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Guidelines

Commissioning Guidelines PROFINET

Industrial

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1 Introduction

1.1 Prologue

This document describes the procedure for commissioning and acceptance of PROFINET networks on machines and plants. It is based on the PROFINET commissioning guidelines of the PROFIBUS user organization e.V. as well as many years of experience of the Softing service technicians. It should help to optimize and shorten commissioning and acceptance with regard to PROFINET cabling and network communication. Applicative aspects of PROFINET communication are not part of this document.

While building production lines, which consist of individual, self-sufficient functional units, separate commissioning can occur. This document takes the commissioning of the individual functional units at the location of the supplier companies and the production line at the site of the client into account.

1.2 Safety instructions

Use of the PROFINET Commissioning Guideline may result in handling hazardous substances or tools or dangerous work. Due to the many different applications of PROFINET, however, not all options or security requirements can be taken into account. Each system has different requirements. In order for you to be able to evaluate potential hazards expertly, you must obtain information about the safety requirements of the respective system before starting work. In particular, you must observe the laws and regulations of the respective country in which the system is to be operated. Also, consider general health and safety requirements and the requirements of the company for which the equipment is being built. Also consider the documentation supplied by the manufacturer for the PROFINET components.

1.3 Exclusion of liability

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2 Requirements

As a prerequisite for successful commissioning, all planning and installation work must be in conformity with the planning and installation guidelines of the PNO. All components used must be certified and approved by the manufacturers for use in PROFINET with "Conformance Class B" or higher.

The tools Analyzer IE and TH SCOPE, which scan and analyze the actual expansion of the network, are used as an integral part of the commissioning and subsequent monitoring. For this purpose, an arbitrary free port must be available in the network to be checked. A TAP (Test Access Point) or mirror port is not required.

For the cable certification further measuring devices are used:

- ❑ - WireXpert IE
- ❑ - leakage current clamp
- ❑ - impedance measuring clamp

3 Cabling measurement

3.1 General information

PROFINET is based on 100 Mbps full duplex Ethernet communication. Copper cables of category "Cat 5" or higher and fiber optic cables are used. The distances between two active components, also known as end-to-end links, must not exceed 100 m in length and have no more than 6 connectors. It is always necessary to measure the entire communication distance, regardless of the number of transitions.

Example:

- ❑ A prefabricated cable has a plug at each end ⍰ A total of two connectors
- ❑ If two cables are connected via a coupler or outlet (two connectors each) → The end-to-end link has four connectors in total

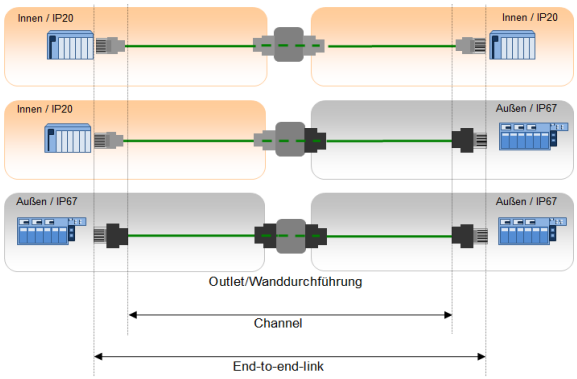

Figure 1 Definition of terms „channel“ and „end-to-end link“

Cabling Example	Number of pairs
	2
	2
	2
	4
	4
	6
	6

Figure 2 Sum of possible connectors in an end-to-end link

For manual assembly, the manufacturer's recommendations must be followed (data sheet, cable diameter) so that the selected components (cables, connectors, couplings) match. The assembly must be carried out with a suitable tool, a so-called stripping tool.

The grounding of the Ethernet cables is done on both sides by attaching the cables to the components. Additional shielding requirements are only required for cables leaving the control cabinet.

3.2 Cable certification

Basically, all cables must be certified in the installed state by means of WireXpert IE.

During certification, the cables are tested against current, relevant standards (TIA / EIA 568-C, ISO / IEC 11801, EN 50173 ...), regardless of how they are used later. Thus, they not only fulfill a specific application, but all requirements for this class, e.g. "Class D" with PROFINET. The standards not only describe the parameters and limit values for the cables and components (NEXT, FEXT, ACR, IL etc.), but also specify the measuring methods. For PROFINET cabling, a test must be carried out according to the end-to-end link measuring method. The classic channel measurement method must not be used as the first and the last connector are hidden here (see Figure 1).

For PROFINET, a test in accordance with ISO / IEC 11801, Cat 5 / Class D must be performed.

3.3 Measuring shield currents

Shielded cables are used with PROFINET. The shield must be connected to the shield contact of the connectors at both ends of the cable. These in turn have contact with the ground connections of the ports. The active PROFINET components must ensure that they themselves and the ground of the port are connected with low impedance to the protective conductor.

If two components with different potentials are connected with an Ethernet cable, potential equalization across the shield can occur. This shield current is not permitted and can lead to disturbances in the transmission or even destruction of the modules.

The shield current is determined with the leakage current clamp and must not exceed the value of 40 mA. Otherwise, the grounding measures must be checked.

The measurements are to be carried out on the PROFINET cables which connect different parts of the system. The measurements must be made under "load condition" (i.e. system in operation). In order to avoid potential equalization current across the shield, a very fine wire (at least 6mm2) must be laid between the potentials.

The documentation is given in the corresponding checklist in the annex with details of the cable number / equipment number.

4 Target/actual-comparison

For the tests listed below, a diagnostic module TH LINK PROFINET with TH SCOPE or a PC with Analyzer IE is used. The system must be ready for operation and switched on.

4.1 Line depth

The definitions made in the planning regarding the topology and line depth must be checked. To determine the line depth, all passing devices of a communication link (delay times of the switches) are counted.

The maximum recommended line depth depends on the type of switch and the cycle time. The following tables of the PNO Commissioning Guidelines show the recommended maximum values.

Maximum line depth when using store-and-forward switches

Maximum line depth at refresh time of			
1 ms	**2 ms**	**4 ms**	**8 ms**
7	14	28	58

For these line depths, the transit time for line topology in worst-case view reaches the magnitude of the update time.

Maximum line depth when using cut-through switches

Maximum line depth at refresh time of			
1 ms	**2 ms**	**4 ms**	**8 ms**
64	100	100	100

Mixed arrangements of store-and-forward and cut-through switches are possible. In this case, the thresholds for "store-and-forward" switches should be assumed. For reasons of diagnosability and availability of the system, only manageable switches should be used.

4.2 Check number of participants and IP addresses

- ❑ Do the number of configured and found PN participants agree?
- ❑ Are there other occupied IP addresses? Are they correct?
- ❑ Have devices been found in delivery state?
- ❑ Have unconfigured unassigned devices been found?
- ❑ Have failed devices been found?
- ❑ Have all devices set the same subnet mask and gateway address?

4.3 Check the naming scheme

- ❑ The name scheme and the IP range must be agreed with the responsible electrical planner. All participants must be checked for plausible and complete names.

4.4 Check firmware and GSDML

- ❑ The firmware and software versions are checked and documented using TH SCOPE / Analyzer IE
- ❑ Do all devices have plausible order numbers and firmware versions (no prototypes)? With the help of the firmware whitelist, automatically released firmware versions can be compared in TH SCOPE / Analyzer IE. If no firmware whitelist is available, make sure that all devices of the same type have the same firmware version.

4.5 Check topology and network statistics

- ❑ Does the automatically generated topology show the same arrangement of participants as the planned topology?
- ❑ Do all PROFINET participants have topology information?
- ❑ Are the participants connected to the correct ports?
- ❑ Is the redundancy manager marked for media redundancy (MRP) and free from interference?
- ❑ Does the line depth meet planning requirements, depending on the refresh rate and switch behavior?
- ❑ Is 100 Mbps full duplex negotiated for all ports to which PROFINET devices are connected?
- ❑ Is the port utilization at max. 50%?

4.6 Check diagnostics and error statistics

- ❑ Are failures, diagnoses or lost packages displayed?
- ❑ Can the causes of any problems be identified and eliminated?

5 Performance test

After commissioning and acceptance, the PROFINET communication of the system is tested for 24 hours under production conditions. The TH LINK is restarted for this purpose and all diagnostic entries are deleted. After 24 hours, an evaluation is made of any defects that have occurred.

6 Documentation

The documentation of all results is done in 3 steps.

6.1 Documentation of visual inspection

A checklist will be filled which will evaluate the quality of the installation. This list contains the criteria of the commissioning guidelines of the PNO.

The checklist can be found in the annex "Checklist visual inspection “

6.2 Documentation of cabling measurement

For all PROFINET cables, a measurement protocol (certification) must be created. All cables must be measured after installation. The automatically generated measurement protocols must contain the cable names.

The measured shield currents and impedances are tob e entered in the corresponding lists in the annex.

6.3 Documentation of actual state

When documenting the actual state, all participants should be listed in the inventory data including firmware versions, error and network statistics. Likewise, a current topology plan automatically generated by TH SCOPE / Analyzer IE and a reference file must be created.

7 Checklist visual inspection

No.	Action	Result
1	Cables labeled at both ends?	Yes ☐ No ☐
2	Cables laid according to plan?	Yes ☐ No ☐
3	Cable type corresponds to the planning (flexible, prefabricated)?	Yes ☐ No ☐
4	Maximum 100m line length (end-to-end link) complied with?	Yes ☐ No ☐
5	Maximum number of connectors in the end-to-end link complied with (6 pieces)?	Yes ☐ No ☐
6	Connectors used according to the planning (RJ45, M12, ...)?	Yes ☐ No ☐
7	Minimum cable distances maintained (unshielded power cable 200 mm) or if necessary metallic separator bars inserted (aluminum 100 mm, steel 50 mm)?	Yes ☐ No ☐
8	PROFINET cables undamaged?	Yes ☐ No ☐
9	Bending radii kept (approx. 10x cable diameter)?	Yes ☐ No ☐
10	Cable intersections executed at right angles?	Yes ☐ No ☐
11	Sharp edges on the cableway removed or covered?	Yes ☐ No ☐
12	No cables kinked?	Yes ☐ No ☐
13	Precautions against mechanical damage at critical points? (e.g., wall penetrations)	Yes ☐ No ☐
14	Strain relief installed (about 300 mm between unloading and participants)?	Yes ☐ No ☐
15	Cable certification performed?	Yes ☐ No ☐
16	Equipotential bonding made at the stations?	Yes ☐ No ☐
17	Cable shield is placed in the plugs?	Yes ☐ No ☐
18	Cable shield connected to the equipotential bonding at the barrier entry?	Yes ☐ No ☐
19	Cable ducts connected to equipotential bonding?	Yes ☐ No ☐

8 Checklist shield current measurement

No.	Cable label	Current in mA	Passed (< 40 mA)
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐

9 Checklist impedance measurement PROFINET cables

No.	Cable label	Impedance in Ω	Passed (≤ 0,6 Ω)
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐

10 Checklist impedance measurement grounding cables

No.	Measuring location	Impedance in Ω	Passed (≤ 0,3 Ω)
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐
			Yes ☐ No ☐

11 Checklist target/actual-comparison

1. Check the number of participants and IP addresses		
1.1	Does the number of configured and found PN participants match?	Yes ☐ No ☐
1.2	Are there any other assigned IP addresses?	Yes ☐ No ☐
1.3	Do these other addresses belong to the network?	Yes ☐ No ☐
1.4	Were devices found in delivery state?	Yes ☐ No ☐
1.4	Have unconfigured unassigned devices been found?	Yes ☐ No ☐
1.6	Are failed devices displayed?	Yes ☐ No ☐
1.7	Have all devices set the same subnet mask and gateway?	Yes ☐ No ☐
2. Check the naming scheme		
2.1	Is a naming scheme specified by the client?	Yes ☐ No ☐
2.2	Is the given length of names correct?	Yes ☐ No ☐
2.3	Has the naming scheme been adhered to for the participants?	Yes ☐ No ☐
3. Check firmware and GSDML		
3.1	Have FW and SW revisions been displayed and documented in TH SCOPE?	Yes ☐ No ☐
3.2	Do all devices have plausible order numbers and firmware versions (no prototypes etc.)?	Yes ☐ No ☐
4. Check topology and network statistics		
4.1	Does the automatically generated topology show the same arrangement of participants as the planned topology?	Yes ☐ No ☐
4.2	Do all PN participants have topology information?	Yes ☐ No ☐
4.3	Are the participants connected to the correct ports?	Yes ☐ No ☐
4.4	Is the redundancy manager marked with ring redundancy and free from interference?	Yes ☐ No ☐
4.5	Does the line depth match the planning specifications, depending on the refresh rate and switch behavior?	Yes ☐ No ☐
4.6	Are 100 Mbps DX negotiated for all ports to which PROFINET devices are connected?	Yes ☐ No ☐
4.7	Is the port utilization at max. 50%?	Yes ☐ No ☐
5. Check diagnostics and error statistics		
5.1	Are failures, diagnoses or lost packages displayed?	Yes ☐ No ☐
5.2	Can the causes of any problems be identified and eliminated?	Yes ☐ No ☐
6. Documentation actual state		
6.1	Topology, reference, export created with TH SCOPE / Analyzer IE?	Yes ☐ No ☐
6.2	Report created with TH SCOPE / Analyzer IE?	Yes ☐ No ☐