Indu-Sol GmbH – Specialist in Industrial Networks

PROFINET

Safety for the future

Products

Diagnosis

Monitoring

Training

Consulting

Notes

Content

Industry 4.0 – New challenges for automation

The 4th industrial revolution – also known as Industry 4.0 – describes a development where production companies increase the degree of networking and automation in their value creation chain so high that intelligent machines and systems can process digital product information automatically for the most part and increasingly organise processes autonomously. In this manner, even single pieces can be manufactured according to individual sizes (so-called batch size 1) within a reasonable economical range and thus open up new markets.

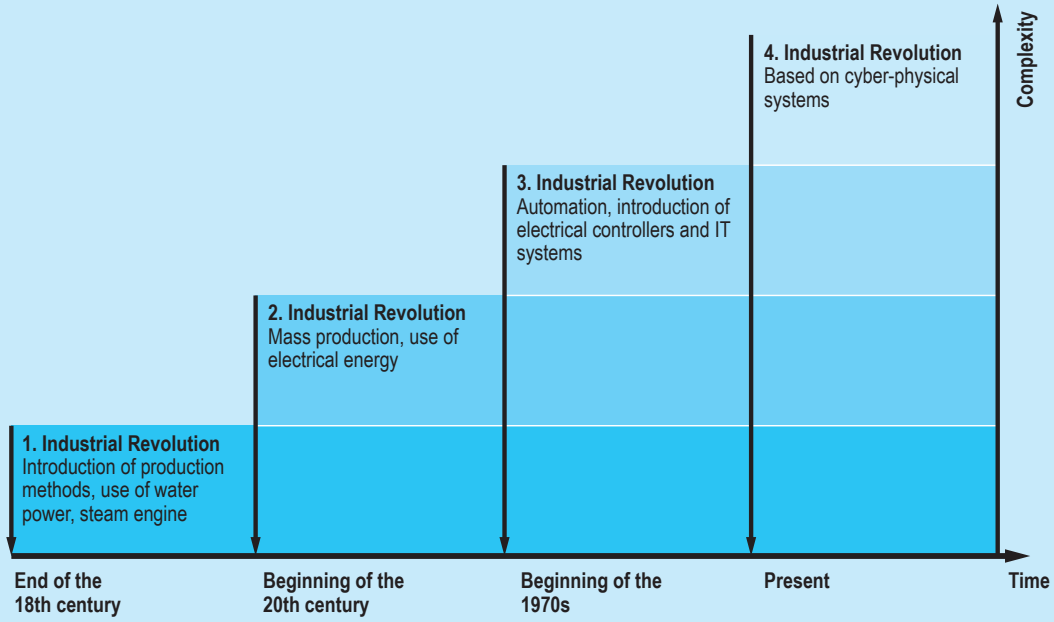


Fig. 1: Schematic presentation of the four industrial revolutions

Source: DFKI

Prof. Dr. Henning Kagermann (German Academy of Sciences), Prof. Dr. Wolf-Dieter Lukas (Federal Ministry for Education and Research) and Prof. Dr. Wolfgang Wahlster (German Research Centre for Artificial Intelligence) went public in 2011 with the "Initiative Industry 4.0" and thus coined a term that has found rapid increased use since. By establishing the "Platform Industry 4.0" (2013) for the coordination of the developments, the federal government has declared this as a topic for top management.

In practical application, it is becoming clear that Ethernet-based networks such as PROFINET will gradually replace field-bus technology and thus become the pathfinder for Industry 4.0 at the production level (operational technology, OT). Networks, which still have a mostly local structure today, will in the future grow together from the classically hierarchic structure of the automation pyramid into a large, complex network of decentralised distributed intelligences (so-called cyber-physical systems, CPS) (see Fig. 2 and 3).

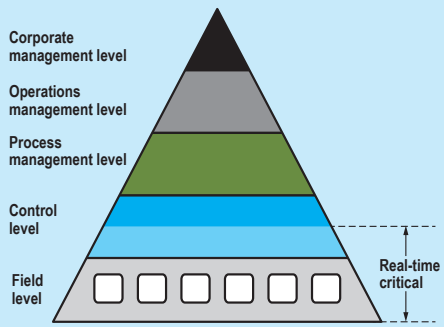


Fig. 2: Automation pyramid

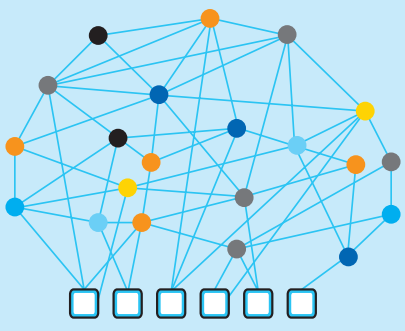


Fig. 3: CPS-based automation

Source: VDI

In the face of a vast array of solutions offered by industrial Ethernet-applications, the challenge lies in finding a common system without communications obstacles that satisfies all requirements. It is becoming clear that in the future more interest will be focussed on standard Ethernet and different, parallel existing protocols will drop away. The IEEE task force TSN (Time Sensitive Networking) was created to give real-time capability to standard Ethernet.
Security aspects are gaining importance as well (see below). Thanks to the advances of digitisation, production is increasingly controlled by data that is provided by intelligent sensors and devices. This data can be retrieved directly from the office level (information technology, IT), which likewise communicates via Ethernet. External (unauthorised) access is possible just as well however.

In order to understand data flows under the conditions of an increasing blending of IT and OT and to ensure security, it is becoming increasingly important to know:
Who communicated what with whom when by which means?

Security for Automation 4.0

The blending with IT however does not permit the acceptance of its security measures for the automation technology. The task for IT is rather to prevent unauthorised external access to data whereas automation technology places its focus on attacks „from inside“. Whether they are own staff or visiting service technicians – they can, possibly even unintentionally, cause quality-relevant incidences by supposedly harmless actions such as an active network scan or the loading of firmware updates.

Currently such accesses to the network cannot be regulated without endangering its availability. The correct concept by IT of shielding off to the outside for protecting the data is, however, in direct contrast to the point of view of automation technology with its idea of increasing networking of customers and producers in the whole world. The events need to be recorded though to recognise their causes and to even notice such attacks.
Today‘s approach by Indu-Sol is based on the log analysis by permanent network monitoring (PNM). In combination with the network monitoring software **PROmanage® NT** (see page 24), the passively operating measurement and diagnostic tool **PROFINET-INspektor® NT** (see page 17) thereby analyses the logical data traffic in the network. Anomalies, such as unknown participants in the network or delays in the data transmission (so-called jitters, see page 8), are reported immediately.

When these quality-relevant events are recorded additionally and kept on hand, the operator knows at any time what is going on in his network.

Basics

PROFINET is a universal, Ethernet-based communication network that can be used in all areas of automation technology. Speedy vertical and horizontal data exchange across all levels – including the corporate control level – is the foundation for successful systems concepts.

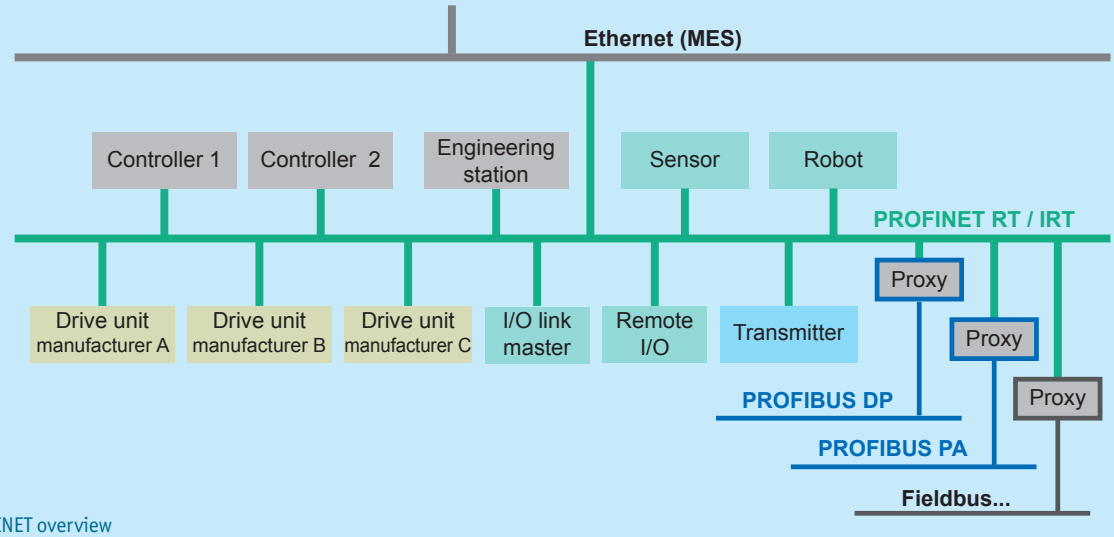


Fig. 4: PROFINET overview

Like PROFIBUS, PROFINET distinguishes between acyclical and cyclical data communication (RT – Real Time) and additionally supports fast I/O communication (IRT – Isochronous Real Time). This is done while retaining the familiar design with a cyclical transfer of peripheral data between the field devices (IO devices) and the process image in the IO controller. This results in a high degree of flexibility because update rates are scalable (see Fig. 5).

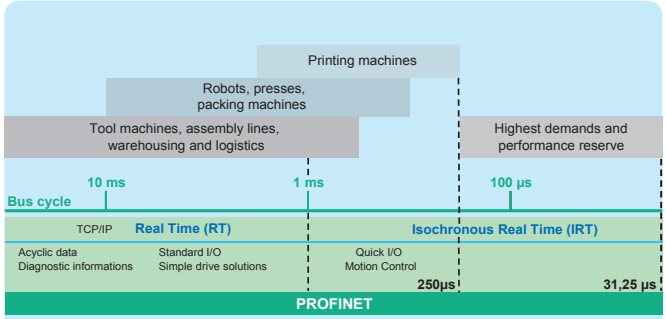


Fig. 5: Scalable bus cycle times (RT and IRT) in PROFINET

PROFINET describes a device model that is based on the principles of PROFIBUS and consists of slots and groups of IO channels (sub-slots). The technical characteristics of the field devices are described by a so-called GSD (General Station Description) that is based on XML.

Data in PROFINET networks is highly varied. Besides prioritized, cyclical PROFINET I/O data, acyclical data (e.g. TCP/IP, diagnostic messages or SNMP requests) can be transmitted (see Fig. 6).

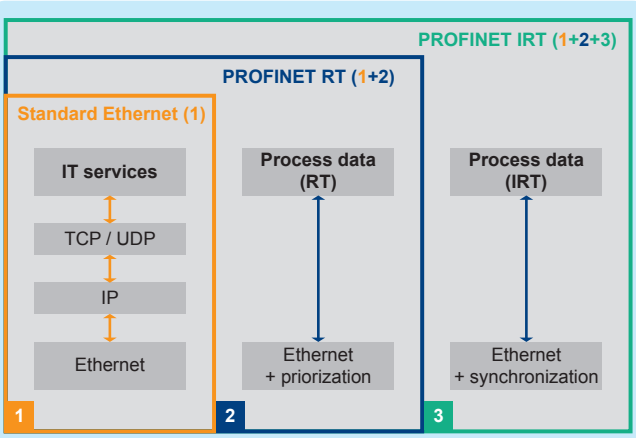


Fig. 6: Three communication channels in PROFINET

Network topologies in PROFINET derive from the requirements of the systems to be networked. The most common structures are star, line, tree and ring-shaped. In practice, systems usually are a mix of the above structures. They can be implemented either with copper or fiber-optic cables.

Standards and guidelines

Criteria for quality evaluation in the PROFINET are based on the following list of standards and guidelines as well as the experience of **Indu-Sol GmbH**. Observing them is the basis for any measurement, planning, acceptance inspection and commissioning.

- PI PROFINET Design Guideline and Commissioning Guideline – (V 1.14 and V 1.36) December 2014
- PROFINET I/O Security Level 1 (netload) – Version 1.2.1 – March 2016
- PI PROFINET Assembly Guideline – (V 1.0) January 2009
- PROFINET Conformance Classes – Version 1.1 – March 2011
- EN 50173 / ISO IEC 11801 – Structured cabling systems
- EN 50310 – Application of equipotential bonding and earthing in buildings with information technology equipment
- VDI / VDE Guideline 2184 – Reliable operation and maintenance of fieldbus systems
- Functional grounding and shielding of PROFIBUS and PROFINET

PROFINET Design Guideline and Commissioning Guideline

The extensive options for configuration and utilization of a network necessitate careful planning and practice-oriented commissioning of the system. The user organization PROFIBUS & PROFINET International (PI) has defined quality criteria for planning, acceptance and commissioning, as well as the metrological evaluation of a network in its latest **Design and Commissioning Guideline**. It is intended as a guideline for all persons and organizations involved in the planning, installation, operation and maintenance of such systems.

In the planning stage, network utilization should be considered in addition to structure. For this purpose, it is important to know the relationships between update rate, line depth and network structure. Practical planning tools like **PROnetplan** by **Indu-Sol** can be used to display such relationships in an interactive graphic to avoid weak spots.

Moreover, it is useful to define the requirements for IO devices in advance. The categorization in Conformance Classes (CC-A, CC-B, CC-C) is a useful aid to users when selecting devices that have no more than the required functionality. Requirements include simultaneous access to devices by several controllers (IO controllers), support for media redundancy, detection of topology information in the network, device exchange without repeated use of a parameterization device, as well as applications with very short cycle times and low variation.

The selection and placement of network components in the network structure depends on the performance of the devices. It is described by the net load classes (IO Security Level 1 – see the “standards and guidelines” box).

The years of experience with fieldbus technology have shown that the extensive diagnostic options of controllers in the area of device diagnostics should be expanded by an additional measurement to verify the quality of communication. The measurements serve as dual purpose, namely a description of the PROFINET network on the one hand and ensuring operational reliability on the other. Special attention should be paid to assuring the quality of the line connections (test when plant is stopped) as well as the transmission during operation.

RECOMMENDATION

In order to ensure reliable long-term functionality of the plant, measurements to verify compliance with the quality requirements (pages 9 and 19) are urgently recommended.

Parameters for network planning

Planning the network structure

The key properties of PROFINET are a variable network structure and the unlimited combinations provided by exploiting all topological shapes of the standard Ethernet. The topology results from the following criteria:

- Spatial arrangement of the components
- Distances to be bridged
- Requirements for the use of primary infrastructure / increased availability
- Consideration of netload (netload planning) and TCP/IP traffic
- Update rate in consideration of line depth
- Communication quality and telegram traffic
- Requirements for potential isolation/EMC

Selecting the right topology is important for the further planning of a PROFINET automation system. If required, the topology has to be adapted in a later inspection step.

Sources: PI Design Guideline (V 1.14 / Dec. 14) **pp. 51-56**
PI Commissioning Guideline (V 1.36 / Dec. 14) **pp. 91/92**

Update time

The update rate is the interval at with the data between the controller and IO device is updated. It can be set individually for each device in the controller (standard setting: 2 ms). In addition to considering the requirements of the process, also consider the PLC cycle time. Indu-Sol recommends setting the update time for devices to at least half the PLC cycle time. The guiding principle is **"Update only as necessary – not as much as possible."** The switching behavior of each device and the installed line depth, i.e. the number of passing devices (switches and IO devices with integrated switches) on the line, are critical for compliance with the update rate. An increasing number of passing devices prolongs the duration of the telegram. The variation of the real from the set update rate keeps increasing. It is called **"jitter"** and indicated in percent. Measurements to show compliance with the set update rates and their variation may serve as a basis for an assessment of system stability and provide an early warning of potential weak spots.

Sources: PI Design Guideline (V 1.14 / Dec. 14) **pp. 97-99**
PI Commissioning Guideline (V 1.36 / Dec. 14) **p. 104**

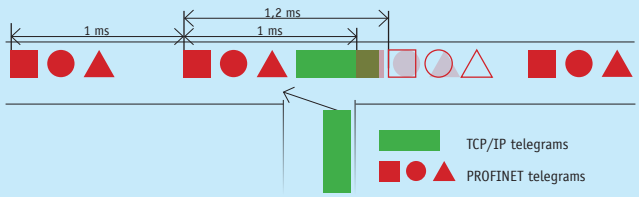


Fig. 7: Illustration of telegram jitter

Netload

The cyclical netload generated by each PROFINET device has a maximum in the connection between the controller and the first device. In order to permanently ensure the flawless functioning of the PROFINET network the following tolerances for planning and realization have to be ensured:

Netload	Recommendation
< 20%	No action required
20% ... 50%	Review of planned netload is recommended
> 50%	Take action to reduce netload

It can be seen from the practical applications that the existing netload consists of both PROFINET and TCP/IP communication. Although the PROFINET communication is generally prioritized at switches (network nodes), TCP/IP communication may sometimes jump the queue. Whether and to what extent this happens – or can happen – can be seen from the load ratio (PROFINET to TCP/IP communication). Since different netloads (peak loads) affect the compliance with update rates and devices of different netload classes are especially sensitive to peak loads demonstrating the network quality in consideration of utilization is especially important during the acceptance test or troubleshooting of a system.

Sources: PI Design Guideline (V 1.14 / Dec. 14) **pp. 115-118**
PI Commissioning Guideline (V 1.36 / Dec. 14) **pp. 95/96**

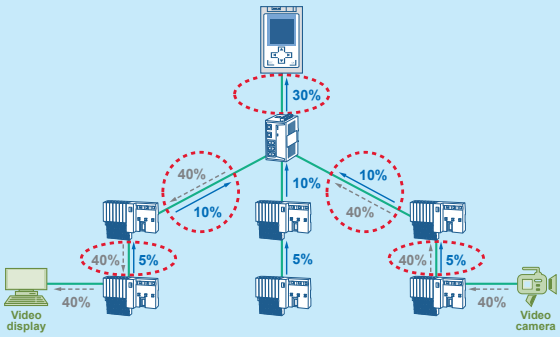


Fig. 8: TCP/IP devices are connected unfavorably → higher netload

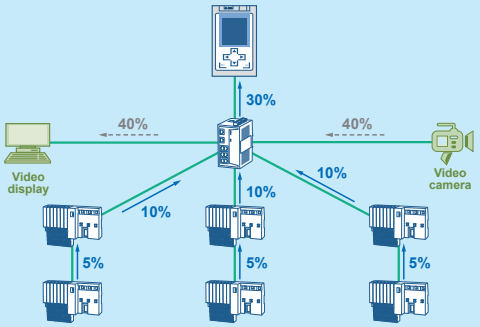


Fig. 9: TCP/IP devices are connected optimally → low netload

Line depth

Because in PROFINET (RT) it cannot be determined whether a device (switch) is operating in store-and-forward or in cut-through mode a delay has to be expected for every passing device.

This delay has to be considered when designing a network in the planning phase. Fundamentally, the maximum line depth depends on the update time and the switch mode (see the "line depth" tables). Indu-Sol recommends observing the values from the PI guideline "Line depth for store-and-forward switches".

Source: PI Design Guideline (V 1.14/Dec. 14) **pp. 111-114**

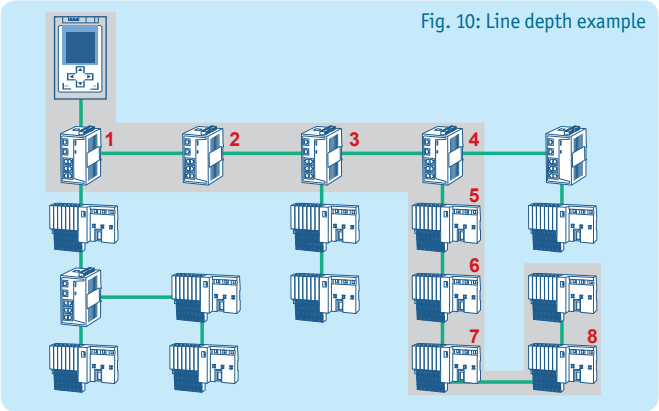


Fig. 10: Line depth example

Line depth for store-and-forward switches

Max. line depth for update time of			
1 ms	2 ms	4 ms	8 ms
7	14	28	58

Line depth for cut-through switches

Max. line depth for update time of			
1 ms	2 ms	4 ms	8 ms
64	100	100	100

Access points

When planning PROFINET networks the guideline recommends passive access points for network diagnostics.

Why?

- During commissioning or maintenance, to analyze the network traffic or read out devices
- To connect diagnostic devices during running operation without interruption
- For troubleshooting or long-term diagnosis/preventative maintenance of the network condition

How?

- Using passive, feedback-free TAPs
  (e.g. **PROFINET measuring points PNMA II/PNMX** – see page 27)
- Using a smart TAP
  (e.g. **PROFINET-INspektor® NT/iPNMA** – see page 17, 23)

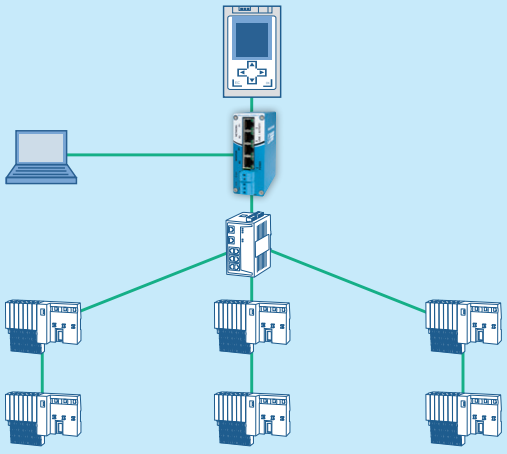


Fig. 11: Network diagnosis via access point (TAP) – e.g. PNMA II

Please note:

In principle, an initial rough analysis of the network traffic (telegram analysis) is also possible via a mirror port on the switch using analysis software (e.g. Wireshark). However, this port only delivers 100 Mbps.

But the cable carries incoming data to the controller at 100 Mbps on one wire pair and outgoing data from the controller at 100 Mbps on the other wire pair. Thus the port of the switch cannot diagnose more than one half of the data flow.

Source: PI Design Guideline (V1.14/Dec. 14) **pp. 90-91**

RECOMMENDATION – Quality values

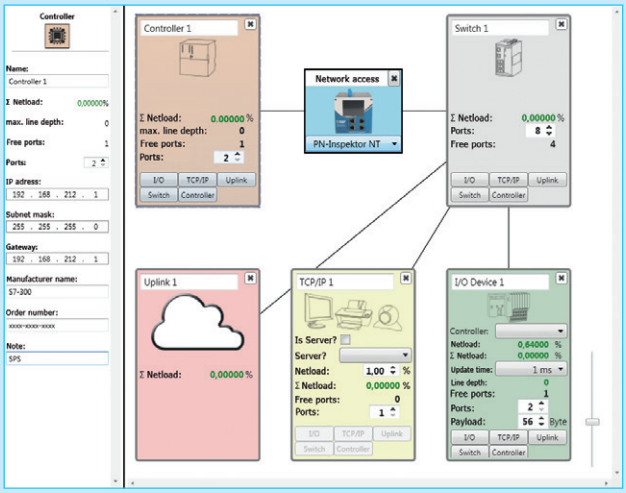
Recommendations on the quality values in PROFINET by **Indu-Sol**

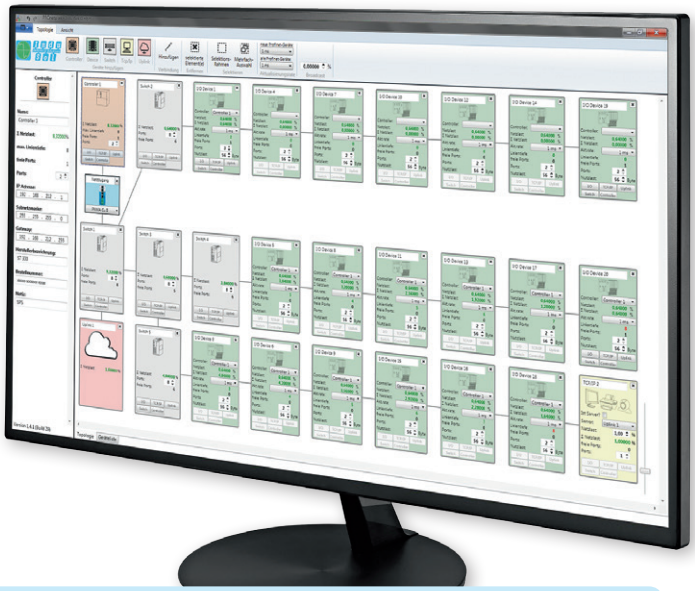
Jitter (deviation from the planned update time)	**≤ 50 %**
Telegram gap (missing telegram)	**0**
Error telegram (defective telegrams)	**0**
Load ratio (How heavily the network is loaded?)	**100 : 1**
Netload (in 100 Mbps)	**< 20 %**

PROnetplan network planning software

PROnetplan is a software for the preliminary planning of industrial networks. The network can be assembled intuitively on a graphic interface. Important parameters like the net load at the controller are calculated and displayed automatically based on the line depth and the preset update rate. With a simple simulation of the communication parameters or changes in the network structure, potential bottlenecks can be identified and eliminated during the planning stage. All devices and the predicted net load for each interface are listed in a clear overview. Free switch or device ports as well as the line depth are shown for each device. A special feature is the automated notification about the impact on net load when integrating components with TCP/IP communication. As in real hardware configuration the update rate can be set uniformly for all devices or separately for each device. Security pop-ups show the locations in a network where the use of a firewall would be advisable.

In addition to network optimization, the topology created with **PROnetplan** may serve both as a platform for discussion with the customer and as a document for network installation.

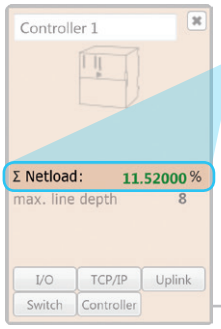




Device type	Device name	Number of ports	Free ports	Netload (Byte)	Netload generated (%)	Local netload (%)	Allocated controller
Controller	Controller 1	2	1		0	7,4	
Switch	Switch 1	8	4		0	7,4	
Switch	Switch 2	8	6		0	2,56	
Switch	Switch 3	8	5		0	4,84	
Uplink	Uplink 1	1	0		0	0	
IO Device	IO Device 1	2	0	56	0,64	2,56	Controller 1
IO Device	IO Device 2	2	0	56	0,64	1,92	Controller 1
IO Device	IO Device 3	2	0	56	0,64	1,28	Controller 1
Switch	Switch 4	8	6		0	1,92	
IO Device	IO Device 5	2	0	56	0,64	1,92	Controller 1
IO Device	IO Device 6	2	0	56	0,64	1,28	Controller 1
Switch	Switch 5	8	6		0	2,92	
IO Device	IO Device 8	2	0	56	0,64	2,92	Controller 1
IO Device	IO Device 9	2	0	56	0,64	2,28	Controller 1
IO Device	IO Device 4	2	1	56	0,64	0,64	Controller 1
IO Device	IO Device 7	2	1	56	0,64	0,64	Controller 1

Fig. 12: All devices are shown in a clear device list (including all relevant parameters)

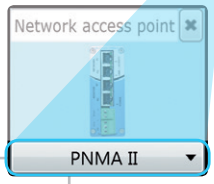
Automatically generated detail information:



Netload

Σ Netload: 11.52000 %

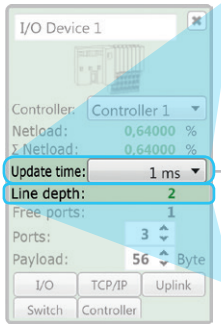
PROnetplan dynamically shows the resulting load for every connection in the network. This also applies with complex network structures or networks with multiple controllers.



Network access

PNMA II

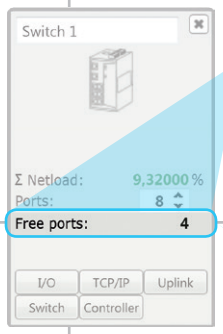
All net access devices are shown in the software and can be considered in the planning phase.



Update time

Update time: 1 ms

The update rate can be set uniformly for all devices or separately for each device.



Free ports

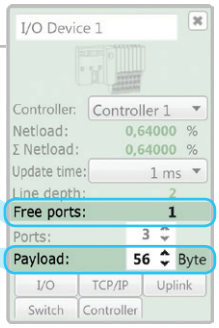
Free ports: 4

Displays remaining free ports on switches and devices.

Line depth

Line depth: 2

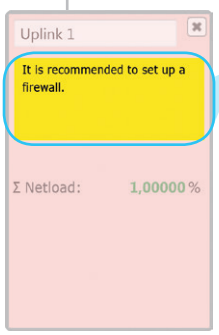
PROnetplan shows the line depth dynamically for each device. The communication partner can be assigned for every device in the network.



Payload

Payload: 56 Byte

For a more accurate calculation of the netload the real payload can be set for each device in the expanded view.



Security information

It is recommended to set up a firewall.

The user-friendly pop-ups with security information show immediately which devices have free ports that may need to be blocked and where the use of a firewall might be advisable.

Highlights

- Display of the netload for every connection in the network
- Update rate setting
- Indication of line depth for every device
- Separate netload settings for each device
- Definition of different network access devices, e.g. **PROFINET-INspektor® NT** or the measuring points **iPNMA**, **PNMA II, PNMX**
- Clear device list for all devices
- Pop-ups with security information
- Display of remaining free ports on switches and devices
- Full-featured printer functionality
- PDF export with numerous functions

PROnetplan in conjunction with PROscan® Active V2

The topologies scanned with the **PROscan® Active V2** analysis software (see page 13) can easily be fed into **PROnetplan**. This enables a comparison between the plan and reality. This procedure is very useful during planning an expansion or optimization of the network.

ETHERtest V5.0 / V5.1 and PROlinetest cable tester

Certification and acceptance

The **ETHERtest V5 (V5.1/V5.2)** cable tester provides for all measurements required for the acceptance and certification of network cables up to Class F_A/Category 6_A (1000 MHz). Not only line length but also attenuation, resistance, crosstalk (NEXT), delays, shielding and the proper contacts (connection schematic) are measured and evaluated. Beyond the certification of copper cables, attenuation and OTDR can be measured for single and multi-mode fiber optic cables by means of additional adapters (**ETHERtest V5.1**).

All recorded values are displayed graphically, which enables the error sources to be identified and localized with an accuracy of 10 centimeters. All measurements are stored automatically in the device and can be retrieved as measurement report using PC software.

Verification and troubleshooting

PROlinetest is an indispensable tool for all those who install or troubleshoot PROFINET systems. The device detects any wiring errors and tests the wires and wire pairs for continuity, breaks, short-circuits, cross-wiring and exceeded maximum cable lengths.
The measurement of the total cable length and the distance to the error location significantly simplifies troubleshooting. The adapter can also be used to check Drive-Cliq and M8/M12 cable systems.

Source: PI Commissioning Guideline (V1.36 / Dec. 14) **pp. 47-62**

Fig. 13: ETHERtest V5

Fig. 14: PROlinetest

RECOMMENDATIONS – Cable lengths and attenuation

Compliance with the limit values acc. to ISO IEC 11801 Class D is monitored by the measuring devices for a maximum length of 100 m, e.g. 24 dB insertion loss. This means that, with a shorter cable (e.g. 10 m), compliance is monitored only for the maximum attenuation of 24 dB. Weak spots are therefore not detected early. For this reason, all measurement results for insertion loss and near-end crosstalk should be evaluated against the cable length using the following tables. The near-end crosstalk is basically only evaluated as of an insertion loss of at least 4 dB.

Cable length	Max. insertion loss acc. to standard for 100 MHz	Length-dependent max. insertion loss, Indu-Sol GmbH	Length-dependent recommended max. insertion loss by Indu-Sol GmbH
100,0 m	24dB	24dB	**21dB**
50,0 m	24dB	21dB	**18dB**
25,0 m	24dB	18dB	**15dB**
12,0 m	24dB	15dB	**12dB**
6,0 m	24dB	12dB	**9dB**
3,0 m	24dB	9dB	**6dB**
1,5 m	24dB	6dB	**3dB**

The qualitative evaluation of **insertion loss (IL)** should be performed while taking the line length into account.

Cable length	Max. near-end crosstalk acc. to standard for 100 MHz	Length-dependent max. near-end crosstalk, Indu-Sol GmbH	Length-dependent recommended max. near-end crosstalk by Indu-Sol GmbH
100,0 m	30dB	30dB	**33dB**
50,0 m	30dB	33dB	**36dB**
25,0 m	30dB	36dB	**39dB**
12,0 m	30dB	39dB	**42dB**
6,0 m	30dB	42dB	**45dB**
3,0 m	30dB	45dB	**48dB**
1,5 m	30dB	48dB	**51dB**

The qualitative evaluation of the **near-end crosstalk (NEXT)** should be performed while taking the line length into account.

PROscan® Active V2 acceptance test and validation software


PROscan® Active V2

Online analysis / topology scan

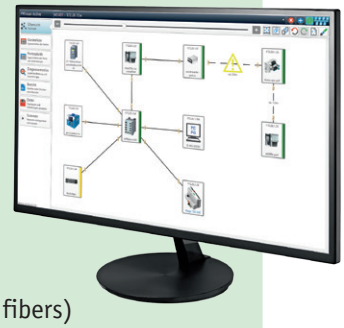
With the **PROscan® Active V2** software you can generate a detailed description of your PROFINET networks online during running production at any time. Thanks to PROFINET devices' integrated LLDP protocol (detection of neighborhood relationships) it is possible to generate a complete topology map including all designations and connections in an extremely short time, and thereby simultaneously perform an initial simple diagnosis (line interruptions, device failures etc.) during operation. Other strengths of this product include flexible options for integration into existing plants and a simple, intuitive user interface.

The software helps to efficiently organize a complex network and, if required, perform necessary maintenance in a timely and direct manner. Its low resource requirements enable **PROscan® Active V2** to be installed on any commonly available touch panel.

Source: PI Commissioning Guideline (V 1.36 / Dec. 14) **pp. 91/92**

Highlights

- Optimized for touch panel
- Easy to use
- Resource-saving
- Diagnostics mode
- Acceptance log
- Node information
  - PROFINET name
  - IP-/MAC address
  - Subnet mask
  - Gateway
  - Hardware/software version
  - Device version/name
  - Order number
- Port statistics
  - Discards
  - Errors
- Cable information
  - Cable length
  - Attenuation reserve (polymer fibers)
- Suitable for PROFINET and Ethernet networks



› Advanced printing and export functions (PDF) › comprehensive documentation options

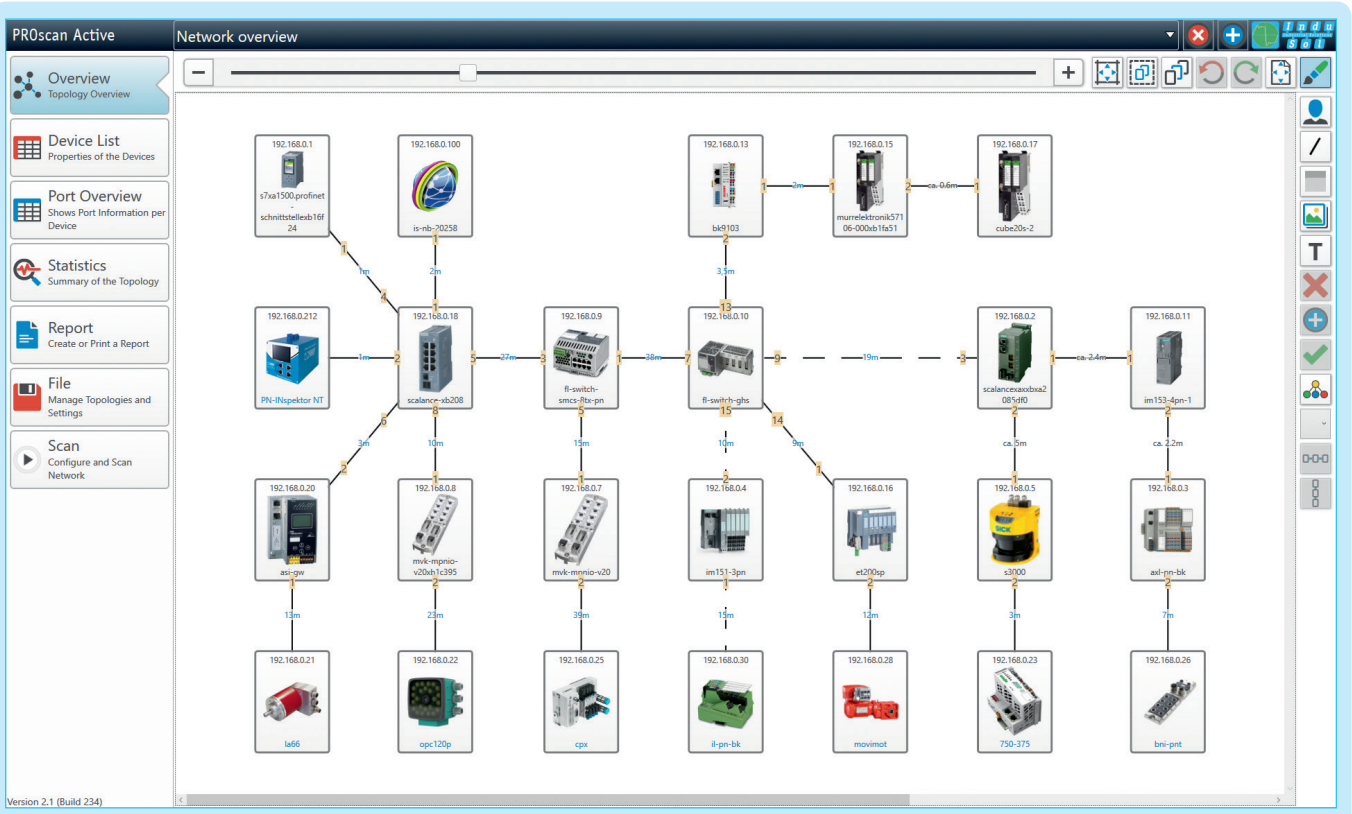


Fig. 15: PROscan® Active V2 - clear visualization of the network topology

PROscan® Active V2 acceptance test and validation software

Device list

In addition to the device information (manufacturer, ordering details), the automatically generated device list also gives a quick overview of the hardware and firmware versions of all devices used, allocating the device names, IP and MAC addresses accordingly. The evaluation of this data can be exported into an acceptance-relevant log or for documentation as a CSV file at the push of a button.

Device List
Properties of the Devices

Device type	IP adresses	Subnet	Gateway	MAC adress	Device name	HW version	SW version	Device type name	Order number	Vendor ID	Device ID	Controller	RealTime Class
PROFINET	172.20.1.51	255.255.255.0	172.20.1.51	00:1B:1B:72:7E:89	x208-cu-zeile4	6	V4.5.0	SCALANCE X-200	6GK5 208-0BA10-2AA3	42	2561	controller-tafel	RTClass2
PROFINET	172.20.1.54	255.255.255.0	172.20.1.54	00:A0:45:68:20:F9	phoenix-switch-zeile3	5	V3.80.0	FL SWITCH SMCS 8TX-PN	2989103	176	78	controller-tafel	RTClass2
PROFINET	172.20.1.55	255.255.255.0	172.20.1.55	00:1B:1B:34:83:A6	x202-pof-zeile2	5	V5.0.22	SCALANCE X-200	6GK5 202-2BH00-2BA3	42	2561	controller-tafel	RTClass2
PROFINET	172.20.1.56	255.255.255.0	172.20.1.56	00:1B:1B:1E:1B:21	et200s-pn-pof-zeile3	2	V7.0.1	IM151-3	6ES7 151-3BB23-0AB0	42	769	controller-tafel	RTClass2
PROFINET	172.20.1.58	255.255.255.0	172.20.1.58	00:0E:8C:D7:E3:32	x208-cu-zeile1	4	V4.5.1	SCALANCE X-200	6GK5 208-0BA10-2AA3	42	2561	controller-tafel	RTClass2
PROFINET	172.20.1.59	255.255.255.0	172.20.1.59	00:1B:1B:24:DA:80	et200m-pn-zeile1	2	V4.0.0	IM153-4	6ES7 153-4AA01-0XB0	42	770	controller-tafel	RTClass2
PROFINET	172.20.1.60	255.255.255.0	172.20.1.60	00:1B:1B:3A:EC:7E	x208-cu-zeile5	6	V4.5.1	SCALANCE X-200	6GK5 208-0BA10-2AA3	42	2561	controller-tafel	RTClass2
PROFINET	172.20.1.64	255.255.255.0	0.0.0.0	00:80:63:66:54:B0	octopus-zeile7	130	V4.2.3	Hirschmann OCTOPUS	6GK5 208-0BA10-2AA3	42	2561	controller-tafel	RTClass2
PROFINET	172.20.1.65	255.255.255.0	172.20.1.65	00:16:77:00:8F:A1	pn-asi-gw-zeile5	2	V2.0.0	AS-i	BWU1912	289	1912	controller-tafel	RTClass2
PROFINET	172.20.1.70	255.255.255.0	172.20.1.70	00:0F:9E:05:30:47	murr-mvk-rechts1	1	V3.1.0	MVK ProfiNet	55288	303	289	controller-tafel	RTClass2
PROFINET	172.20.1.71	255.255.255.0	172.20.1.71	00:90:E8:3D:1D:BD	eds-510e	100	V4.0.0	MOXA EtherDevice Switch	0054-000510-E000	553	84	controller-tafel	RTClass2
PROFINET	172.20.1.74	255.255.255.0	172.20.1.74	00:01:05:16:EE:87	bk9103			BK Device		288	9000		
PROFINET	172.20.1.75	255.255.255.0	172.20.1.75	00:0F:9E:05:2F:CF	murr-mvk-links1	1	V3.1.0	MVK ProfiNet	55288	303	289	controller-tafel	RTClass2
PROFINET	172.20.1.80	255.255.255.0	0.0.0.0	00:06:71:26:00:7A	pn-inspektor-v1			PROFINET INspektor		273	256		
IP	172.20.1.81			00:06:71:20:00:37	„PB-INspektor V2“								
IP	172.20.1.82			00:16:77:00:28:9C	ASi-INspektor								

Port overview

In addition to the device list with all device-relevant data, a list of port relevant data for each device is also available. The overview shows both the cable lengths of copper and polymer fiber connections as well as the attenuation reserve of polymer fiber connections.

Information on error telegrams or rejected telegram packets (CRC error or discards) is important for detecting weaknesses and to perform an error analysis.

Port Overview
Shows Port Information per Device

Number	Name	Connected with	Line type	Length	Send power budget	Remote power budget	Connection	InDiscards	OutDiscards
172.20.1.200 (controller-tafel)									
2	port-002	172.20.1.55 (x202-pof-zeile2)	Copper	ca. 58,6m			100BaseTXFD	0	78
172.20.1.54 (phoenix-switch-zeile3)									
1	port-001	172.20.1.60 (x208-cu-zeile5)	Copper	17,2m			100BaseTXFD	0	0
2	port-002	172.20.1.51 (x208-cu-zeile4)	Copper	47,1m			100BaseTXFD	0	0
3	port-003	172.20.1.248 (inblox)	Copper	5,0m			100BaseTXFD	0	0
4	port-004	172.20.1.82 (ASi-INspektor)	Copper	5,0m			100BaseTXFD	0	0
5	port-005	172.20.1.81 („PB-INspektor V2“)	Copper	5,0m			100BaseTXFD	0	0
172.20.1.55 (x202-pof-zeile2)									
1	port-001	172.20.1.200 (controller-tafel)	Copper	ca. 58,6m			100BaseTXFD	0	0
2	port-002	172.20.1.71 (eds-510e)	Copper	10,5m			100BaseTXFD	0	0
3	port-003	172.20.1.56 (et200s-pn-pof-zeile3)	Fibre-optic Cable	20,5m	4,2 dB	10,8 dB	100BaseTXFD	0	0
172.20.1.56 (et200s-pn-pof-zeile3)									
1	port-001	172.20.1.55 (x202-pof-zeile2)	Fibre-optic Cable	20,5m	10,8 dB	4,2 dB	100BaseTXFD	0	0

Explanations (Discards/Error telegrams)

Data packets may be discarded by the switch, e.g. because of malfunctions, transmission errors or queue overflow at the switches.

PROscan® Active V2 determines the number of such discards (see Fig. 16) and the number of defective telegrams (CRC errors) from the devices and displays them in a table. This provides clues as to potential causes of error.

During the analysis of such information special attention needs to be paid to devices in communication lines with high load.

Source: PI Commissioning Guideline (V 1.36 / Dec. 14) **pp. 93/94**

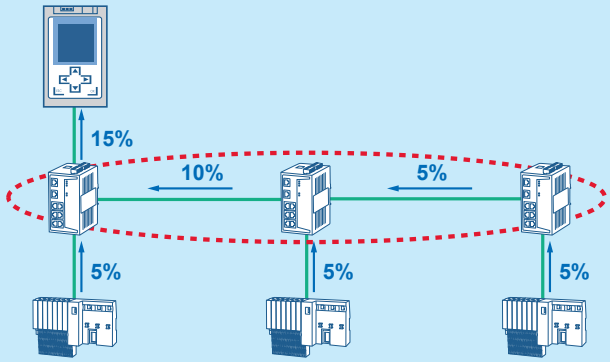
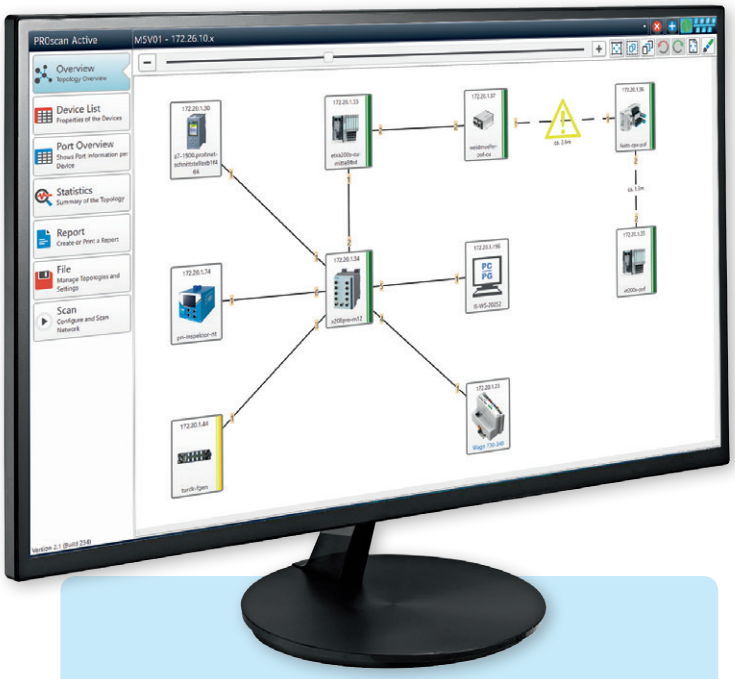


Fig. 16: Reading out switch components for discards



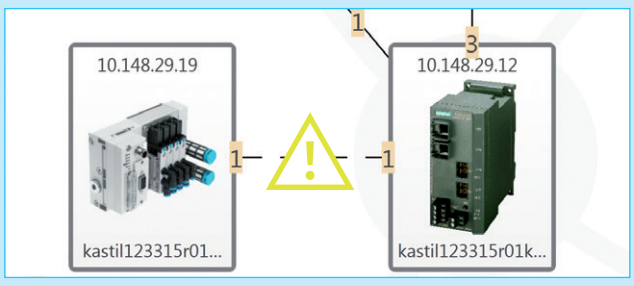


Fig. 17: Display when transmission problems occur

Checking the system reserve for optical cabling

If using polymer optical fiber (POF), the optical system reserve (power budget) of every single connection can be determined in online operation. It is a measure for the available optical power reserve between transmitter and receiver to ensure trouble-free operation. It can be read out and displayed as a diagnostic value. If the attenuation reserve of a POF connection falls below 5 dB, it is immediately apparent where transmission problems might occur.

These are represented by an exclamation mark ⚠ in the connection. This enables you to detect and remedy the weaknesses in your system at any time.

Source: PI Commissioning Guideline (V 1.36 / Dec. 14) **pp. 88/89**

System reserve	Evaluation
> 6 dB	The value is above the measurement range. No action required.
> 2 dB to 6 dB	The value is within the valid measurement range. Trouble-free communication is ensured. Typical values for cabling without other plug-in connections: • 5 dB for cable lengths up to 30 m • 3,5 dB for cable lengths from 30 m to 40 m • 2,5 dB for cable lengths from 40 m to 50 m In case of deviation from the listed value ranges a cable inspection is recommended (check for additional plug-in connections, attenuation check).


PROscan® Active V2

PROscan® Active V2 acceptance test and validation software

Diagnostics mode

An overview immediately shows the user all anomalies detected by the network scan. In the connection statistics, for example, device ports are listed with accumulated discards or error telegrams as well as a too low optical fibre system reserve. Additionally, a statistic of the software and hardware statuses of all devices quickly reveals whether there are discrepancies between devices of the same type.

Statistics
Summary of the Topology

	Manufacturer designation	Order number	SW Version	HW Version	Num. of devices
	AXL BK PN-ME	2688132	V1.2.0	5	1
!	BNI PNT-502-102-Z015	BNI006C	V2.2.0	5	1
!			V2.3.0	5	1
	Cube20S	57106	V1.3.6	1	1
	ET200SP	6ES7 155-6AU00-0CN0	V3.1.0	4	1
	FL SWITCH GHS 4G/12	2700271	V2.62.0	6	1
	FL SWITCH SMCS 8TX-PN	2989103	V4.40.0	5	1
	FTS3100-A	20781104000	V2.2.2	256	1
	Helmholz PN-Switch	700-850-4PS01		0	1
	IM151-3	6ES7 151-3BB23-0AB0	V7.0.5	3	1
	IM153-4	6ES7 153-4AA01-0XB0	V4.0.0	2	1
	PN-INspektor NT	124030100			1
	PROscanActive	117000014	2.0.0.218		1
	S7-300	GES7 318-3FL01-0AB0	V3.2.6	5	1
!	SCALANCE X-200	6GK5 208-0BA10-2AA3	V5.1.0	6	1
!			V5.1.3	6	1
	SICK-S3000PROFIsafe	1064234	V1.11.0	0	1
	WAGI-I/o-SYSTEM 75x	750-370	V2.5.10	4	1
	wenglor ident	weQube	V1.1.4	100	1

Fig. 18: Version statistics

IP-Adress	Device	Port	Value
Connections/Ports with IN DISCARDS			
10.1.9.5	fl-switch-ghs	port-001-00009	2
10.1.9.6	bk9103-1-1	port-001	4
10.1.9.6	bk9103-1-1	port-002	164
10.1.9.18	bnipnt502102z015-1	port-001	187206
10.1.9.18	bnipnt502102z015-1	port-002	383429
10.1.9.19	bnipnt502102z015	port-002	427308
10.1.9.21	wenglor-cam	port-001	2
10.1.9.94	iPNMA	Pa????	6
10.1.9.96	profinet-inspektor-nt	port-passive	4
10.1.9.97	PN-INspektorNT5	port-passive	17
Connections/Ports with IN ERRORS			
10.1.9.2	pn-io	port-002	869365
10.1.9.3	scalance-x208	port-003	874391
10.1.9.3	scalance-x208	port-005	949
10.1.9.3	scalance-x208	port-006	21172
10.1.9.4	fl-switch-smcs-8tx-pn	port-001	23
10.1.9.5	fl-switch-ghs	port-001-00009	4
10.1.9.15	im153-4pn-1	port-002	1
10.1.9.17	helmholz-pn-switch	port-001	1
10.1.9.17	helmholz-pn-switch	port-004	1
10.1.9.18	bnipnt502102z015-1	port-001	1189
10.1.9.21	wenglor-cam	port-001	3
10.1.9.62	mobmesse-x208	port-004	59
10.1.9.96	profinet-inspektor-nt	port-passive	17
10.1.9.97	PN-INspektorNT5	port-passive	22
Connections with too low attenuation reserve			
10.1.9.9	im151-3pn	port-001	16,4
Connections/Ports with OUT DISCARDS			
10.1.9.17	helmholz-pn-switch	port-001	60
10.1.9.17	helmholz-pn-switch	port-003	49
10.1.9.17	helmholz-pn-switch	port-004	330474
10.1.9.21	wenglor-cam	port-001	5
Connections/Ports with OUT ERRORS			
10.1.9.21	wenglor-cam	port-001	6

Fig. 19: Connection statistics

Acceptance log

PROscan® Active V2 is able to create a complete acceptance log with only a few clicks.

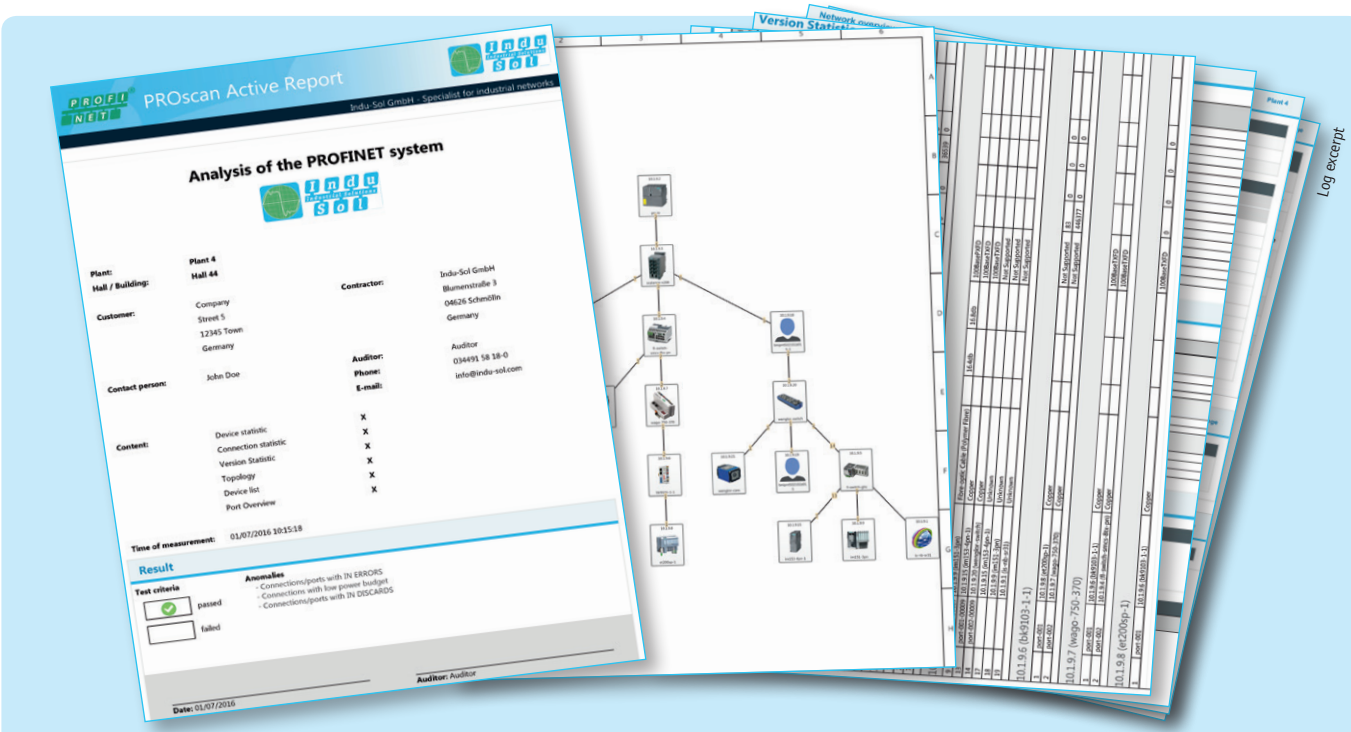


Fig. 20: Clear overview of all important information – this includes all system information (e.g. records of EMC conditions in the bus environment)

PROFINET-INspektor® NT analysis and diagnostic tool


PN-INspektor® NT

The **PROFINET-INspektor® NT** is an intelligent, passive measurement and diagnostic tool for temporary or permanent monitoring of PROFINET networks. Due to its passive and feedback-free behavior it is highly suitable for online analysis.

The **PROFINET-INspektor® NT** is both a full-featured measuring device for network acceptance and a tool for condition monitoring.

Highlights

- Display that shows errors directly
- Netload display with millisecond accuracy
- Choice of active or passive network diagnostics
- Seamless monitoring even for high network loads

SECURITY

- Alarms in case of unknown devices
- Network anomaly detection
- Detection of programming accesses to the PLC

Network parameters – Quality parameters

All subsequently listed quality parameters are detected as events, evaluated, cached and displayed in a clear overview.

- Network load
- Telegram jitter
- Load ratio (broadcast and multicast net loads)
- Update times
- Sending cycle of the controller
- Device diagnoses
- Device failures
- Device restarts
- Telegram gaps
- Consecutive telegram gaps
- Error telegrams
- Telegram overtakes

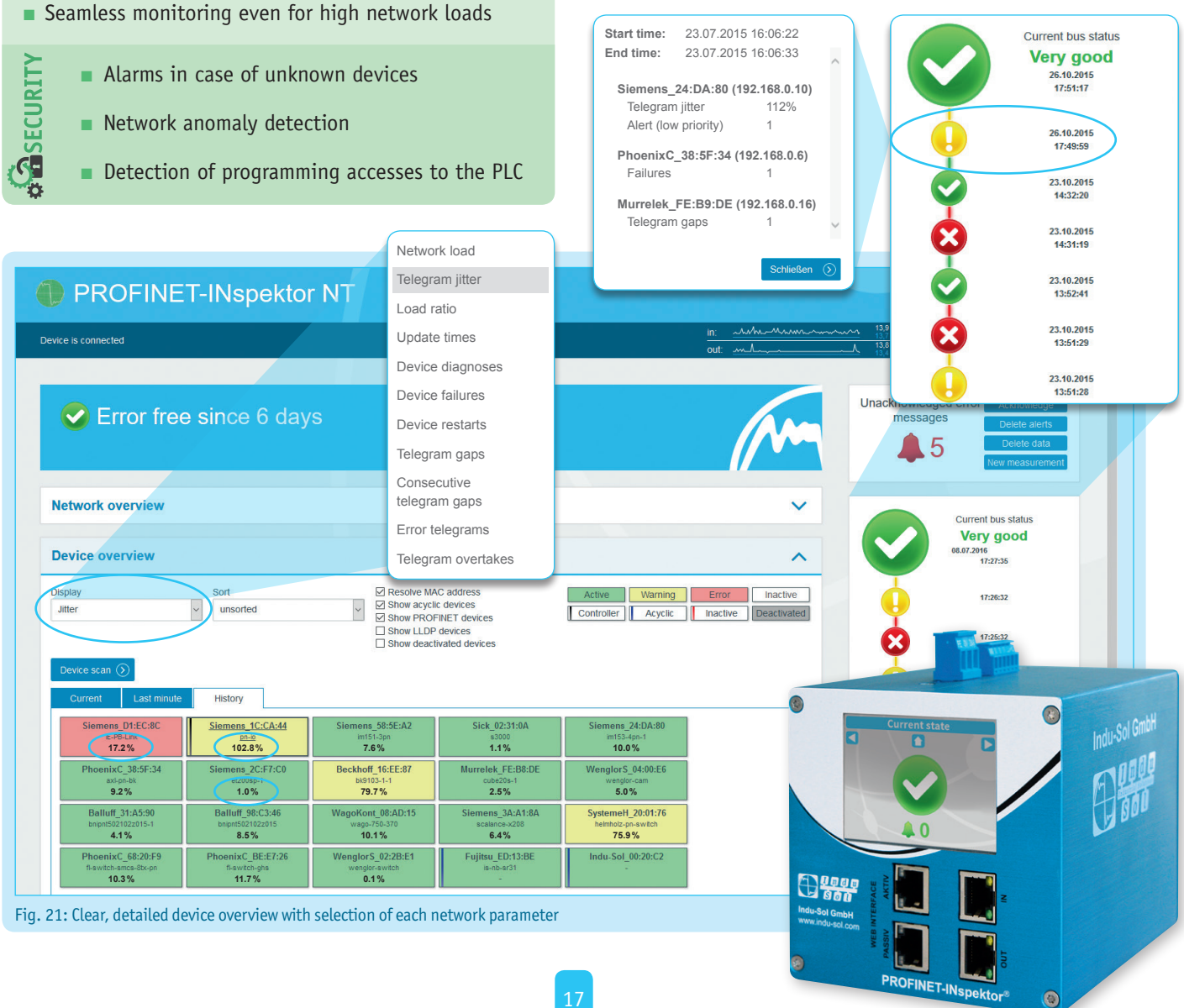


Fig. 21: Clear, detailed device overview with selection of each network parameter

PROFINET-INspektor® NT analysis and diagnostic tool

Device information

	Last minute			History		
MAC address	PhoenixC_38:5F:34					
IP address	10.1.9.10					
Name	axl-pn-bk					
Alias						
Vendor	AXL BK PN-ME					
Vendor ID	Phoenix Contact GmbH & Co. KG (176)					
Device ID	4096					
Device role	Device					
Alert (low priority)	0			0		
Alert (high priority)	0			0		
Failures	0			0		
Restarts	0			0		
Frame gaps	0			0		
Concurent frame gaps	0			0		
Frame overtakes	0			0		
Error frames	0			0		
Jitter	8.4%			122.0%		
	min	avg	max	min	avg	max
Update rate	0.25ms	-	0.25ms	0.25ms	-	0.25ms
Measured update rate	0.23ms	0.25ms	0.27ms	0.01ms	0.25ms	0.56ms
Payload (sent)	174,90 B	176,00 B	177,14 B	108,72 B	176,00 B	226,69 B
Payload (received)	174,90 B	176,00 B	177,14 B	108,72 B	176,00 B	226,64 B
Netload (sent per sec)	2.16% 270,30 kB	2.18% 272,00 kB	2.19% 273,77 kB	1.34% 168,10 kB	2.18% 272,00 kB	2.80% 350,27 kB
Netload (received per sec)	2.16% 270,30 kB	2.18% 272,01 kB	2.19% 273,77 kB	1.34% 168,03 kB	2.18% 272,01 kB	2.80% 350,34 kB

Network statistics

	Last minute	History
Load ratio	>500 : 1	>500 : 1
Broadcasts (of these PROFINET)	0 (0 | 0%)	0 (0 | 0%)
Multicasts (of these PROFINET)	0 (0 | 0%)	0 (0 | 0%)
Frames (sent) (of these PROFINET)	239.997 (239.999 | 100.00%)	100.176.240 (100.176.132 | 100.00%)
Frames (received) (of these PROFINET)	240.000 (240.000 | 100.00%)	100.177.025 (100.176.916 | 100.00%)

Netload visualization (see Fig. 22)

While other diagnostic devices determine the network load by the second or even the minute, the **PROFINET-INspektor® NT** measures netload by the millisecond and displays it. This makes even minimal load changes in a network detectable. Even in the millisecond range peak loads may cause significant disturbances in the network which would not be detectable without this analysis.

Such short-term peak loads may be caused, e.g. by erroneous hardware settings or active diagnostic tools that continuously send queries into the network.

The network should always be monitored for a consistent netload and any sources of disturbances should be removed. Continuous, passive analysis as provided by the **PROFINET-INspektors® NT** is an indispensable prerequisite.

Please note:

According to the current certification guideline PROFINET devices are tested and specified with a maximum load per millisecond between 1 and 10%, depending on the netload class.

Source: PROFINET I/O Security Level 1 (Netload) – Version 1.2.1 – March 2016

Netload chart

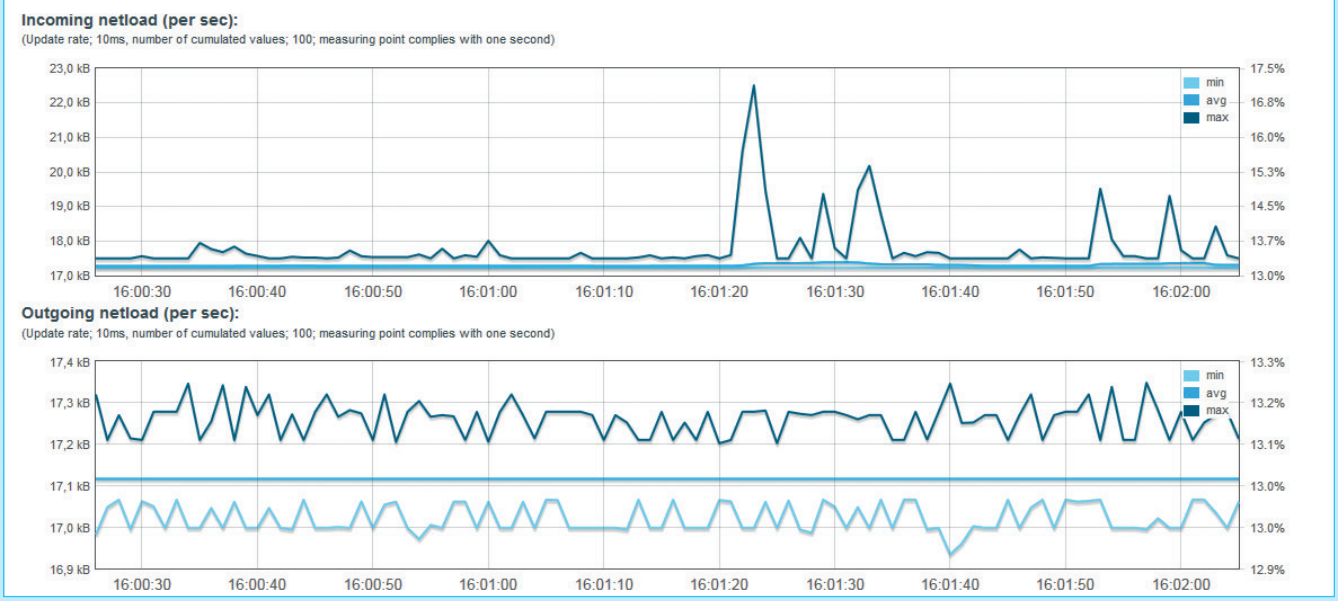


Fig. 22: Netload display with millisecond accuracy

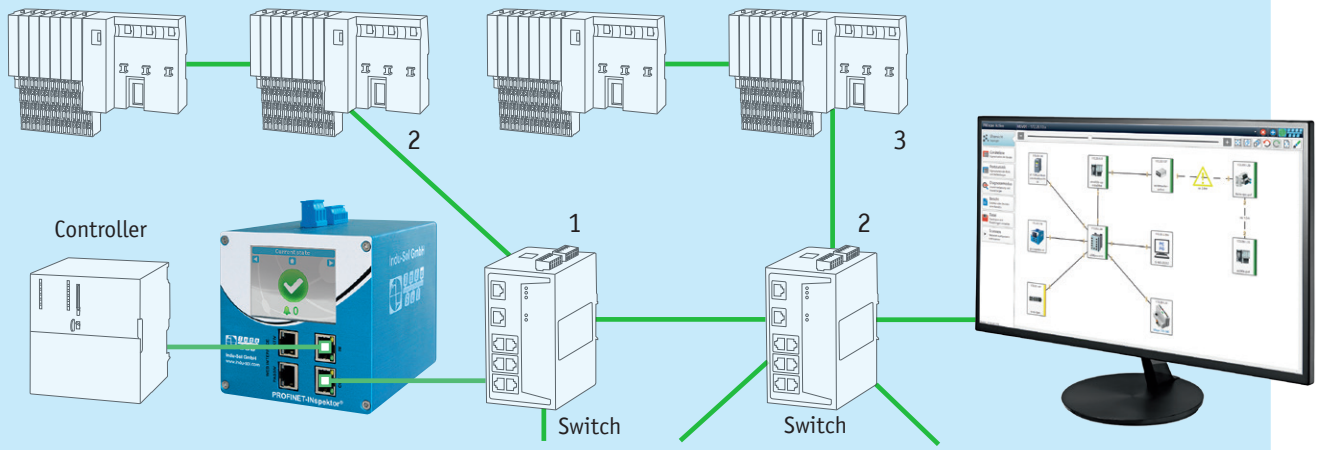


Fig. 23: Integration of the PROFINET-INspektor® NT in the PROFINET network

Trigger function – Alarms

Trigger functions enable the setting of quality parameters for the network as a whole, but also individually for each device if required.

In the event of changes that exceed the preset thresholds alarm messages (SNMP, email, web interface) are sent or displayed directly via a potential-free contact. The **PROFINET-INspektor® NT** has an integrated web server and a freely selectable IP address. This enables a visualization of the network condition by means of an Internet browser on any PC, on site or remotely.

In addition to each alarm message telegram copies are stored on the **INspektor®** and can be downloaded via the web interface for a more detailed error evaluation.

Type	Device	Event	Date	
Status change	00:01:05:16:EE:87	Jitter	26.10.2015 17:49:59.316	
Status change	28:63:36:2C:F7:C0 192.168.0.6		23.10.2015 14:32:20.171	
Status change	28:63:36:85:B1:B8 192.168.0.1	Telegram gaps	23.10.2015 14:31:21.983	
Status change	28:63:36:2C:F7:C0 192.168.0.6	Bus node failure	23.10.2015 14:31:18.777	
Status change	28:63:36:2C:F7:C0 192.168.0.6		23.10.2015 13:52:41.164	
Status change	28:63:36:85:B1:B8 192.168.0.1	Telegram gaps	23.10.2015 13:51:32.572	
Status change	28:63:36:2C:F7:C0 192.168.0.6	Bus node failure	23.10.2015 13:51:27.861	
Status change	28:63:36:2C:F7:C0 192.168.0.6	Alert (low)	23.10.2015 13:51:27.665	

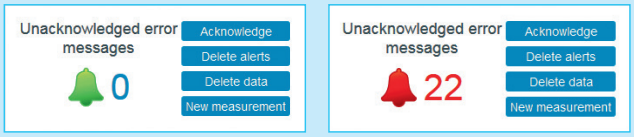


Fig. 24: Display of alarms in the overview screen

User-friendly display of network conditions with traffic light colors and time graphs enable any user to respond quickly in an emergency and ensure a good general overview.

RECOMMENDATION – Quality values

Recommendations on the quality values in PROFINET by **Indu-Sol**

Jitter (deviation from the planned update time)	**≤ 50 %**
Telegram gap (missing telegram)	**0**
Error telegram (defective telegrams)	**0**
Load ratio (How heavily the network is loaded?)	**100 : 1**
Netload (in 100 Mbps)	**< 20 %**

PROFINET-INspektor® NT analysis and diagnostic tool

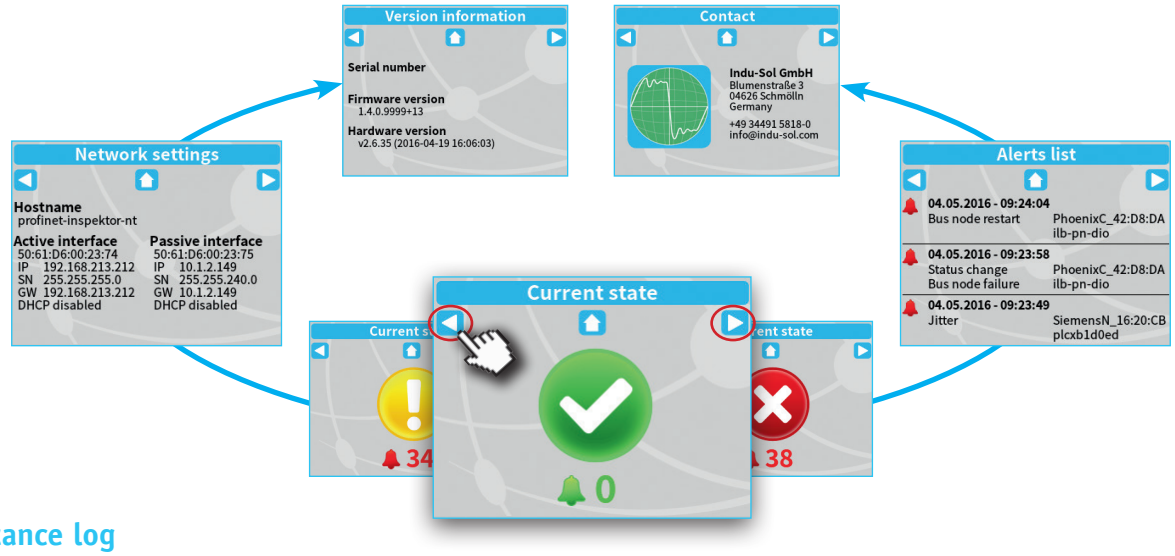

PN-INspektor® NT

Touchscreen

The display serves primarily to show the current status of the network and the accumulated faults. This information makes it possible, without an additional computer, to make an assessment about the status of the network.

Much important system information of the PROFINET-INspektors® NT is displayed as well. Thus the network settings are needed to connect to the web interface and to view further detail information. Notes on firmware and hardware versions can be accessed via the display as well.

Navigation between the individual windows is done by touch control via the arrow buttons.



Acceptance log

Just like with **PROscan® Active V2**, the **PROFINET-INspektor® NT** provides the option to have a comprehensive acceptance log generated with just a few clicks.

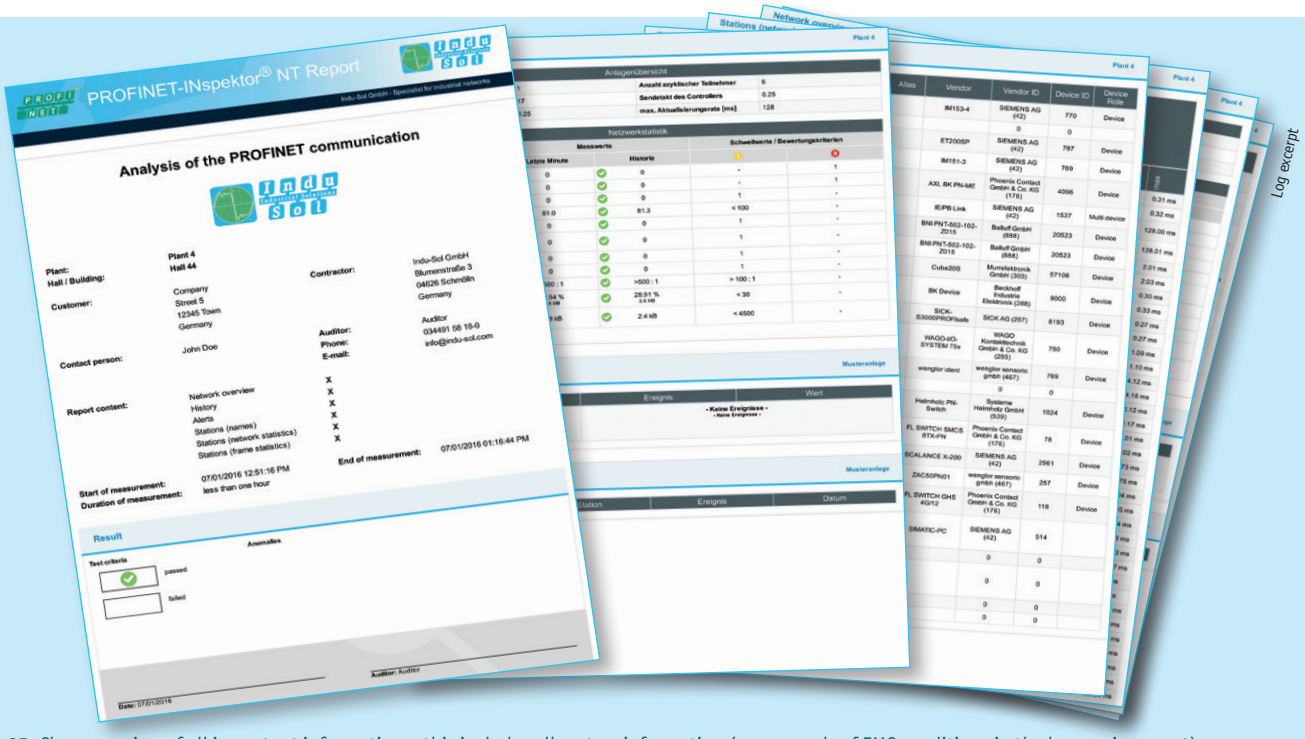
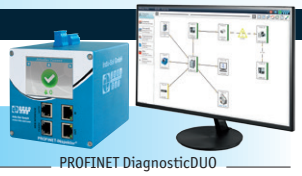


Fig. 25: Clear overview of all important information – this includes all system information (e.g. records of EMC conditions in the bus environment)


PROFINET DiagnosticDUO

PROFINET DiagnosticDUO (PROscan® Active V2 & PROFINET-INspektor® NT)

Combined, the **PROscan® Active V2** software and the passive data collector **PROFINET-INspektor® NT** form the perfect navigation system for your network: the **PROFINET DiagnosticDUO**.

Thanks to the teamwork between a live topology map and a diagnostic display the position of each device can be found immediately and its "health status" can be assessed. This enables you to respond promptly and directly to any irregularities. Intuitive traffic-light colors provide a network analysis at a glance.

Highlights

- First user-friendly topological visualization of in-depth network analysis
- Continuous analysis of the communication quality (network load, telegram gaps, jitter etc.)
- Device status is indicated graphically with traffic-light colors in the topology
- Retrieval of current device list (PROFINET name, IP/MAC address, hardware/software versions, device types etc.)

Interaction of diagnosis and topology – PROFINET DiagnosticDUO

By activating the function "Read out **PROFINET-INspektor® NT**" in the **PROscan® Active V2** software, you can combine the recordings of both tools. This gives you a navigation system for your PROFINET network so you can see the status of all devices displayed graphically with traffic-light colours in the topology.

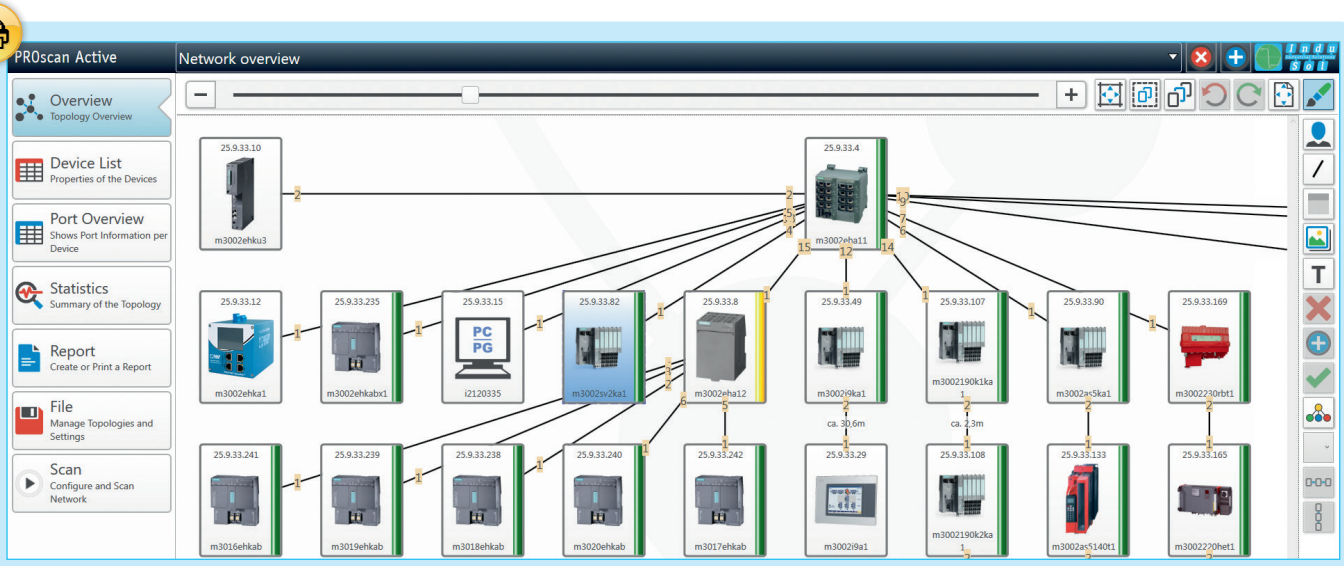
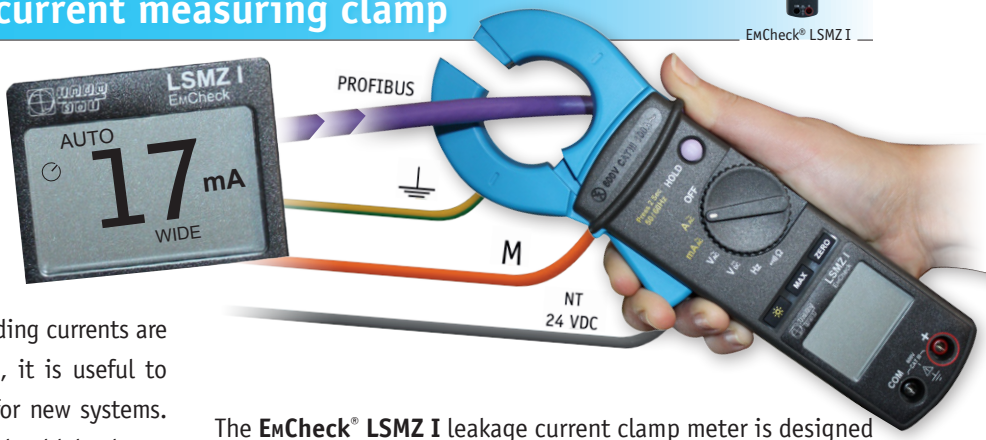


Fig. 26: Information from the topology with PROscan® Active in conjunction with the evaluated quality parameters of the PROFINET-INspektor® NT

EMCheck® LSMZ I leakage current measuring clamp

EMCheck® LSMZ I



EMCheck® LSMZ I

Ever more often, compensating currents caused by high-frequency shielding currents create intermittent faults in industrial data communication systems. On one hand, these currents may disturb the transmission itself. On the other, they may damage the devices by overloading. Because such effects of high shielding currents are only noticeable after a some time has passed, it is useful to define limits and document compliance even for new systems. Shielding currents during running operation should be lower than 40 mA.

RECOMMENDATION

Independently of the system specification, experiences at Indu-Sol show that shielding currents of < 40 mA can be tolerated. The decision of what is acceptable should always be made in the context of the frequency range in order to be able to perform suitable measures to reduce shielding currents.

The **EMCheck® LSMZ I** leakage current clamp meter is designed specifically to measure leakage and shielding currents in the frequency range of 50/60 Hz or 5 Hz - 1 kHz. The adjustable measurement range can be set between 30 µA and 100 A. For measuring shielding currents on a data cable, the lower end of the range is more relevant. The **EMCheck® LSMZ I** leakage current clamp meter is also an ideal tool to find insulation faults and unplanned shutdowns caused by leakage currents and tripped FI switches. It also offers all the features of a multimeter clamp. To determine loop impedances, the **EMCheck® MWMZ II** loop impedance measurement clamp (see page 32) can be used.

PROFINET Diagnostic set

PN Diagnostic set

PROFINET Diagnostic set

Highlights

- Online network diagnostics: **PROFINET-INspektor® NT**
- Topology software: **PROscan® Active V2**
- Network monitoring software: **PROmanage® NT**
- Leakage current measuring clamp: **EMCheck® LSMZ I**
- Cable diagnostics: **PROlinetest** or alternatively **ETHERtest V5.0** or **V5.1**

On request we will provide you with an instruction to the functions, benefits and uses of the complete contents of the **PROFINET Diagnostic set** (see page 31). This introduction is especially suitable for those in charge of commissioning, service and maintenance.

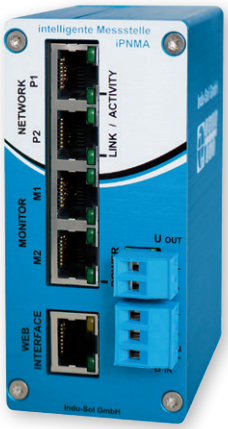
We will gladly provide a separate offer for individual devices (see page 30 ff.).


iPNMA

Intelligent PROFINET measuring point iPNMA

The intelligent PROFINET measuring point **iPNMA** combines the functions of a PROFINET measuring point with a simple PROFINET network analysis. The following quality parameters are determined:

- Telegram jitter
- Telegram gaps
- Telegram overtakes
- Network load
- Update rate
- Device diagnoses
- Device failures and restarts
- Error telegrams



In this case, the evaluation of the recorded data does not take place on the device itself, but instead all data is queried and processed by the **PROmanage® NT** software (see page 24) and processed accordingly.

In addition to the integrated diagnostics function, an analysis tool (e.g. **PROFINET-INspektor® NT** or laptop) can be connected completely reactionless to the two monitor jacks (monitor M1 and M2) for a more thorough network analysis or troubleshooting.

Highlights

- Monitoring all important PROFINET quality values
- Reactionless measurement point
- Compact design
- In case of a power supply failure, the PROFINET communication remains intact
- Power supply of additional analytic tools via the UOUT (24 V DC) connector

General properties	PN-INspektor® NT	iPNMA
Passive network access (TAP)	×	×
24 V supply for additional device (PN-INspektor® NT)		×
Number of monitored participants	512	256
Decoding of DCP / PROFINET parameters	×	×
Monitoring of non-PROFINET communication	×	
Evaluation of the recorded data		
PROmanage® NT	×	×
Touch display showing the network status and further information	×	
Webinterface	×	
Diagnostics mode with PROscan® Active V2	×	

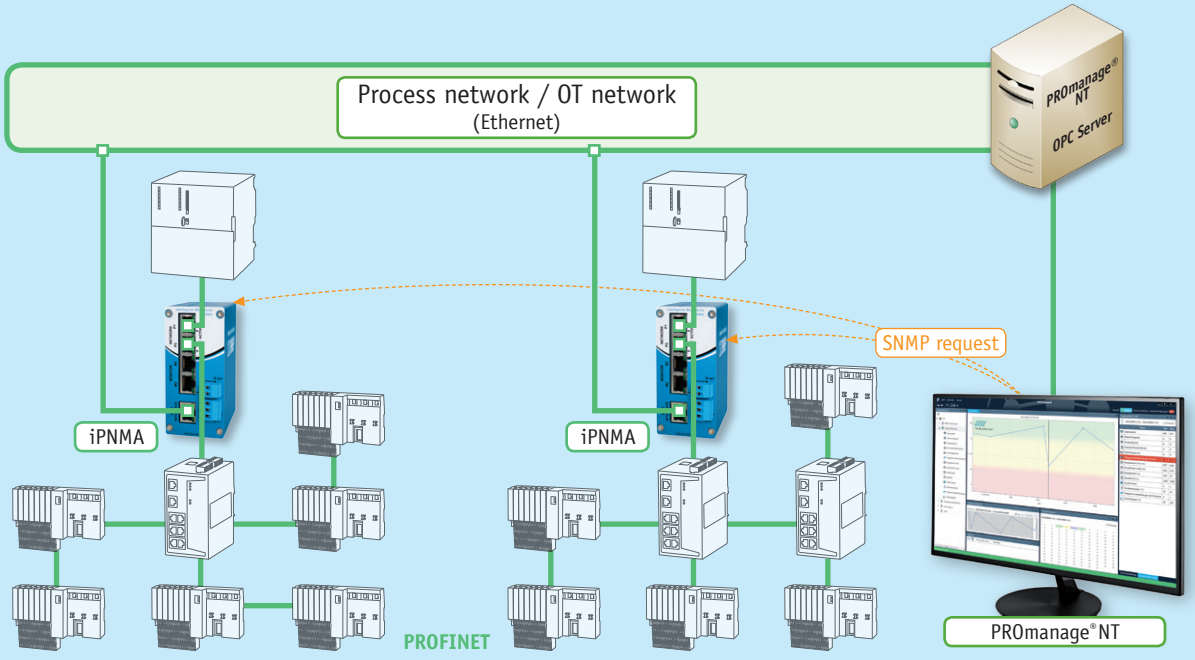


Fig. 27: Integration of the iPNMA measurement point in the PROFINET network and evaluation of the data via PROmanage® NT

PROFINET permanent network monitoring

PROmanage® NT network monitoring software

For preventative, condition-oriented maintenance of PROFINET networks **Indu-Sol** has developed a strategy for permanent network monitoring (referred to as PNM in the following). It provides for condition monitoring with the goal of **"warning before failure"**.

The concept of PNM provides for a continuous network analysis with a decentral, passive data collector, the **PROFINET-INspektor® NT**. Whenever preset threshold values are exceeded this event is stored together with a time stamp. The installation is between the controller and the first switch port. Each controller therefore requires an **INspektor®**. With **PROmanage® NT** all external **INspektors®** are integrated in the monitoring via the existing Ethernet network, and the network conditions are bundled centrally on a server. The network-specific events are pre-processed by the **PROFINET-INspektor® NT** and provided chronologically by the **PROmanage® NT** network monitoring software for further processing and evaluation.

PROmanage® NT enables the evaluation, analysis and long-term storage of condition data for your fieldbuses and other industrial networks. For this purpose **PROmanage® NT** retrieves the port statistics of manageable switches and the events of the decentral data collectors (**INspektors®**), evaluates them and displays them graphically.

This sophisticated method of analysis makes irregularities immediately apparent. When a value exceeds or falls below a configurable threshold value an alarm activates. The statistic function keeps data exact to the minute available up to one year. This means historical events can be opened up for viewing at any time for cause analysis, e.g. of sporadic failures.

Highlights

- Central monitoring of all fieldbuses and networks
- Avoid system failures
- Timely warning via OPC, SNMP trap or email in case of irregularities
- Data exact to the minute available up to one year
- Quick installation
- Easy device set-up due to automatic and manual device scan

To improve system availability the following targets are set for a PNM system:

- Continuous monitoring of real communication
- Complete monitoring and detection of causes of network weaknesses
- Automatic alarms when negative developments occur
- Central overview of all networks

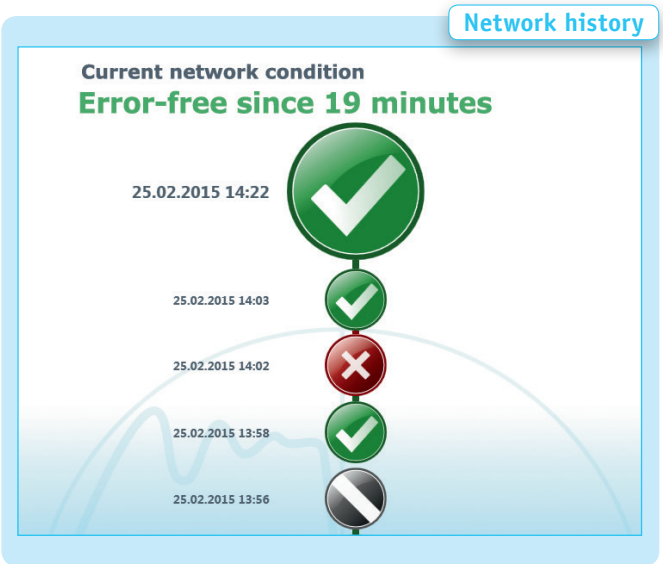
PROmanage® NT

Network history

How is my network?

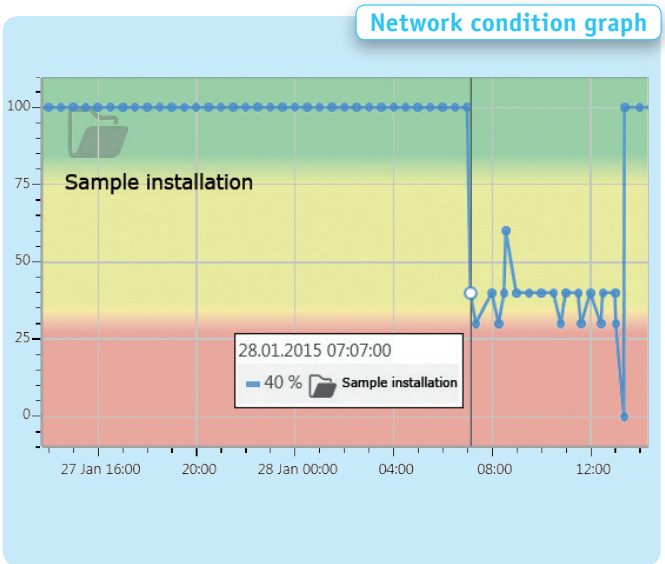
The network history provides a quick and clear overview of:

- The current network status
- How long a network has run without error
- When the last error occurred (with time stamp)



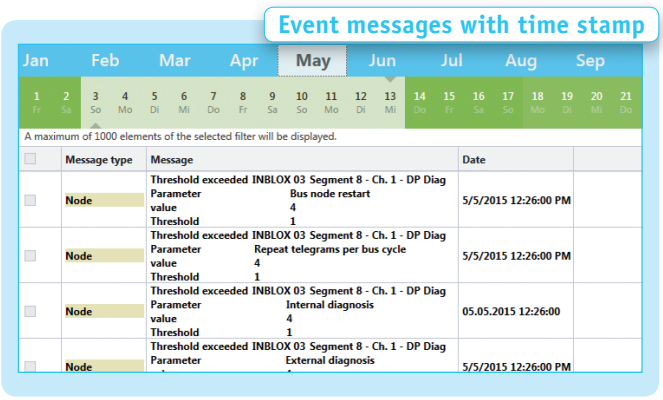
Network condition graph

A user-friendly interface can be used to display and evaluate the information. The interface can be adapted to your unique needs and spread over several physical screens for better overview.
Various parameters of different devices such as device temperature and failures can be compared in a graph to detect links in the event of malfunction.



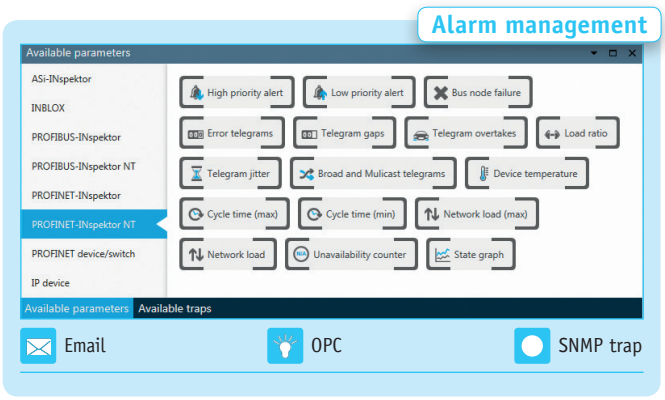
Event messages with time stamp

With the integrated threshold management threshold values can be defined for every network parameter. When a limit is reached an entry with a time stamp and event description is made automatically in the event list. Information about network errors can be retrieved from the event list with a mouse click.



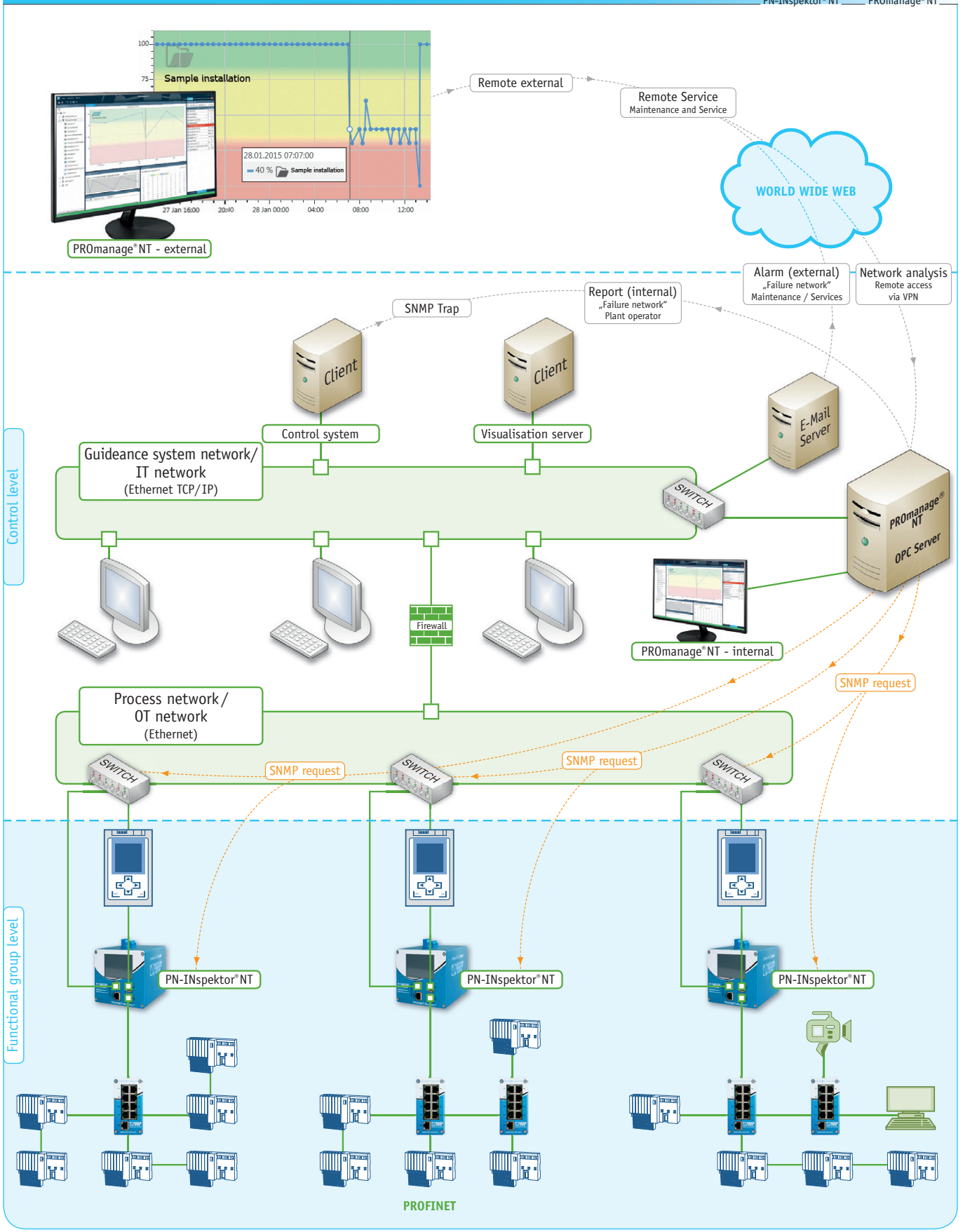
Alarm management

Integrated alarm management enables automatic forwarding of device notifications. By selecting suitable information medium (email, message services, OPC, SNMP) all messages can be transmitted to the responsible persons in a timely fashion. This shortens notification paths and prevents undesired plant breakdowns.



PROFINET permanent network monitoring

Configuration example (PNM)



PROFINET measuring points PNMA II / PNMX

The PNMA II provides feedback-free access for telegram recording in the PROFINET and other Ethernet-based networks during running production. We recommend installing the PNMA II measuring point permanently in the network connection between the automation device (controller) and the first switch, because the major part of the communication typically passes through here.

The measurement point with the PNMX version and IP 67 protection can be installed in rough production environments without any protective housing. Diagnostic tools are connected via M12 measurement jacks (M12 D-coded).

Highlights

- If connecting a **PROFINET-INspektor® NT** via a **PNMA II**, only two additional patch cables are needed (no crossover cable required).
- In case of a power supply failure the PROFINET communication via the **PNMA II** remains intact.
- Power supply of additional analytic tools via the UOUT (24VDC) connector
- **PNMX IP 67** for rough production environments

Function

For the feedback-free connection of an analysis tool (e.g. **PROFINET-INspektor® NT** or laptop) two monitor sockets (M1 and M2) are available on the **PNMA II / PNMX** for diagnostics. This means both communication directions can be monitored simultaneously.

An analysis tool is connected to the monitor sockets by means of two network cables. For analysis and evaluation of the measurement results the telegrams from both communication directions can be overlaid. The **PNMA II / PNMX** does not discard error telegrams. Instead, it forwards them.

Properties

- Monitoring of all protocols
- Supports all packet sizes
- No packet loss
- All connection ports on the front panel
- No additional effort to connect a measuring device
- Tested interaction with the **PROFINET-INspektor® NT**
- No free switch port necessary
- Bi-directional data transmission up to 100 Mbps
- No network interruption when connecting diagnostic tools

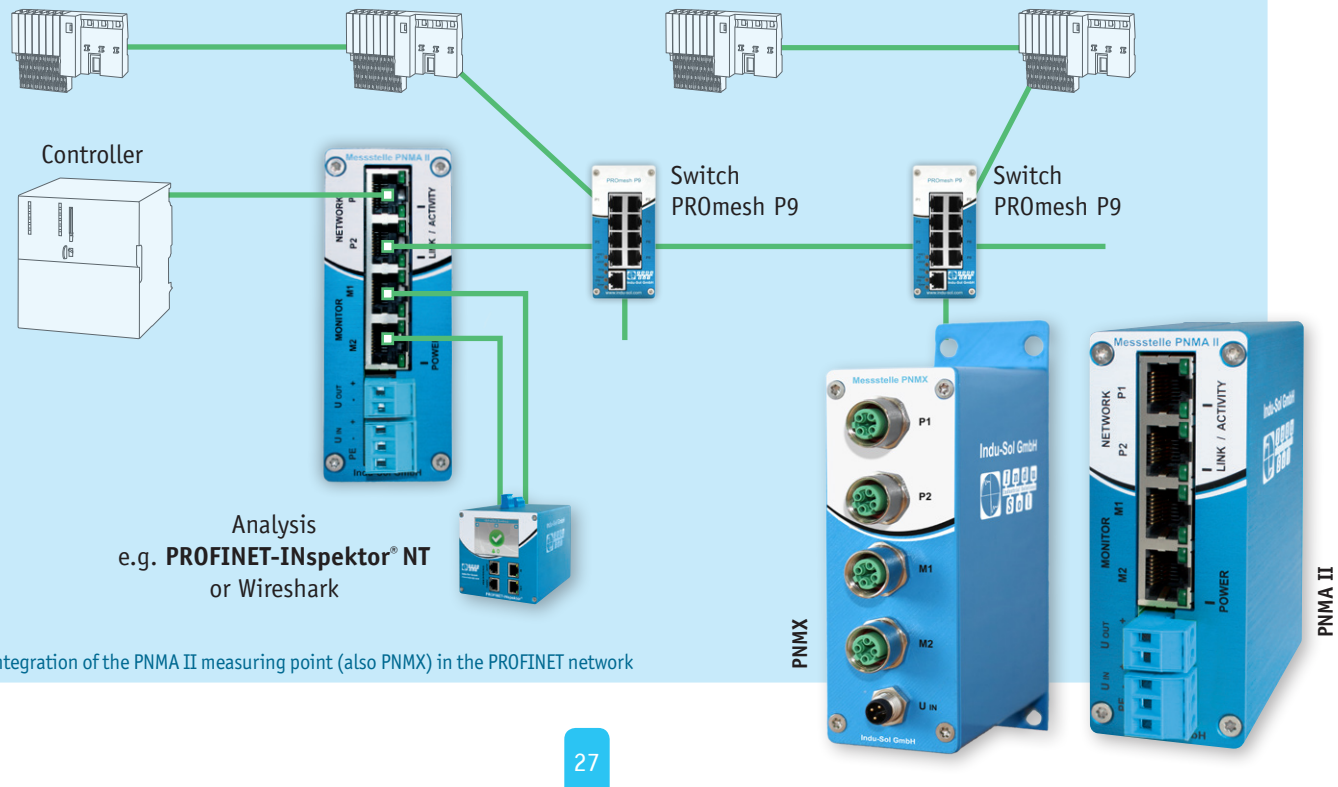


Fig. 28: Integration of the PNMA II measuring point (also PNMX) in the PROFINET network

PROFINET Switch PROmesh P9


PROmesh P9

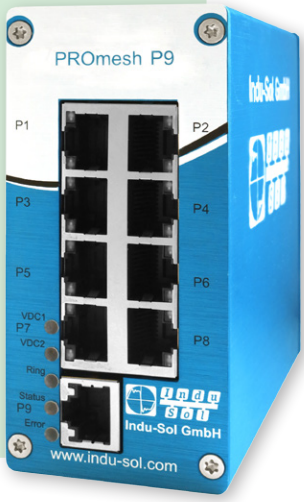
The Indu-Sol PROFINET Switch **PROmesh P9** is the first full PROFINET switch that is equipped for the increased performance requirements in the PROFINET and conforms to Conformance Class B and Netload Class III requirements. This functionality makes it possible to integrate the switch into the automation system (Step7, TIA Portal) by an engineering tool in order to make a comprehensive network diagnostic feasible. This feature supports numerous necessary and useful functions as opposed to standard switches:

- Higher availability thanks to ring redundancy (MRP)
- Sending of device diagnostics to the controller (PN-RTA)
- Neighbourhood detection (LLDP)
- Port-related network statistics (PDEV)
- Network diagnostics via IT mechanisms (SNMP)

With its optimised shielding contacts in the RJ45 jacks and leakage current monitoring, the **PROmesh series** not only meets the requirements for PROFINET functionality but also fulfils highest demands for EMC resistance in the industrial environment.

Highlights

- Optimised shielding contact of ports
- Display of discards on the web interface
- Simple exchange of devices with removable media
- Full PROFINET functionality (Conformance Class B)
- Netload Class III Certification
- Leakage current monitoring, incl. frequency spectrum
- Graphic display of the port utilisation (with millisecond precision)
- Mirror port, VLAN, SNTP, SMTP, DHCP
- 9x 100 Mbit/s RJ45 Ports
- Redundant power supply
- Compact design



Diagnosis function

The PROmesh P9 can be adapted individually to your needs and network specifications. If requested you get notified about any changes in the network to be up-to-date and swift to react. The clear structured web interface of the PROmesh P9 shows at a glance all relevant information to evaluate the data traffic quality on a central position in the network. Special attention is drawn to the following quality parameters:

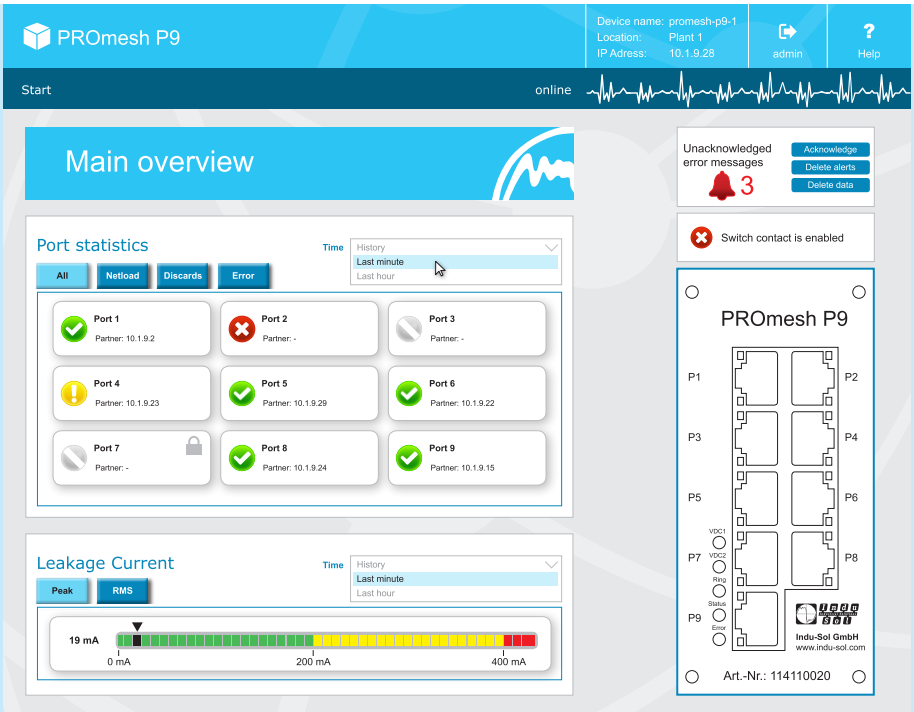


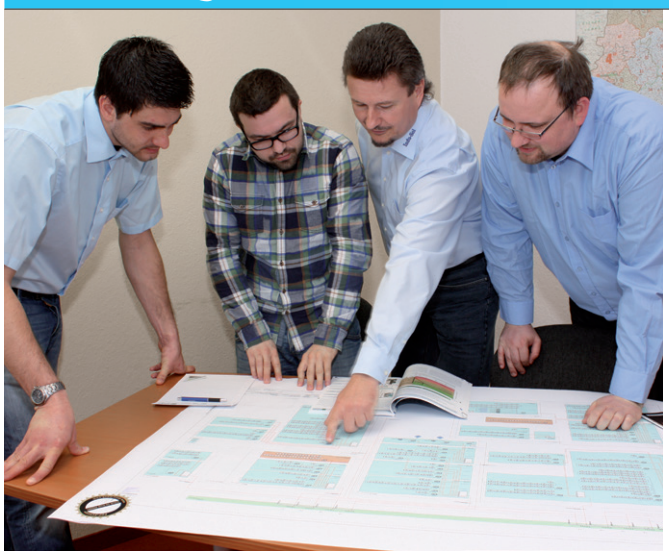
Fig. 29: With a clearly structured web interface you have all important information at a glance

- Number of error telegrams
- Number of discarded telegrams
- Network load level
- Correct port configuration
- Leakage current level

Leakage current monitoring

Leakage current monitoring makes it possible to permanently record and evaluate the sum of all shielding currents of the PROFINET lines. The corresponding spectrum with the respective frequency components is specified for this in addition to the current value. Using this integrated function, the PROmesh series also offers mechanisms for detecting EMC faults or couplings in addition to the complete PROFINET diagnostics.

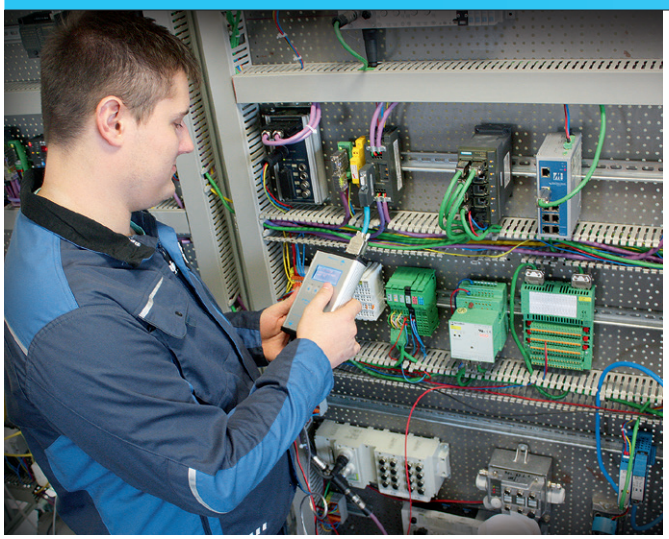
Consulting



Services include:

Based on years of experience we offer expert consultation in all matters related to fieldbuses and industrial data communication at all stages from the concept to practical use. We support you during network planning, documentation and commissioning. This includes e.g. the drafting of delivery specifications or product requirement documents. Our service also includes assembly supervision and the final acceptance and certification of your network. We offer training for your operating personnel to familiarize employees with the network specifications of your system.
We will gladly visit you for a “round table” and demonstrate the opportunities offered by our permanent network monitoring.

Measurement



Services include:

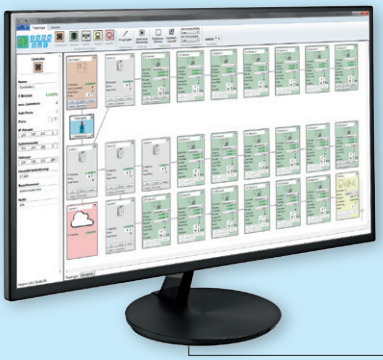
- Measurement of communication quality and creation of a measurement report
- Acceptance and certification of systems according to standards and PI guidelines
- Commissioning support
- Emergency support for troubleshooting
- Close-to-bus EMC evaluation / evaluation of equipotential bonding quality
- WLAN measurement incl. site survey

Training

Services include:

- Planning / installation / service
- Fundamentals of Ethernet / PROFINET / WLAN / EMC
- Practical network know-how (cables, plugs, structure, address assignment, commissioning etc. ...)
- Measurement devices / principles / methods / diagnostic options
- Practice (installation, telegram exchange, PNM, switch management, network security etc.)
- Certification of PROFINET installers

Network planning



PROnetplan (see page 10)

Network planning software

Ordering Details	Art. No.
PROnetplan	114010009

Analysis | Diagnostics | Measurement

ETHERtest V5 (see page 12)

PROFINET Cable tester (suitable for certification)

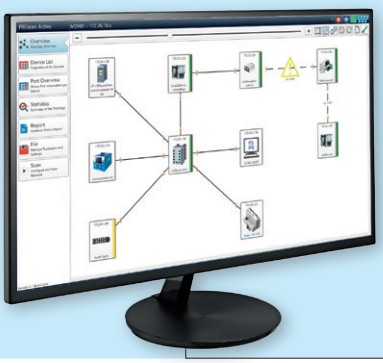
Ordering Details	Art. No.
ETHERtest V5.1 (extendable for FOC)*	112010011
ETHERtest V5.2	112010020

PROlinetest (see page 12)

PROFINET Cable tester

Ordering Details	Art. No.
PROlinetest*	112010010

*All adapters for PROlinetest and ETHERtest V5.1/V5.2 on request.



PROscan® Active V2 (see page 13)

Active acceptance test and validation software

Ordering Details	Art. No.
PROscan® Active V2 – 1x license* (Basic license)	117000053
PROscan® Active V2 – 5x license*	117000057
PROscan® Active V2 – 25x license*	117000061
Upgrade PROscan® Active V1 to V2	117000052

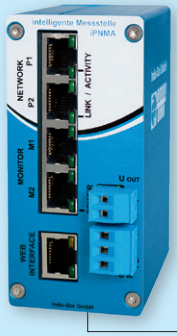
*Further licences upon request

Analysis | Diagnostics | Measurement

PROFINET-INspektor® NT (see page 17)

Analysis and diagnostic tool

Ordering Details	Art. No.
PROFINET-INspektor® NT	124030100



iPNMA (see page 23)

PROFINET intelligent measuring point

Ordering Details	Art. No.
iPNMA	114090200

PROFINET DiagnosticDUO (see page 21)

PROscan® Active V2 (1x license)
PROFINET-INspektor® NT

Ordering Details	Art. No.
PROFINET DiagnosticDUO	124030020

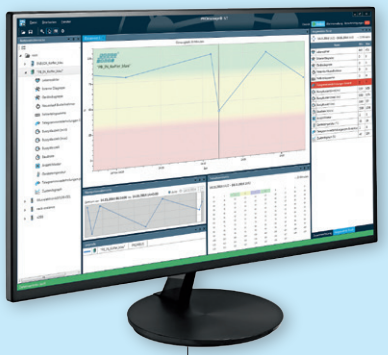
PROFINET Diagnostic set (see page 22)

All essential tools for commissioning and troubleshouting

- Analysis and diagnostic tool **PROFINET-INspektor® NT**
- Topology software **PROscan® Active V2**
- Network monitoring software **PROmanage® NT**
- Cable tester **PROlinetest** (optionally incl. **ETHERtest V5.1/V5.2**)
- Leakage current measuring clamp **EMCheck® LSMZ I**

Ordering Details	Art. No.
PROFINET Diagnostic set (with **PROlinetest**)	114010020
PROFINET Diagnostic set (with **ETHERtest V5.1**)	114010040
PROFINET Diagnostic set (with **ETHERtest V5.2**)	114010050

Network monitoring



PROmanage® NT (see page 24)

Network monitoring software

*The licence defines the maximum number of network ports or devices retrieved simultaneously. (Ethernet switch: number of network ports = number of licence ports, 1 PB-INspektor® = 8 ports, 1 PN-INspektor® = 16 ports)

Ordering Details	Art. No.
PROmanage® NT (80 Ports*)	117000032
PROmanage® NT (320 Ports*)	117000034
PROmanage® NT (640 Ports*)	117000036

*Further licences upon request

EMC analysis | EMC diagnosis | EMC measurement

EMCheck® LSMZ I (see page 22)

Leakage current measuring clamp

Ordering Details	Art. No.
EMCheck® LSMZ I	122010005
Set of measuring clamps (LSMZ I and MWMZ II)	122010006

EMCheck® MWMZ II

Mesh resistence measuring clamp

Ordering Details	Art. No.
EMCheck® MWMZ II	122010010
Set of measuring clamps (LSMZ I and MWMZ II)	122010006

Infrastructure components

PNMA II

PNMX IP67

PNMA II / PNMX (see page 27)

PROFINET measuring points

Ordering Details	Art. No.
PNMA II	114090100
PNMX IP 67 (for rough production environments)	114090300

PROmesh P9 (see page 28)

PROFINET/Ethernet Switch

Ordering Details	Art. No.
PROmesh P9	114110020

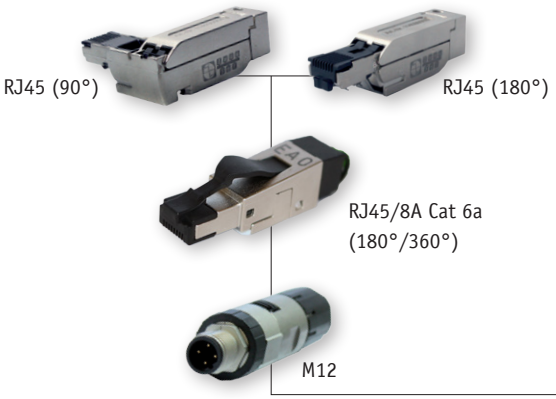
Infrastructure components

PROFINET BLUambas®

PROFINET wireless system via Bluetooth

Ordering Details	Art. No.
BLUambas® PN classic IP20* (4 device participant)	125100200
BLUambas® PN classic IP65* (4 device participant)	125100201
BLUambas® PN comfort IP20* (6 device participant)	125100202
BLUambas® PN comfort IP65* (6 device participant)	125100203
BLUambas® PN premium IP20* (6 dp + PROFIsafe)	125100204
BLUambas® PN premium IP65* (6 dp + PROFIsafe)	125100205

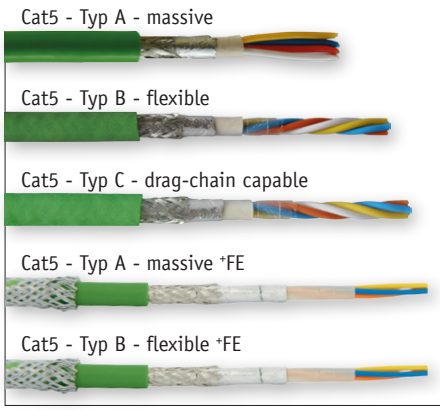
*Antennas and accessories on request



PROFINET plugs

RJ45 / M12 Fast Connect

Ordering Details	Art. No.
PROFINET plug RJ45 (180°)	114030003
PROFINET plug RJ45 (90°)	114030004
PROFINET plug RJ45/8A Cat 6a (180°)	112030008
PROFINET plug RJ45/8A Cat 6a (360°)	112030009
PROFINET plug M12	114030002



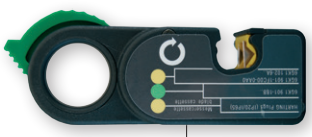
PROFINET cable

Cat5 / +FE (massive / flexible / drag-chain capable)

Ordering Details	Art. No.
PROFINET cable Cat5 (Typ A - massive)	114050010
PROFINET cable Cat5 (Typ B - flexible)	114060001
PROFINET cable Cat5 (Typ C - drag-chain capable)	114070001
PROFINET cable +FE (Typ A - massive)	114050011
PROFINET cable +FE (Typ B - flexible)	114060003

PROFINET tools

Ethernet Fast Connect Stripping Tool

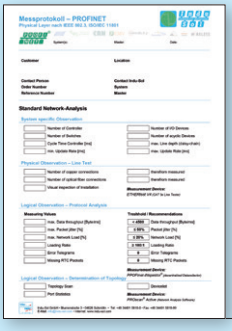


EMFlex Stripping Tool

Stripping Tools

Ordering Details	Art. No.
Ethernet Fast Connect Stripping Tool	112020005
EMFlex Stripping Tool	122130010

Services (Measurement | Training)



Measurement / Troubleshooting (see page 29)

Network analysis / Certification, Troubleshooting

Ordering Details	Art. No.
Network analysis / Certification	210030000
Troubleshooting	210030003

Training (see page 29)

PROFINET seminars

Ordering Details	Art. No.
One-day seminar (1 day)*	220030012
User training PROFINET (2 days)*	220030001

Training (see page 29)

PROFINET seminar **PI certified** incl. test

Ordering Details	Art. No.
Certified PROFINET Installer (2,5 days)*	220030007
Certified PROFINET Engineer (2,5 days)*	220030016

Training (see page 29)

Security seminar

Ordering Details	Art. No.
One-day seminar (1 day)*	220090010

Training (see page 29)

Wireless LAN seminar

Ordering Details	Art. No.
Training Wireless LAN (2 days)*	220080001

*On-site training at your premises.

Notes

Indu-Sol GmbH
Blumenstrasse 3
04626 Schmoelln

Telephone: +49 (0) 34491 5818-0
Telefax: +49 (0) 34491 5818-99

info@indu-sol.com
www.indu-sol.com

Certified according to DIN EN ISO 9001:2008

PROFINET - The Movie | Technology Made Easy

www.indu-sol.com/profinet-movie or use the QR code directly

Updated 03/2018