



INDUSTRIAL AUTOMATION

## The new PROFIBUS *Tester 5*

*The easy Approach for Beginners and Professionals*

## ***Most of the typical problems in Profibus networks are caused by***

- Issues with cables
- missing, unpowered or surplus bus terminations
- overlong bus lines
- dead-end branches
- wrong cable types
- predamaged / defectice bus drivers
- excessive transfer resistances due to aging / cc
- cable routing in environments subject to strong interference
- EMC impacts
- faulty configuration of Profibus parameters, GSD files etc.....



# Introduction

- PROFIBUS Tester 5 is the new „All-in-One“ tool to quickly and easily detect all these types of problems in Profibus networks.
- PROFIBUS Tester 5 supports you to
  - reduce network downtime
  - increase network reliability
  - reduce maintenance costs of your Profibus networks



# Introduction

## The PROFIBUS Tester 5 Supports two Modes of Operation



# Stand-Alone-Mode:

*Network Diagnostics without a PC*



The PROFIBUS Tester 5 is a true hand-held device.

The tester is

- **battery-powered** and has a
- **3.5" graphical display** to comfortably display the test results while working on the shop floor.

In Summary:

The **PROFIBUS Tester 5** is a groundbreaking all-in-one diagnostic and troubleshooting instrument. It provides diagnostic functions to test

- cable installations,
- evaluate electrical signal quality and
- analyze the data being transmitted on the network.

# PB-DIAG-SUITE:

## Import Diagnostic Data

The screenshot displays the 'Import Test Data' dialog box in the foreground, which is overlaid on a larger application window. The 'Import Test Data' dialog has the following fields and table:

Active Device: BC-600-PB      Serial Number: 101900239

Status	Memory Location	Start Time	Duration	Action	Network	Project	Test Location
	Quick Test 1	1/18/2012 09:20:04.000	00:00:10	Import & Delete	Please Select		
	Quick Test 2			None			
	Quick Test 3			None			
	Quick Test 4			None			
	Quick Test 5			None			
	Quick Test 6			None			
	Quick Test 7			None			
	Quick Test 8			None			
	Quick Test 9			None			
	Quick Test 10			None			
	Trend	1/18/2012 09:21:08.000	00:01:57	Import & Delete	Please Select		

Below the table are 'Start' and 'Stop' buttons.

The 'Select Network' dialog box is also visible, showing a table of available networks:

Network Name	Project Name	Assigned Tool
Default Network		-
SPS1_Busstrang1_Segment1	Anlage1_Ort1(Beispiel)	-
PLC1_Bus1_Segment1	Plant1_Location1(example)	-
PROFI-LAB	SNA PROFIBUS diagnostic demonstration	-
SNA-Test	Test Network	-

Buttons at the bottom of the 'Select Network' dialog include 'Add new network', 'OK', and 'Cancel'.



# PB-DIAG-SUITE:

## Welcome Screen



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### **PROFIBUS Diagnostic Suite:**

Up-to 75 test results can be saved in memory to be imported from the included PROFIBUS Diagnostic Suite (PC software) for more advanced analysis.

The Diagnostic Suite offers additional features including

- Topology Analysis
- Report Generation

The PROFIBUS Diagnostic Suite is free-of-charge and does not require any form of licensing.



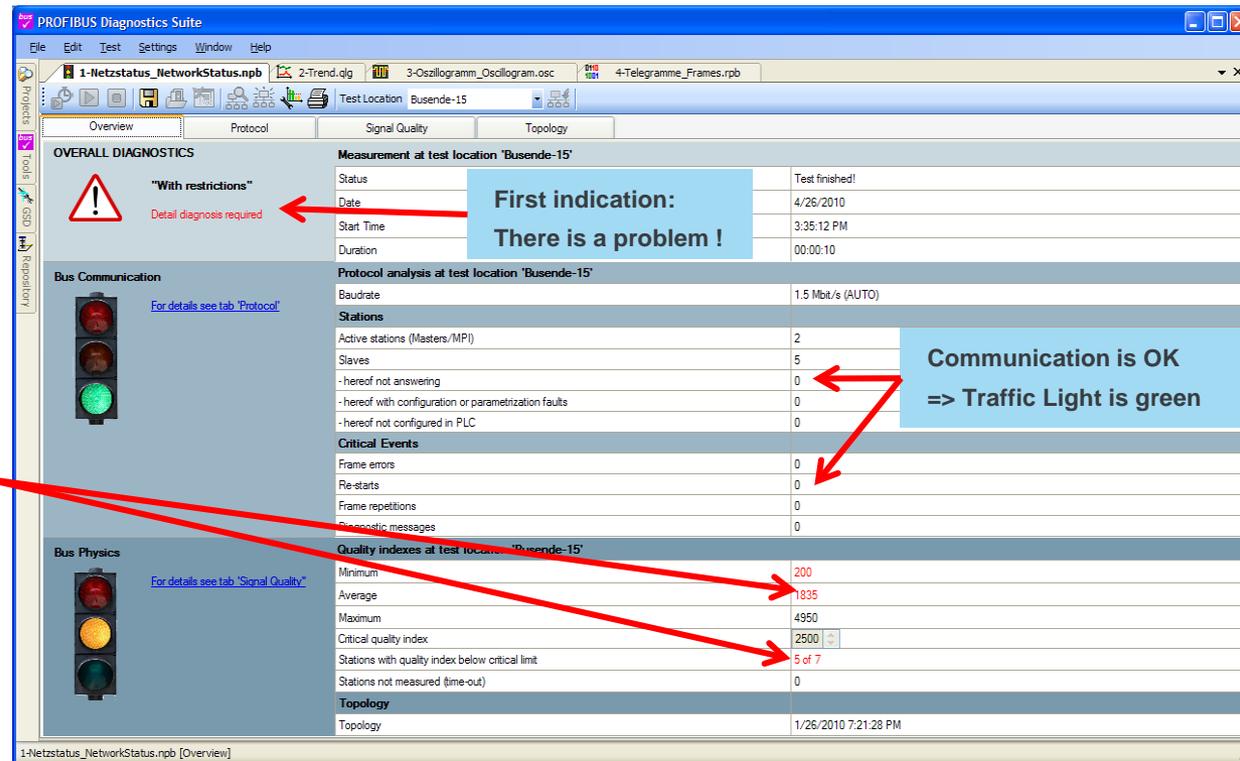
# PB-DIAG-SUITE:

## Overview Window

### See at a glance:

- Is your network OK or do you need more detailed analysis ?
- In case of problems: are they related to communication or to bus physics ?

Electrical characteristics are critical:  
Some nodes show bad signal quality  
=> Traffic Light is yellow  
=> Further Analysis required



The screenshot shows the PROFIBUS Diagnostics Suite interface. The 'OVERALL DIAGNOSTICS' section displays a warning icon and the text 'With restrictions' and 'Detail diagnosis required'. The 'Bus Communication' section shows a green traffic light icon and the text 'Communication is OK => Traffic Light is green'. The 'Bus Physics' section shows a yellow traffic light icon and the text 'Electrical characteristics are critical: Some nodes show bad signal quality => Traffic Light is yellow => Further Analysis required'. The 'Measurement at test location 'Busende-15'' table shows the following data:

Measurement at test location 'Busende-15'		
Status		Test finished!
Date		4/26/2010
Start Time		3:35:12 PM
Duration		00:00:10

The 'Protocol analysis at test location 'Busende-15'' table shows the following data:

Protocol analysis at test location 'Busende-15'		
Baudrate		1.5 Mbit/s (AUTO)
Stations		
Active stations (Masters/MPI)		2
Slaves		5
- hereof not answering		0
- hereof with configuration or parametrization faults		0
- hereof not configured in PLC		0
Critical Events		
Frame errors		0
Re-starts		0
Frame repetitions		0
Diagnostic messages		0

The 'Quality indexes at test location 'Busende-15'' table shows the following data:

Quality indexes at test location 'Busende-15'		
Minimum		200
Average		1835
Maximum		4950
Critical quality index		2500
Stations with quality index below critical limit		5 of 7
Stations not measured (time-out)		0
Topology		1/26/2010 7:21:28 PM

# PB-DIAG-SUITE:

## Protocol Screen



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The screenshot shows the PROFIBUS Diagnostics Suite interface. The main window title is "PROFIBUS Diagnostics Suite". The menu bar includes File, Edit, Test, Settings, Window, and Help. The current network is "BC-600-PB [Default Network]". The bus state is "active, 1.5 Mbit/s (AUTO)". Other status indicators include "Token Rotation Time: 1.40 / 1.70 / 2.30 msec", "Frame Errors: 0", and "Master Simulator: not applicable".

The interface is divided into several sections:

- Network Status:** Includes tabs for Network Status, Trend, Oscilloscope, and Frames.
- Tools:** A toolbar with various diagnostic tools.
- Overview:** Shows a tree view of the network topology. The selected segment is "1.5 Mbit/s Segment", which contains:
  - (1) Master
  - (10) Slave
  - (11) Slave
  - (12) Slave
  - (14) Slave
  - (2) Master
  - (100) Slave
- Protocol:** The active tab, showing detailed information about the selected segment.
  - Info:** Includes Station Statistics and Frame Errors.
  - Bus Data:**
    - Baud Rate: 1.5 Mbit/s
    - Bus cycle (min./avg./max.): 0.32/1.52/1.86 ms
  - Bus Devices:**
    - Total number of Masters: 2
    - Total number of non-DP devices: 0
    - Total number of Slaves: 5
    - thereof not answering: 0
    - thereof with diagnostic messages: 0
  - Identification:**
    - Segment Name: (empty)
    - Test Location: Default test loc
  - Baud Rate:** Transmission speed in the PROFIBUS network.
- 1.5 Mbit/s Segment:** A table showing the last 7 messages.

Date and Time	Message
1/18/2012 10:26:36.8520000	Slave (10) Data Exchange
1/18/2012 10:26:36.8520000	Slave (11) Data Exchange
1/18/2012 10:26:36.8520000	Slave (12) Data Exchange
1/18/2012 10:26:36.8520000	Slave (14) Data Exchange
1/18/2012 10:26:36.9982848	Slave (100) Data Exchange
1/18/2012 10:26:37.1228090	Master (1) OPERATE
1/18/2012 10:26:37.5490065	Master (2) OPERATE

The status bar at the bottom indicates "BC-600-PB [Default Network] [Protocol] Running measurements: none".



# PB-DIAG-SUITE:

## Signal QualityScreen



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PROFIBUS Diagnostics Suite

File Edit Test Settings Window Help

BC-600-PB [Default Network] Token Rotation Time: 1.40 / 1.70 / 2.10 msec | Frame Errors: 0 | Master Simulator: not applicable

Bus State: active, 1.5 Mbit/s (AUTO)

Network Status | Trend | Oscilloscope | Frames

View: Whole Network | Test Location: Default test loc | Station(s): 1: Master

Overview | Protocol | Signal Quality | Topology

Network

Station	Quality Index
1	1,800
2	3,100
10	3,900
11	3,800
12	4,150
14	3,600
100	3,800

Test Location		Default test loc	
Accumulated errors	Glitch: 0	Edge: 0	Level: 0
Quality Index Summary	Minimum value	1,800	1/18/2012 10:47:39.434
	Average	3,457	-
	Maximum value	4,150	1/18/2012 10:47:39.434

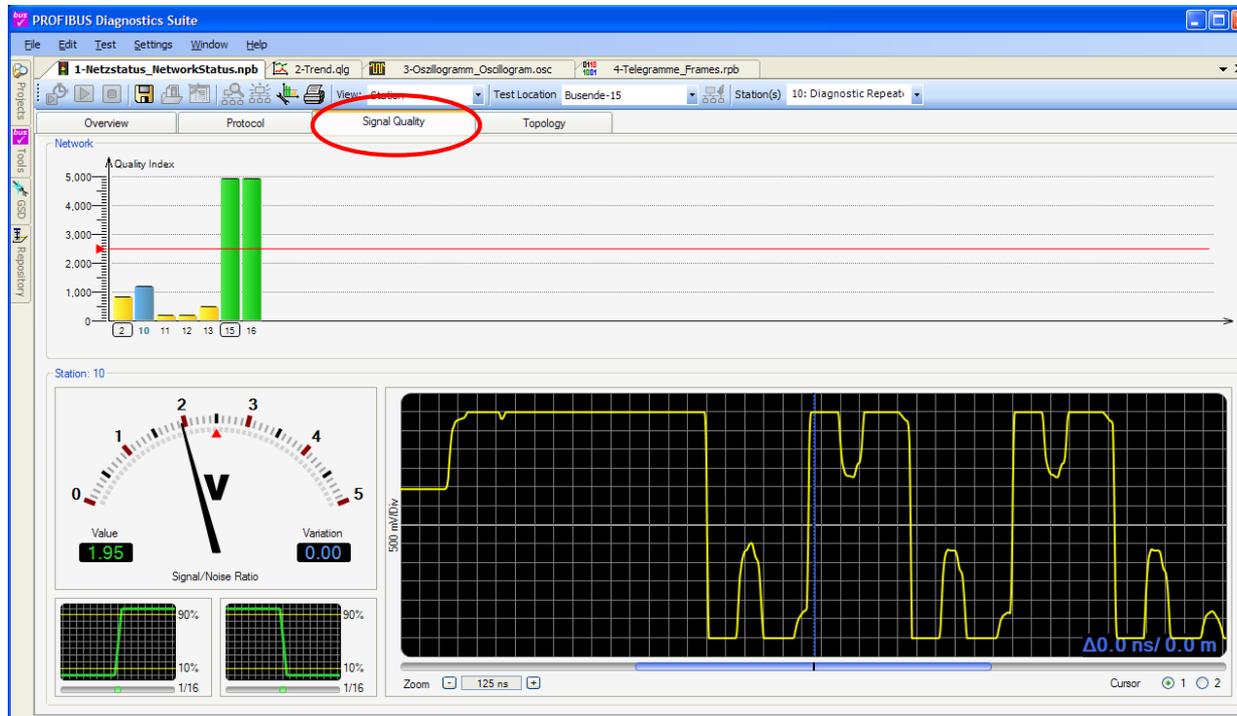
Selected		1: Master	
Errors per 1,000 bits	Glitch: 0	Edge: 0	Level: 0
Quality Index	Minimum value	1,800	1/18/2012 10:47:39.434
	Current value	1,800	1/18/2012 10:47:43.843
	Maximum value	1,800	1/18/2012 10:47:39.434
Signal/noise ratio	Minimum value	4.20 V	1/18/2012 10:47:39.135
	Current value	4.21 V	1/18/2012 10:47:43.843
	Maximum value	4.21 V	1/18/2012 10:47:43.618

BC-600-PB [Default Network] [Signal Quality] Running measurements: none



# 3. PB-DIAG-SUITE: Signal Quality Window

- As indicated in the „Overview Window“ there are electrical issues in our demo network.
- For more details open the Signal Quality Window.  
This shows you the signal quality for all PROFIBUS stations as a bar graph and provides an oscilloscope view for a selected station.



### 3. PB-DIAG-SUITE:

#### Signal Quality Window: Oscilloscope

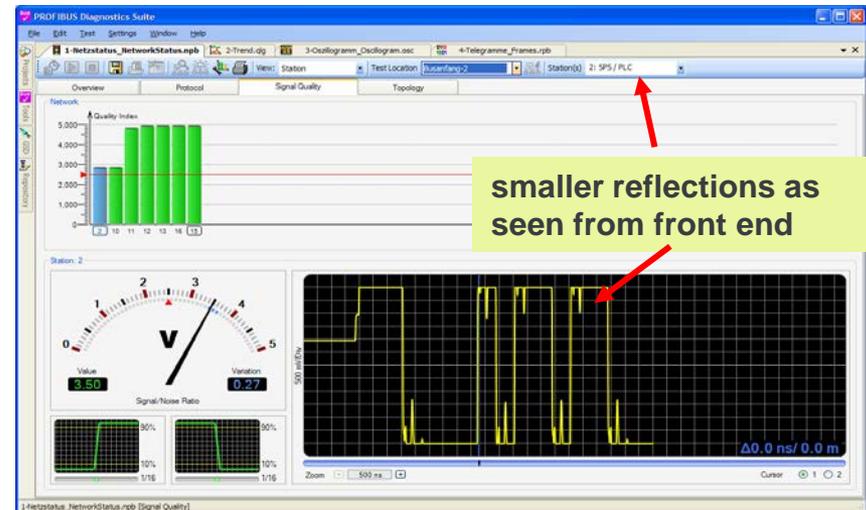
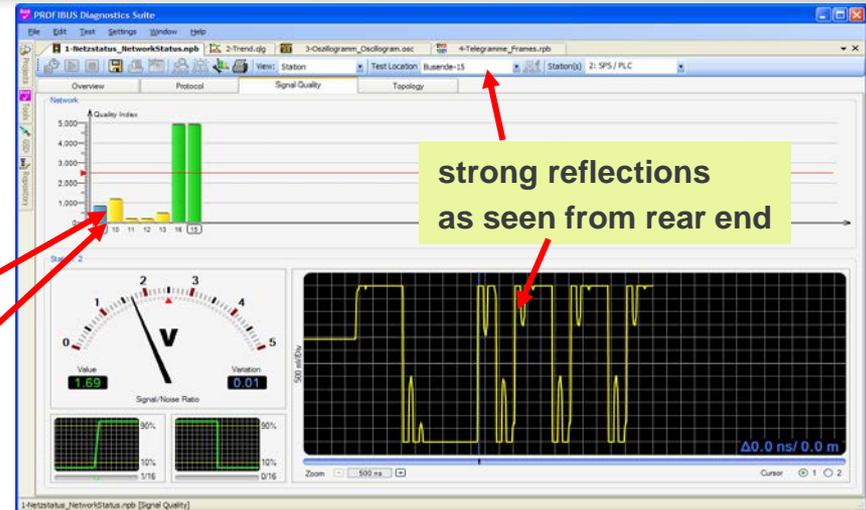
Poor signal quality is mainly caused by

- Reflections (e.g. missing termination, wrong cable type)
- High transmission resistance (e.g. defective cable, corrosion)
- EMC impacts

#### Visualize Reflections:

A double click on any bar opens the oscilloscope view

Once open, a single click on any bar displays the signal of the respective node



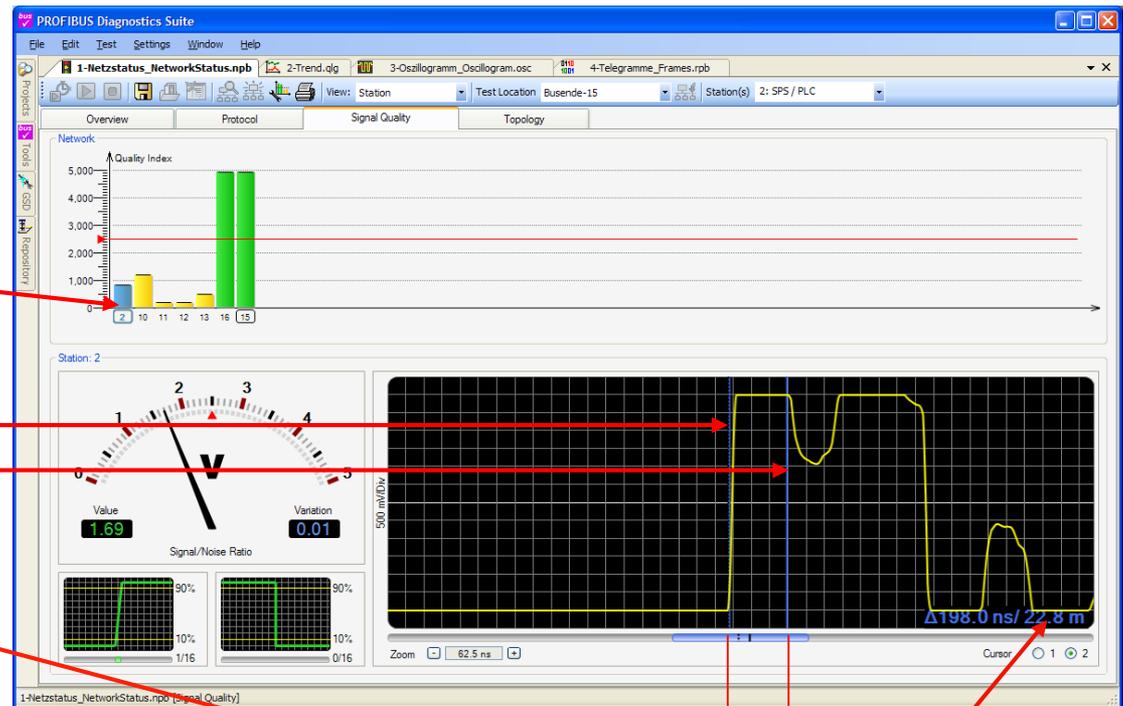
### 3. PB-DIAG-SUITE:

#### Signal Quality Window: Oscilloscope

#### Localize the problem with the Oscilloscope:

Select device by a click to show the signal of this node

Place cursor 1 to rising edge  
Place cursor 2 to distortion  
=> Now you can read the distance from selected device (in this case No. 2) to the point where the reflection is caused: 22,8 m



Distance 22,8 m



### 3. PB-DIAG-SUITE:

#### Signal Quality Window: Oscilloscope

*Now you can compare the distances between the failure and the different stations:*

Click on bar #2

Place cursors

Now distance to problem is 22,8 m

Click on bar #12

Place cursors

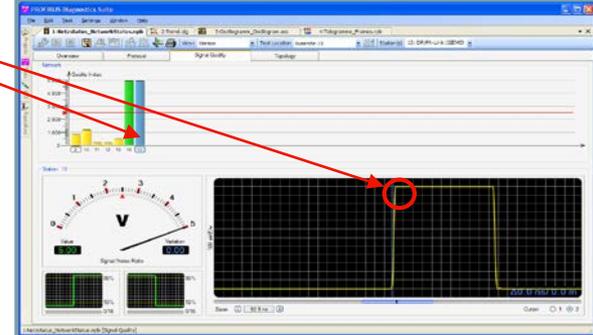
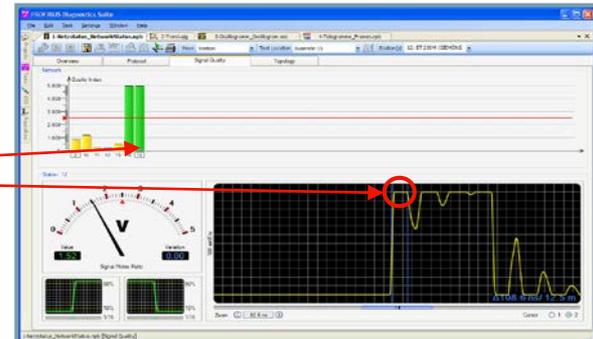
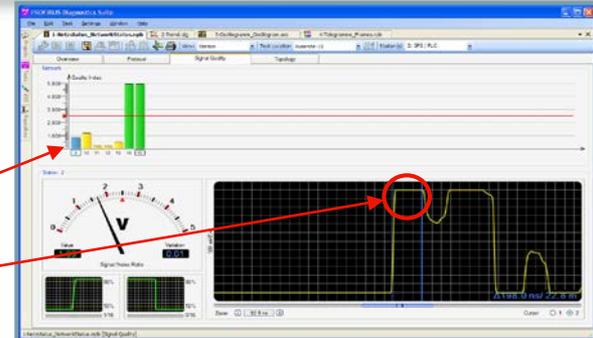
Now distance to problem is only 12,5 m

Click on bar #15 (Busend)

Now distance to problem is 0 m and no distortion

**Result:** the reflection is caused by (or is close to) node #15 (e.g. missing terminator).

Consequently no reflections can be seen there.



# 3. PB-DIAG-SUITE:

## Protocol Window

***In case of communication problems open the „Protocol Window“***

Typically, communication issues are caused by wrong PROFIBUS parameters settings in the master.

Click on “Protocol”

Click on Segment

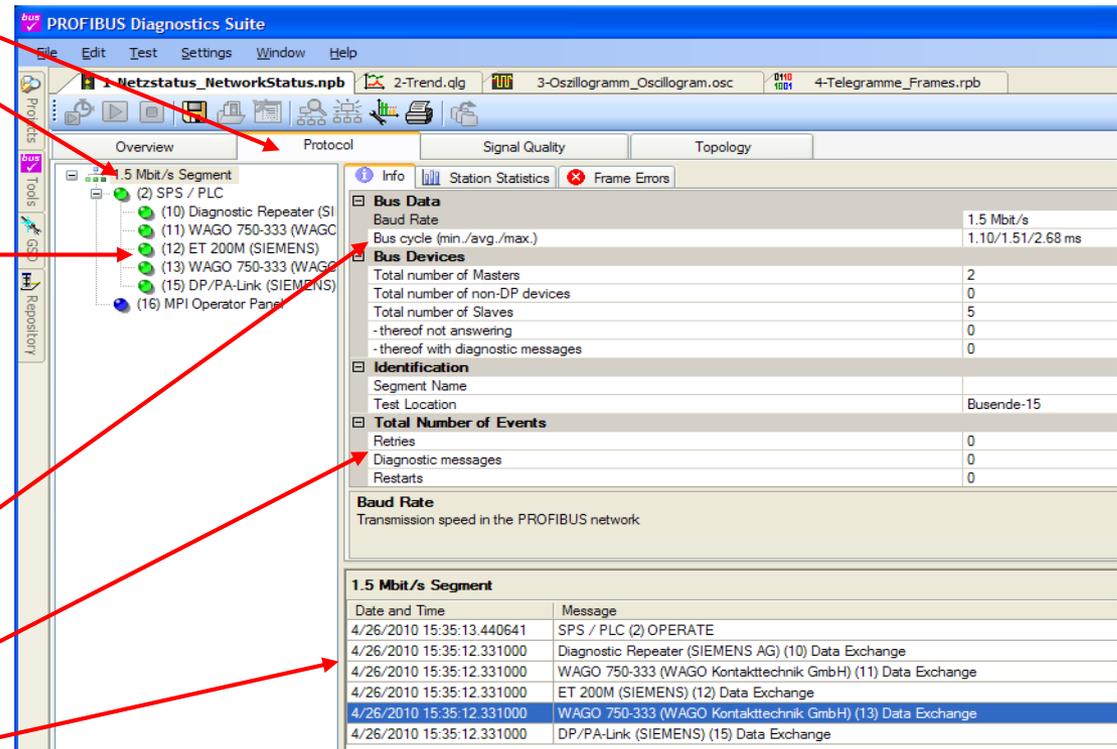
Live List

- Green = data exchange okay
- Yellow = slave reports diagnose
- Orange = config or param failure
- Red = no answer, station is dead
- Blue = station not configured in Master

Bus cycle time

Number of Retries, Diagnostic Frames, Restarts are an indicator for developing problems in the network

Log for main communication events between master and slaves (e.g. communication start-up, etc.)



Date and Time	Message
4/26/2010 15:35:13.440641	SPS / PLC (2) OPERATE
4/26/2010 15:35:12.331000	Diagnostic Repeater (SIEMENS AG) (10) Data Exchange
4/26/2010 15:35:12.331000	WAGO 750-333 (WAGO Kontakttechnik GmbH) (11) Data Exchange
4/26/2010 15:35:12.331000	ET 200M (SIEMENS) (12) Data Exchange
4/26/2010 15:35:12.331000	WAGO 750-333 (WAGO Kontakttechnik GmbH) (13) Data Exchange
4/26/2010 15:35:12.331000	DP/PA-Link (SIEMENS) (15) Data Exchange



# 3. PB-DIAG-SUITE:

## Protocol Window

All relevant communication parameters at a glance:

By clicking on the slaves you get specific info on each device.

Check GSD-file configuration:  
Expected GSD = real GSD ?

If not => configuration failure  
Configuration can be seen under configuration bookmark

Large variation of Station Delay Times indicates a problem of the station

Log file of the selected station

The screenshot shows the PROFIBUS Diagnostics Suite interface. On the left, a network tree displays a 1.5 Mbit/s Segment with several stations. Station (11) WAGO 750-333 is selected. The main window shows the configuration for this station, including identification, state, and station delay parameters. A log window at the bottom shows the date and time of the last message.

Parameter	Value
Station Type	"Slave"
Station Name	WAGO 750-333 (WAGO Kontakttechnik GmbH)
Station Address	11
Vendor	WAGO Kontakttechnik GmbH
Model	WAGO 750-333
GSD File	Wagob754.gsd
Expected Ident Number	B754
Manufacturer Number	B754
State	Data Exchange
Related Master	2
Last Bus Cycle	5,844
Last Poll Cycle	5,821
Station Delay	
Last Station Delay Time	22 bit times
Station Type	Master station or slave station

Date and Time	Message
4/26/2010 15:35:12.331000	WAGO 750-333 (WAGO Kontakttechnik GmbH) (11) Data Exchange



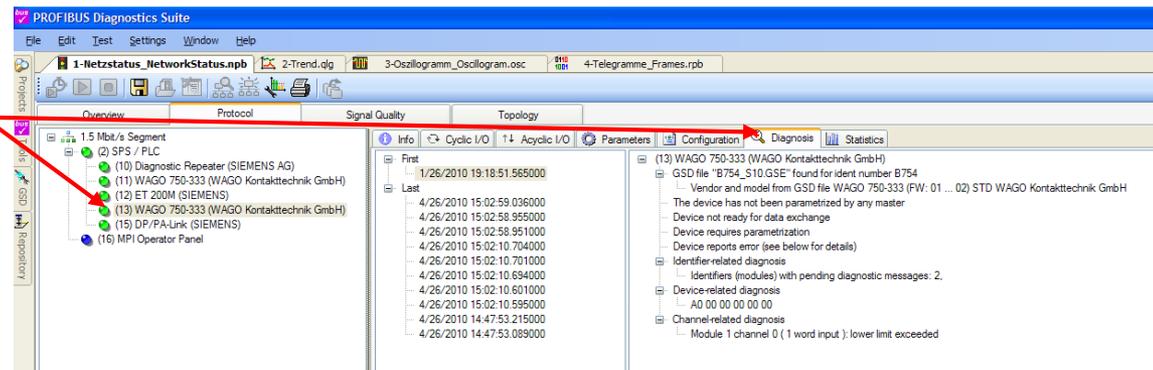
### 3. PB-DIAG-SUITE:

#### Protocol Window

#### Diagnose Messages in Plain Text:

If a device reports problems you can read the respective diagnose telegrams in plain text (and not only in hex code).

Click on "Diagnosis" to read diagnostic messages of selected slaves in plain text (not only hex strings)



Example of a diagnose message of a modular WAGO 750 slave:

One module was taken out and consequently the device reports „K-bus Break behind 3. module“

```
(13) WAGO 750-333 (WAGO Kontakttechnik GmbH)
... GSD file "Wagob754.GSD" found for ident number B754
... Vendor and model from GSD file: WAGO 750-333 (FW: 09 ...)
... Address of master that configured this device: 2
... Watch dog activated
... Device reports error (see below for details)
... Static diagnosis pending (I/O data invalid)
... Manufacturer-specific status Module 0
... A0 00 00 44 02 00
... K-Bus Break behind 3. Module
```

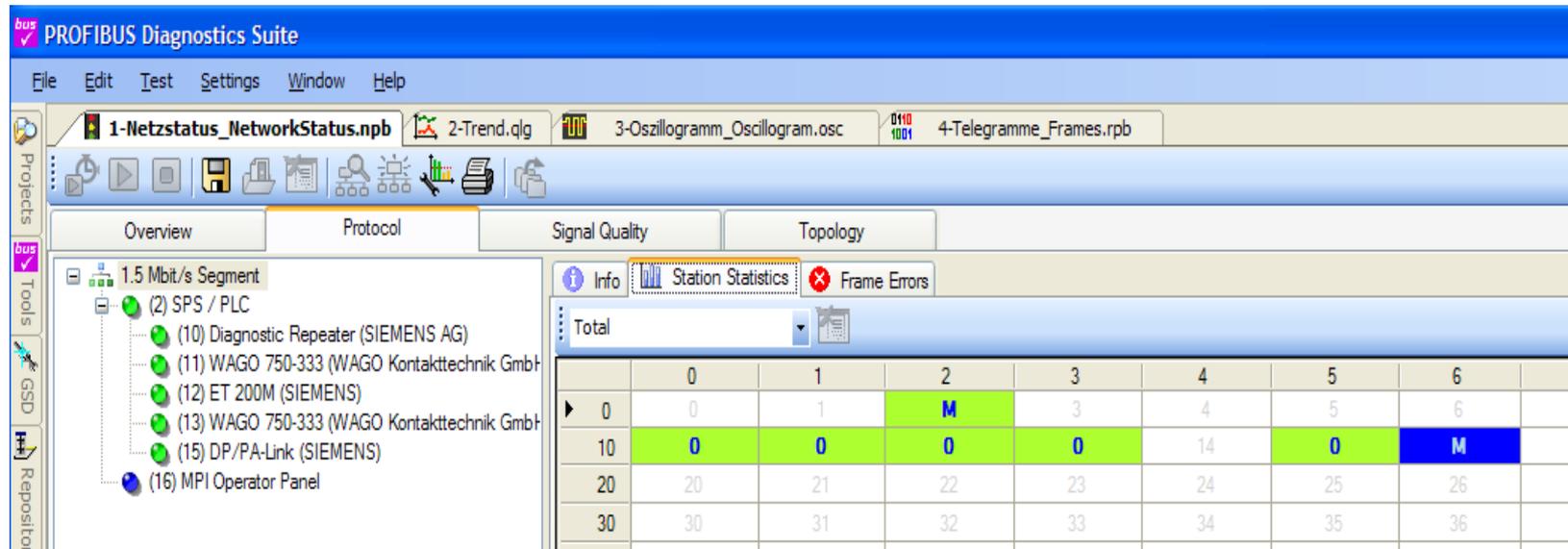
# 3. PB-DIAG-SUITE:

## Protocol Window

### The Matrix Overview:

monitor important frames which indicate problems coming in the future:

- Retries
- Diagnose frames
- Set parameter frames



The screenshot shows the PROFIBUS Diagnostics Suite interface. On the left, a tree view displays a 1.5 Mbit/s Segment with two SPS / PLCs and several diagnostic repeaters and stations. The main window is divided into tabs: Overview, Protocol, Signal Quality, and Topology. The Protocol tab is active, showing a Station Statistics matrix. The matrix has columns for station IDs 0 through 6 and rows for station IDs 0, 10, 20, and 30. The cell at row 10, column 6 is highlighted in blue and contains the letter 'M', indicating a problem. Other cells with '0' are highlighted in green.

Total	0	1	2	3	4	5	6	
0	0	1	M	3	4	5	6	
10	0	0	0	0	14	0	M	
20	20	21	22	23	24	25	26	
30	30	31	32	33	34	35	36	



### 3. PB-DIAG-SUITE: Frame Window

#### Frame Window

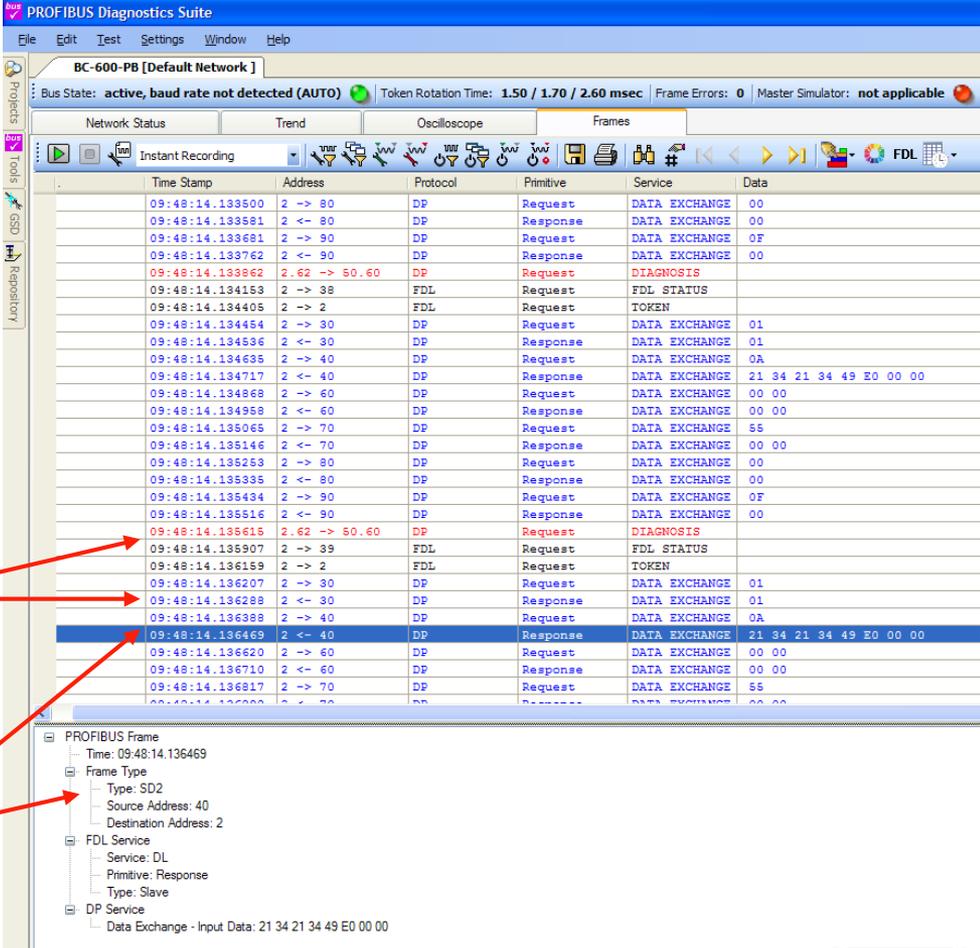
#### The Detailed Look for Professionals:

With the Frame Window you can monitor the entire communication down to a single bit:

- Decode all frames
- Analyse timing by time stamps
- Trigger for frames or specific bits to analyse sporadic events

You may define individual color coding for each type of frame

Click on a single frame to get the decoded contents



The screenshot displays the PROFIBUS Diagnostics Suite interface. The main window shows a list of frames with columns for Time Stamp, Address, Protocol, Primitive, Service, and Data. The frames are color-coded: blue for DP (Data Exchange) and red for FDL (Field Data Link) and DIAGNOSIS. A detailed view of a selected frame is shown at the bottom, showing the frame type (SD2), source and destination addresses, FDL service (DL), primitive (Response), type (Slave), and DP service (Data Exchange - Input Data).

Time Stamp	Address	Protocol	Primitive	Service	Data
09:48:14.133500	2 -> 80	DP	Request	DATA EXCHANGE	00
09:48:14.133581	2 <- 80	DP	Response	DATA EXCHANGE	00
09:48:14.133681	2 -> 90	DP	Request	DATA EXCHANGE	0F
09:48:14.133762	2 <- 90	DP	Response	DATA EXCHANGE	00
09:48:14.133862	2.62 -> 50.60	DP	Request	DIAGNOSIS	
09:48:14.134153	2 -> 38	FDL	Request	FDL STATUS	
09:48:14.134405	2 -> 2	FDL	Request	TOKEN	
09:48:14.134454	2 -> 30	DP	Request	DATA EXCHANGE	01
09:48:14.134536	2 <- 30	DP	Response	DATA EXCHANGE	01
09:48:14.134635	2 -> 40	DP	Request	DATA EXCHANGE	0A
09:48:14.134717	2 <- 40	DP	Response	DATA EXCHANGE	21 34 21 34 49 E0 00 00
09:48:14.134868	2 -> 60	DP	Request	DATA EXCHANGE	00 00
09:48:14.134958	2 <- 60	DP	Response	DATA EXCHANGE	00 00
09:48:14.135065	2 -> 70	DP	Request	DATA EXCHANGE	55
09:48:14.135146	2 <- 70	DP	Response	DATA EXCHANGE	00 00
09:48:14.135253	2 -> 80	DP	Request	DATA EXCHANGE	00
09:48:14.135335	2 <- 80	DP	Response	DATA EXCHANGE	00
09:48:14.135434	2 -> 90	DP	Request	DATA EXCHANGE	0F
09:48:14.135516	2 <- 90	DP	Response	DATA EXCHANGE	00
09:48:14.135615	2.62 -> 50.60	DP	Request	DIAGNOSIS	
09:48:14.135907	2 -> 39	FDL	Request	FDL STATUS	
09:48:14.136159	2 -> 2	FDL	Request	TOKEN	
09:48:14.136207	2 -> 30	DP	Request	DATA EXCHANGE	01
09:48:14.136288	2 <- 30	DP	Response	DATA EXCHANGE	01
09:48:14.136388	2 -> 40	DP	Request	DATA EXCHANGE	0A
09:48:14.136469	2 <- 40	DP	Response	DATA EXCHANGE	21 34 21 34 49 E0 00 00
09:48:14.136620	2 -> 60	DP	Request	DATA EXCHANGE	00 00
09:48:14.136710	2 <- 60	DP	Response	DATA EXCHANGE	00 00
09:48:14.136817	2 -> 70	DP	Request	DATA EXCHANGE	55

PROFIBUS Frame  
Time: 09:48:14.136469  
Frame Type  
Type: SD2  
Source Address: 40  
Destination Address: 2  
FDL Service  
Service: DL  
Primitive: Response  
Type: Slave  
DP Service  
Data Exchange - Input Data: 21 34 21 34 49 E0 00 00

# 3. PB-DIAG-Suite:

## Automatically generated Test Report



### Protocol Report:

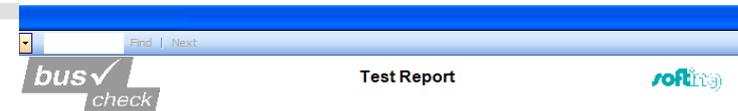
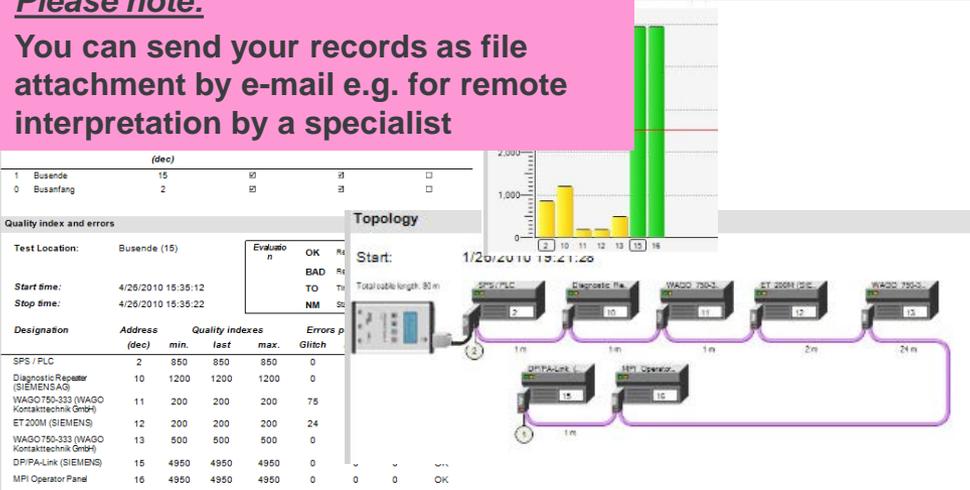
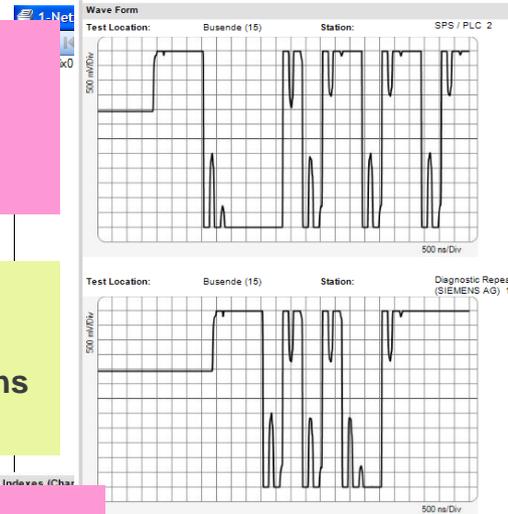
- live list and status of stations
- retries, diagnose, set parameter for each station

### Signal Quality Report:

- min, max, avg value per station
- bar graphs from all test locations
- oscilloscope charts

### Please note:

You can send your records as file attachment by e-mail e.g. for remote interpretation by a specialist



PROFITEST Inc., 1 Fieldbus Plaza, 12000 Profibus City  
**Softing AG**  
 Bernie Buscheck  
 Richard-Reitzner-Allee 6  
 85540 Haar  
 Germany

### The test was performed by:

Tester: Tom Tester  
 Address: PROFITEST Inc.  
 1 Fieldbus Plaza  
 12000 Profibus City

Telephone:  
 E-mail:  
 Creation Date: 7/21/2010  
 Tool: Device Type: -  
 Serial Number: -

### Evaluation/remarks

### Conclusion

- Approval suggested
- Approval with restrictions
- Approval not suggested

\_\_\_\_\_  
 City Date City Date  
 Signature (Softing AG) Signature (Tom Tester, PROFITEST Inc.)

### Results of Protocol Analysis

Measuring Period Start: 4/26/2010 15:35:12.331000  
 Stop: 4/26/2010 15:35:22.549000

### Segment (DP)

Name 1.5 Mbit/s Segment



# 4. Topology Scan

*Shows the correct sequence of the devices and the cable length*

The screenshot shows the PROFIBUS Diagnostics Suite interface for a BC-600-PB network. The main display area is divided into two sections: a table of station data and a physical topology diagram.

Station	Address	Id. No.	Distance (m)	Progress
all Stations				
Master	2	0x0000	-	0 %
Station	30	0x0000	-	0 %
Station	40	0x0000	-	0 %
Station	60	0x0000	-	0 %
Station	70	0x0000	-	0 %
Station	80	0x0000	-	0 %
Station	90	0x0000	-	0 %

Below the table, a physical topology diagram shows a linear arrangement of devices. On the left is a Master device (address 2) connected to a chain of six Station devices (addresses 30, 40, 60, 70, 80, 90). Each connection between adjacent devices is labeled with "? m", indicating that the cable length has not yet been determined. The total cable length is also listed as "unknown".



## 5. Strategy for Analysing Networks with *PROFIBUS Tester 4*

### ***We recommend the following initial steps:***

#### **▪ Step 1:**

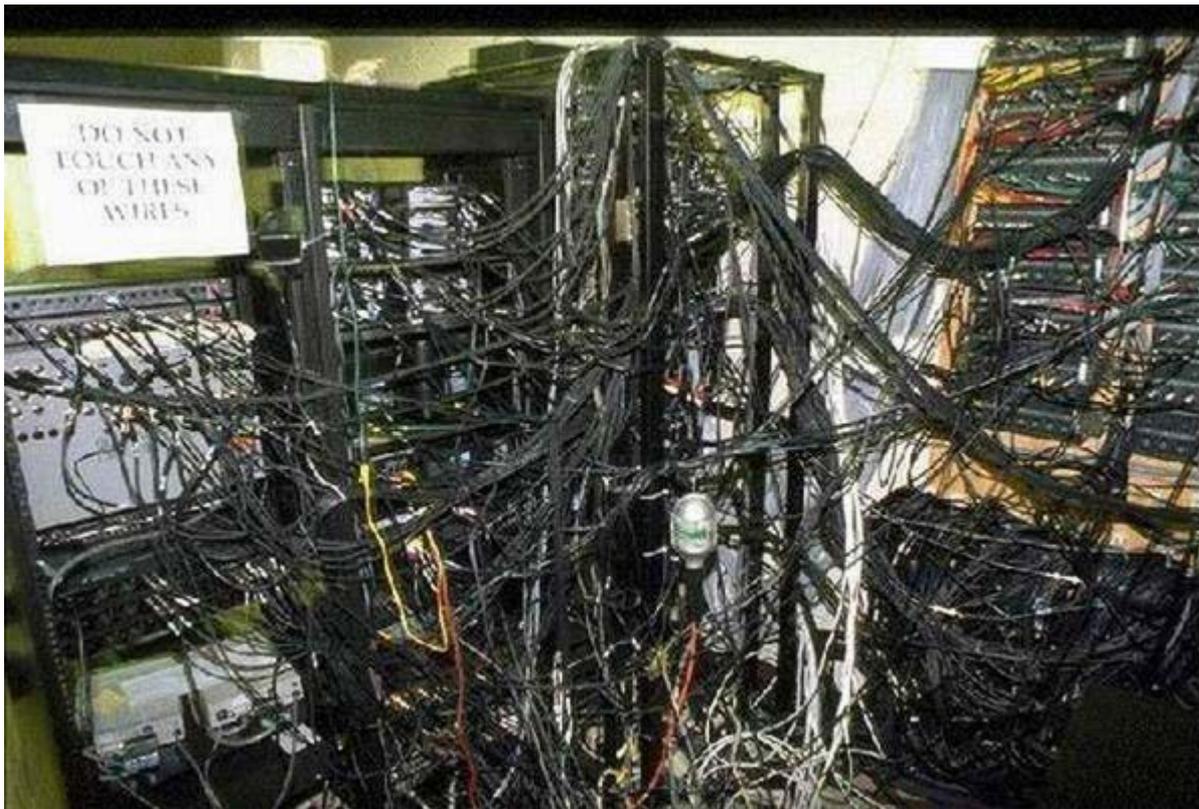
- Perform a „Live-Status“ with PB-T4 in „Stand-Alone-Mode“ (without PC)
- Always (!) execute this „Live-Status“ on both ends of your network
- Case 1: Your network is OK (no further actions required):
  - if all quality levels are good in both measurements and
  - if there are no error frames or frame repetitions in both measurements
- Case 2: your network needs service if there are :
  - bad signal levels or
  - error frames or
  - frame repetitions in one or in both measurements

#### **Step 2:**

- Connect PB-T4 again to that end of the network that displayed problems
- Perform a „Stand-alone“
- Connect PB-T4 to USB-port of your PC and start PB-DIAG-SUITE software
- Perform a „Quick Test“ from your PC
- The „Overview Window“ will help you to determine whether you are faced with electric or communication problems
- Select „Protocol“ and / or „Signal Quality“ views for further diagnostic details



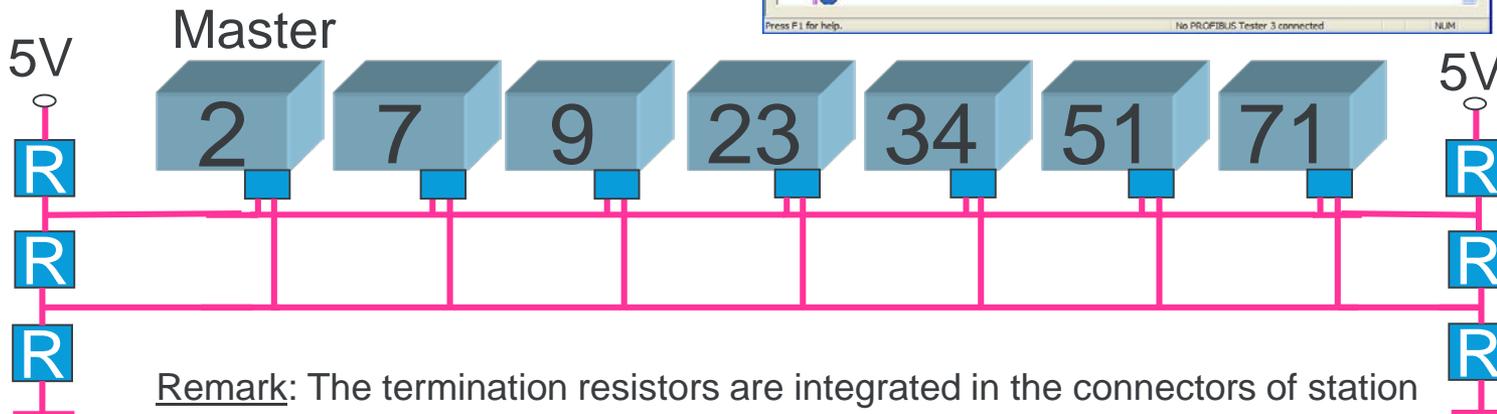
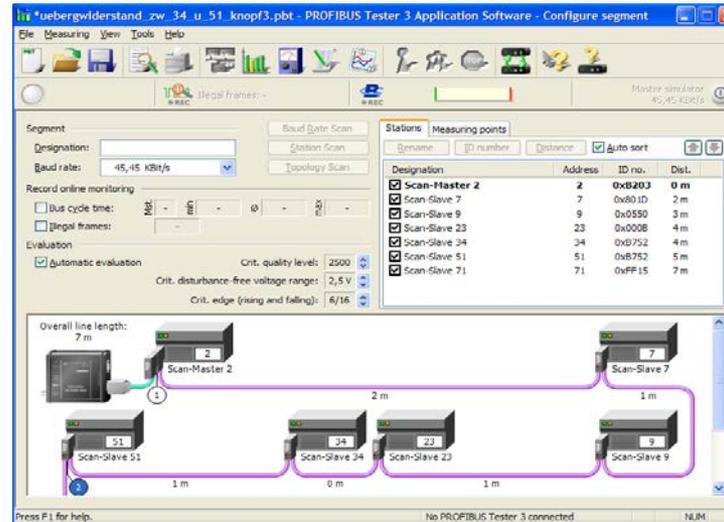
## Examples of Common PROFIBUS Network Issues



# 6. Typical Network Issues in a Profibus Network

## Sample Network

The following network issues were recorded on a sample network as shown below:



**Remark:** The termination resistors are integrated in the connectors of station 2 and 71; the 5V supply for the termination is provided by the respective device.



# 6. Typical Network Issues in a Profibus Network

## Case 1: Reversal of results from both ends of the system

### Case 1:

#### **Step 1:**

connect and test from left end side (Master 2)

#### **Step 2:**

connect and test from right end side (Slave 71)

### Result:

Test results on the left end:

- good quality values for stations 2 - 34
- bad quality values for stations 51 - 71

Test results on the right end:

- bad quality values for stations 2 - 34
- good quality values for stations 51 - 71

→ Reversal of Q-Levels!



measurement from left side (Master 2)



measurement from right side (slave 71)

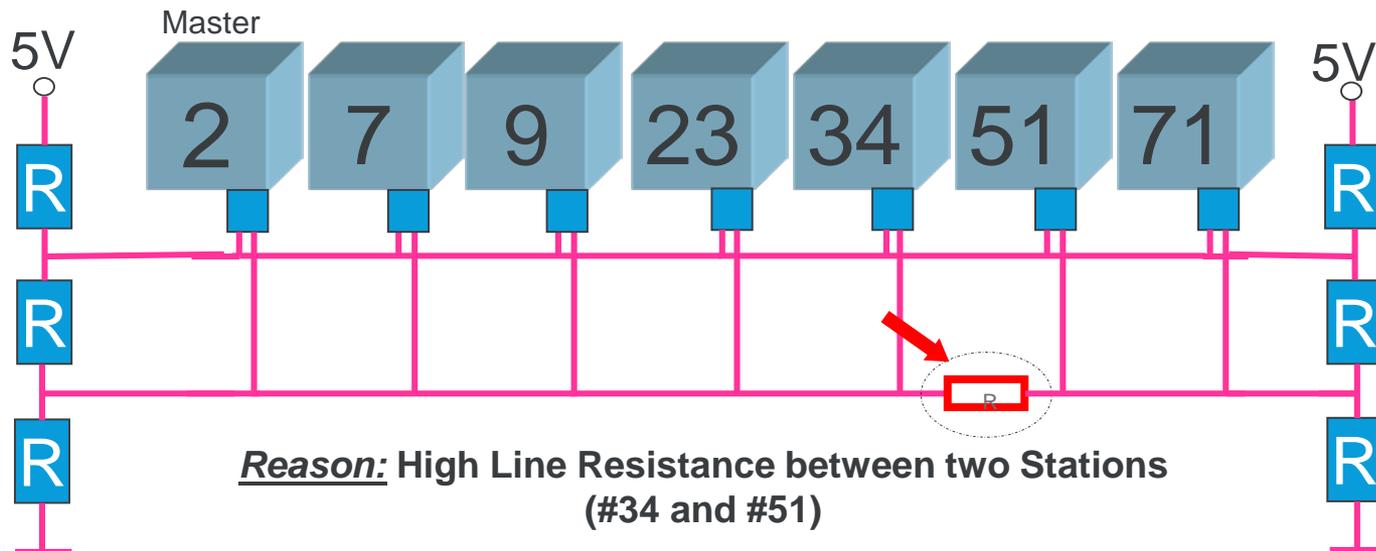
## 6. Typical Network Issues in a Profibus Network

### Case 1: Reversal of results from both ends of the system

#### **Interpretation:**

The test result from the **right** side is the **reversal (!)** of the test results from the **left** side and vice versa.

This kind of reversal is a clear indication for a **high resistance** in the network. In this case the problem is caused somewhere between slave 34 and slave 51 e.g. corrosion, sharply bent cable, etc.



## 6. Typical Network Issues in a Profibus Network

*Case 2: Q-level becomes worse from one measuring point to the next*

### Case 2:

- Step 1: perform test at **left** end (Master 2)
- Step 2: perform test at **right** end (Slave 71)
- Step 3: perform tests at random stations located in the **middle** of the network

### Result:

- No reversion of Q-level between left and right side
- Instead, the Q-level for all stations generally declines from one station to the other.



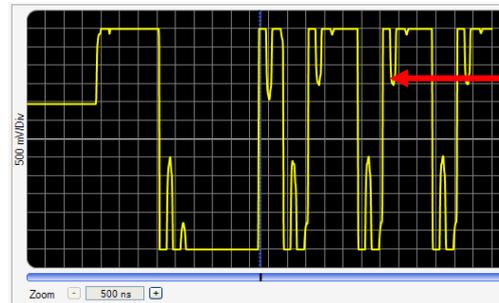
## 6. Typical Network Issues in a PROFIBUS Network

*Case 2: Q-level becomes worse from one measuring point to the next*

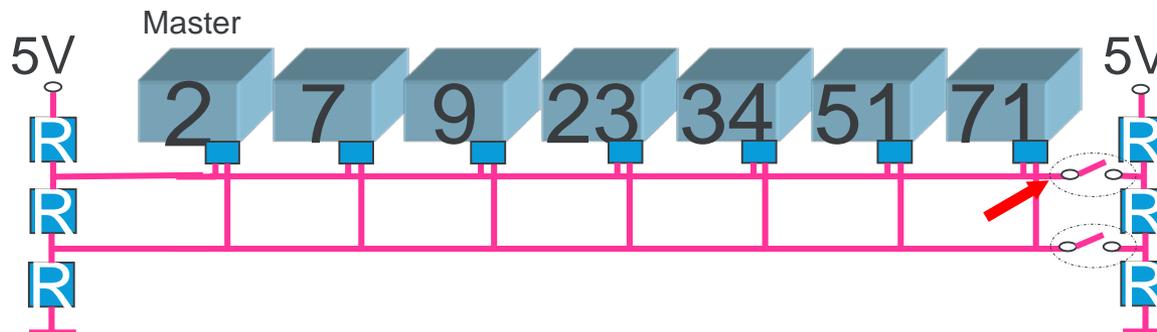
### Interpretation:

- The problem is **not** caused by resistance problems (corrosion, cable too long, etc...)
- The problem is caused by signal **reflections** in the network, in this case by a missing termination resistance at Slave 71.

***Typically, the problem is located at the test point that shows most stations with a bad Q-level.***



You can see the reflections in the oscilloscope display of master 2 while connected at test point Slave 71.

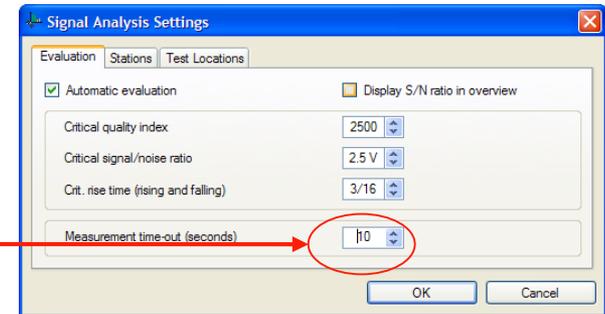


# 6. Typical Network Issues in a PROFIBUS Network

Case 3: Some stations are “missing” depending on the test location

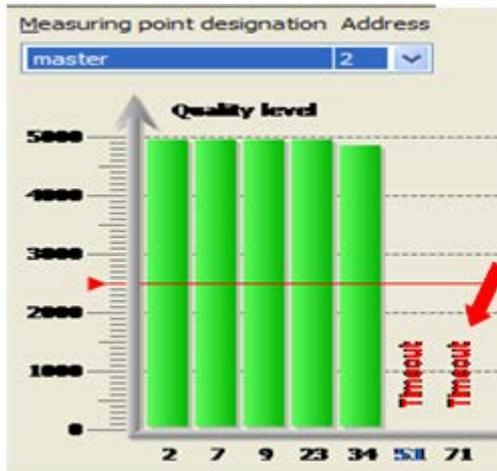
## Case 3:

- Step 1: perform test at left side (Master 2)
  - Step 2: perform test at right side (Slave 71)
- (Note: make sure that Timeout is not caused by the time-out setting in PB-T4: => Tools / settings)



## Result:

- Test at left end: Slave 53 and 71 are missing
- Test at right end: all stations are missing



## 6. Typical Network Issues in a PROFIBUS Network

Case 3: Some stations are “missing” depending on the test location

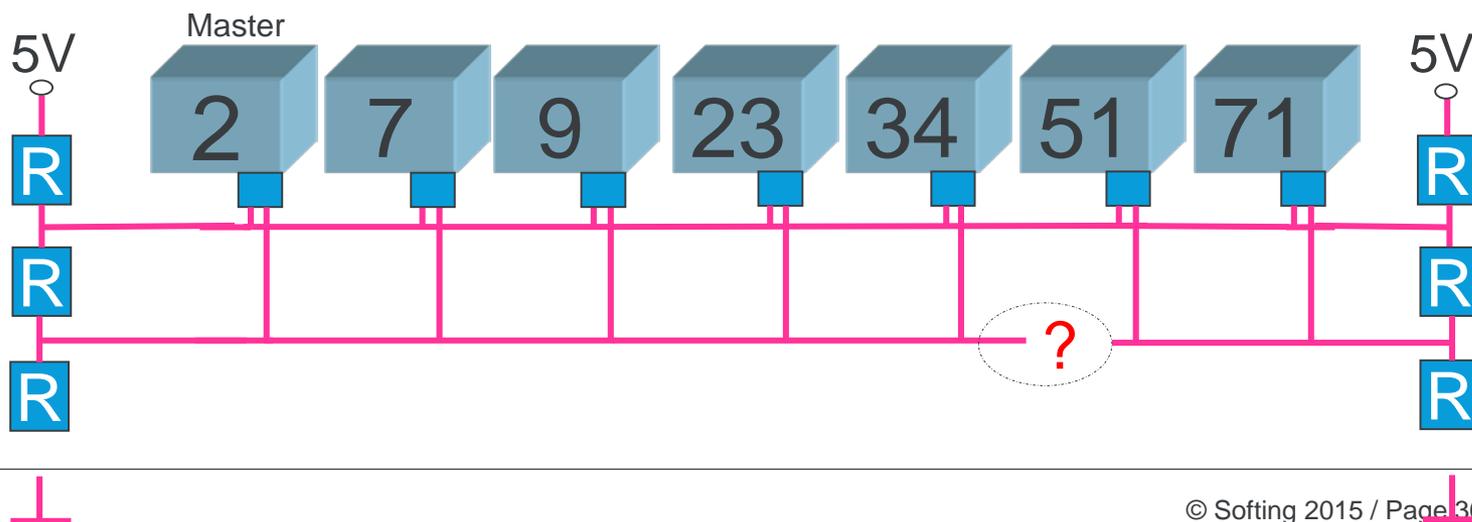
### Interpretation:

The fact that some devices can be seen from one end but not from the other indicates that the problem is not be caused by the devices themselves.

The test result at the left end shows that the Q-levels are good until slave 34. After slave 34 the Q-levels are not testable. This indicates that the problem must be in the line between slave 34 and 51.

### Conclusion:

The problem is caused by a break of one or both signal lines.



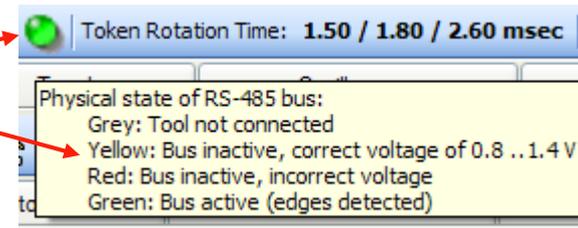
## 6. Typical Network Issues in a PROFIBUS Network

### Case 5: Bus-termination is not powered correctly

#### **Indication of idle voltage:**

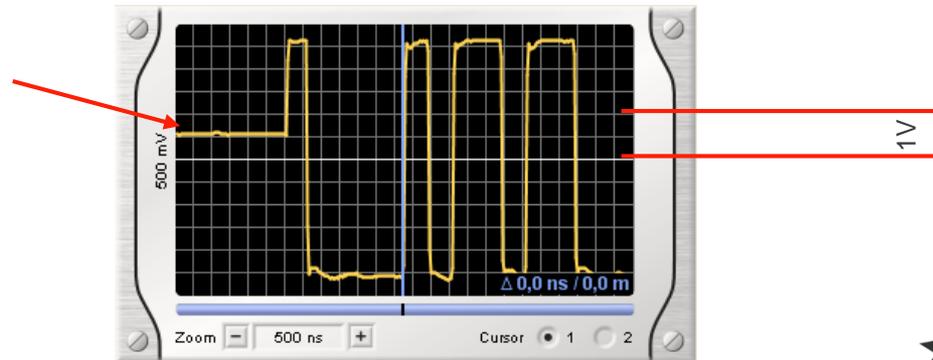
The correct idle voltage is supposed to be between 0.8 and 1.4 V.

An idle voltage lower than that indicates that one or both bus-terminations are not powered correctly.



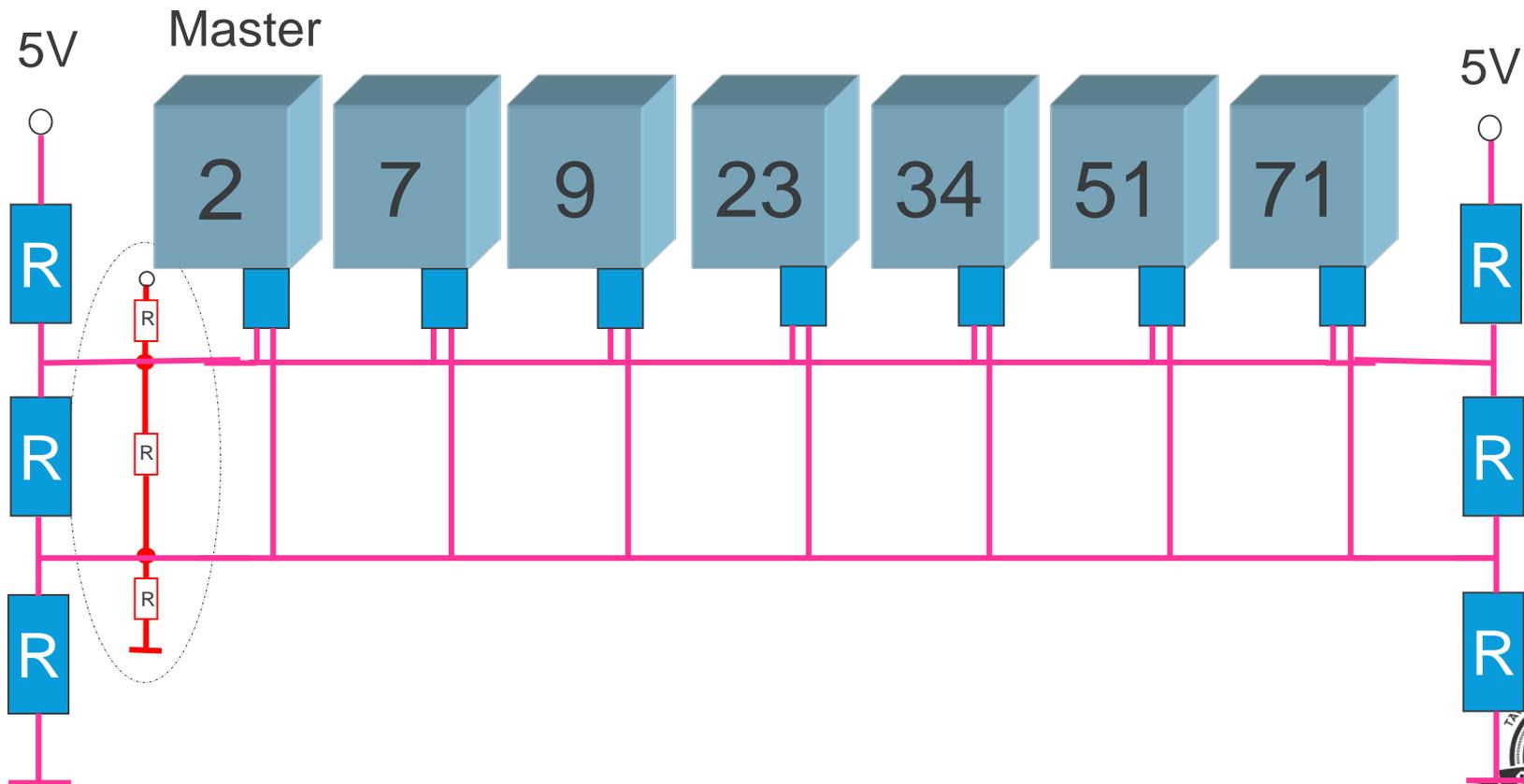
- An idle voltage of approx. 0.6 Volts indicates that only one bus-termination is powered correctly  
⇒ communication may work, sporadic failures likely
- An idle voltage close to 0 Volts (both terminations not correctly powered or one termination missing/one not correctly powered) ⇒ PROFIBUS will not start

In addition, you can detect a low idle-voltage in the oscilloscope (in this case approx. 0.5 V)



## 6. Typical Network Issues in a PROFIBUS Network

Case 6: *Too many bus-terminations or additional electrical resistance*



# 6. Typical Network Issues in a PROFIBUS Network

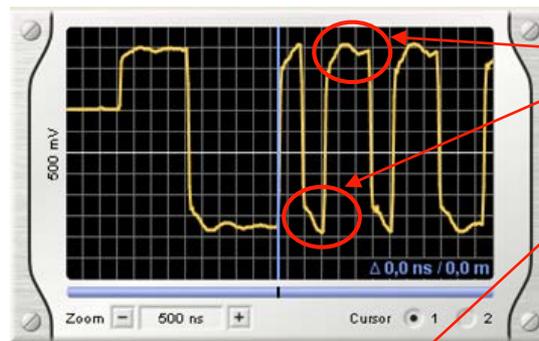
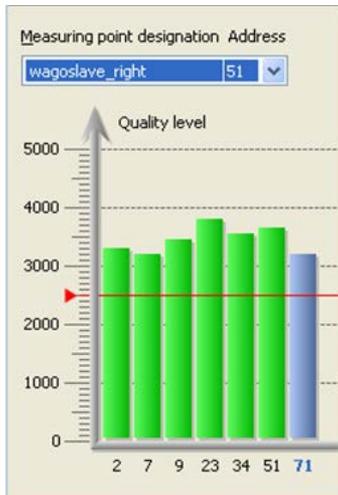
## Case 6: Too many bus-terminations or additional electrical resistance



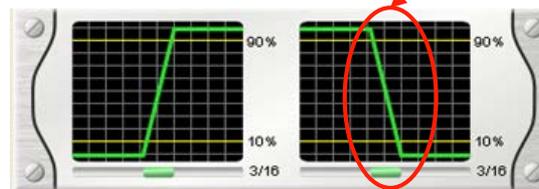
Note: The test results get worse the closer the PBT-4 is connected to the location of the problem (Master #2).

However, the signal quality level of the problematic station (Master #2) might be one of the best.

Unfortunately, the test results do not change as strikingly when dealing with too many bus-terminations as they do with missing bus-terminations. Additional resistance usually affects all stations.

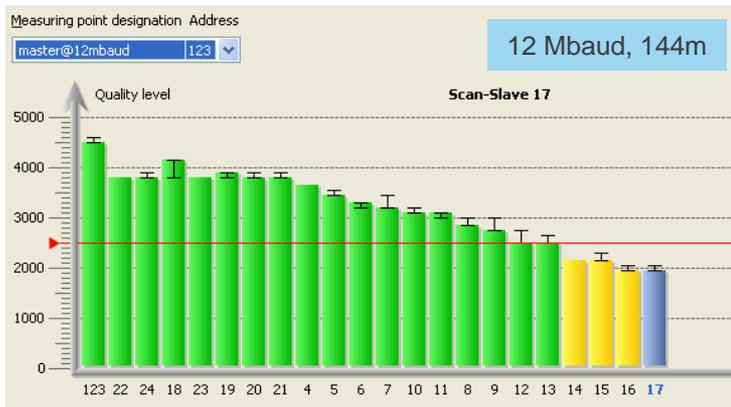


signal blurred  
only some drops in signal due to reflections  
bad signal edges



# 6. Typical Network Issues in a PROFIBUS Network

## Case 7: Cable too long for selected baud rate (transmission speed)



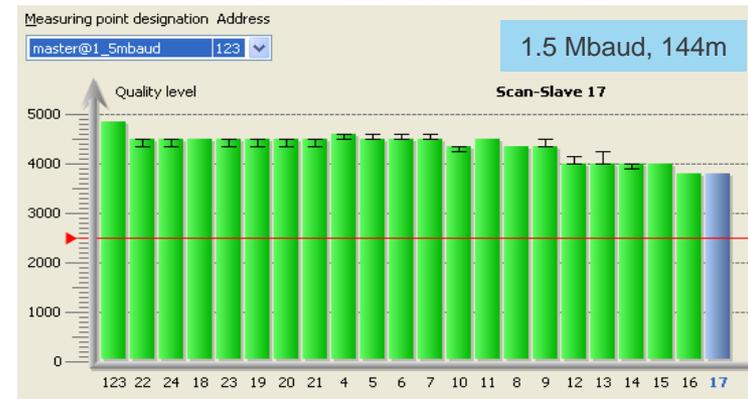
### Note 1:

A cable length of 144m is too long for 12 Mbaud (100m max.).

Therefore, the quality levels / signal level of the stations measured at the master drop with the distance to the referring slave.

### Note 2:

A test performed at the opposite end of the network (station #17) will show a “mirrored image”. In contrast to high line resistance the signal quality degrades gradually.



### Note:

Here the built-in Master functionality of the PB-T5 comes in very handy.

Without changing the PLC-program, the network can be tested at different baud rates (e.g. 1.5 Mbaud). As shown above, running the same network at a baud rate of 1.5 Mbaud is perfectly acceptable.



Industrial Automation

# PROFINET Diagnostics

# PROFINET Diagnostics



## Market and Customer Situation

- ▶ PROFINET is widely used, particularly in the manufacturing industry
- ▶ Ethernet technology presents users with new challenges
- ▶ Maintenance is under efficiency and cost pressure, the division of labor with neighboring areas (e.g. IT) is not always clear



## Target

- ▶ Simple acceptance of PROFINET networks based on transparent criteria
- ▶ Efficient permanent monitoring of PROFINET networks
- ▶ Simple integration into higher-level systems
- ▶ Early detection of problems
- ▶ Preventing production downtime
- ▶ Simple error detection and correction
- ▶ Also usable by non-experts



# Products for PROFINET Diagnostics



## TH LINK PROFINET Gateway

- ▶ Controller and control center-independent network access point
- ▶ Non-reactive integration at any time, even during operation
- ▶ No configuration, no engineering required
- ▶ Separate access for control center and plant level, no routing
- ▶ Monitoring of multiple controllers or multiple IP subnets (up to 255 participants)
- ▶ Usability concept tailored to maintenance and operators
- ▶ Web interface



## TH LINK Industrial Ethernet Gateway

- ▶ Same functions as TH LINK PROFINET Gateway
- ▶ Additional support for Ethernet/IP and Modbus TCP



# Products for PROFINET Diagnostics



## TH LINK PC Industrial Ethernet

- ▶ Same functional scope as TH LINK Industrial Ethernet Gateway
- ▶ Software solution for standard PCs (Windows operating system)
- ▶ Installable together with TH SCOPE
- ▶ Particularly suitable for temporary use, e.g. as part of commissioning and acceptance testing



## TH SCOPE

- ▶ Software for monitoring and maintaining industrial networks
- ▶ Visualizes collected data from TH LINK gateways
- ▶ Functions to support maintenance work processes (trend view, reference comparison, data export, printing)
- ▶ Functions to integrate existing applications (OPC Server, SNMP Agent, web link)
- ▶ Cross-protocol information analysis (PROFINET, standard Ethernet TCP/IP, Modbus TCP, Ethernet/IP, PROFIBUS)



# TH SCOPE – Ease of use



Navigation

Click on an icon to show the corresponding information in the right panel.

- Network overview
- TH-LINK-C102
- TH-LINK-D308
- TH-LINK-F503
- TH-LINK-R301
- TH-LINK-S403
- TH-LINK-S503

Network list | Error statistics | Trend

Error statistics of all TH LINK ( TH-LINK-D308 | 192.168.0.10 | 10.50.1.20 )

Updated on 20 Jun 2014 at 05:06:46 PM. Σ Failures: 66 Σ Diagnostics: 235 Σ Repeats/Lost packets: 16

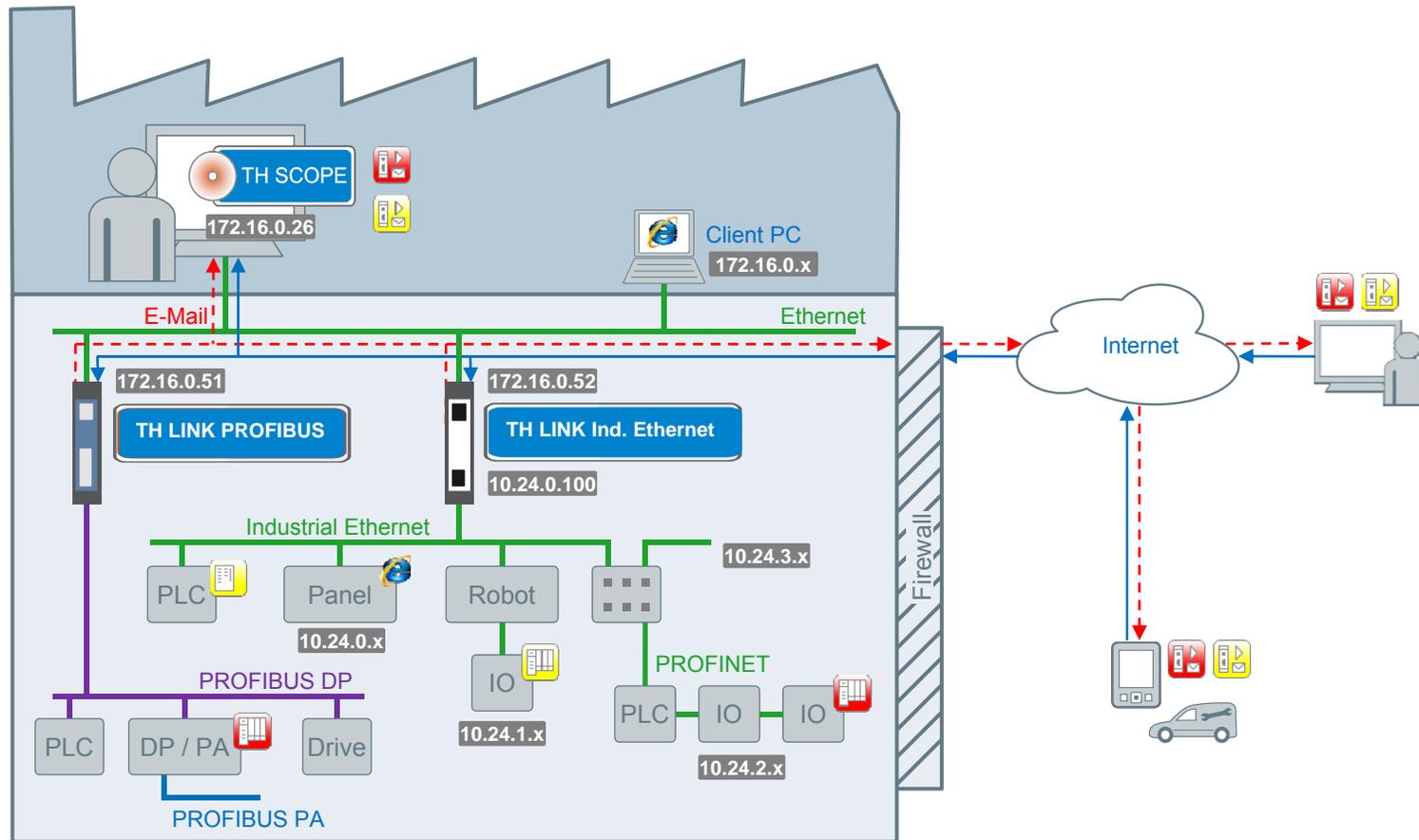
State	Station	TH LINK pr...	Address	Tag	Failures master/co...	Failures slave/dev...	Failures network ...	Diagnostics	Repeats/Lost pac...	Show
	TH-LINK-D308		10.50.1.20	TH LINK D308	0	0	0	21	8	<input checked="" type="checkbox"/>
	TH-LINK-C102		192.168.0.11	TH LINK C102	0	3	0	63	3	<input checked="" type="checkbox"/>
	TH-LINK-R301		192.168.0.12	TH LINK R301	0	4	0	32	4	<input checked="" type="checkbox"/>
	TH-LINK-S503		192.168.0.14	TH LINK S503	0	55	0	108	1	<input checked="" type="checkbox"/>
	TH-LINK-S403		192.168.0.15	TH LINK S403	0	4	0	11	0	<input checked="" type="checkbox"/>

Graphical interpretation of:  Failures master/controller  Failures slave/device  Failures network devices  Diagnostics  Repeats/Lost packets

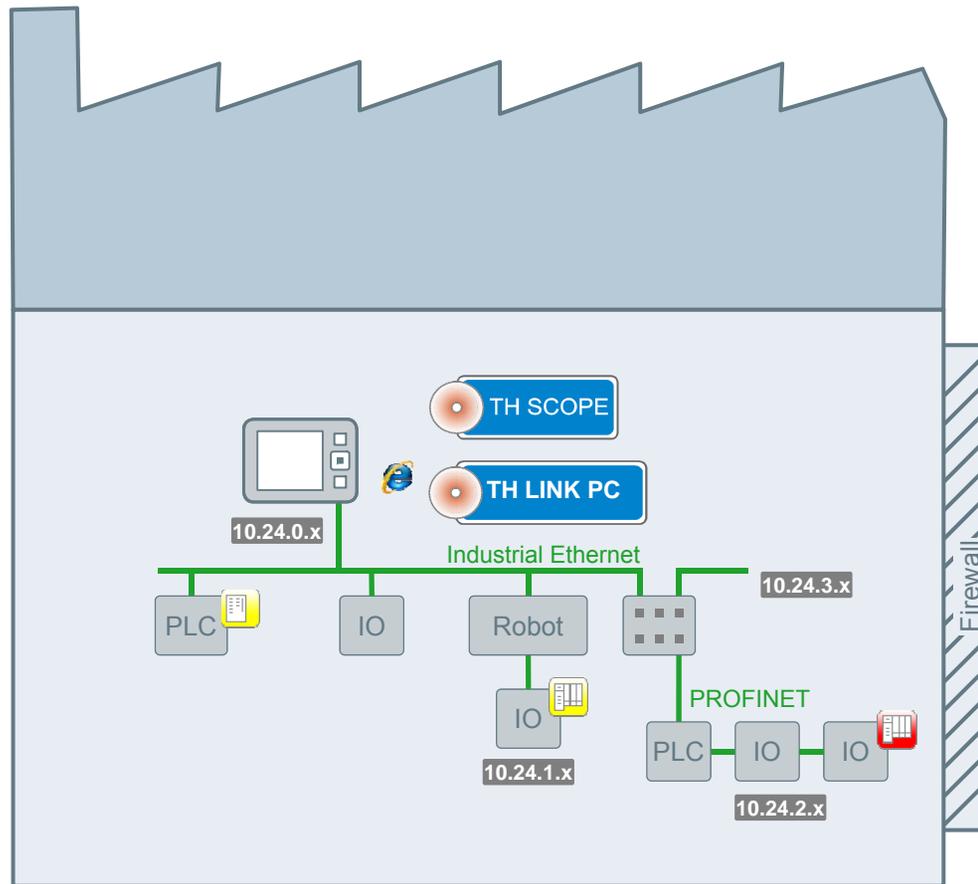
Station	Failures master/controller	Failures slave/device	Failures network devices	Diagnostics	Repeats/Lost packets
TH-LINK-S503	55	4	0	108	1
TH-LINK-R301	0	4	0	32	4
TH-LINK-S403	0	4	0	11	0
TH-LINK-C102	0	3	0	63	3
TH-LINK-D308	0	0	0	21	8



# TH SCOPE | TH LINK – Permanent Diagnostics

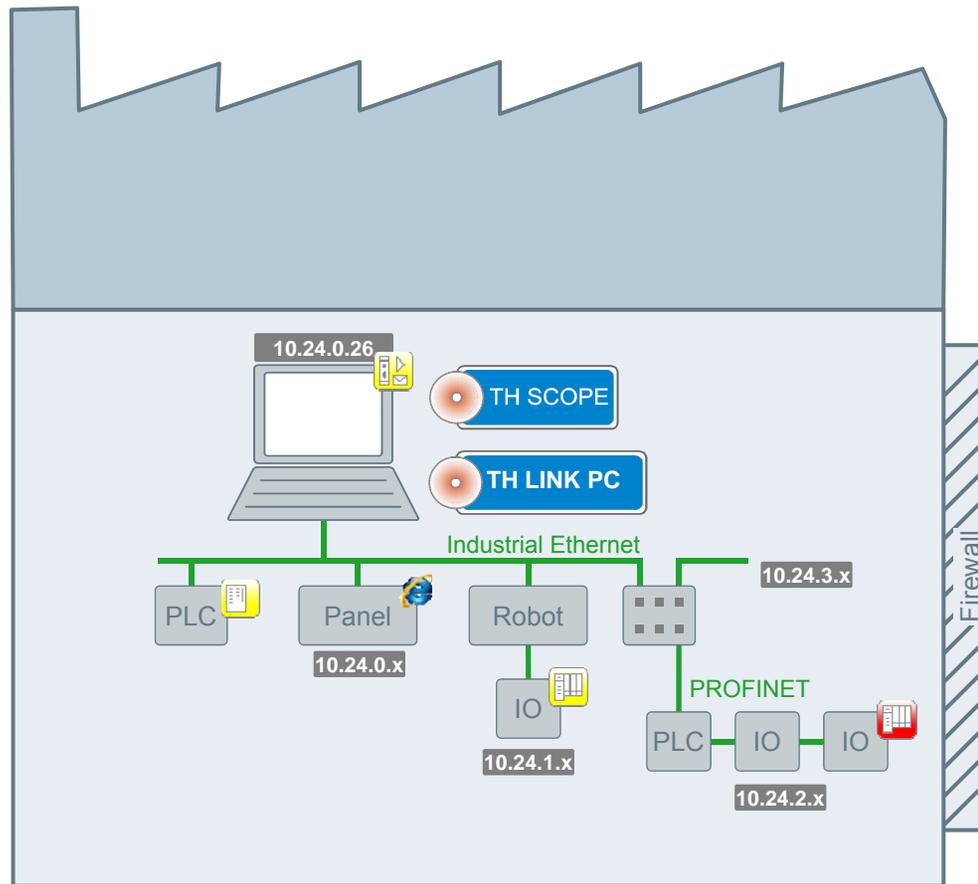


# TH SCOPE | TH LINK – Permanent Diagnostics



- Software based Diagnostics on panel

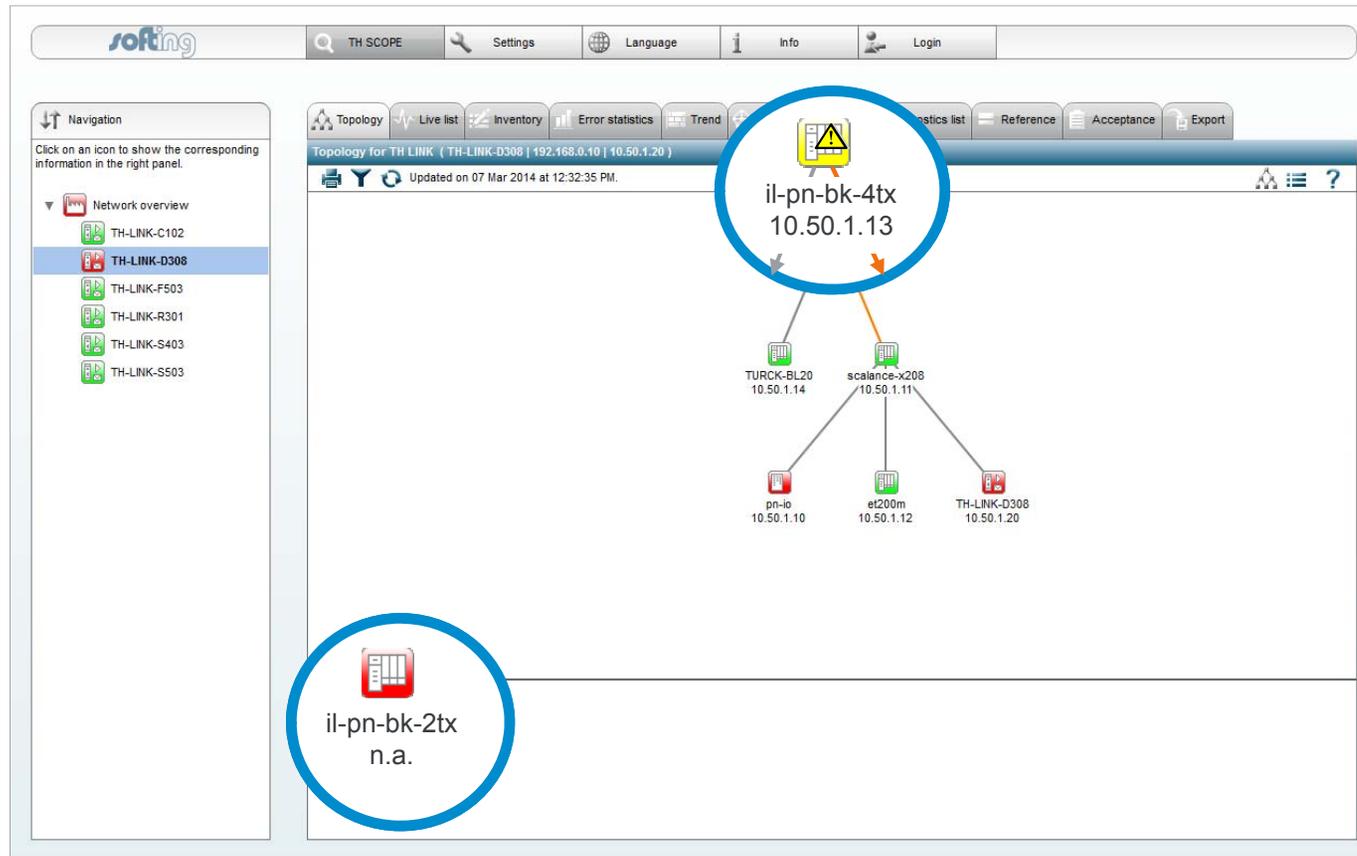




- ▶ Software based Diagnostics mobile PC



# Configuration Error



- ▶ Controller searches for a device with the name il-pn-bk-2tx
- ▶ But a device was found with the name il-pn-bk-4tx





# Firmware Check II



## Same Device Type but Different Firmware

- ▶ Filter in export by device ID shows that two devices of same type are present, but which have different firmware

State	Station	Protocol	Address/Slot	Device type	Device ID	Vendor ID	Serial number	Description	Order number	HW version	FW version
Device ok	et200m	PROFINET	10.50.1.12	ET200M	0x0302	0x002A	S C ADV214672010	Siemens, SIMATIC S7, IM153-4PN, , 6ES7 153-4AA01-UXBU	6ES7 153-4AA01-0XB0	2	V3.0.0
Device ok	et200m2x	PROFINET	10.50.1.15	ET200M	0x0302	0x002A	S C-ADV214672054	Siemens, SIMATIC S7, IM153-4PN, , 6ES7 153-4AA01-0XB0	6ES7 153-4AA01-0XB0	2	V2.5.0



# Network Load Check



The screenshot shows the 'Network statistics' page for 'TH LINK (TH-LINK-D308)'. The main table lists stations and their protocols. Below it, a detailed table shows port statistics. A blue oval highlights the 'Transmission speed in kBit/s' and 'Lost packets' columns.

Port	Status	Bandw...	Duplex ...	Absorp...	roa...	Transmission speed in kBit/s		Lost packets		Unknow...			
						Receive	Send	Error pa...	Discard...				
1	Up	100	DX	n.a.	20	1131	1132	0	0	0			
2	Up	100	DX	n.a.	162	647	648	0	0	0			
3	Down	0	DX	n.a.	0			0	0	0			
4	Up	100	DX	n.a.	18203733			0	0	0			
5	Down	0	DX	n.a.	0			0	0	0			
6	Down	0	DX	n.a.	0			0	0	0			
7	Down	0	DX	n.a.	0			0	0	0			
8	Up	100	DX	n.a.	1192782903	1678016	1194649264	4677564	491	490	0	0	0

An Ethernet device was replaced in the network or an RIO was expanded

- ▶ Check port load, or compare with reference (if available)
- ▶ In case of high or increased network load, check for lost packets



# Analysis Device Diagnostics



The screenshot shows the Softing TH SCOPE interface. The main window displays a 'Diagnostics list for TH LINK ( TH-LINK-D308 | 192.168.0.10 | 10.50.1.20 )' updated on 18 Nov 2014 at 12:33:07 PM. A table lists device details, and a detailed view for ID 174 shows a 'Power supply fault' message. A blue oval highlights this message box.

ID	Date_Time	State	Station	Address/Slot	Type	Message
177	18 Nov 2014 10...	Yellow	et200m	10.50.1.12 / 0x0001 / 0x0001		
176	18 Nov 2014 10...	Yellow	et200m	10.50.1.12 / 0x0001 / 0x0001		
175	18 Nov 2014 10...	Green	et200m	10.50.1.12 / 0x0000 / 0x8002	ET-D308	
174	18 Nov 2014 10...	Green	et200m	10.50.1.12 / 0x0000 / 0x8001	ET-D308	<b>Diagnostics message</b> Diagnostics for submodule <b>Power supply fault</b> Proper module

- ▶ Graphical display of device states (green, yellow, red, grey)
- ▶ Aggregated total view of the network
- ▶ Troubleshooting tips



# Device- or Connection Failure?



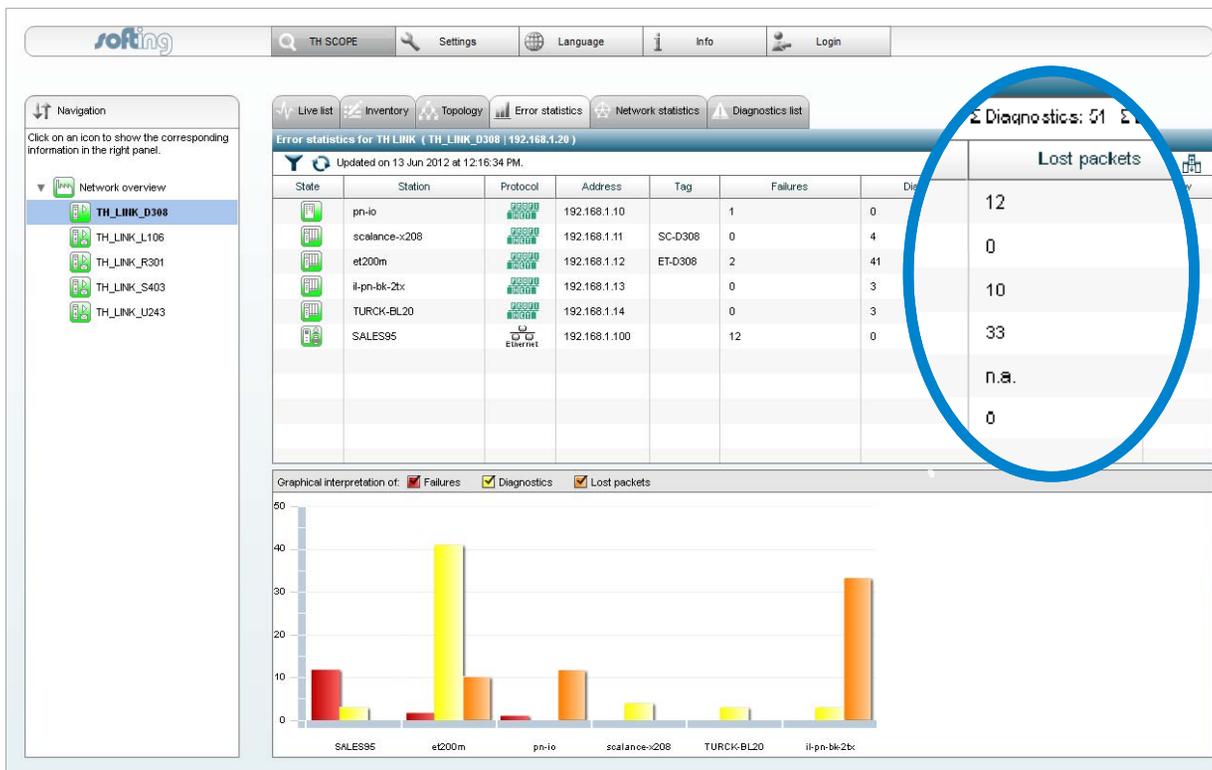
The screenshot shows the Softing network management interface. The main panel displays 'Network statistics for TH LINK (TH-LINK-D308 | 192.168.0.10 | 10.50.1.20)' updated on 26 May 2014 at 11:30:38 AM. Below this is a table with columns for State, Station, Protocol, Address, Tag, Data rate in Byte/c..., and Transmission speed in Receive. A blue circle highlights the 'System up time' column in the diagnostics table, which shows values like '018d:18h:58m:16s' and '018d:19h:01m:34s'.

Port	Status	Bandw...	Duplex ...	Absorp...	Received packets		Sent packets		Transmission speed in			
					Unicast	Multicast/Broa...	Unicast	Multicast/Broa...	Receive	Transmit	Receive	Transmit
1	Up	100	DX	n.a.	2827373118	1723942	2825005504	4631238	1131	1131	0	0
2	Up	100	DX	n.a.	1627555924	1362122	1627554857	4677574	647	648	0	0
3	Down	0	DX	n.a.	0	0	0	0	0	0	0	0
4	Up	100	DX	n.a.	18203733	4329958	18706992	425179	34	41	0	0
5	Down	0	DX	n.a.	0	0	0	0	0	0	0	0
6	Down	0	DX	n.a.	0	0	0	0	0	0	0	0
7	Down	0	DX	n.a.	0	0	0	0	0	0	0	0
8	Up	100	DX	n.a.	1192782903	1678016	1194649264	4677564	491	490	0	0

- ▶ Diagnostics list shows failure
  - Uptime “large“, hence connection failure
  - Uptime “very small“, hence reboot after device failure



# Detection of Connection Problems



- ▶ High number of lost packets
- ▶ Negotiated bandwidth 10MBit
- ▶ Low attenuation reserve



# Commissioning Documents



## Commissioning Report

- ▶ Created with the TH SCOPE export function
- ▶ Template-based (Excel)
- ▶ Clear and understandable criteria
- ▶ Consideration of standardization activities (PNO, VDI)
- ▶ Simple adjustment to customer or project-specific requirements
- ▶ Contents:
  - ▶ Summary, detailed test results, recommendations for action

## Additional Documents

- ▶ Topology printout (pdf)
- ▶ Inventory list (Excel)
- ▶ Reference measurement for later comparison

**TH SCOPE Network Report**

Softing Industrial Automation GmbH  
Max. Westermann  
Richard-Reitzner-Allee 6  
D-85540 Haar  
089 / 48066-334  
support.automation@softing.com

Address field customer  
Company / Department  
Name  
Address  
Phone  
Email

**Plant Data**

Location:	Haar	Σ IO Controller:	1
Plant name:	Demosystem	Σ IO Devices:	4
Network name:	D308	Σ Network devices:	1

**Overview of Test Cases and Test Results**

Measurement period: 30 Jun 2014 09:00 am - 01 Jul 2014 09:00 am  
Export file name: ExportResult.xlsx  
Report file name: ExportResult.xlsx

	Good without reservation	Good with remarks	Rework recommended
Consistency check		x	
Detection of network stations	x		
Detection of topology	x		
Comparison with engineering data	x		
Comparison with reference measurement	n.a.	n.a.	n.a.
Analysis of statistics data		x	
Analysis of diagnostics data		x	

**Current Network Status**

The network is working properly and it is installed expertly in compliance with industry standards. No further action is necessary.

x The network is working properly and it is installed expertly in compliance with industry standards. Please check facts and suggestions in chapter "Detailed Results".

Defects have been found, a properly working network cannot be guaranteed; and/or the risk of failures is high. For details, please see chapter "Evaluation of Results".

Customer: \_\_\_\_\_ Examiner: \_\_\_\_\_  
Date: \_\_\_\_\_ Signature: \_\_\_\_\_ Date: \_\_\_\_\_ Signature: \_\_\_\_\_

01.07.2014 15:03 Page 19  
Softing Industrial Automation GmbH



# Interim Result Workgroup PNO (Excerpt)



## Switchtiefen

13

**Table 4: Maximum number of IO devices in a line assuming direct device to device connection based on use case 1 (RT traffic with TCP/IP traffic caused by the PROFINET communication)**

IO Update Time	1 ms	2 ms	4 ms	8 ms	1ms	2 ms	4 ms	8 ms
Switch Type	SF	SF	SF	SF	CT	CT	CT	CT
Maximum number of IO devices in a line assuming direct device to device connection	30	60	120	200	64	128	200	200
Same as above assuming Media redundancy	30	50	50	50	50	50	50	50

SF= Store and Forward  
CT= Cut Through

If switch type is not known, use figures for Store and Forward

**Table 5: Maximum number of IO devices in a line assuming direct device to device connection based on use case 2 (worst case including TCP/IP traffic)**

IO Update Time	1 ms	2 ms	4 ms	8 ms	1ms	2 ms	4 ms	8 ms
Switch Type	SF	SF	SF	SF	CT	CT	CT	CT
Maximum number of IO devices in a line assuming direct device to device connection	7	14	28	56	64	128	200	200
Same as above assuming Media redundancy	7	14	28	50	50	50	50	50

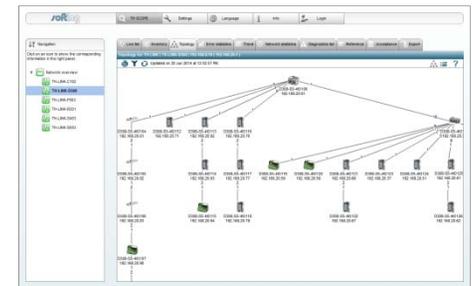
SF= Store and Forward  
CT= Cut Through

If switch type is not known, use figures for Store and Forward



## Functions

- ▶ Display of the interconnected stations
- ▶ Show/Hide information via filter:
  - Station referred: Name, Address, Device images, Protocol, stations without topology information, Redundancy manager
  - Connection referred: Ports, Type of connection, Connection state, Bandwidth, Duplex type
  - Double-click on a station chooses this as the top node
  - Print-out as PDF file for total or visible topology

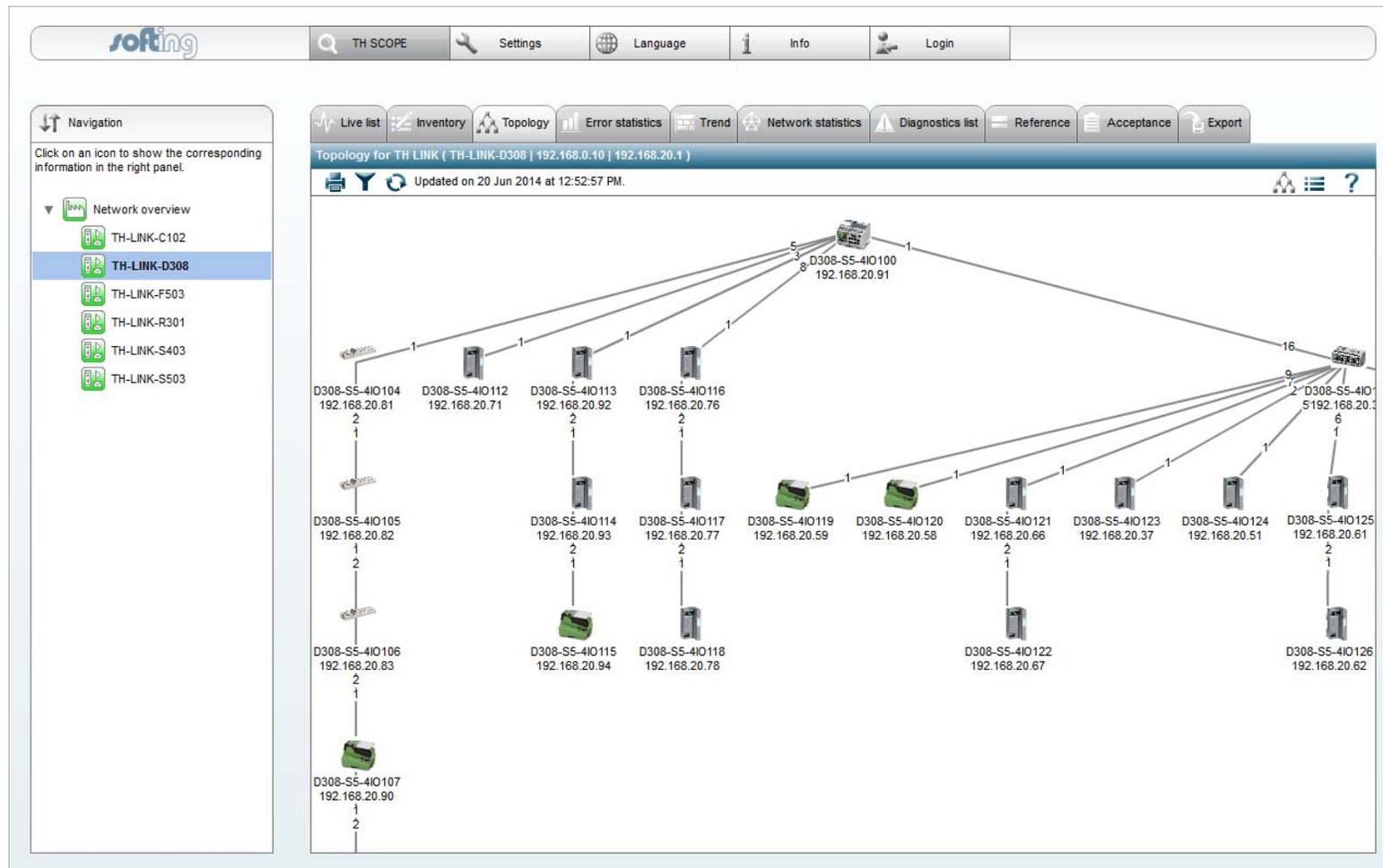


## Benefits

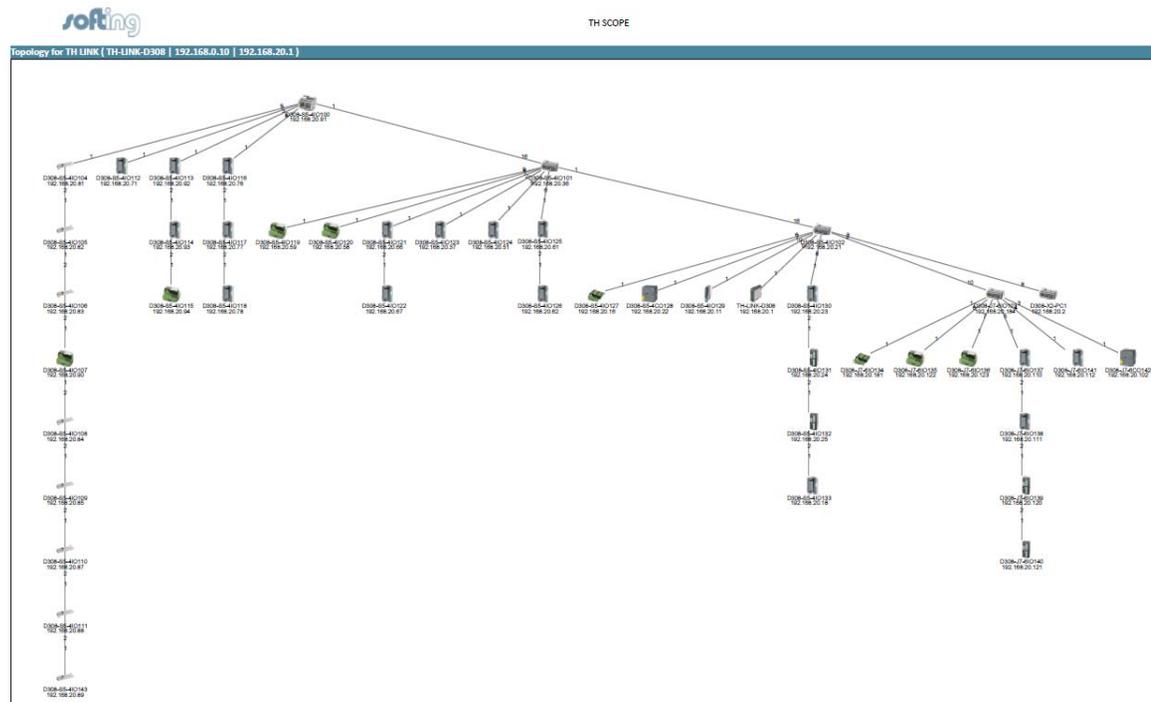
- ▶ Individual view adjustable and changeable at any time
- ▶ Easier orientation in the topology and a better assignment to the real installation by using device images
- ▶ Saving and print-out of the topology for a plant acceptance



# Topology



# Topology Printout



Topology: Updated on 20 Jun 2014 at 12:52:57 PM.

1/1

PDF document,  
adjustable  
presentation, free text  
field for comments



# Reference Measurement



**Navigation**

Click on an icon to show the corresponding information in the right panel.

- Network overview
- TH-LINK-C102
- TH-LINK-D308
- TH-LINK-F503
- TH-LINK-R301
- TH-LINK-S403
- TH-LINK-S503

Reference comparison for TH LINK ( TH-LINK-D308 | 192.168.0.10 | 172.16.1.42 )

Updated on 20 Jun 2014 at 04:18:17 PM.

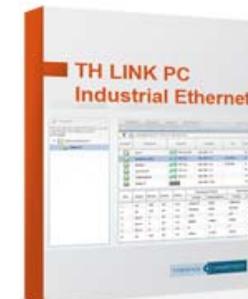
Define reference state	
Current network as reference state	<input type="button" value="Save"/>
Run comparison	
Choose reference state	<input type="button" value="Load"/>
Chosen reference state	TH_LINK_D308_[20140523]_Reference.xml
Compare	<input type="button" value="Ok"/>
Comparison result	
Result	
Following differences have been detected.	
Error statistics	
Reference state	Current state
cpu-pn (172.16.1.10) Lost packets: 94	cpu-pn (172.16.1.10) Lost packets: 107
Network statistics	
Reference state	Current state
scalance-x208 (172.16.2.1) Port 5 Bandwidth: 0 MBit/s Status: Down Port 6 Bandwidth: 100 MBit/s Status: Up	scalance-x208 (172.16.2.1) Port 5 Bandwidth: 100 MBit/s Status: Up Port 6 Bandwidth: 0 MBit/s Status: Down
Topology	
Reference state	Current state
scalance-x208 (172.16.2.1) Port 5 Port 6 cpu-pn (Port 1)	scalance-x208 (172.16.2.1) Port 5 cpu-pn (Port 1) Port 6
cpu-pn (172.16.1.10) Port 1 scalance-x208 (Port 6)	cpu-pn (172.16.1.10) Port 1 scalance-x208 (Port 5)

Before you can run the reference comparison, you have to define a reference state.  
After that you choose a saved reference state and compare this with the current network.  
Then you can view and print the result.

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## Advantages TH SCOPE and TH LINK

- ▶ Controller and control center-independent network access
- ▶ Easy installation, even during plant operation
- ▶ Assumes no expert knowledge, no expensive training
- ▶ Suitable for acceptance and for permanent monitoring
- ▶ Reliable and proven solution



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Thank You!

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