

INDUSTRIAL AUTOMATION

The new PROFIBUS *Tester 4*

The easy Approach for Beginners and Professionals

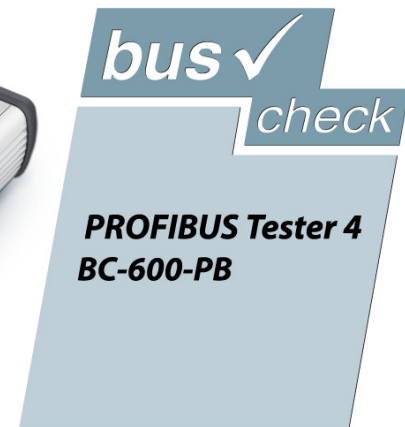
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29 March 2011

1. Introduction

Most of the typical problems in Profibus networks are caused by

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



1. Introduction

- PROFIBUS Tester 4 is the new „All-in-One“ tool to quickly and easily detect all these types of problems in Profibus networks.
- PROFIBUS Tester 4 supports you to
 - reduce network downtime
 - increase network reliability
 - reduce maintenance costs of your Profibus networks



2. The Stand-Alone-Mode:

Rapid Network Analysis without a PC



Preventive Maintenance made easy:

Use the unique ***Stand-Alone-Mode*** for a first and simple test of

- communication
- signal quality (Qmin and Qmax of total network)

from ***both*** ends of a network:



Bus : OK
Comm. : OK
Phys. : OK
Details →

DP Segment
R=0 Qmin = 4248
E=0 Qmax = 4942
Bus device(s) ->

Example:

Step 1: Measurement from one end:

the Live Status reports:

→ All details are good from this end:

- all quality levels are OK
- communication is OK: no frame repetitions (R=0), no error frames (E=0)

Bus : ERROR
Comm. : OK
Phys. : Warning
Details →

DP Segment
R=0 **Qmin = 217**
E=0 Qmax = 4942
Bus device(s) ->

Step 2: Measurement from the other end:

the Live Status reports:

→ There is a warning on signal quality

- there are poor signals from this end
- communication is OK: no frame repetitions (R=0), no error frames (E=0)

2. Stand-Alone-Mode:

Rapid Network Analysis without a PC



Conclusion:

Bus : OK
Comm. : OK
Phys. : OK
Details →

If you get this result from **both** ends of your network, your segment is OK.

There are no error frames and frame repetitions.

➔ There is no need for further tests!

Bus : ERROR
Comm. : ERROR
Phys. : Warning
Details →

If your network test results in an error message on one and/or both ends you know that your network needs service.

➔ Continue your test at the location with the worst result.

➔ Connect your PB-T4 with your PC and start PB-DIAG-SUITE for further tests

DP Segment
R=3 Qmin = 217
E=0 Qmax = 4942
Bus device(s) ->

Bus : ERROR
Comm. : ERROR
Phys. : OK
Details →

Here is a unique case:

- Communication indicates „ERROR“

- R=0, E=0, all signals are OK

Interpretation: At least one PROFIBUS node is down but the rest of the network is working perfectly.

➔ Connect your PB-T4 with your PC and start PB-DIAG-SUITE to identify the missing node(s)

DP Segment
R=0 Qmin = 4248
E=0 Qmax = 4942
Bus device(s) ->

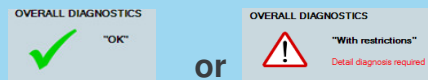
3. PB-DIAG-SUITE:

Overview Window

The Overview Window indicates:

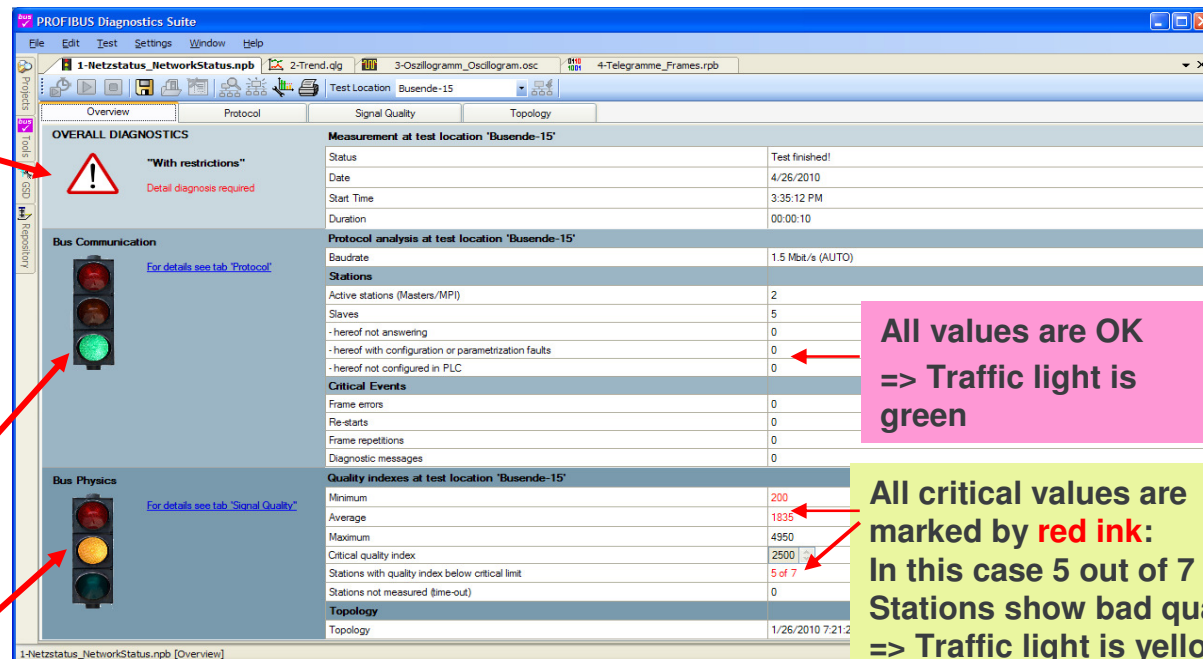
- Is the network OK from this side?
- if not, the problem is either related to communication or electrical problems

First indication:



Green light indicates:
„Communication is okay“

yellow light indicates:
„Problems with the
electrical signal quality“



Result:

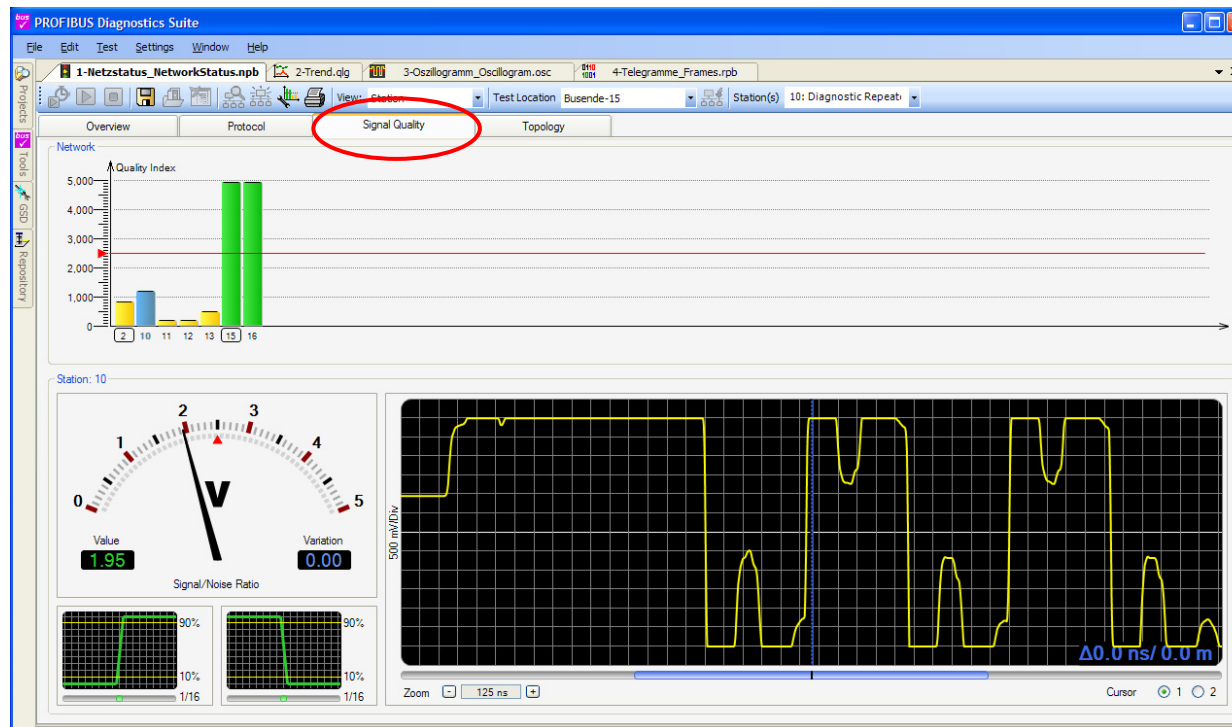
Measurement from this end indicates bad signal quality. Click on „Signal Quality“ (link or tab) for more details

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

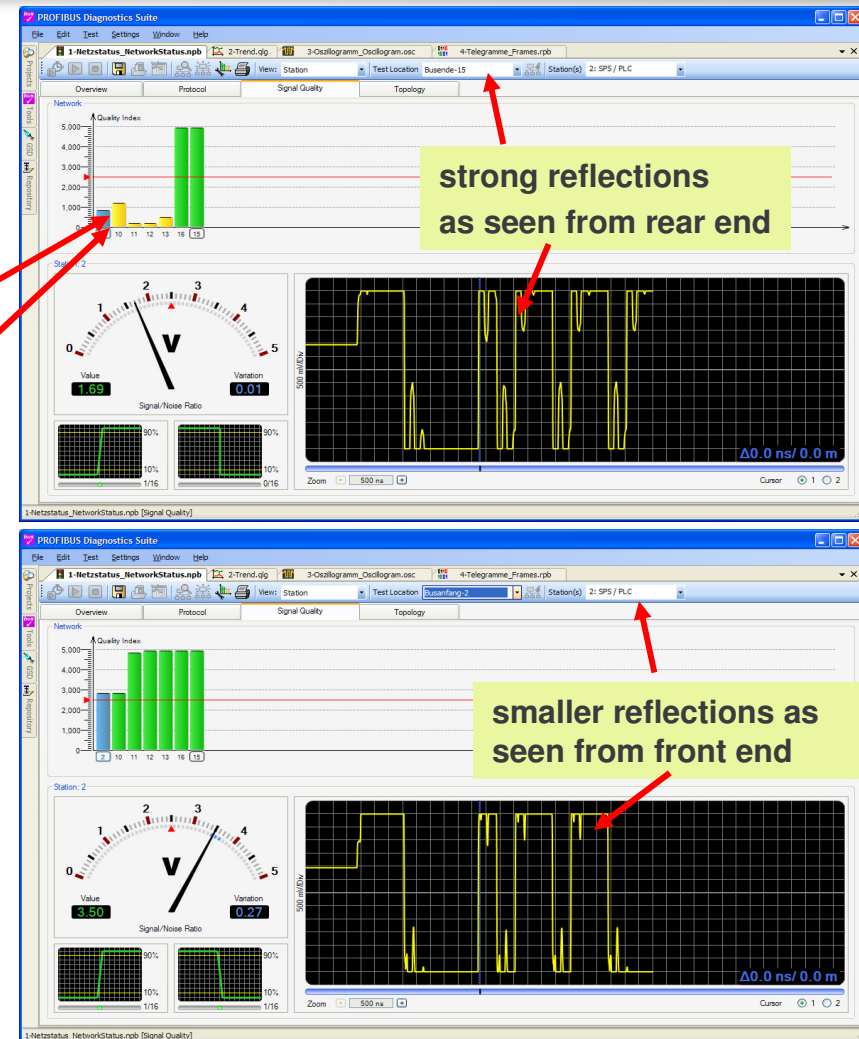
Poor signal quality is mainly caused by

- 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



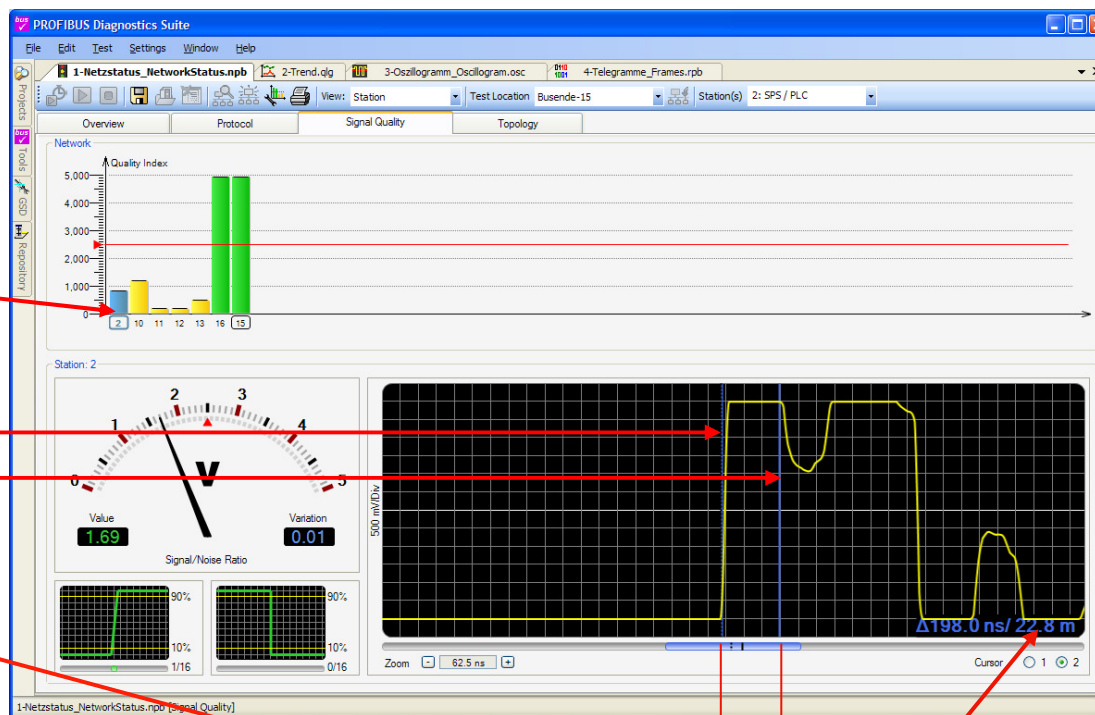
3. PB-DIAG-SUITE:

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

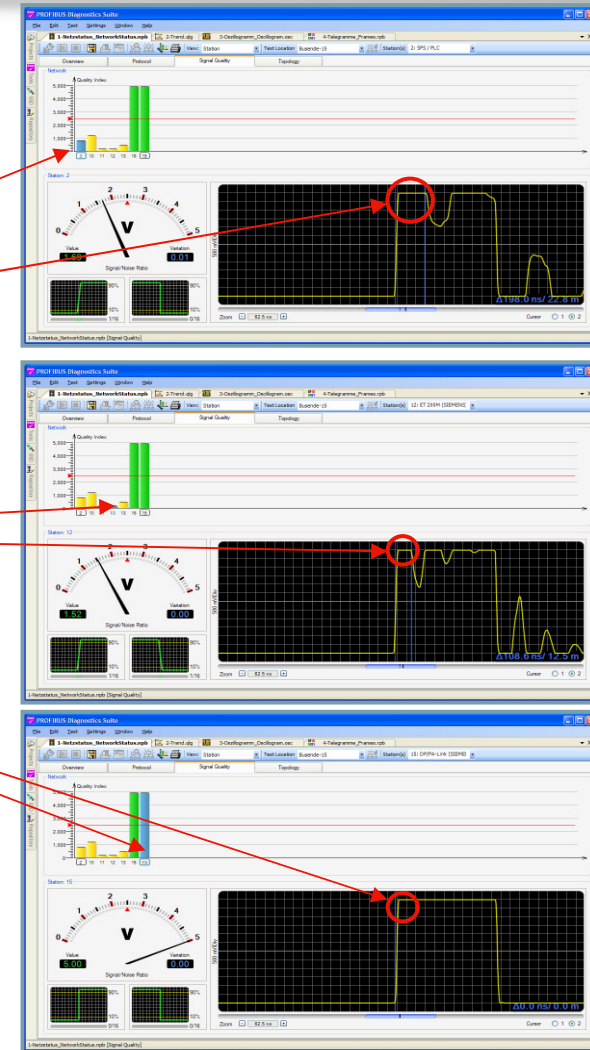
Place cursors

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.)

PROFIBUS Diagnostics Suite

File Edit Test Settings Window Help

Netzstatus_NetworkStatus.npb 2-Trend.qlg 3-Oszillogramm_Oscillogramm.osc 4-Telegramme_Frames.rpb

Overview Protocol Signal Quality Topology

5 Mbit/s Segment

- (2) SPS / PLC
- (10) Diagnostic Repeater (SIEMENS AG) (10)
- (11) WAGO 750-333 (WAGO Kontakttechnik GmbH) (11)
- (12) ET 200M (SIEMENS) (12)
- (13) WAGO 750-333 (WAGO Kontakttechnik GmbH) (13)
- (15) DP/PA-Link (SIEMENS) (15)
- (16) MPI Operator Panel

Info Station Statistics Frame Errors

Bus Data

Baud Rate	1.5 Mbit/s
Bus cycle (min./avg./max.)	1.10/1.51/2.68 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	
Test Location	Busende-15

Total Number of Events

Retries	0
Diagnostic messages	0
Restarts	0

Baud Rate

Transmission speed in the PROFIBUS network

1.5 Mbit/s Segment

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 displays the PROFIBUS Diagnostics Suite software interface. The main window is titled "PROFIBUS Diagnostics Suite" and features a menu bar (File, Edit, Test, Settings, Window, Help) and a toolbar. The "Protocol" tab is active, showing a tree view of the network topology. A slave device, (11) WAGO 750-333 (WAGO Kontakttechnik GmbH), is selected. The right pane displays the "Info" tab for this device, showing various parameters:

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

Below the parameters, a log file for the selected station is displayed, showing the date and time (4/26/2010 15:35:12.331000) and the message (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“

PROFIBUS Diagnostics Suite

File Edit Test Settings Window Help

1-Netzstatus_NetworkStatus.npb 2-Trend.dlg 3-Oszillogramm_Oscillogramm.osc 4-Telegramme_Frames.rpb

Overview Protocol Signal Quality Topology

1.5 Mbit/s Segment
(2) SPS / PLC
(10) Diagnostic Repeater (SIEMENS AG)
(11) WAGO 750-333 (WAGO Kontakttechnik GmbH)
(12) ET 200M (SIEMENS)
(13) WAGO 750-333 (WAGO Kontakttechnik GmbH)
(15) DP/PA-Link (SIEMENS)
(16) MPI Operator Panel

Info Cyclic I/O Acyclic I/O Parameters Configuration **Diagnosis** Statistics

First 1/26/2010 19:18:51.565000
Last 4/26/2010 15:02:59.036000
4/26/2010 15:02:58.955000
4/26/2010 15:02:58.951000
4/26/2010 15:02:10.704000
4/26/2010 15:02:10.701000
4/26/2010 15:02:10.694000
4/26/2010 15:02:10.601000
4/26/2010 15:02:10.595000
4/26/2010 14:47:53.215000
4/26/2010 14:47:53.089000

(13) WAGO 750-333 (WAGO Kontakttechnik GmbH)
GSD file "B754_S10.GSE" found for ident number B754
Vendor and model from GSD file WAGO 750-333 (FW: 01 ... 02) STD WAGO Kontakttechnik GmbH
The device has not been parametrized by any master
Device not ready for data exchange
Device requires parametrization
Device reports error (see below for details)
Identifier-related diagnosis
Identifiers (modules) with pending diagnostic messages: 2
Device-related diagnosis
A0 00 00 00 00
Channel-related diagnosis
Module 1 channel 0 (1 word input): lower limit exceeded

(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 displays the PROFIBUS Diagnostics Suite software. The main window is titled "1-Netzstatus_NetworkStatus.npb". The interface includes a menu bar (File, Edit, Test, Settings, Window, Help) and a toolbar with various icons. The left sidebar shows a tree view of the network topology, including a 1.5 Mbit/s Segment, (2) SPS / PLC, and several diagnostic repeaters and PLCs. The main area is divided into tabs: Overview, Protocol, Signal Quality, and Topology. The "Overview" tab is active, showing a "Matrix Overview" window. This window displays a table of frame statistics for various stations. The table has columns for station numbers (0, 1, 2, 3, 4, 5, 6) and rows for frame types (0, 10, 20, 30). The table shows the number of frames received and the number of frames with errors (M for Message, R for Retries, D for Diagnose, S for Set Parameter).

	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



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 Data Exchange, red for Diagnosis, and green for FDL Status. A detailed view of a selected frame (Time: 09:48:14.136469) is shown at the bottom, detailing the Frame Type (SD2), Source Address (40), Destination Address (2), FDL Service (DL), Primitive (Response), Type (Slave), and DP Service (Data Exchange - Input Data: 21 34 21 34 49 E0 00 00).

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
09:48:14.136900	2 <- 70	DP	Response	DATA EXCHANGE	00 00

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:

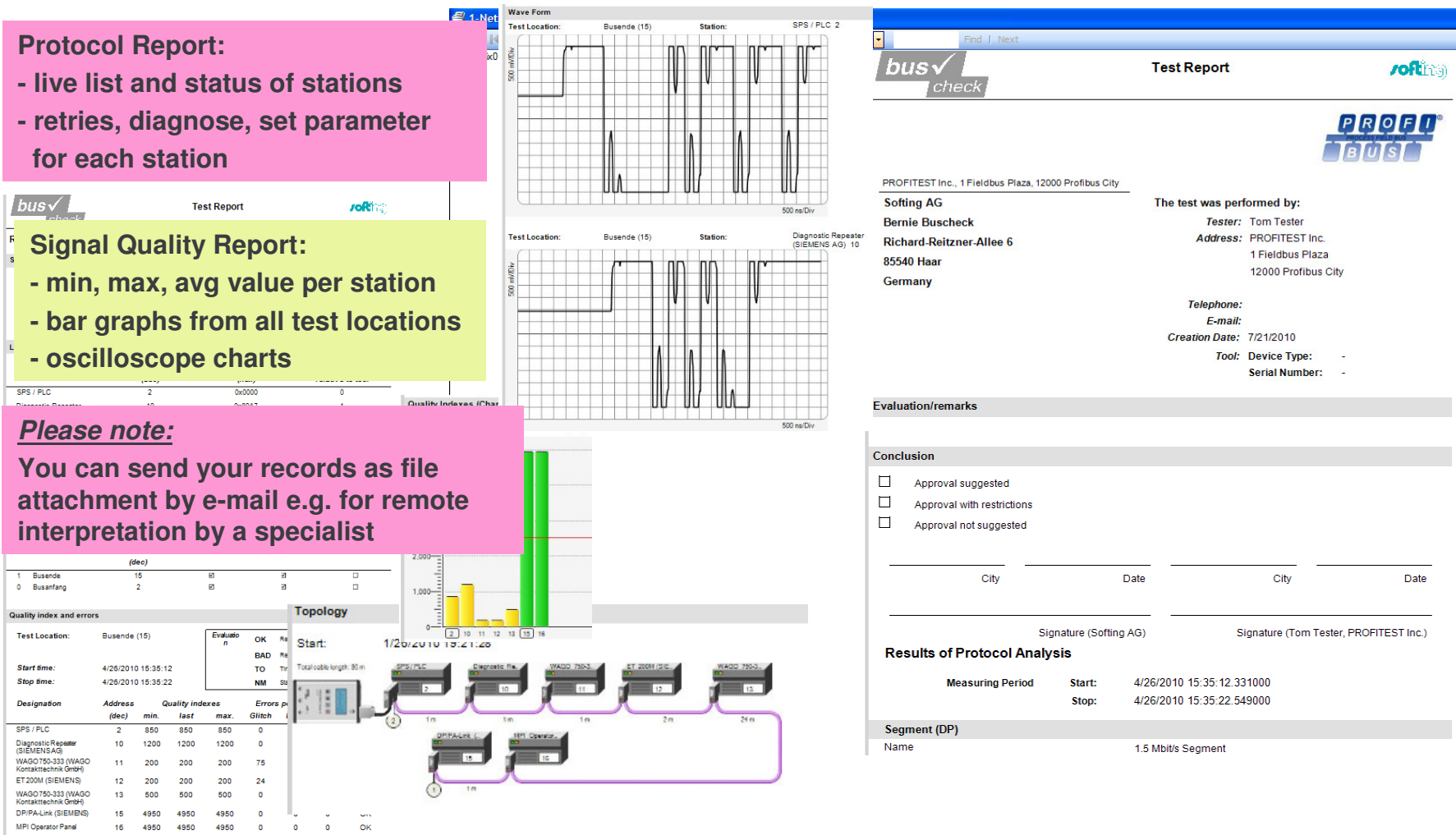
- live list and status of stations
- retries, diagnose, set parameter for each station

Signal Quality Report:

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

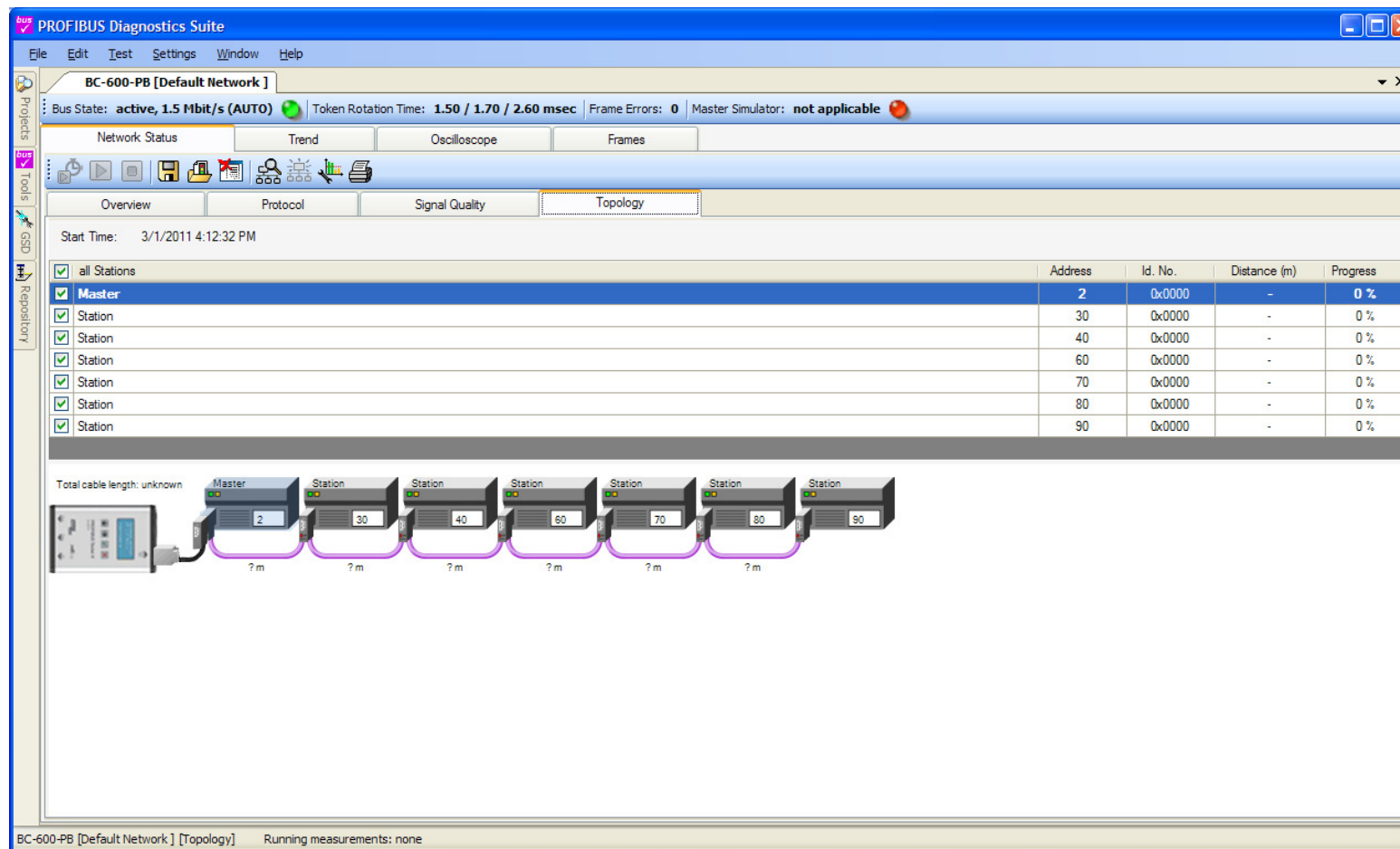
Please note:

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



4. Topology Scan

Shows the correct sequence of the devices and the cable length



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

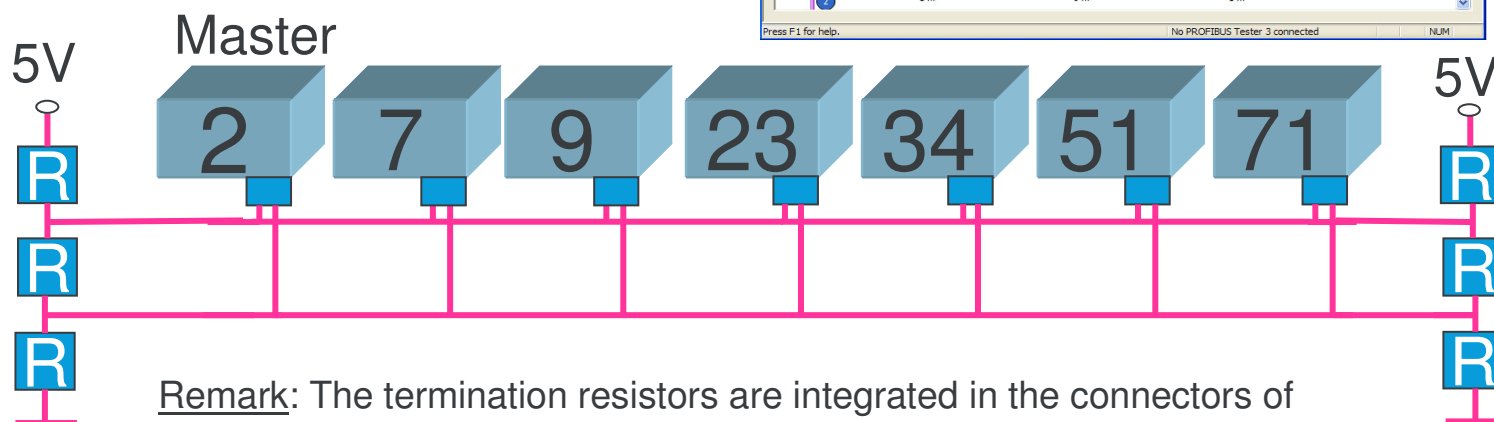
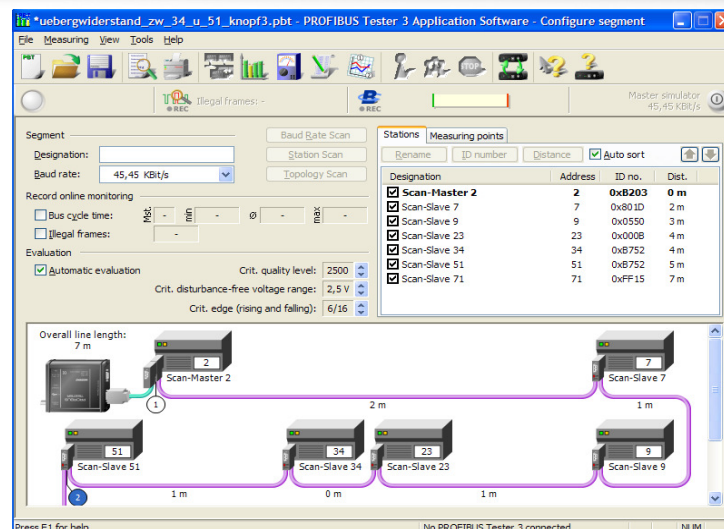
Step 2:

- Connect PB-T4 again to that end of the network that displayed problems
- 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 and/or communication problems
- Select „Protocol“ and / or „Signal Quality“ views for further diagnostic details

6. Typical Failure Cases 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 Failure Cases 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:

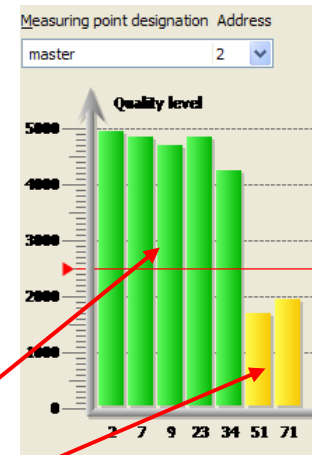
Test results on the left end:

- 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 Failure Cases in a Profibus Network

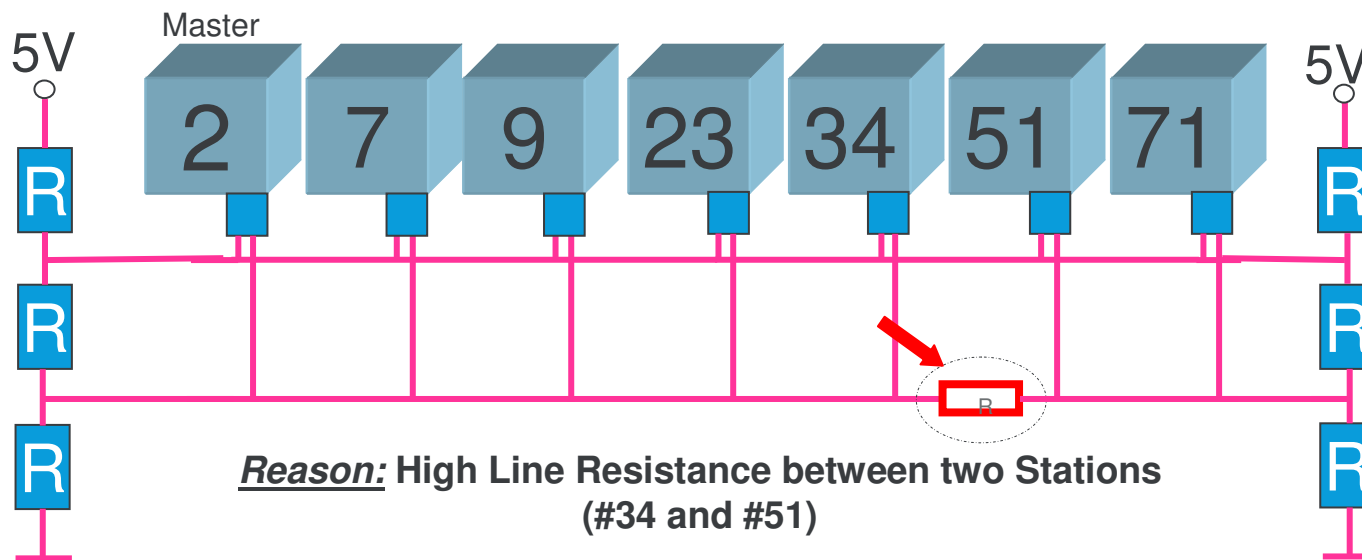
Case 1: Reversal of results from both ends of the system

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 Failure Cases 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.



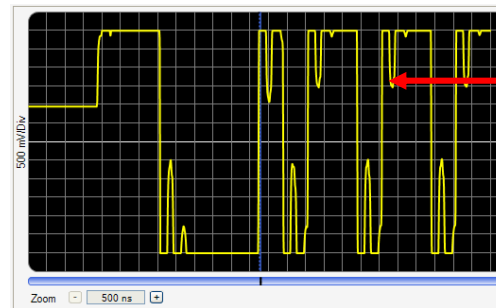
6. Typical Network Issues in a PROFIBUS Network

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

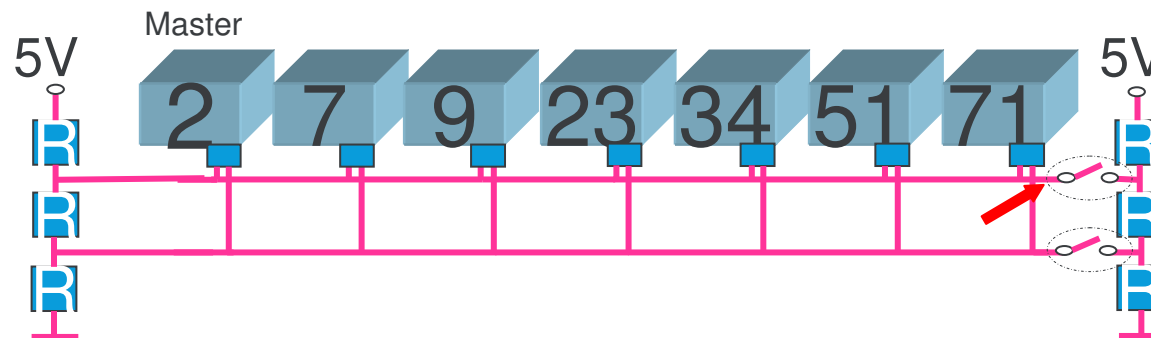
Interpretation:

- 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

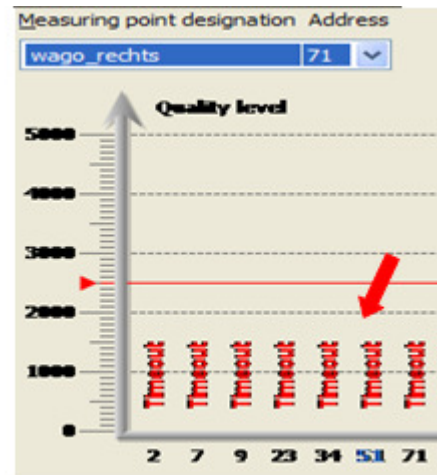
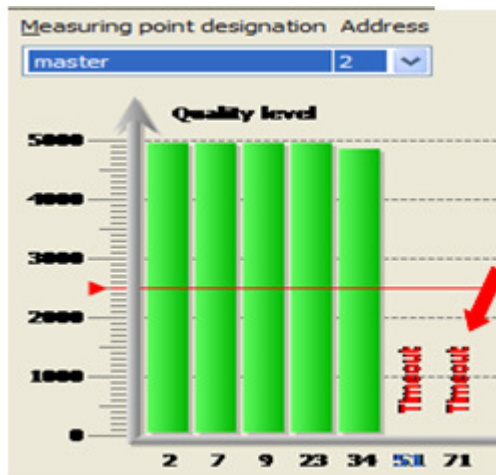
Case 3: Some stations are “missing” depending on the test location

Case 3:

- Step 1: perform test at left side (Master 2)
- Step 2: perform test at right side (Slave 71)

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

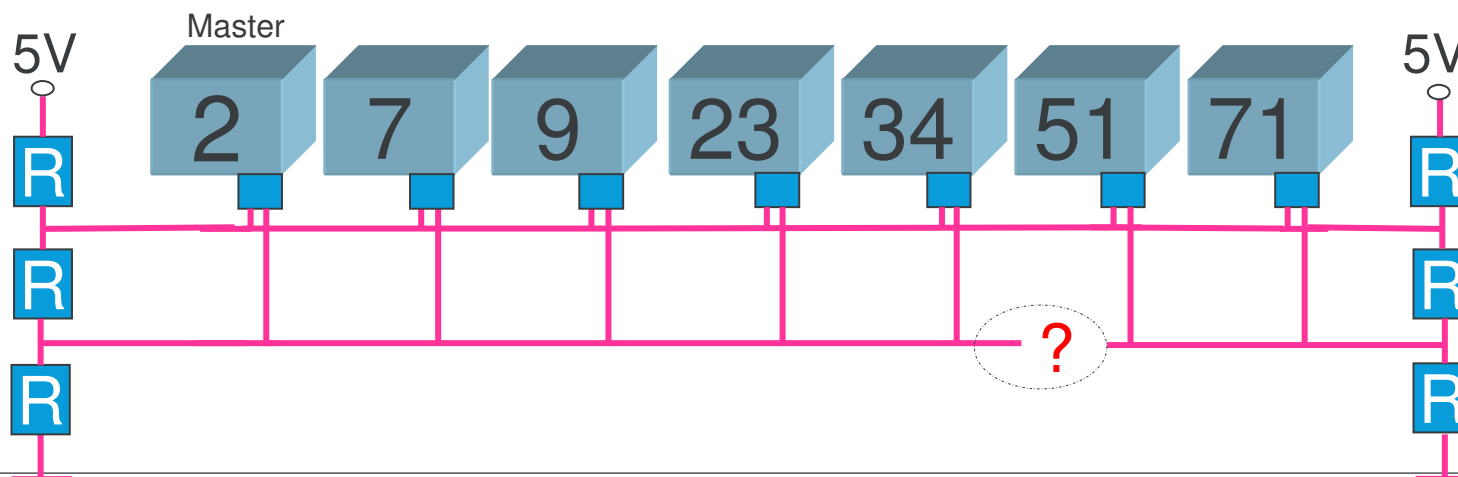
Interpretation:

The fact that some devices can be seen from one end but not from the other indicates that the problem is not 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 4: Quality Level of one device is bad

Case 4:

- Step 1: perform test at left side (Master 2)
- Step 2: perform test at right side (Slave 123)
- Step 3: perform test at Slave 23

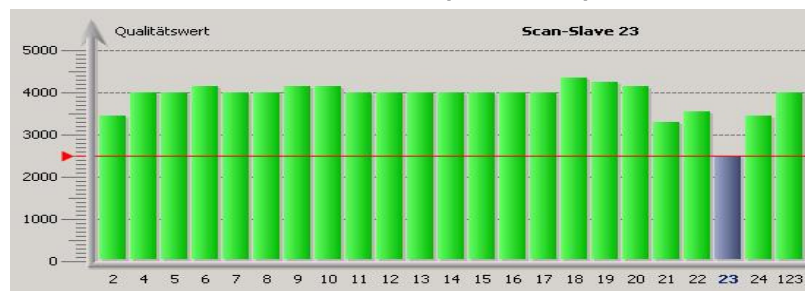
Result:

The Q-level of slave 23 is bad. All others are good. The result of all three measurements is basically identical.

Interpretation:

The voltage level of RS485 driver of station 23 (and only station 23) is too low.

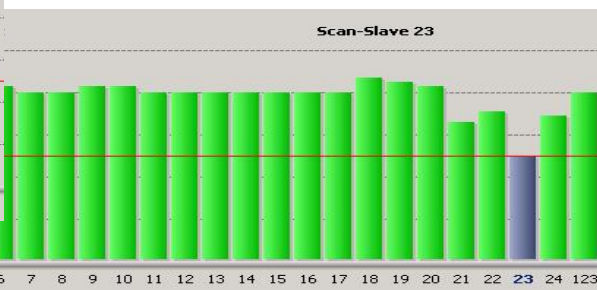
measurement from left side (master 2)



measurement directly from slave 23



measurement from right side (slave 123)



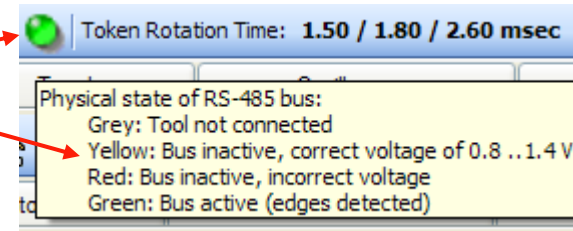
6. Typical Network Issues in a PROFIBUS Network

Case 5: Bus-termination is not powered correctly

Indication of idle voltage:

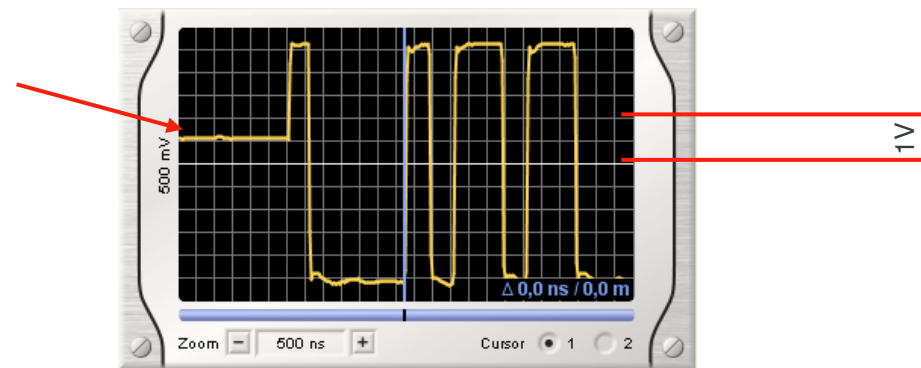
The correct idle voltage is supposed to be between 0.8 and 1.4 V.

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



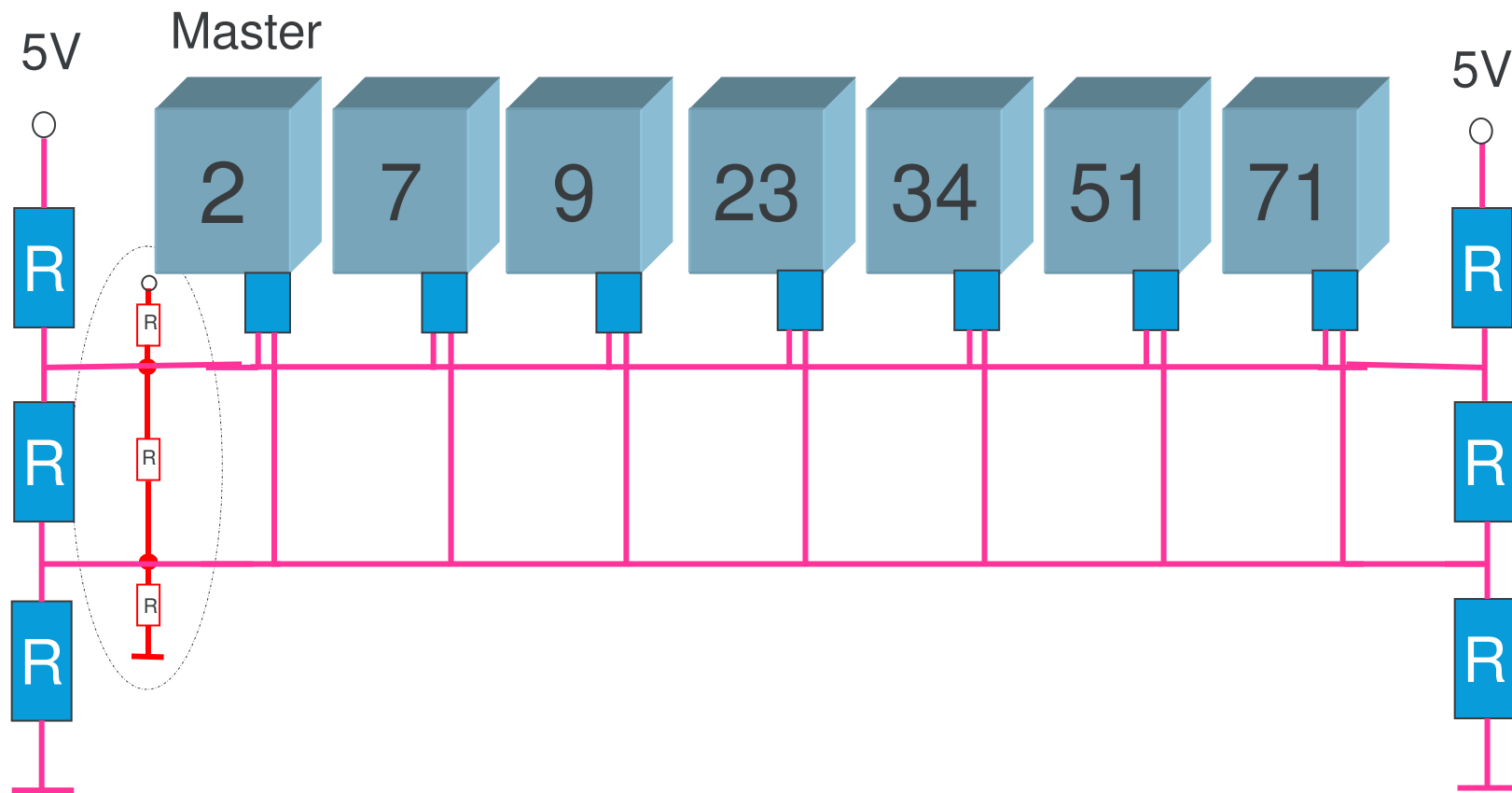
- An idle voltage of approx. 0.6 Volts indicates that only one bus-termination is powered correctly
⇒ communication may work, sporadic failures likely
- An idle voltage close to 0 Volts (both terminations not correctly powered or one termination missing/one not correctly powered ⇒ PROFIBUS will not start

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



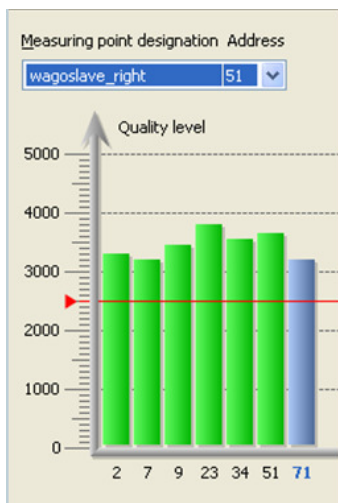
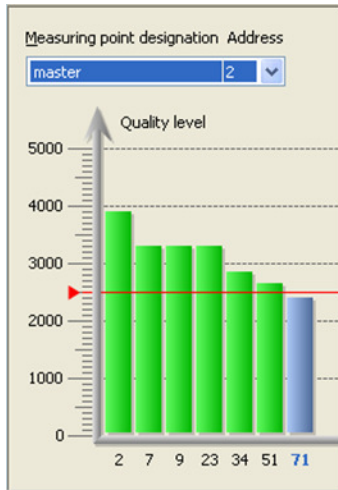
6. Typical Network Issues in a PROFIBUS Network

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



6. Typical Failure Cases in a PROFIBUS Network

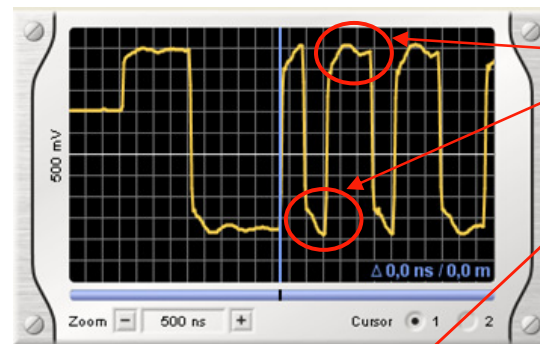
Case 6: Too many bus-terminations or additional electrical resistance



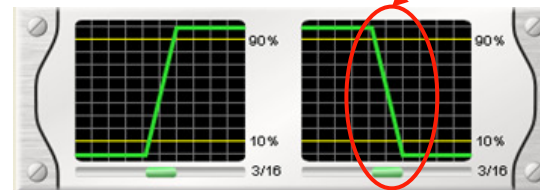
Note: The test results get worse the closer the PBT-4 is connected to the location of the problem (Master #2).

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

In this case 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.

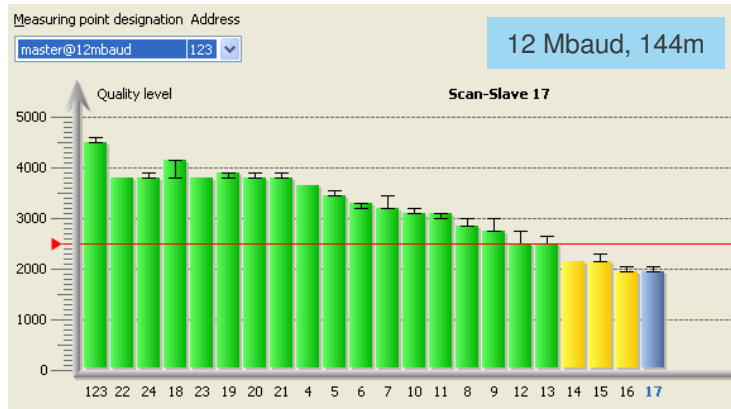


signal blurred
only some drops in signal due to reflections
bad signal edges



6. Typical Network Issues in a PROFIBUS Network

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



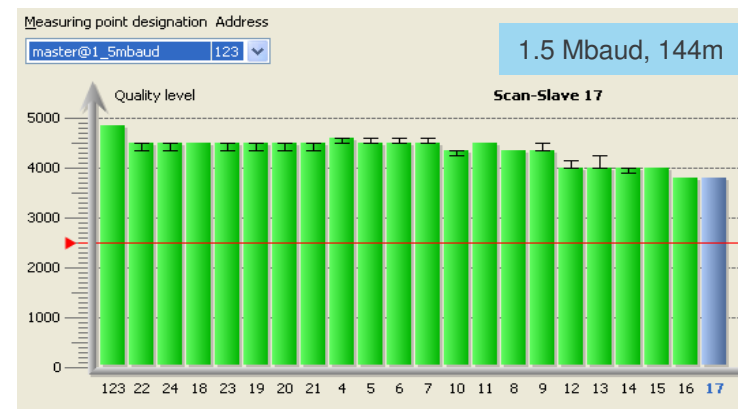
Note 1:

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

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-T4 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.

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Thank You!

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