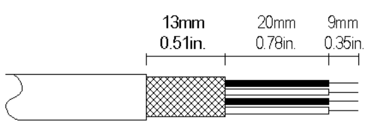
## Line Termination Switch

A line termination switch is is provided to switch a built-in termination resistor. If the line termination switch is switched OFF, the signals `CAN_H` and `CAN_L` of the outgoing cable are disconnected.

View of the TSX CAN TDM4 with line termination switch




Cable preparation template



## Wiring

**⚠ CAUTION**

**UNEXPECTED CANopen NETWORK OPERATION**

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

**Failure to follow these instructions can result in injury or equipment damage.**

The following table shows terminal block wiring depending on the signal:

| Signal | Terminal Block 1 | Terminal Block 2 | Wire Color |
|---|---|---|---|
| CAN_H | CH1 | CH2 | white |
| CAN_L | CL1 | CL2 | blue |
| CAN_GND | CG1 | CG2 | black |
| CAN_V+ | V+1 | V+2 | red |

# VW3 CAN TAP2

## Overview

The VW3 CAN TAP2 allows connection of 2 devices like ATV31, ATV71, Lexium05 by branching the drop cable to the 2 connectors S1 and S2. It additionally allows the connection of a Modbus-based tool on connector S3.

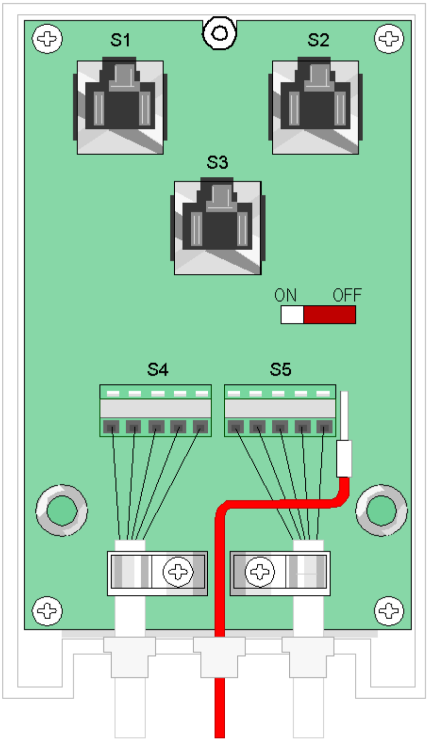
## Wiring

CAN signals (CAN_H, CAN_L, and CAN_GND) from incoming and outgoing cables and the 2 RJ45 connectors (S1, S2) are interconnected inside the box. Similarly, connector shield is connected to the cable shield. Connection to the PE terminal (ground) must use the green-yellow cable.

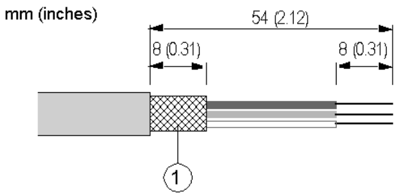
## Line Termination Switch

A line termination switch is provided to switch a built-in termination resistor.

View of the VW3 CAN TAP2 with line termination switch



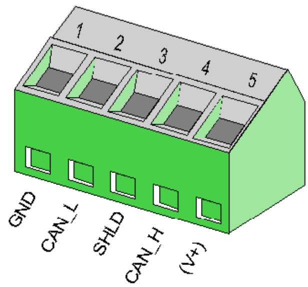
Cable preparation template




**1** shielding

## Pin Assignment

The figure below shows an S4/S5 connector:




## ⚠ CAUTION

**UNEXPECTED CANopen NETWORK OPERATION**

The V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

**Failure to follow these instructions can result in injury or equipment damage.**

The following table shows pin assignment together with the color of the wire:

| Pin | Signal | Wire Color | Description |
|---|---|---|---|
| 1 | GND | black | ground |
| 2 | CAN_L | blue | CAN_L bus line |
| 3 | SHLD | (bare cableshield) | optional shield |
| 4 | CAN_H | white | CAN_H bus line |
| 5 | (V+) | red | optional positive power supply |

# 4.4 CANopen - Daisy Chain Connector

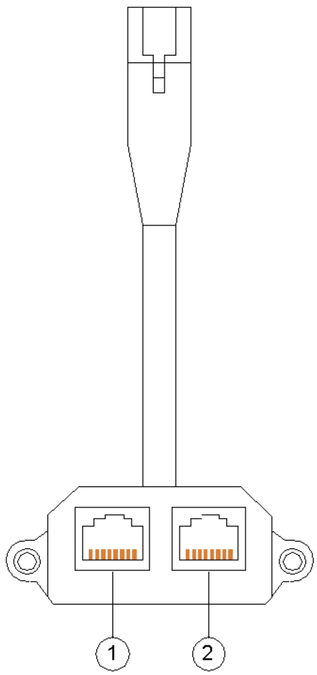
## CANopen - Daisy Chain Connector

### Overview

The TCSCTN023F13M03 provides a Y-junction for RJ45 connectors, thus allowing to daisy chain the CAN cable.

### Mechanical View

The figure below shows the mechanical view of the daisy chain connector:

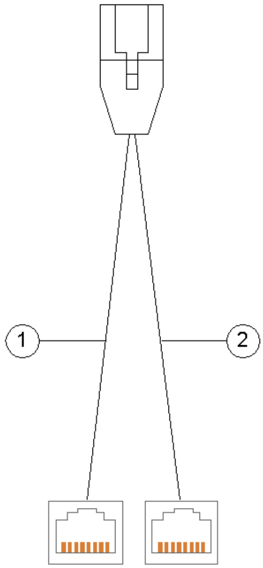



**1** in connector
**2** out connector

Even though the visible cable length of this connector is 0.30 m (0.98 ft) you must consider an absolute length of 0.60 m (1.97 ft) when calculating the maximum cable length due to its electrical wiring (see figure below).

## Electrical Wiring

The figure below shows the electrical wiring of the daisy chain connector:




**1** CAN_H, CAN_L, CAN_GND
**2** CAN_H, CAN_L, CAN_GND

# 4.5 Preassembled Cord Sets

## Preassembled Cord Sets

### Overview

Schneider Electric offers several preassembled cord sets for easy CANopen cabling for IP20 and IP67 environments.

### Design

Those cord sets consist of a cable with certain length and ready-mounted connectors. The CAN signals (CAN_H, CAN_L, CAN_GND, CAN_V+) and the cable shield are wired through the cables.

For a complete list of preassembled cord sets refer to the Schneider Electric CANopen catalog.

# CANopen - Connectors

5

## CANopen Device Connector Pinout

### Overview

Schneider Electric devices are equipped with the following types of CANopen connectors:

- SUB-D 9
- open style
- IP67 M12
- RJ45 connector

**⚠ CAUTION**

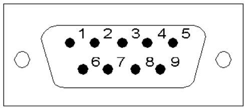
**UNEXPECTED CANopen NETWORK OPERATION**

The `CAN_V+` signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following tables.

**Failure to follow these instructions can result in injury or equipment damage.**

## SUB-D 9 Connector

The figure below shows the male SUB-D 9 connector:

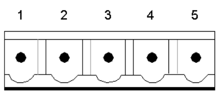



The following table shows the pin assignments of the SUB-D 9 connector:

| Pin | Signal | Meaning |
|---|---|---|
| 1 | – | reserved |
| 2 | `CAN_L` | CAN_L bus line |
| 3 | `CAN_GND` | CAN ground |
| 4 | – | reserved |
| 5 | `(CAN_SHLD)` | optional CAN shield |
| 6 | `GND` | ground, connection to pin 3 |
| 7 | `CAN_H` | CAN_H bus line |
| 8 | – | reserved |
| 9 | `(CAN_V+)` | optional external positive supply |

## Open Style Connector

The figure below shows the open style device connector:




The following table shows the pin assignments of the open style device connector:

| Pin | Signal | Meaning |
|---|---|---|
| 1 | `CAN_GND` | CAN ground |
| 2 | `CAN_L` | CAN_L bus line |
| 3 | `CAN_Shield` | CAN_Shield |
| 4 | `CAN_H` | CAN_H bus line |
| 5 | `(CAN_V+)` | optional external positive supply |

## IP67 M12 Connector

For the pinout of the IP67 M12 connector refer to IP67 M12 Connector *(see page 46)*.

## RJ45 Connector

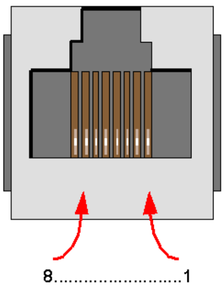
Schneider  Electric provides CANopen devices with 1 RJ45 connector or with 2 RJ45 connectors.

The devices with 2 connectors allow an easy daisy chaining of the CAN, because the 2 connectors are internally connected.

For devices with 1 RJ45 connector (like ATV31, ATV71, Lexium05) the following adapters are required:

| Catalog No. | Adapter Type |
|---|---|
| VW3 CAN A71 | adapting the ATV71 to SUB-D9 |
| VW3 CAN TAP2 | TAP allowing to connect 2 drop cables |
| TCSCTN023F13M03 | daisy chain connector |

The figure below shows the RJ45 connector:

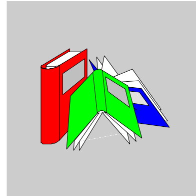



The following table shows the pin assignments of the RJ45 connector:

| Pin | Signal | Meaning |
|---|---|---|
| 1 | CAN_H | CAN_H bus line |
| 2 | CAN_L | CAN_L bus line |
| 3 | CAN_GND | CAN ground |
| 4 | D1* | Modbus signal |
| 5 | D0* | Modbus signal |
| 6 | not connected | – |
| 7 | VP* | supply for RS323/RS485 converter or remote terminal |
| 8 | Common* | Modbus common |

* These signals are provided by ATV31, ATV71, Lexium05 and VW CAN TAP2 only. Otherwise the according pins are not connected.

# Glossary



## C

**cable connector**

the part of a connector mounted on the cable. A cable connector may provide the connection of 2 cables for chaining. A cable connector may include the termination resistor.

**CAN**

**Controller Area Network**: field bus originally developed for automobile applications which is now used in many sectors, from industrial to tertiary

**CANopen**

CANopen specifies the higher layer protocol and is based on CAN

## D

**drop cable**

unterminated derivation cord used for connection between TAP and device

## L

**LT**

**Line Termination**: termination of the trunk cable with 120 $\Omega$ resistor, the resistor may be integrated in the TAP or in the cable connector

# T

**TAP**

**Terminal Access Point**: junction box connected to the trunk cable, allows to plug some drop cables

**trunk cable**

the main cable terminated at both physical ends with line termination resistors.

# Index

# S



# T



# V