



Certified PROFINET Network Installer

CPNI

**TC 1 / WG 9 draft
Learning Outcomes**

for PROFINET

**Version 1.0
August 2008**

Order No: 4.822

Document Identification: TC1-WG9-08-0001
File name : LO_CPNI_4822_V095_Aug08.doc

Prepared by the PROFIBUS Working Group 9 "Training" in the Technical Committee 1 "Test and Certification".

This Learning Outcome is one of a series of several courses:

- 5.11 Certified PROFIBUS Engineer
- 5.12 Certified PROFIBUS Installer
- 5.13 Certified PROFIBUS-PA Engineer
- 5.21 Certified PROFINET Engineer
- 5.22 Certified PROFINET Installer

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Content

1	Aims & Objectives	4
2	Learning Outcomes	5
3	Instructors	5
4	Training and assessment methods	6
5	Syllabus	6
5.1	General PROFINET knowledge [2 hour]	6
5.2	Signal transmission and pickup [30min].....	6
5.3	Installation practice [2 hour].....	6
5.4	Fibre optics [15 min]	6
5.5	Proxy technology [15 min].....	6
5.6	Switch technology [1 hour].....	6
5.7	Test preparation [30 min]	6
6	Text Books	6
7	Training Equipment	7
8	Assessment Scheme	8

List of tables

Table 1: LO

Revision Log

Identification	Version	Originator	Date	Change Note / History / Reason
TC1-WG9-08-0001a	1.0	TC1 WG9 Training	29 Aug 08	Initial version

1 Aims & Objectives

Automation and control system networks operate in a different environment and have different performance requirements to office and IT networks. For example, factory automation or plant control systems are quite often installed in environments where interference from electrical equipment is present. Mechanical vibration, physical impact and exposure to corroding chemicals are also common hazards. Cable, connectors and other network components must be robust and protected against such factors. The requirements on network performance and reliability are also much more challenging because the automation and control systems must operate for long periods without any failure, disruption of communications or delay. For this reason, it is essential that industrial network installations are designed correctly and installed by suitably trained and qualified people.

This course aims to provide the theoretical knowledge and practical competence to layout, install, test and maintain PROFNET networks in an industrial environment. The Course is suitable for those with no previous experience of networking or digital communications. However, even experienced technicians can gain significantly from taking this course. The course provides a first stage of training course for those who are involved with the design, installation, commissioning and ongoing maintenance of PROFINET systems.

The course provides an introduction to PROFINET terminology, operation and characteristics. It aims to provide a basic understanding of the problems that can occur in high speed digital communication systems, their causes and solutions. The various rules and guidelines for PROFINET network layout and installation are covered and practical techniques for implementing these are explored in a hands-on and practical way. The course teaches how to make-up and test common types of cable and connectors. The common types of fibre-optic cables are also covered, but fibre splicing and testing is outside the scope of the course. The course covers the basic methods of configuring and testing switched and other intelligent network components.

2 Learning Outcomes

On successful completion of this course candidates will be able to:	Assessment Mode
General PROFINET knowledge	
Know how PROFIBUS International is organised and know how to obtain information and support.	Theory Exam
Outline the OSI/ISO seven-layer model focused on Layer 1 to 4 and 7. State the layers that are used in PROFINET and in particular the RT and non-RT channels.	Theory Exam
Understand the meaning of IP address, Subnet mask, MAC address and Device name.	Theory Exam
Describe the basic characteristics of a repeater, hub, switch, router, gateway and proxy.	Theory Exam
Understand that PROFINET uses 100Mbit/s full duplex communication, implemented exclusively using switches. Understand that switches can be integrated in devices.	Theory Exam
Understand that PROFINET cabling can use copper or fibre-optic wiring.	Theory Exam
Appreciate the various types of IO device that are found in PROFINET networks.	Theory Exam
Understand concept of network configuration and the function of GSD files.	Theory Exam
Signal transmission and pickup	
Understand the basic mechanisms of interference pickup and apply a range of methods to avoid or reduce pickup on PROFINET cables.	Theory Exam
Understand that PROFINET cables are always between two devices and that termination is provided by the connected devices. Recognise the possible causes of reflections on PROFINET cables. Understand that spurs must never be used on PROFINET cabling.	Theory Exam
Understand the differences between an IT (office) environment and the factory or plant floor. Know that Screened twisted pair cables are always used on PROFINET Installations.	Theory Exam
Understand and apply the length restrictions for PROFINET cables.	Theory Exam
Recognise the importance of cable segregation. Determine the required cable separation distances for a range of applications.	Theory Exam
Understand that trunking or conduit can be used to improve pickup performance.	Theory Exam

Table 1: LO

3 Instructors

The instructor(s) must have passed the Certified PROFINET Engineer Course as a minimum and must be registered with PI.

4 Training and assessment methods

The training should cover the topics listed in the syllabus below and must cover the required learning outcomes. An example slide-set in English is provided by PI as a guideline. The delivery may be customised and formatted to suit the desires of the instructor and the needs of the candidates. The training must include a significant practical element in which the candidates build and test a small network and practice finding faults on pre-made test cables.

It is a good idea to include a short tutorial session in which revision/practice questions are answered and checked with the aid of the instructor. The tutorial questions should generally be open-ended to promote discussion and explore any weaknesses or misunderstandings the candidate(s) may have. If possible, pictures or examples of poorly installed networks and wiring errors from real installations should be included to give realism to the training.

5 Syllabus

- | | |
|---|-----------------|
| 5.1 General PROFINET knowledge | [2 hour] |
| <input type="checkbox"/> Organisation of PROFIBUS International.
<input type="checkbox"/> Overview of PROFINET technology, layout, cabling and devices.
<input type="checkbox"/> Outline of the OSI/ISO seven-layer model.
<input type="checkbox"/> IP addressing, subnet masks, MAC address and device names.
<input type="checkbox"/> Repeaters, hubs, switches, routers, gateways and proxys.
<input type="checkbox"/> Concept of PROFINET network configuration and use of GSD files. | |
| 5.2 Signal transmission and pickup | [30min] |
| <input type="checkbox"/> Basic mechanisms of interference pickup on cables.
<input type="checkbox"/> Special requirements for network wiring in an industrial environment. | |
| 5.3 Installation practice | [2 hour] |
| <input type="checkbox"/> PROFINET cable construction and specification.
<input type="checkbox"/> Practical building and testing of PROFINET cables using standard types of connectors.
<input type="checkbox"/> Alternative cabling arrangements including power over the cable schemes.
<input type="checkbox"/> Overview of causes and effects of reflections on PROFINET cables.
<input type="checkbox"/> Length restrictions for PROFINET cables.
<input type="checkbox"/> Cable segregation requirements and application. | |
| 5.4 Fibre optics | [15 min] |
| <input type="checkbox"/> Advantages of using fibre-optic cables for PROFINET.
<input type="checkbox"/> Overview of common types of fibre-optic cable and the general requirements for making and testing fibre-optic cables. | |
| 5.5 Proxy technology | [15 min] |
| <input type="checkbox"/> Basic function and characteristics of a proxy. | |
| 5.6 Switch technology | [1 hour] |
| <input type="checkbox"/> Basic function and characteristics of switches.
<input type="checkbox"/> Practical set up of a switch using web-page based configuration.
<input type="checkbox"/> Use of common switch topologies including redundant systems. | |
| 5.7 Test preparation | [30 min] |
| <input type="checkbox"/> Tutorial questions and examples of good/bad practice | |

6 Text Books

- PI; "PROFINET Cabling and Interconnection Technology Guideline", Version 2.00, March 2007, Order No: 2.252.

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- Popp. M and Weber, K; "The Rapid Way to PROFINET", PI Order No 4.182, 2004.
 - IEC61000-5-3; "Electromagnetic Compatibility (EMC), part 5: Instillation and mitigations guidelines, section 2: Earthing and cabling", 1997

7 Training Equipment

The following description of training equipment represents a minimum requirement and is included as a guide only. Each PITC (PROFINET International Training Centre) is free to decide on the precise type of equipment and its configuration. The practical setup must be suitable for the teaching and practice exercises and for the practical test.

Example set-up:

A typical training kit should meet the following minimum requirements:

- The training rack should have at least two PROFINET IO devices with standard (RJ45 or M12) connectors. At least one switch must be provided, however this can be integrated into one of the PROFINET devices. The devices and switch should be mounted together with a suitable power supply. Note that manufacturer's electrical safety instructions should apply to the power supply wiring.
- No more than two candidates should share each training rack.
- Sufficient cable, connectors and installation tools should be provided to allow the devices to be wired into a network.
- Each pair of candidates will require a hand-held cable test tool.
- Optionally a PROFINET controller can be included to exercise the network; however this is not a course requirement.
- A set of pre-made test cables each with a single defined built-in fault (e.g. short circuit, open circuit, crossed wires, wrong pairing etc). The test cables should be easily identifiable.
- A laptop computer should be available with an internet browser suitable for configuring a switch. However. it is not necessary for each pair of candidates to have their own laptop.

8 Assessment Scheme

The assessment is a combination of practical and theory examinations. Candidates must pass both components to pass the course. A score of 70% is required to pass each component. All testing is “open book”, that is the candidate can use the course notes and other reference material freely during the test.

Practical Test (45mins)

Build and test a PROFINET cable	30%
Locate and describe the fault in a given (unseen) test cable.	20%
Check the configuration of a switch using a web-page browser	40%

Theory Test: (45mins)

The exam questions are to be picked from a central database of questions. This database is set up and administered by PI. Each question in the database is given a percentage weight. Each PITS should select appropriate number of questions from each section to achieve the approximate breakdown given below.

General PROFINET knowledge	30%
Signal transmission and pickup	10%
Installation practice	30%
Fibre optics	10%
Proxy technology	10%
Switch technology	10%

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