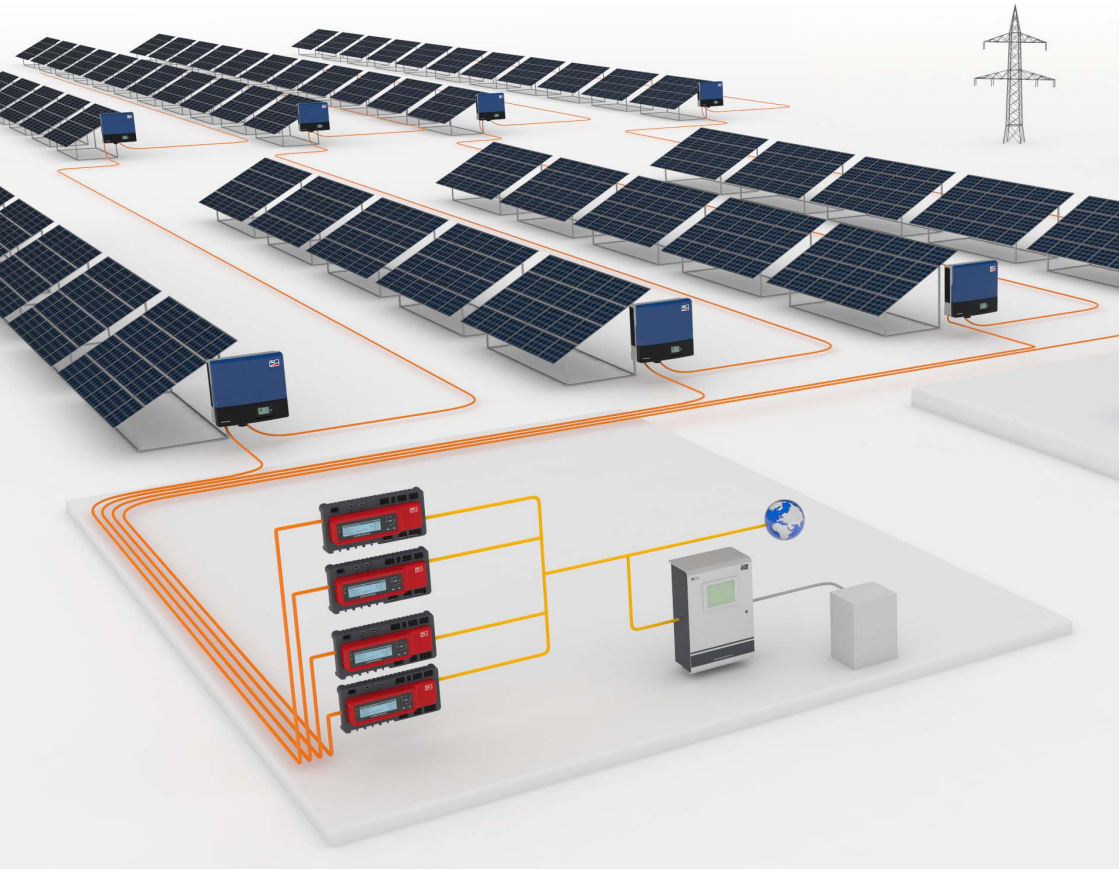
Technical Information

SMA SPEEDWIRE FIELDBUS



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1 Information on this Document

Target Group

This document is for qualified persons who are planning a PV system with SMA Speedwire devices or intend installing one (see Section 2.3 "Skills of Qualified Persons", page 9).

Symbols

Symbol	Explanation
⚠ DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury
⚠ WARNING	Indicates a hazardous situation which, if not avoided, can result in death or serious injury
⚠ CAUTION	Indicates a hazardous situation which, if not avoided, can result in minor or moderate injury
NOTICE	Indicates a situation which, if not avoided, can result in property damage
i	Information that is important for a specific topic or goal, but is not safety-relevant
☐	Indicates a requirement for meeting a specific goal
☑	Desired result
✖	A problem that might occur

Nomenclature

Complete designation	Designation in this document
SMA Speedwire Fieldbus	Speedwire
SMA Speedwire/Webconnect Piggy-Back	Speedwire/Webconnect Piggy-Back
SMA Speedwire/Webconnect data module	Speedwire/Webconnect data module
SMA Speedwire data module Sunny Island	Speedwire data module SI
SMA Webconnect function	Webconnect function
SMA inverter	Inverter
SMA Cluster Controller	Cluster Controller

Abbreviations

Abbreviation	Designation	Explanation
AC	Alternating Current	–
AWG	American Wire Gauge	US American coding system for wire cross-section
DC	Direct Current	–
DHCP	Dynamic Host Configuration Protocol	Protocol for the dynamic assignment of IP configurations
ESS	Electronic Solar Switch	The Electronic Solar Switch and the DC connectors form a DC load disconnect unit
IP	Internet Protocol	–
LAN	Local Area Network	–
LED	Light-Emitting Diode	–
OF	Optical Fiber	–
PV	Photovoltaics	–
WAN	Wide Area Network	–

2 Introduction

2.1 What is Speedwire?

Speedwire is a wired, Ethernet based fieldbus for the implementation of powerful communication networks in decentralized large-scale PV power plants.

Speedwire uses the internationally established Ethernet standard, the Ethernet based IP protocol as well as the communication protocol SMAData2+ optimized for PV systems. This enables a consistent 10/100 Mbit data transmission to the inverter as well as reliable monitoring, control, and regulation of the PV system.

The Speedwire network can be set up with the following optional topologies:

- Line topology (see Section 4.1.1, page 23)
- Star topology (see Section 4.1.2, page 24)
- Tree topology (see Section 4.1.3, page 25)

The Speedwire fieldbus consists of:

- Qualified network components such as network switches or network cables (see Section 3.2 „Requirements for Qualified Network Components“, page 10 and Section 3.4.1 „Cable Requirements“, page 13)
- Speedwire system components of SMA Solar Technology AG such as Cluster Controller, Sunny Home Manager, SMA Energy Meter and inverters with Speedwire interface (see Section 2.2 "Speedwire Products", page 8)

2.2 Speedwire Products

SMA Speedwire Interfaces

There are different Speedwire interfaces for SMA inverters:

- **Speedwire integrated**
  - installed ex works
  - depending on the inverter:
    - Inverter has one network port (tree topology or star topology possible)
    - Inverter has two network ports (line topology, tree topology or star topology possible)
  - connection via plug & play
- **Speedwire/Webconnect data module**
  - available as a retrofit kit or is pre-installed in the inverter
  - has two network ports (line topology, tree topology or star topology possible)
  - connection via plug & play
- **Speedwire/Webconnect Piggy-Back**
  - available as retrofit kit
  - has one network port (tree topology or star topology possible)
  - connection via network cable
- **Speedwire data module Sunny Island**
  - available as retrofit kit
  - has one network port (only star topology possible)
  - connection via plug & play

Supported SMA Speedwire Products

Inverters

All inverters with integrated or retrofitted Speedwire interface.

Information on whether an inverter has an integrated Speedwire interface or can be retrofitted with a Speedwire interface can be found on the product page of the respective inverter at www.SMA-Solar.com.

Communication Products (Devices and Software)

Information on whether a communication product supports Speedwire can be found on the product page of the respective communication product at www.SMA-Solar.com.

2.3 Skills of Qualified Persons

The tasks described in this document must be performed by qualified persons only. Qualified persons must have the following skills:

- Training in the installation and commissioning of electrical devices and systems
- Knowledge of how to deal with the dangers and risks associated with installing and using electrical devices and systems
- Knowledge of how an inverter works and is operated
- Knowledge of all applicable standards and directives such as EN 50173-1, EN 50173-3, EN 60950-1, ISO/IEC 11801, ANSI/TIA 568-C.2
- Knowledge of Ethernet network engineering
- Knowledge of and adherence to this document and all safety precautions

2.4 Safety Precautions

For the connection of the network cables to the Speedwire interfaces of the inverter, the inverter must be opened. Observe all safety precautions in the installation manual of the respective inverter as well as the following safety precautions for working safely on the inverters.

⚠ DANGER

Danger to life due to electric shock when opening the inverter

High voltages are present in the conductive components of the inverter. Touching live components results in death or serious injury.

- Prior to performing any work on the inverter, always disconnect the inverter from all voltage sources on the AC and DC sides (see inverter installation manual). Observe the waiting time to allow the capacitors to discharge.

⚠ CAUTION

Risk of burns due to hot enclosure parts

Some parts of the inverter enclosure can get hot during operation. Touching these enclosure parts can result in burn injuries.

- Do not touch any parts other than the lower enclosure lid of the inverter during operation.

NOTICE

Damage to the inverter due to electrostatic discharge

The internal components of the inverter can be irreparably damaged by electrostatic discharge.

- Ground yourself before touching any inverter component.

3 Speedwire Communication in PV Systems

3.1 Requirements for Using Speedwire

You need the following components to be able to use Speedwire:

- at least one inverter that is equipped with one Speedwire interface (see Section 2.2 "Speedwire Products", page 8)
- one Speedwire-enabled communication product (see Section 2.2 "Speedwire Products", page 8)
- one computer

The network cabling of the PV system must be carried out in accordance with the requirements (see Section 3.4, page 13) described in this document.

3.2 Requirements for Qualified Network Components

You can use standard network components for Speedwire. However, the following minimum requirements must be fulfilled.

Requirements:

- ☐ Data transfer rate Fast Ethernet (10BASE-T/100BASE-TX) or Gigabit Ethernet (1000BASE-T)*
- ☐ Support of autonegotiation **
- ☐ Support of autocrossing
- ☐ Support of the data transfer procedure full duplex
- ☐ Network connection technology RJ45 with shield connection
- ☐ At least two network ports for realization of a line topology; for line topology end users one network port or one network connection is sufficient.
- ☐ The MAC address storage of the network switches used must have at least 512 MAC address entries each and be sufficient for the PV system size planned.
- ☐ Router or network switches that are used outdoors, must have degree of protection IP65.

* Each gigabit interface has 10BASE-T/100BASE-TX/1000BASE-T and is thus downward compatible to Fast Ethernet (10BASE-T/100BASE-TX).

** Autonegotiation (also "auto-sensing"): automatic setting of the fastest possible speed that is supported by both link partners.

3.3 Speedwire Properties

3.3.1 Data Transfer Rate

Speedwire is designed as a fieldbus for PV system communication for a data transfer rate of 100 Mbit/s. This data transfer rate is also supported by network components with the designation "10/100Mbit/s".

All Speedwire devices use two transfer standards:

- 10BASE-T (10 Mbit/s)
- 100BASE-TX (100 Mbit/s)

The data transfer rate is automatically adjusted by all Speedwire devices. 100 Mbit/s with full duplex is selected as standard.

3.3.2 Maximum Line Lengths (End-to-End-Links)

The maximum line length between two nodes is also called "end-to-end-link". The maximum length of the end-to-end-link depends on the cable type used:

- When using installation cables (e.g. Profinet cables) and a maximum of two interfaces*: 100 m at maximum
- When using patch cables: maximum of 50 m

The maximum total length of the Speedwire fieldbus depends on the end-to-end-link and the number of devices allowed per communication product.

Example: maximum total length for PV systems with Cluster Controller

Cluster Controller can only manage a maximum of 75 inverters. The end-to-end-link between the nodes (Cluster Controller, inverter) is 100 m each.

$$75 \times 100\ \text{m} = 7{,}500\ \text{m}$$

Thus, the maximum total length is 7,500 m.

3.3.3 Communication Protocols Used

The Internet protocol v4 (IPv4) is used as a communication protocol (OSI level 3). The user datagram protocol (UDP) is used as a transport protocol (OSI level 4). SMA Data 2+ telegrams are transmitted in the UDP/IP data frame.

Figure 1: Design of the Speedwire communication protocol

* A coupling device or a network connection box can be used as an interface.

3.3.4 Device Addressing and Device Detection

Device Addressing

When using the internet protocol it is necessary for each node to receive a unique IP address in the respective subnetwork. The IP address can be assigned in various ways:

- If there is no DHCP server in the Speedwire network, the IP addresses are assigned automatically among the nodes by means of the IPv4LL protocol.
- If there is a DHCP server in the Speedwire network (e.g. Cluster Controller or router), all IP addresses can be assigned by the DHCP server.
- If necessary, the IP addresses can also be assigned statically, for example by means of the SMA Connection Assist* or via the respective communication device (e.g. Cluster Controller).

Device Detection

Depending on the SMA products used, device detection can take place automatically via a communication product (e.g. Cluster Controller) or via software (Sunny Explorer or SMA Connection Assist) (see manual of the SMA product).

* You can obtain the Sunny Explorer and SMA Connection Assist software free of charge from the download area at www.SMA-Solar.com.

3.4 Cabling in the Speedwire Networks

3.4.1 Cable Requirements

3.4.1.1 General Information

Laying network cables indoors and outdoors

- Only use network cables that have each been approved for laying them inside and outside of buildings. This applies especially to laying the cables underground.

The following terms are used in network device cabling:

- For patch cables:
  - Network cable, flexible
- For fixed cables:
  - Installation cable
  - Profinet cable
  - Network cable, fixed
  - Permanent link

Network cables with eight wires that are arranged in four pairs with two wires each are approved for Speedwire. The respective wire pair is twisted. Cables that have only four wires (minimum requirement) and are either arranged in two twisted wire pairs or in a star quad (four wires twisted at once) are also approved.

Besides pure copper cables there are copper-clad cables that have the same transmission properties. Copper-clad cables are labeled with CCA (copper-clad aluminum). The internationally common coding designation AWGxx/y is used for cable cross-sections. The xx in AWGxx/y stands for the respective conductor cross-section and the y for the number of single wires per insulated conductor.

Examples for the Y Values

- Fixed installation cable: AWGxx/1: 1 single wire
- Flexible cable, stranded wire (e.g. patch cable): AWGxx/7: 7 single wires per insulated conductor
- Flexible cable, stranded wire (e.g. patch cable): AWGxx/19: 19 single wires per insulated conductor

The following conductor cross-sections (xx) are typically used for Ethernet and Speedwire cabling:

- Solid conductor: AWGxx/1; AWG26 to AWG22 (AWG26 to AWG22 corresponds to a conductor cross-section of 0.13 mm^2 to 0.32 mm^2)
- Flexible cable, stranded wire (e.g. patch cable): AWGxx/7; AWG26 to AWG22 (AWG26 to AWG22 corresponds to a conductor cross-section of 0.13 mm^2 to 0.32 mm^2)
- Example of a standard patch cable: AWG26/7 (7 single wires with 0.13 mm^2 cross-section)

The term xxAWG is also used for some network cables. Installation cables are also referred to as "AWG24 fixed" (equals AWG24/1).

3.4.1.2 Cable Categories

Profinet cable types can be used in addition to eight-wire standard network cables for Speedwire.

In European standardization cables are also categorized by classes, but commonly in categories. ("Cat" = "category"). This category determines which data transfer rate is possible at most with the respective network cable.

The following table shows which category network cables must have for Speedwire.

Features/ Properties	Category			
	Cat3	Cat5, Cat5e	Cat6, Cat6a	Cat7
Class	C	D	E	F
Speedwire approval	✗	✓	✓	✓
Data transmission rate	Up to 10 Mbit/s	Up to 10/100 Mbit and gigabit	Up to 1 gigabit and 10 gigabit	Up to 10 gigabit

Symbols used: ✓ = approved; ✗ = not approved

3.4.1.3 Cable Shielding

In order to achieve good transmission properties, you should only use the following cable shield variants for Speedwire.

Designation	Designation in accordance with old standard	Description
SF/UTP	S-FTP	Total braided shields and total shielding foil with unshielded single pairs
S/UTP	–	Total braided shields with unshielded single pairs
SF/FTP	–	Total braided shields and total shield foil with shielded single pairs
S/FTP	S-STP	Total braided shields with foil shielded single pairs

The most common cable types on the market are SF/UTP and S/FTP.

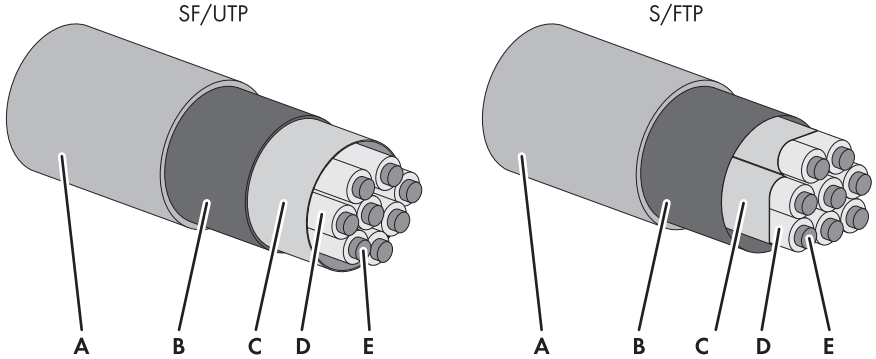

Figure 2: Cable shielding in accordance with ISO/IEC11801

Item	Designation
A	Outer sheath
B	Braided shield
C	Foil shield
D	Inner sheath
E	Copper wire

3.4.1.4 Grounding

For Speedwire devices the cable shield is usually grounded via the respective network port. The cable shield must always be positioned at the network plug. No additional grounding measures are necessary. Only for Speedwire/Webconnect Piggy-Back does the grounding of the cable shield take place via the connection to the shield clamp in the inverter (see Speedwire/Webconnect Piggy-Back installation manual).

3.4.1.5 Cable Sheath

The cable laying site determines the outer sheath cable material. Network cables are available for the following areas:

- Indoor routing
- Outdoor routing
- Underground installation

Network cables are available for each area with the corresponding properties. The most important cable properties are printed on the cable sheath for identifying the network cable.

Examples: imprint cable sheath and cable properties

Imprint	Cable properties
SFTP 300 CAT.5E 26AWGX4P PATCH ISO/IEC11801 & EN50173 verified	• S/FTP, braided shield, CAT5e performance • AWG26 cable with four twisted wire pairs as patch cable • Tested in accordance with standards ISO/IEC11801 and EN50173 • Patch cable, only for short distances
Cat5e SF/UTP patch cable	• Cable suitable for Fast Ethernet Cat5e • Total braided shields and total foil shields for all SF/UTP pairs • Patch cable, only for short distances
S-FTP 4x2xAWG 24/1 CAT5e	• Total braided shields for all pairs and foil shields for the single S/FTP pairs • Installation cable for permanent link, cable fixed • 4 double wires

3.4.1.6 Cabling Plan

Speedwire based on point-to-point connection from device to device. Tapping, single feeders, and parallel use are not allowed. Speedwire devices can be cabled in accordance with two principles:

- Structured cabling for house and office installations
- Application-neutral PV system cabling for industrial locations

Direct Connection without Interface with Two Network Plugs

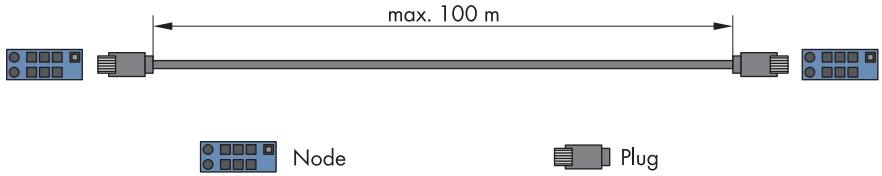

Figure 3: Direct connection principle

A direct connection is favorable if the network cable is being laid directly and adjusted to the end-to-end-link length.

Connection with Interfaces

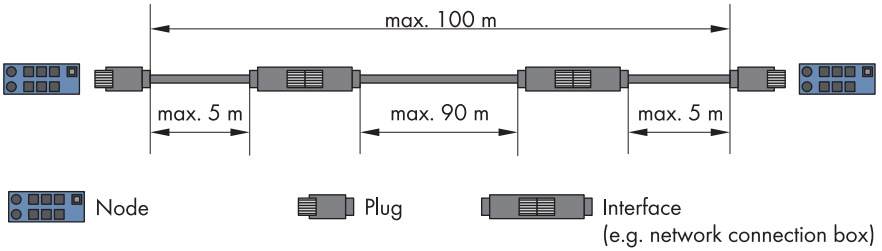

Figure 4: Connection with two interfaces in accordance with the structured cabling principle (example)

The structured cabling requires an installation cable with a maximum length of 90 m. When connecting Speedwire devices via interfaces, 5 m of patch cable should be planned for on both sides.

A maximum of two interfaces may be used in an end-to-end-link with a total length of 100 m. Only a few interfaces should be utilized to prevent additional sources of disturbance. If more interfaces are needed, the maximum length of the end-to-end-link is reduced. For each additional interface that exceeds the maximum number of two interfaces per 100 m, the total length of the network cable must be shortened by approximately 4 m.

Influence of high ambient temperatures on the maximum cable length

The maximum cable length in accordance with the standards of the structured cabling must be reduced at high ambient temperatures.

Use of Optical Fibers

If optical fibers are used besides copper cables in Speedwire networks, corresponding media converters must be used.

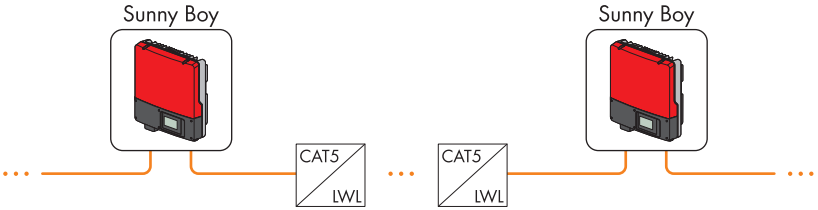

Figure 5: Use of media converters when using optical fibers

More information concerning the specifics when using optical fibers can be found in the respective standards (see Section 2.3 "Skills of Qualified Persons", page 9).

3.4.1.7 Cabling Recommendations

For Speedwire cabling SMA Solar Technology AG recommends cable type SMA COMCAB-OUT for laying outdoors and SMA COMCAB-IN for laying indoors. SMA COMCAB cables are Profinet cables type B for flexible laying and available in 100 m, 200 m, 500 m or 1,000 m.

3.4.2 Network Terminal

3.4.2.1 General Information

The network connection is made via RJ45 (RJ45 network port and RJ45 network plug). RJ45 is the most common connection technology for Ethernet networks.

Only two line pairs are required for Speedwire, meaning four wires of the network cable.

All Speedwire ports support the Auto MDI/MDIX function, also called auto-crossing. This means that an automatic switching of sender and receiver is integrated in all Speedwire devices. Thus, there is no need to differentiate between crossed network cables (crossover cables) and uncrossed network cables when laying cables.

3.4.2.2 Terminal Assignment of Network Plugs

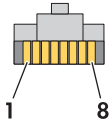

Figure 6: Contact pin assignment network plug

Contact pin of the network plug (RJ45)	Fast Ethernet MDI assignment	Fast Ethernet MDI-X assignment
1	TX+	RX+
2	TX –	RX –
3	RX+	TX+
4	Not assigned	Not assigned
5	Not assigned	Not assigned
6	RX –	TX –
7	Not assigned	Not assigned
8	Not assigned	Not assigned
Shield connection	Cable shield	Cable shield

3.4.2.3 Network Port LEDs

Colors and functionality of the network port LEDs are not standardized

Colors and functionalities of the network port LEDs are not consistently standardized. The colors "green" for the link/activity LED and "yellow" for the speed LED used by SMA Solar Technology AG as well as the respective functionalities might deviate when supplied by third-party manufacturers.

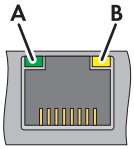

Figure 7: Network port LEDs

LED	Status	Explanation
A - link/activity (green)	off	No network connection has been established.
	flashing	Network connection established Data is being sent or received.
	on	Network connection established
B - speed (yellow)	off	Network connection established 10 Mbit/s mode; the data transfer rate is up to 10 Mbit/s.
	on	Network connection established 100 Mbit/s mode; the data transfer rate is up to 100 Mbit/s.

3.4.2.4 Terminal Assignment Color Schemes

The terminal assignment of the network cables is made in accordance with the standards ANSI/TIA-568-A or ANSI/TIA-568-B. If a Profinet cable such as SMA COMCAB is used, the assignment is based on Profinet's color scheme.

Speedwire requires two pairs as a minimum, meaning four conductors. The following table shows the terminal assignment and the respective color scheme.

Network plug contact pin (RJ45)	Terminal assignment Fast Ethernet	Color scheme for eight-wire cables in accordance with ANSI/TIA-568-A	Color scheme for eight-wire cables in accordance with ANSI/TIA-568-B	Color scheme for four-wire cables (Profinet)
1	TX+	white/green	white/orange	yellow
2	TX	green	orange	orange
3	RX+	white/orange	white/green	white
4	Not assigned	blue	blue	–
5	Not assigned	white/blue	white/blue	–
6	RX –	orange	green	blue
7	Not assigned	white/brown	white/brown	–
8	Not assigned	brown	brown	–
Shield connection	Cable shield	Cable shield	Cable shield	Cable shield

Four-wire cables are approved for Speedwire assignments of the network plugs in accordance with ANSI/TIA-568-A and ANSI/TIA-568-B. It is important that both cable ends are wired in accordance with the same industry standard. Observe the Profinet specification when using four-wire Profinet cables. This also applies to pre-assembled cables.

3.4.2.5 Network Plug Connection

Network plugs of the categories Cat5, Cat5e, Cat6 and Cat6A can be used for Speedwire ("Cat" = "category"). The category determines which data transfer rate is possible at maximum with the respective network plug.

Cat7 network plugs (also called "GG-45") are not approved since they are not downward compatible and use another pin assignment.

Connect all insulated conductors for RJ45 connection.

To avoid communication interferences, all insulated conductors must be connected when connecting the network plugs including the insulated conductors not required.

Properties/ features	Category		
	Cat5, Cat5e	Cat6, Cat6A	Cat7 (GG-45)
Speedwire approval	✔	✔	✘
Data transmission rate	Up to 10/100 Mbit and gigabit	Up to 1 gigabit and 10 gigabit	Up to 10 gigabit

Symbols used: ✔ = approved; ✘ = not approved

NOTICE

Do not use ISDN and RJ11 plugs

ISDN plugs and RJ11 plugs can also be plugged into network ports. The connected device can be damaged irreparably due to the voltage supplied to the ISDN cables.

- Never use network ports together with ISDN and RJ11 plugs.

For the network plug connection the following applies:

- The network cable shield must always be connected with the shield connection of the network plug. For further information on the network plug connection, refer to the respective network plug documentation.

4 Basics for Planning a PV System with Speedwire

4.1 Selecting the Topology

The flexible network design is an essential benefit of Speedwire. The Speedwire devices selected and their physical arrangement within the PV system determine which topology is the ideal selection. The maximum line lengths allowed between the Speedwire devices may not be exceeded (see Section 3.3.2 "Maximum Line Lengths (End-to-End-Links)", page 11). If the line lengths are exceeded, a media converter must be used for optical fibers (see Section 4.1.3 "Tree Topology", page 25).

The Speedwire network can be set up with the following optional topologies:

- Line topology (see Section 4.1.1, page 23)
- Star topology (see Section 4.1.2, page 24)
- Tree topology (see Section 4.1.3, page 25)

4.1.1 Line Topology

Requirement:

☐ The inverters must be equipped with Speedwire interfaces with two network plugs each. One network port is sufficient for the end user of a line topology.

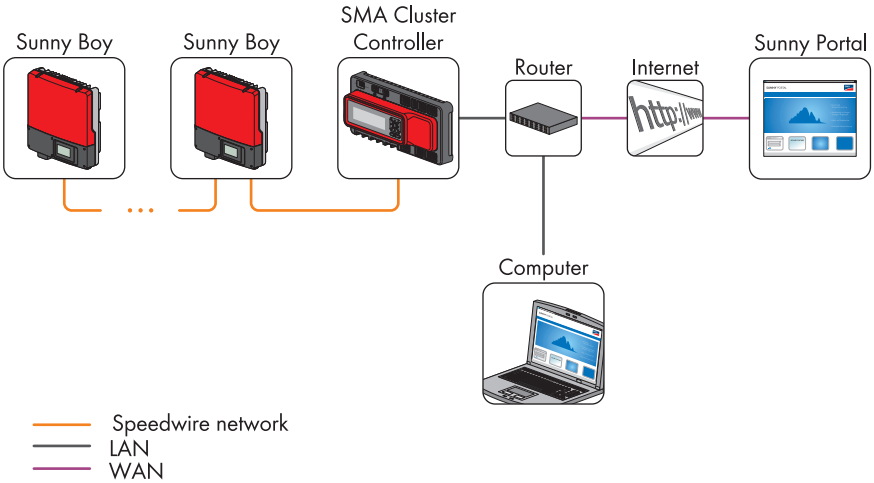

Figure 8: Line topology with Cluster Controller (example)

4.1.2 Star Topology

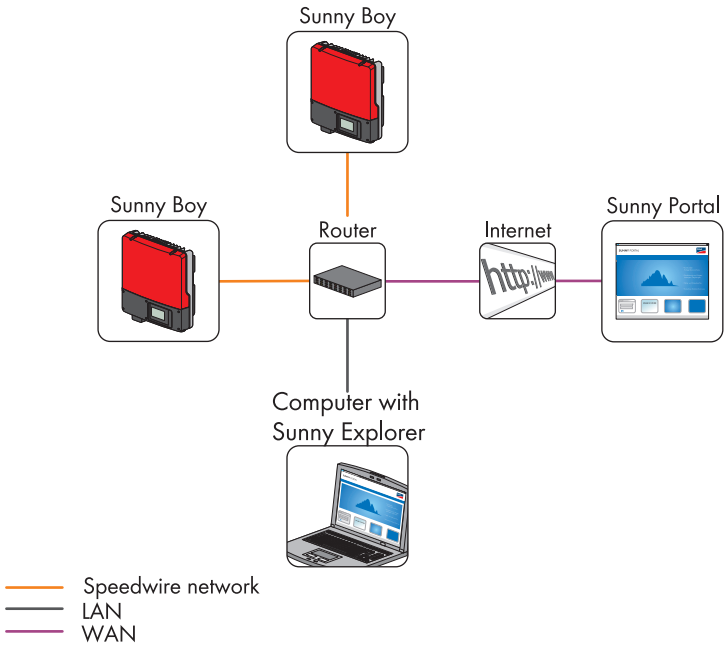

Figure 9: Star topology (example)

4.1.3 Tree Topology

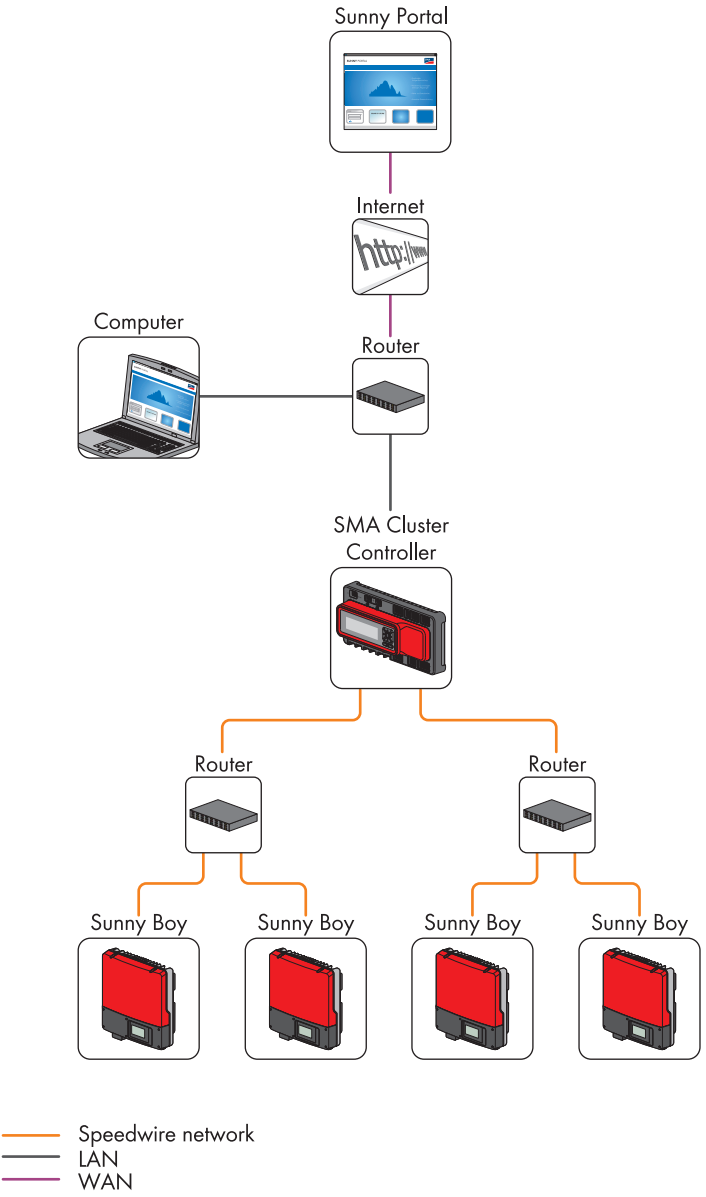

Figure 10: Tree topology with Cluster Controller (example)

4.2 Information on Laying the Network Cables

4.2.1 General Information

To ensure the optimal operation of a Speedwire PV system, the following normative guidelines must be observed when laying network cables among other things:

- EN 50174-2 (2000) Information technology – Installation of communication cabling - part 2: Installation planning and practices in buildings
- EN 50174-3 (2003) Information technology – Installation of communication cabling - part 3: Installation planning and practices outside of buildings

Observe national standards and directives

In addition to the international standards mentioned here, there can be additional national safety and laying directives for energy and data cables in your country.

- When laying network cables, observe the safety and laying directives for energy and data cables applicable in your country in addition to the international standards.

4.2.2 Information on Interference Suppression

- Observe the network cable requirements (see Section 3.4.1, page 13).
- When laying network cables, create a clearance as great as possible to other cables and observe the following minimum clearances:
  - Network cable to unshielded energy cable without separating strip: at least 200 mm
  - Network cable to unshielded energy cable with aluminum separating strip: at least 100 mm
  - Network cable to unshielded energy cable with steel separating strip: at least 50 mm
  - Network cable to shielded energy cable: 0 mm
  - Network cable to network cable: 0 mm
- Keep parallel routing of network cables and other cables to a minimum.
- When cables of different categories are crossed, make a rectangular crossing.
- Always use suitable cable glands for the inverter or switch cabinet enclosure openings.
- When laying the network cables outdoors, always lay them on metallically conductive cableways.
- Connect the joints of the cableways covering a large area and with good conductivity. The connection must be of the same material as the cableways.
- Ground metallically conductive cableways.

4.2.3 Mechanical Protection of Network Cables

NOTICE

Network cables can only be mechanically stressed to a certain extent

The network cables can be damaged when being twisted or bent or being mechanically stressed when applying pressure or being pulled.

- Observe the following mechanical safety measures when laying network cables. The network cable will be protected from cable break, short circuit of the wires and from damage to the cable sheath and cable shield.

- When laying outside of cableways, lay the network cables in a protective plastic tube.
- When laying outside of cableways in areas with heavy mechanical stress, lay the network cables in a metal armored conduit. In areas with light or medium mechanical stress, it is sufficient to lay the cables in protective plastic tubes.
- When laying in a 90° bend or across a building gap (e.g. expansion joint) the protective tube must be cut off. Do not come below the minimum allowable bending radius. It is imperative not to bend the network cables. Refer to the manufacturer's datasheet for the allowable bending radius.
- Lay the network cables in metallic armored conduits or on metallic cableways in areas or parts of buildings that are accessible or in the vicinity of transport routes.
- When storing or transporting the network cables, close both cable ends with a protective cap. Oxidation of individual wires or potential moisture and dirt collection on the network cables will be prevented.
- Laying cables over sharp edges such as cutting edges or end edges of cable channels should be avoided by all means.

4.3 Checking the Speedwire Cabling

It is recommended to check the Speedwire cabling for correct installation prior to commissioning the PV system. Each connection should be checked, especially if the network cables and network plugs were self-assembled.

Step 1 - Visual Inspection

- Were qualified network components used (see Section 3.2, page 10)?
- Were the correct cables used (see Section 3.4.1, page 13)?
- Was the maximum total length observed for the individual end-to-end-links (see Section 3.3.2, page 11)?
- Was the maximum number of interfaces not exceeded in the respective end-to-end-link?
- Were the cables not bent and was the bending radius observed (see manufacturer's data sheet)?
- Were sharp edges removed when laying the cables?
- Were the clearances to unshielded energy cables observed (see Section 4.2.2, page 26)?

Step 2 - Simple Cabling Inspection

- Test the cable shield and all wires individually with a continuity tester for electrical connection. An Ethernet line tester can be used instead of the continuity tester.
- Were all insulated conductor ends positioned correctly (e.g. test with wiremap LAN tester)?
- Using a continuity tester, make sure that there are no short circuits between the wires and the cable shield. An Ethernet line tester can be used instead of the continuity tester.
- Were all cable shields properly positioned at the plugs (see Section 3.4.2.2, page 19)?
- Was the topology observed (see Section 4.1, page 23)?

Step 3 - Extensive Cabling Inspection

The extensive cabling inspection is especially recommended when there are more than two interfaces in the end-to-end-link.

If necessary, the path attenuation must be reduced or the end-to-end link shortened to meet the channel class D requirements.

1. Measure with an Ethernet functional or acceptance tester:

   An Ethernet functional tester can be used to measure if and how fast data packages can be transmitted over the distance measured. Cabling parameters such as cable length, attenuation, crosstalk, etc. can also be measured.

   For further information on Ethernet functional and acceptance testers, refer to the technical documentation of the respective device.

2. Diagnosis of the cabling with the computer: Speedwire data traffic can be recorded and analyzed when a computer with diagnostic software is connected to the Speedwire network already in operation. The diagnostic software available on the market cannot be described more closely in this document due to its functions and operation being different. For further information on Ethernet diagnostic software, refer to the technical documentation of the respective software.

Acceptance of data links

When accepting data links, it is recommended to measure each link with an acceptance tester and to document the test results in a measurement report.

If tested and pre-assembled patch cables are used for connecting interfaces and nodes, it is sufficient to test the fixed part of the connection (permanent link).

5 Commissioning and Operation of a PV System with Speedwire

When using routers or network switches with router function, make sure that Speedwire uses addresses from the Multicast area 239/8 besides directly communicating with the individual IP nodes. The Multicast address group 239/8 (239.0.0.0 to 239.255.255.255) is defined by RFC 2365 as a locally managed address space with local and regional expansion or throughout the organization.

Observe router configuration

Make sure that the routers and network switches in your Speedwire network forward the Multicast telegrams (telegrams with destination address 239.0.0.0 to 239.255.255.255) required for the Speedwire connection to all nodes of the Speedwire network (for information on configuration of the router or network switch, see the manufacturer's manual).

Checking the Speedwire Communication with Sunny Explorer

Requirements:

- ☐ The PV system may only consist of a maximum of 50 inverters.
- ☐ The PV system must be in operation.
- ☐ Automatic IP address allocation with DHCP must be activated in your computer network settings.
- ☐ Sunny Explorer from software version 1.06 must be installed on the computer.
- ☐ Inverters with Speedwire/Webconnect Piggy-Back must be in feed-in operation to be captured.

Procedure:

1. Connect the computer to the router network port or network switch in the Speedwire network.
2. Start Sunny Explorer.
3. For PV systems not yet set up in Sunny Explorer, create a new Speedwire PV system in Sunny Explorer (see Sunny Explorer help).
4. Open the PV system already created in Sunny Explorer (see Sunny Explorer help).
5. Test whether all inverters have been detected.

   Refer to troubleshooting (see Sunny Explorer help) if not all of the inverters were captured.

Checking the Speedwire Communication with a Communication Device (e.g. Cluster Controller)

Requirements:

- ☐ The PV system with communication device must be in operation.
- ☐ The computer and the communication device must be located in the same local network.
- ☐ Inverters with Speedwire/Webconnect Piggy-Back must be in feed-in operation to be captured.

Procedure:

1. Connect the computer to a free network port within the local network.
2. Call up the communication device user interface via the Internet browser (see communication device user manual).

6 FAQ

Why is it smart to use Speedwire?

Due to performance reasons it is not possible to comply with the current standards and directives for grid integration of PV energy in all cases using the standard wired RS485 technology.

As opposed to this, Speedwire is a means to provide a continuous high-speed bus system for a future-proof PV system monitoring that also enables you to reliably control and regulate the PV system using the digital interface. By using Speedwire, the normative and legal requirements can be complied with both domestically and internationally.

Is Speedwire the same as Ethernet?

No. Speedwire is an Ethernet based system with a communication protocol (SMA Data2+) optimized for PV systems.

Are Speedwire and Webconnect the same thing?

No. The Webconnect function enables direct data transmission between the Internet portal Sunny Portal and inverters with Webconnect interface without any additional communication device. This data transmission takes place via a router with Internet access.

Speedwire enables data transmission within a local PV network with e.g. inverters and Cluster Controller or Sunny Explorer.

Do I have to retrofit my router or my network switches with Speedwire?

No. Speedwire supports most standard network components (see Section 3.2 "Requirements for Qualified Network Components", page 10) and is thereby compatible with network devices already present.

7 Glossary

Auto IP

Standard procedure in network engineering by which the Speedwire devices receive valid IP addresses which can be communicated with.

Auto Negotiation

Configuration protocol in Ethernet and Speedwire networks. Before the actual data transmission the fastest possible data transfer rate is negotiated which supports each node.

Central Inverter

Inverter concept in which all PV modules are connected to each other (in series or parallel) and a single inverter is used for feeding power into the utility grid.

DHCP

Abbreviation for "Dynamic Host Configuration Protocol". DHCP is a server service with which nodes are automatically integrated into a local network. If no DHCP should be used by the server or router in the network, nodes must be integrated into the local network manually. Static network settings must be carried out for the affected nodes (an IP address suitable for the local network and subnet mask among other things).

End-to-End-Link

Maximum line length including all connectors and interfaces between two nodes in a Speedwire network.

Ethernet

Wire-based network connection that allows data exchange between individual nodes (hardware such as computer, router, printer) in local networks through transfer of data packages. Network protocols (software such as TCP/IP) control the data transmission.

Full Duplex

Data transfer method where data packages are transmitted between two nodes bidirectionally at once. Both nodes are in send-receive-mode simultaneously.

Half Duplex

Data transfer method where data packages are bidirectionally transmitted alternately between two nodes. Both nodes alternate between send and receive mode.

Inverter

A device for converting the direct current (DC) from the PV array into alternating current (AC), which is necessary for connection of most normal household devices and especially for feeding PV energy into an existing transmission line.

IP Address

A network address that is assigned to each node exactly once so that data packages can be correctly addressed and transmitted. IP addresses can be automatically assigned when auto IP/DHCP is activated or manually assigned to the node when auto IP/DHCP is deactivated.

Network Switch

Network device connecting the nodes to each other and allows for communication in the network segment. The nodes are connected to each other via a network cable with the network switch. The network switch forwards the data packages within the network segment to the addressed nodes.

PV Cell

An electronic component that generates electrical energy when irradiated with sunlight. Since the electrical voltage of a single PV cell is very low (approximately 0.5 V), multiple PV cells are combined with PV modules. The most common semiconductor material presently used for PV cells is silicon, which is manufactured in different forms (monocrystalline, polycrystalline, amorphous).

PV Module

Electrical connection of several PV cells encapsulated in an enclosure to protect the sensitive cells from mechanical stress and environmental influences.

PV System

Designation for PV systems for power generation. This includes the complete collection of components needed for the acquisition and utilization of PV energy. In the case of grid-connected PV systems this includes the PV array as well as the inverter and other system components.

RJ45

Standardized plug in telecommunications and network engineering, also known as Western Bell plug.

Router

Network device that connects several networks with each other and routes data between the networks, e.g. between a home network and the Internet.

SMA Data2+

A communication product for PV systems developed and optimized by SMA Solar Technology AG.

Store and Forward Technology

The store and forward technology is a type of data transmission where information is sent via an intermediate station (e.g a router) which stores the data and then forwards the data to the final destination or another intermediate station at a later point in time.

Transmission Control Protocol (TCP)

Transmission protocol in computer networks which regulates the packet-switched data exchange between the individual nodes.

Twisted-Pair Cable (TP)

Cable types in telecommunications and network engineering where the wires are twisted in pairs with each other. By drilling the wire pairs, the EMC interference couplings in the individual wire loops have an effect in the opposite direction and cancel each other through difference determination.

User Datagram Protocol (UDP)

Wireless network protocol belonging to the transport layer of the internet protocol family. UDP routes the data transmitted via a network to the correct application.

Webconnect Function

A function developed by SMA Solar Technology AG which enables data transmission between the Internet portal Sunny Portal and inverters with Speedwire/Webconnect interface without an additional communication device. This data transmission takes place via a router with Internet access.

SMA Solar Technology

www.SMA-Solar.com