INDUSTRIAL AUTOMATION

The new PROFIBUS *Tester 4*

The easy Approach for Beginners and Professionals

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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 / defectice 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…..

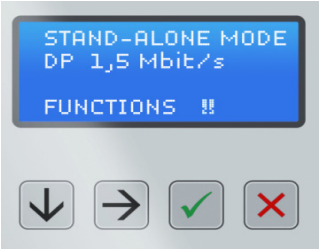
1. Introduction

- 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



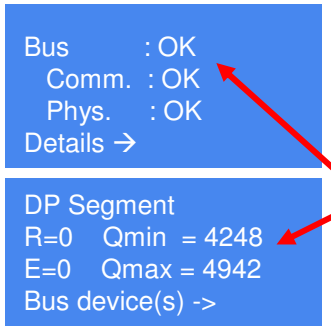
Preventive Maintenance made easy:

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:

Example:

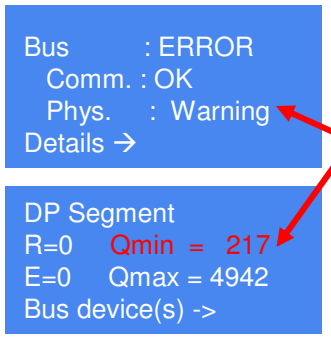


Step 1: Measurement from one end:

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)



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 →

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

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

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

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

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)

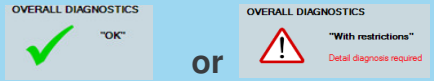
3. PB-DIAG-SUITE:

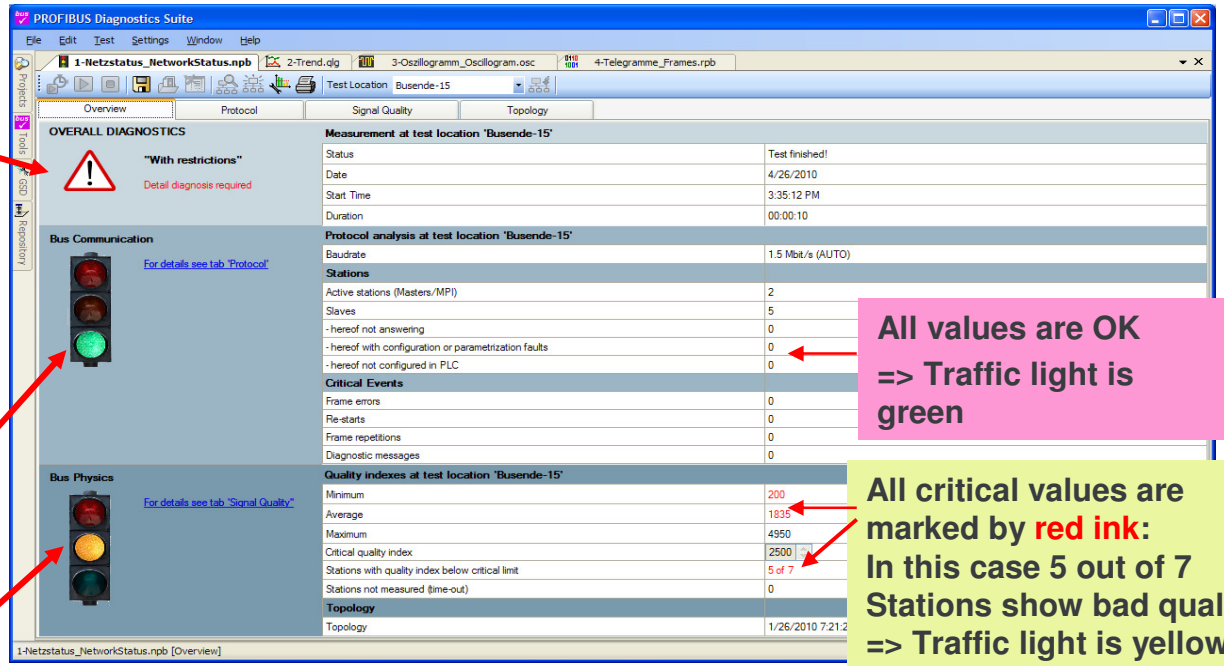
Overview Window

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:





All values are OK
=> Traffic light is green

Green light indicates:
„Communication is okay“

All critical values are marked by red ink:
In this case 5 out of 7 Stations show bad quality
=> Traffic light is yellow

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

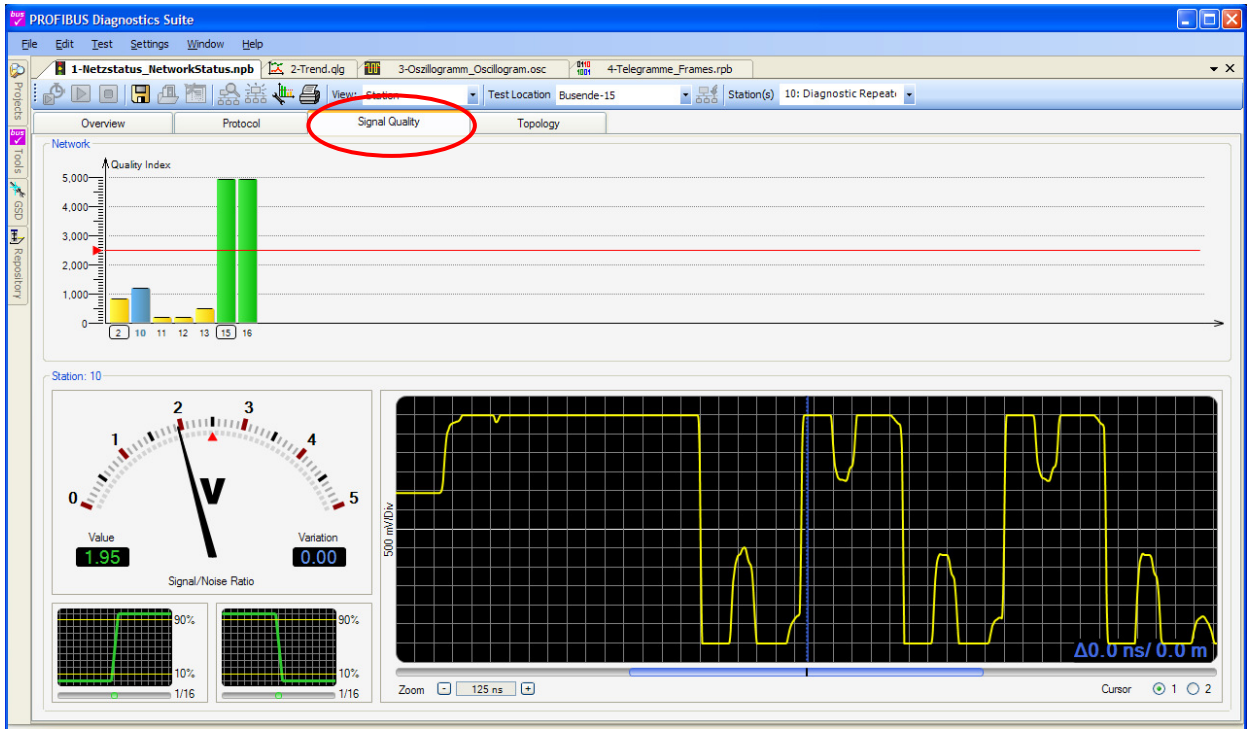
Result:

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

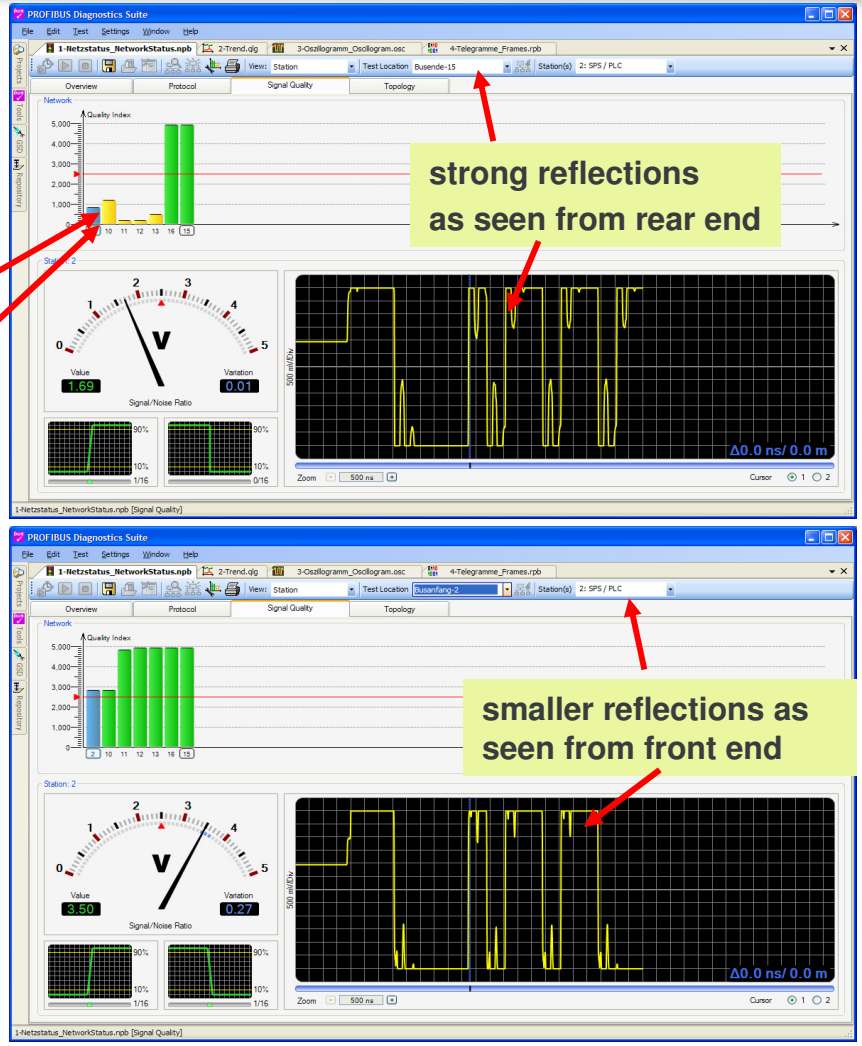
Poor signal quality is mainly caused by

- 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

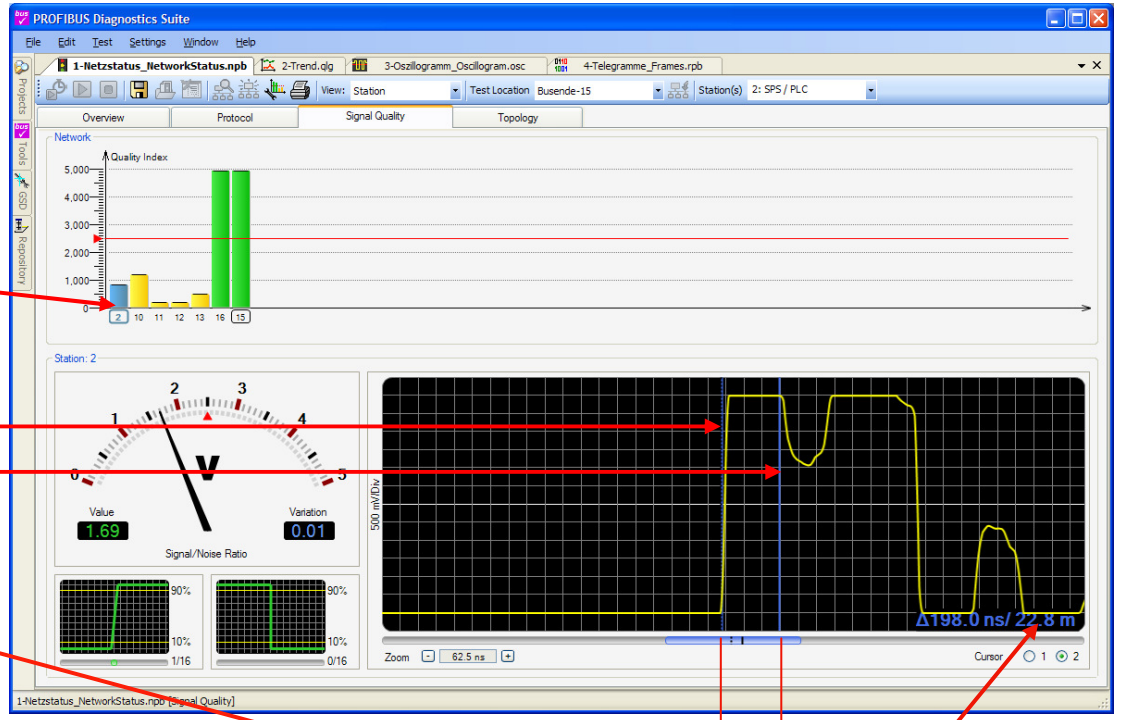
Localize the problem with the Oscilloscope:

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:

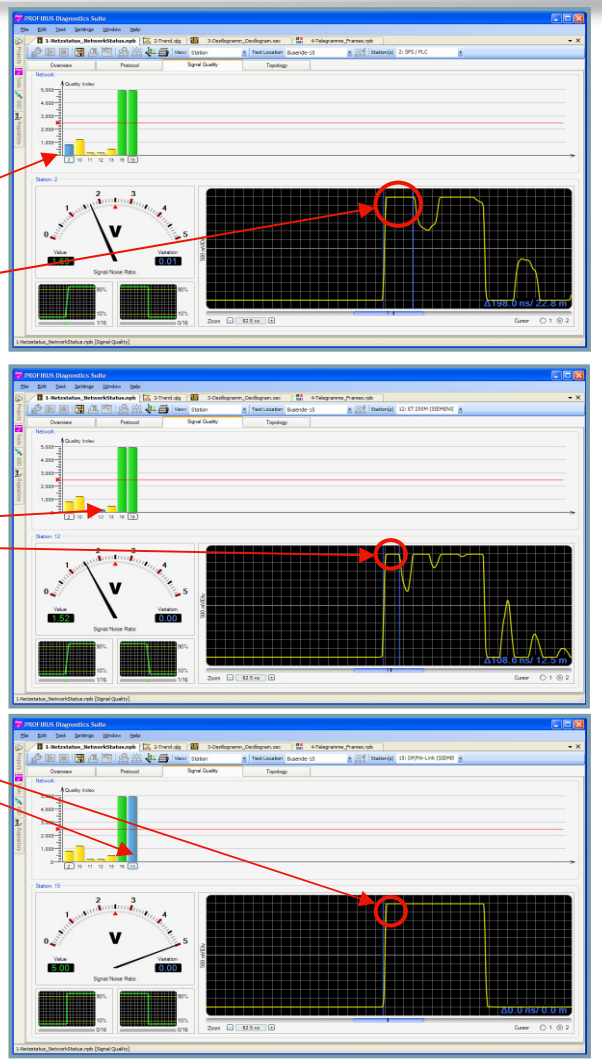
Signal Quality Window: Oscilloscope

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

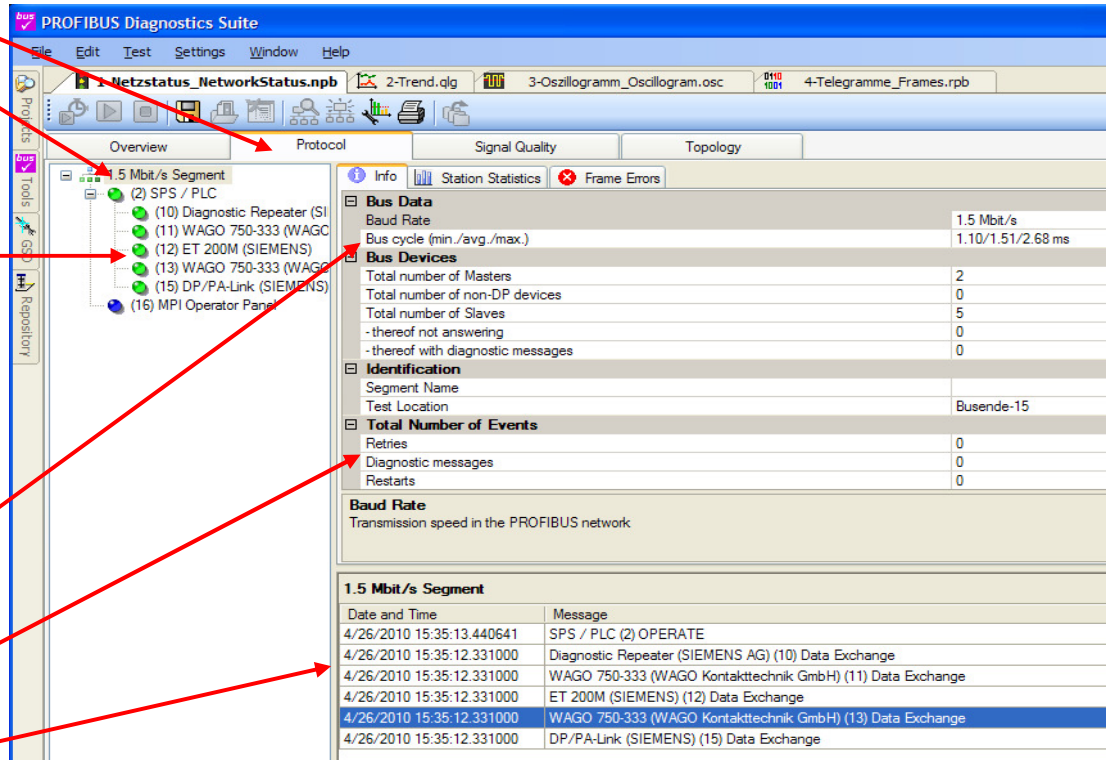
Live List

- **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.)



3. PB-DIAG-SUITE:

Protocol Window

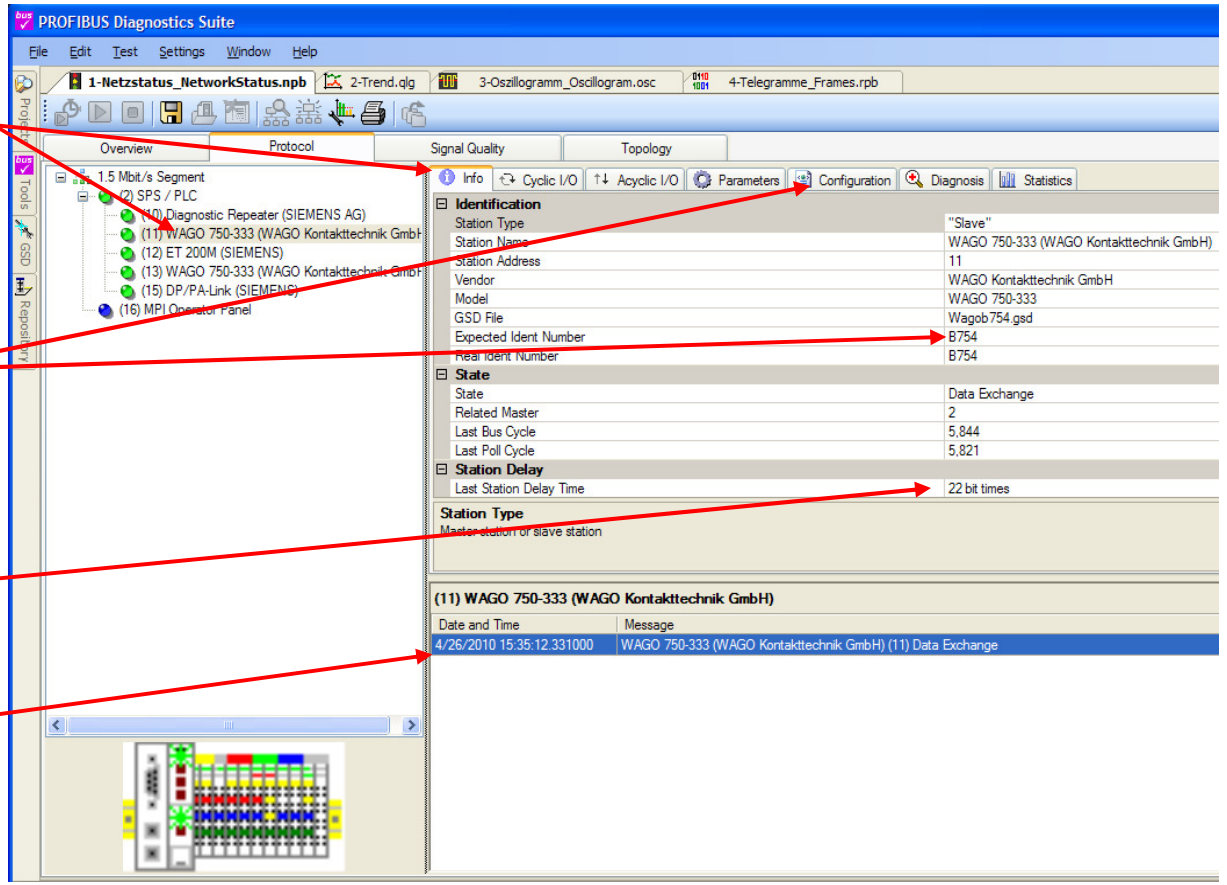
All relevant communication parameters at a glance:

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



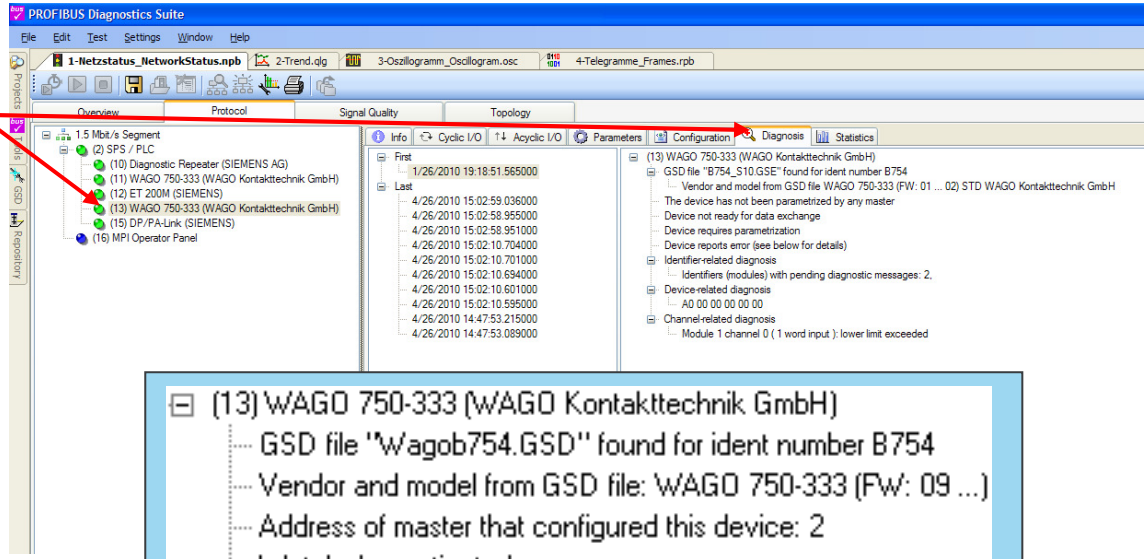
3. PB-DIAG-SUITE:

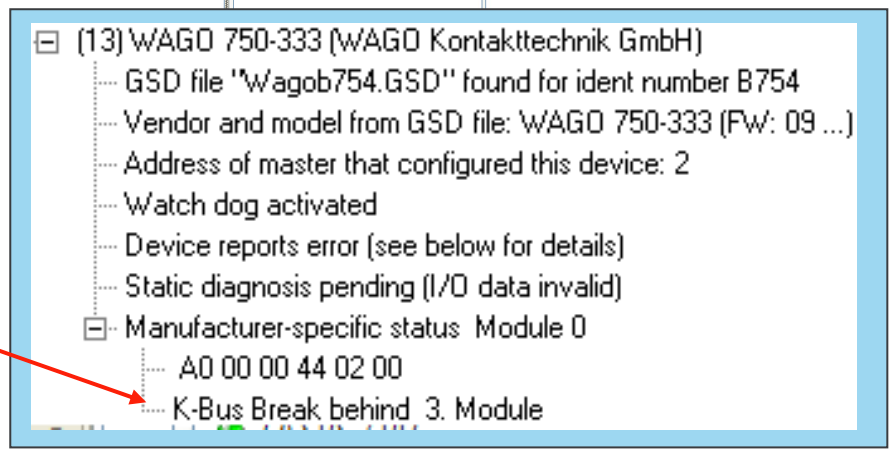
Protocol Window

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“

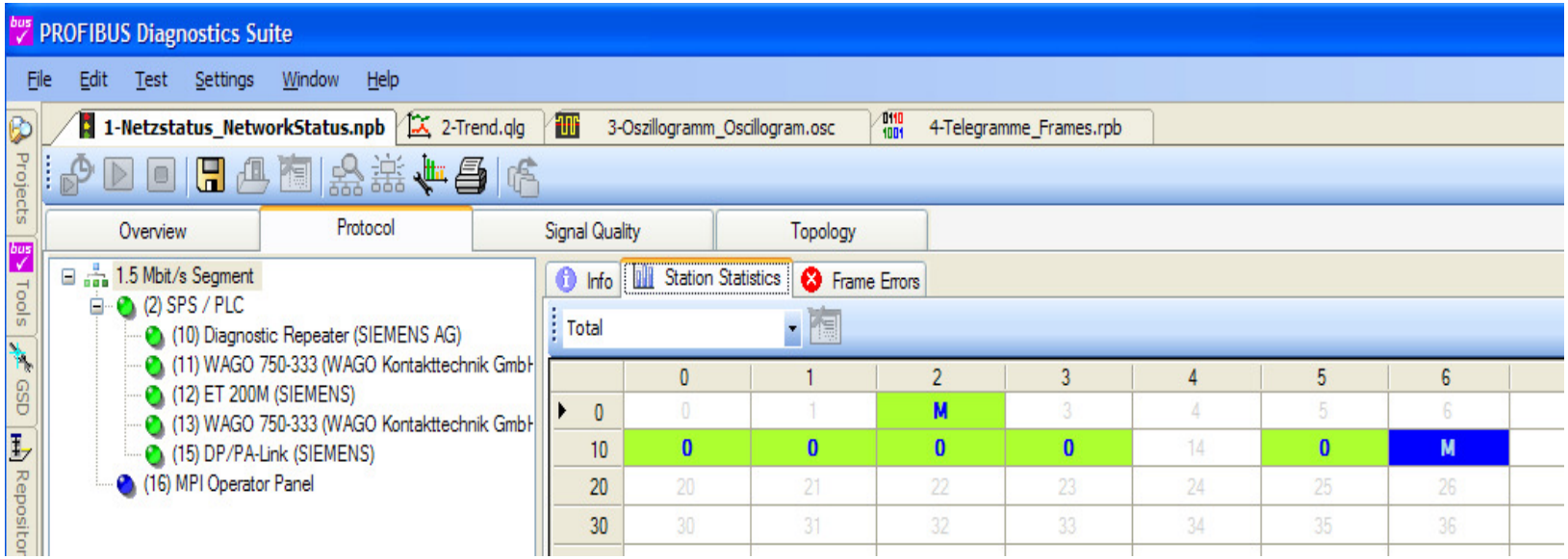
3. PB-DIAG-SUITE:

Protocol Window

The Matrix Overview:

monitor important frames which indicate problems coming in the future:

- Retries
- Diagnose frames
- Set parameter frames



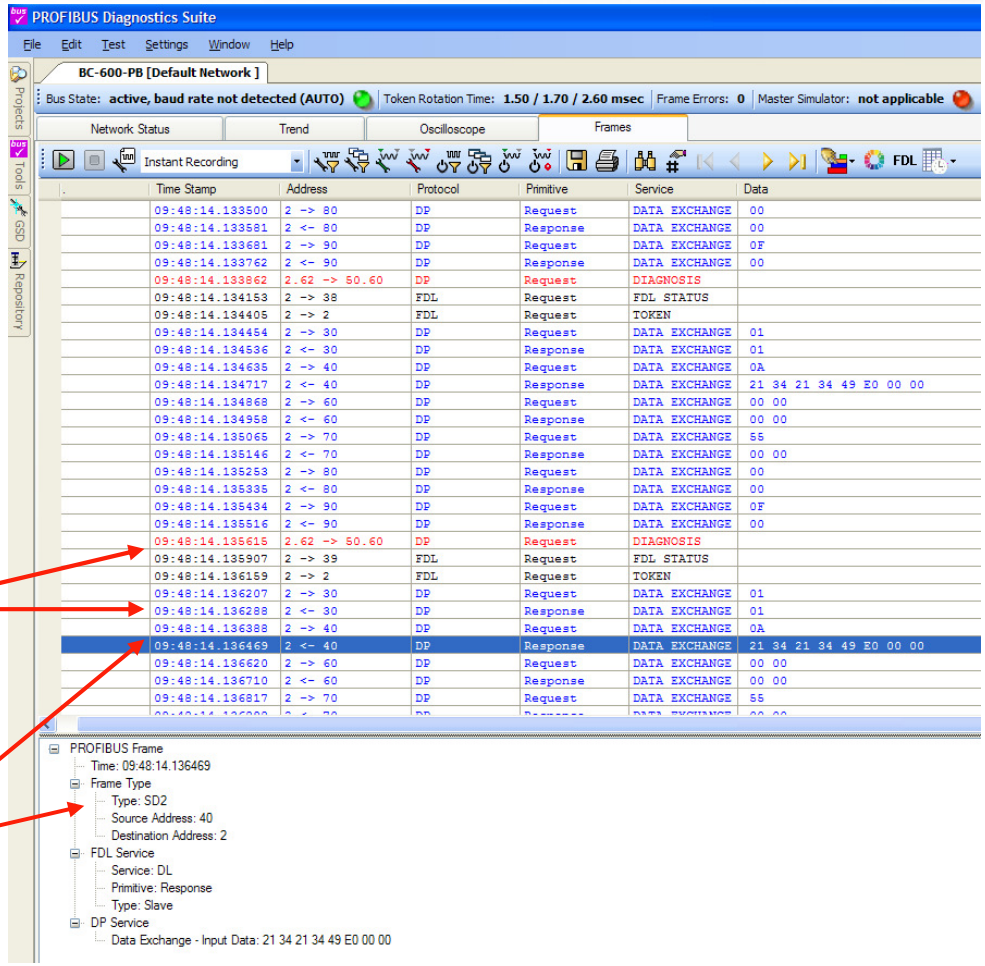
3. PB-DIAG-SUITE:

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

3. PB-DIAG-Suite:

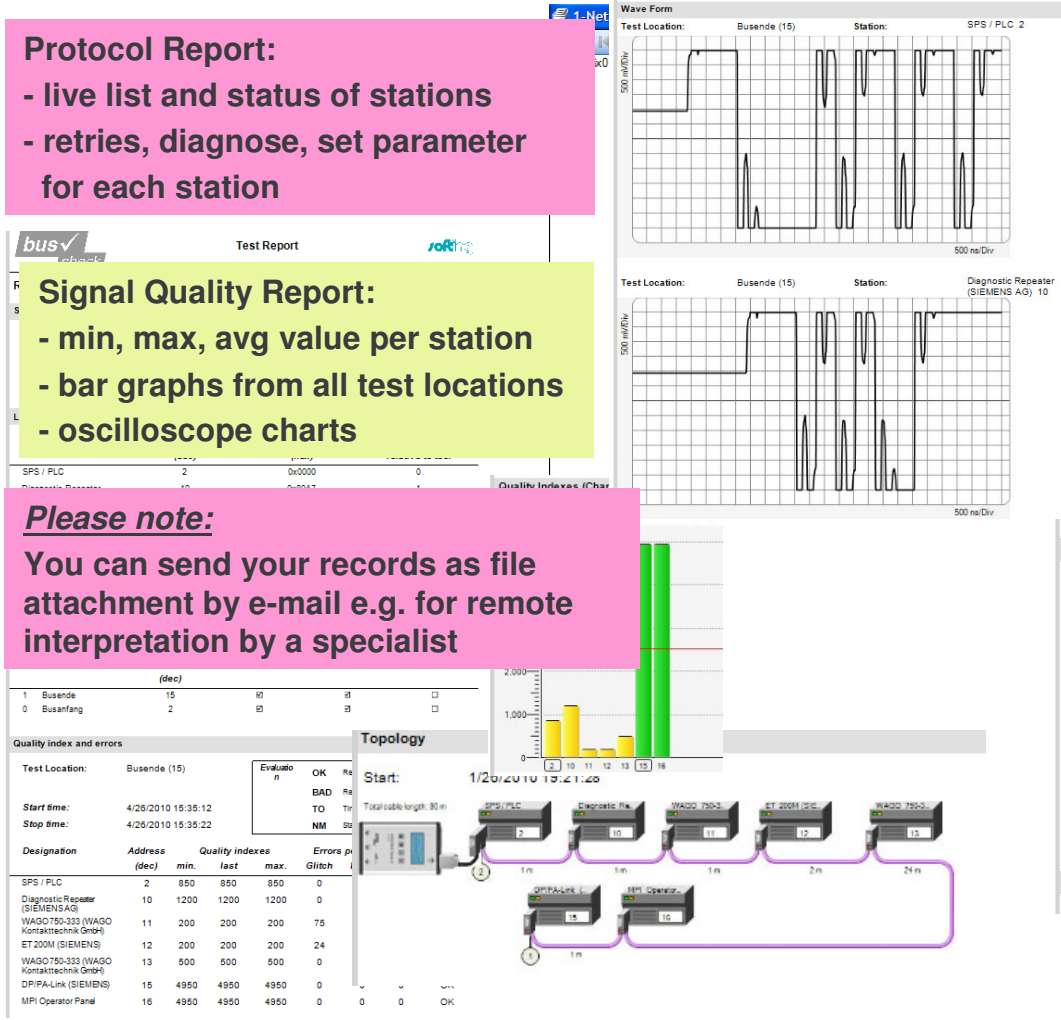
Automatically generated Test Report

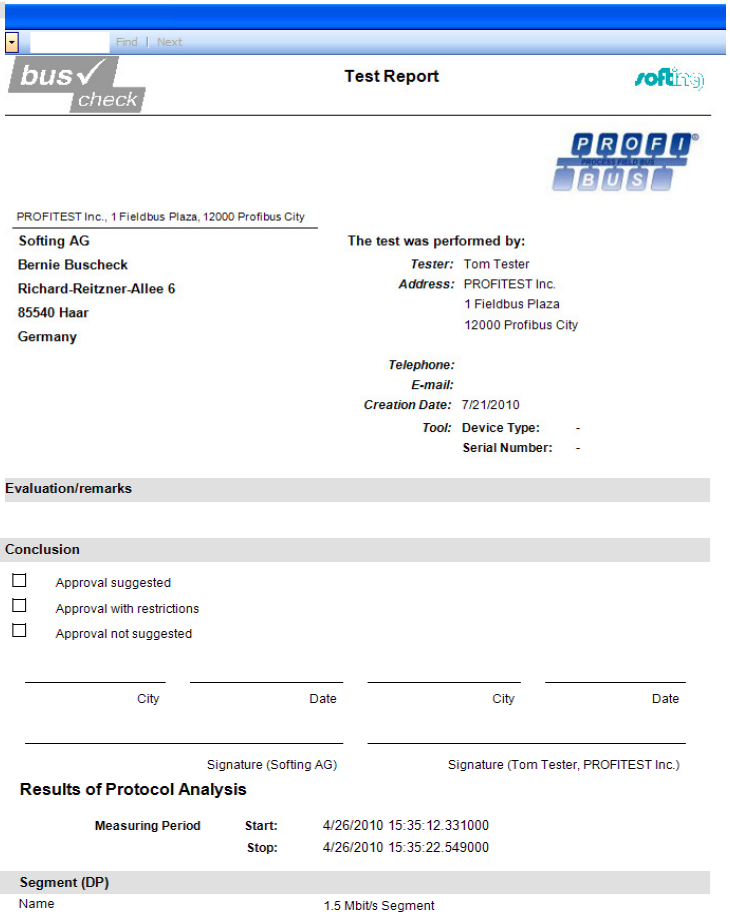
Protocol Report:
- live list and status of stations
- retries, diagnose, set parameter for each station

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

Please note:

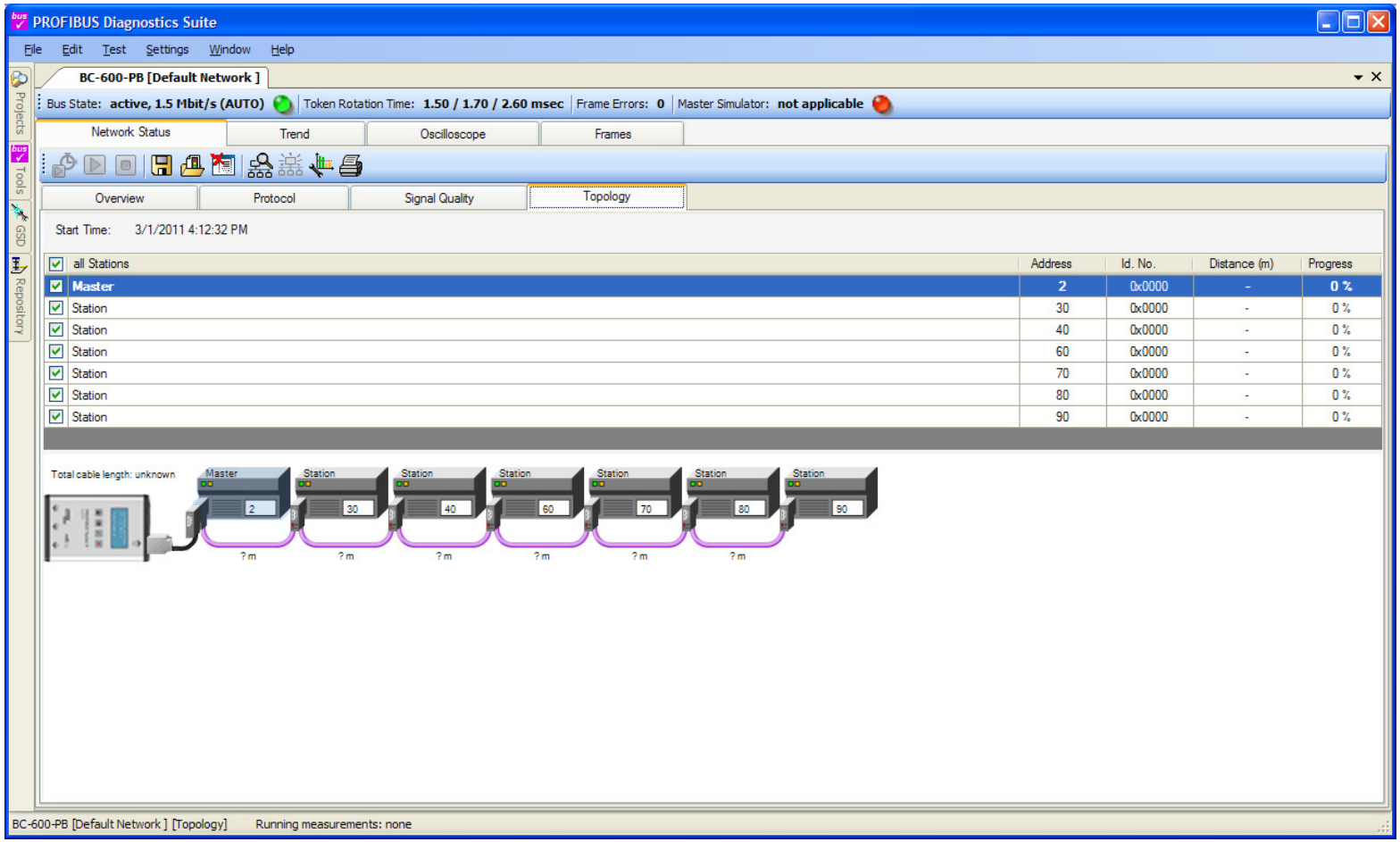
You can send your records as file attachment by e-mail e.g. for remote interpretation by a specialist





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 <u>both</u> 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 repititions 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

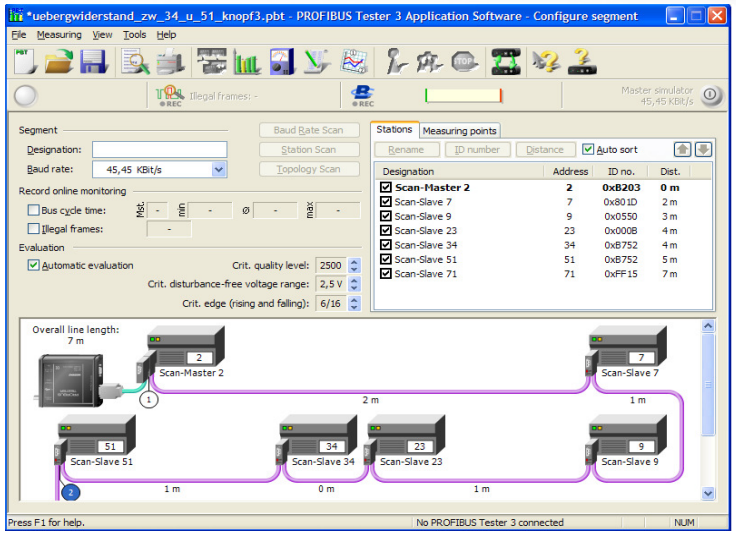
Step 2:

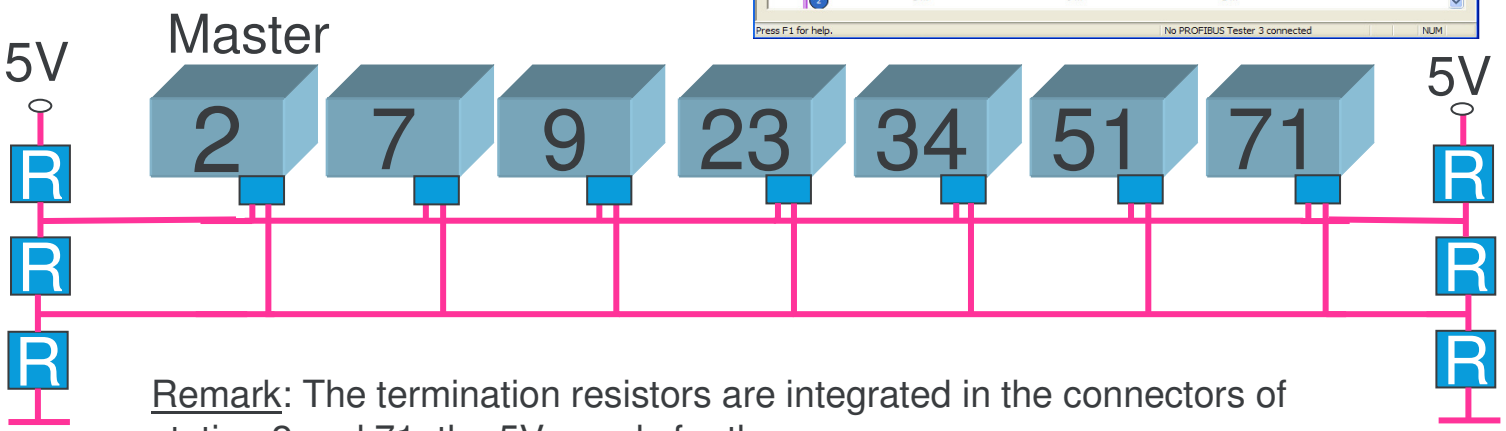
- Connect PB-T4 again to <u>that end</u> of the network <u>that displayed problems</u>
- Connect PB-T4 to USB-port of your PC and start PB-DIAG-SUITE software
- Perform a „Quick Test“ from your PC
- The „Overview Window“ will help you to determine whether you are faced with electric and/or communication 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

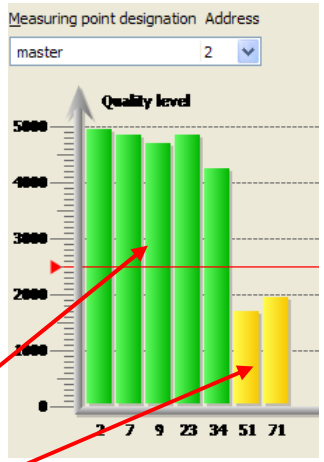
Case 1:

Step 1:

connect and test from ***left*** end side (Master 2)

Step 2:

connect and test from ***right*** end side (Slave 71)



measurement from left side (Master 2)

Result:

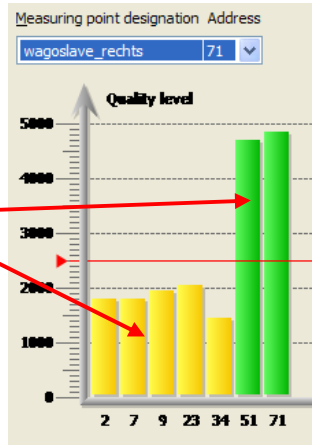
Test results on the **left** end:

- 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 right side (slave 71)

6. Typical Failure Cases in a Profibus Network

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

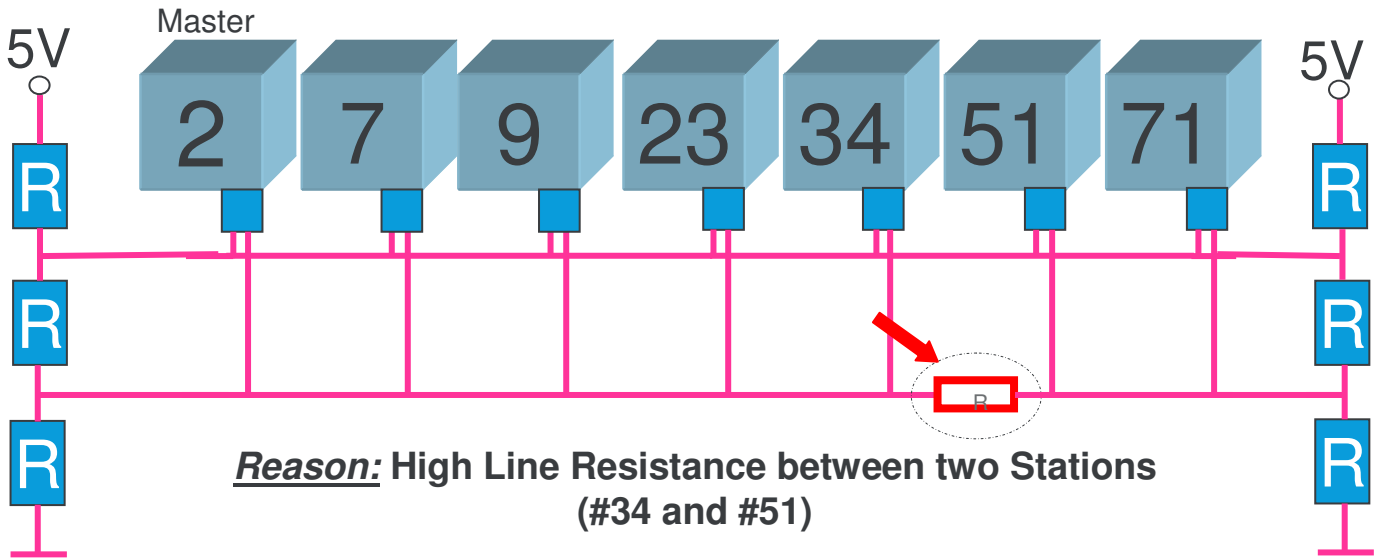
Interpretation:

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.



Reason: **High Line Resistance between two Stations (#34 and #51)**

6. Typical Failure Cases in a Profibus Network

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

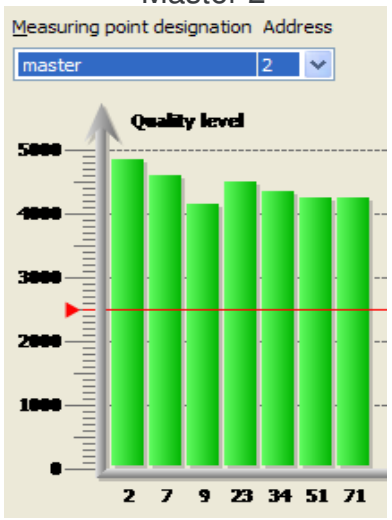
Case 2:

- 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

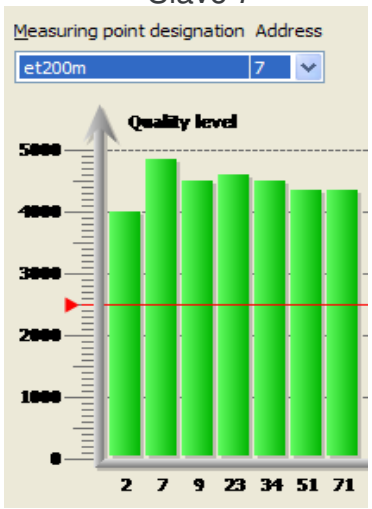
Result:

- 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.

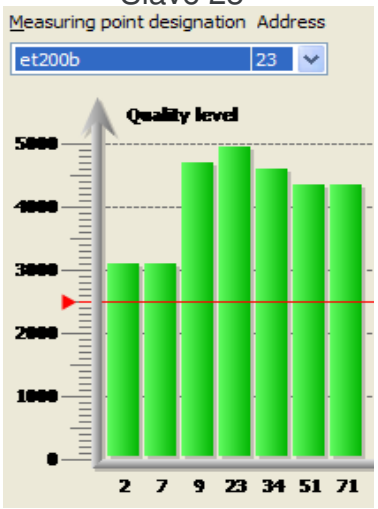
Master 2



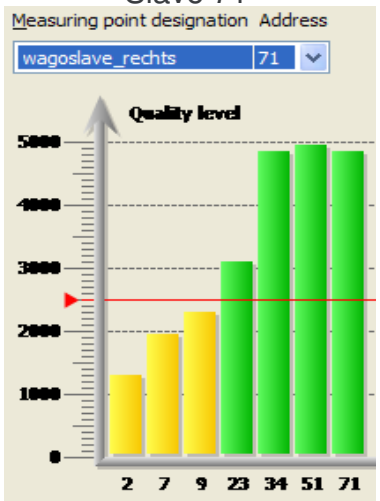
Slave 7



Slave 23



Slave 71



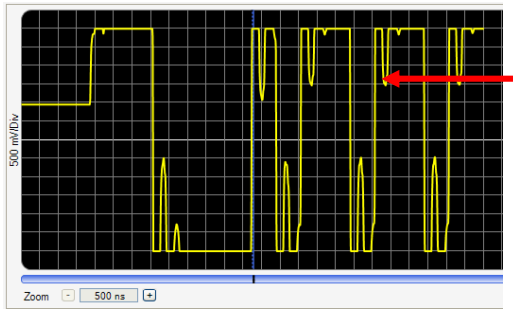
6. Typical Network Issues in a PROFIBUS Network

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

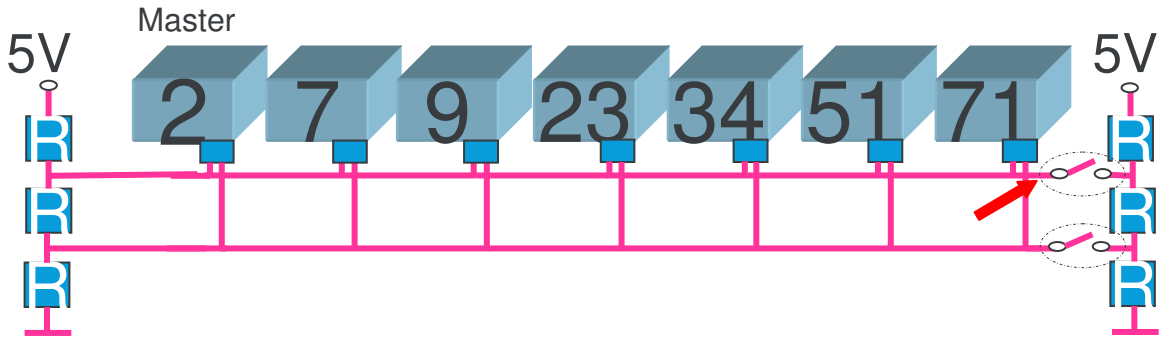
Interpretation:

- 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

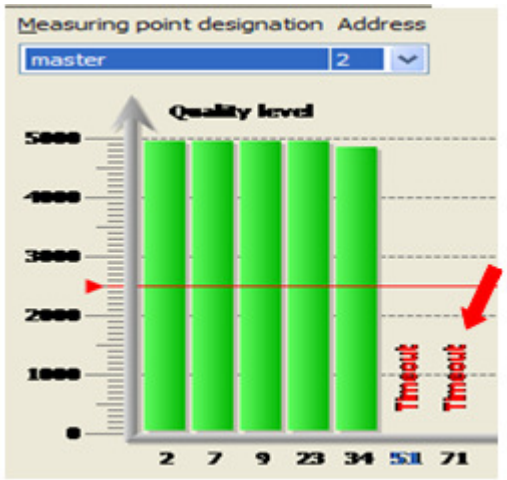
Case 3: Some stations are "missing" depending on the test location

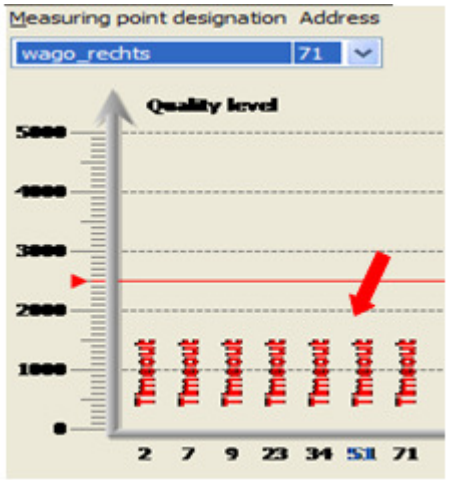
Case 3:

- 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





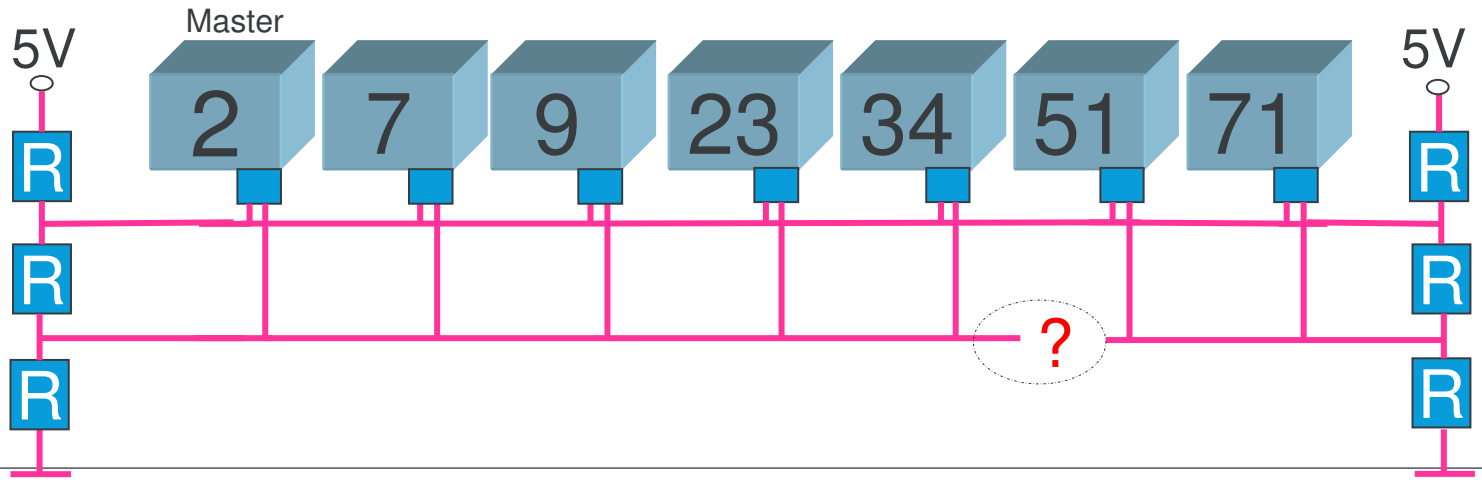
Interpretation:

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 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

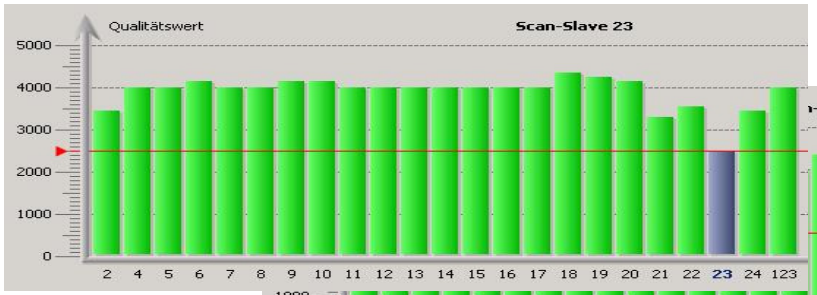
Result:

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

Interpretation:

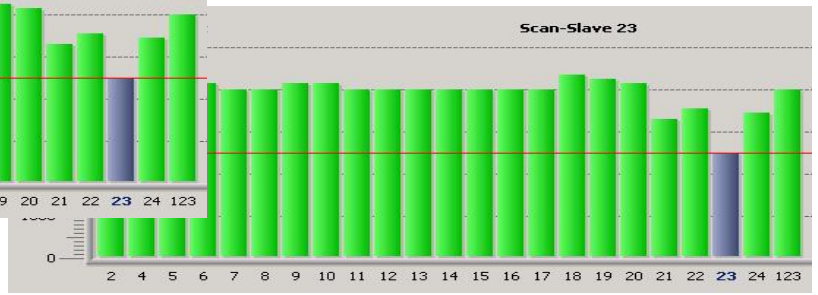
The voltage level of RS485 driver of station 23 (and only station 23) is too low.

measurement from left side (master 2)



measurement directly from slave 23

measurement from right side (slave 123)

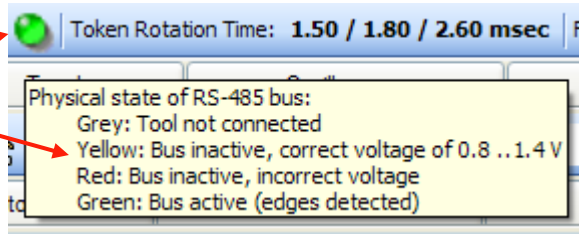


6. Typical Network Issues in a PROFIBUS Network

Case 5: Bus-termination is not powered correctly

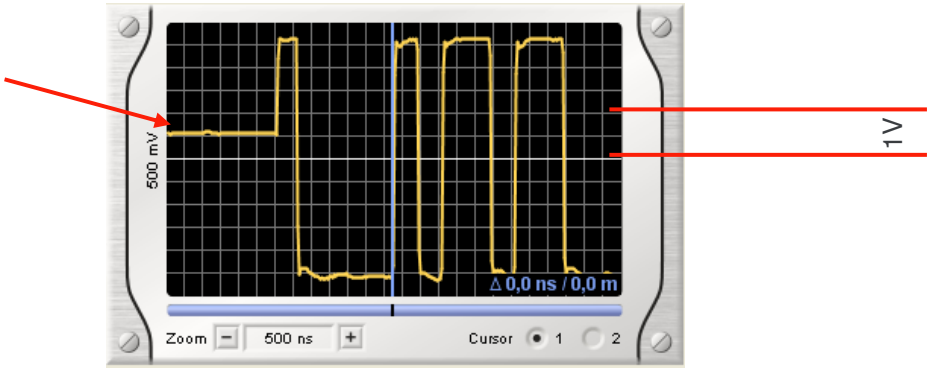
Indication of idle voltage:

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.



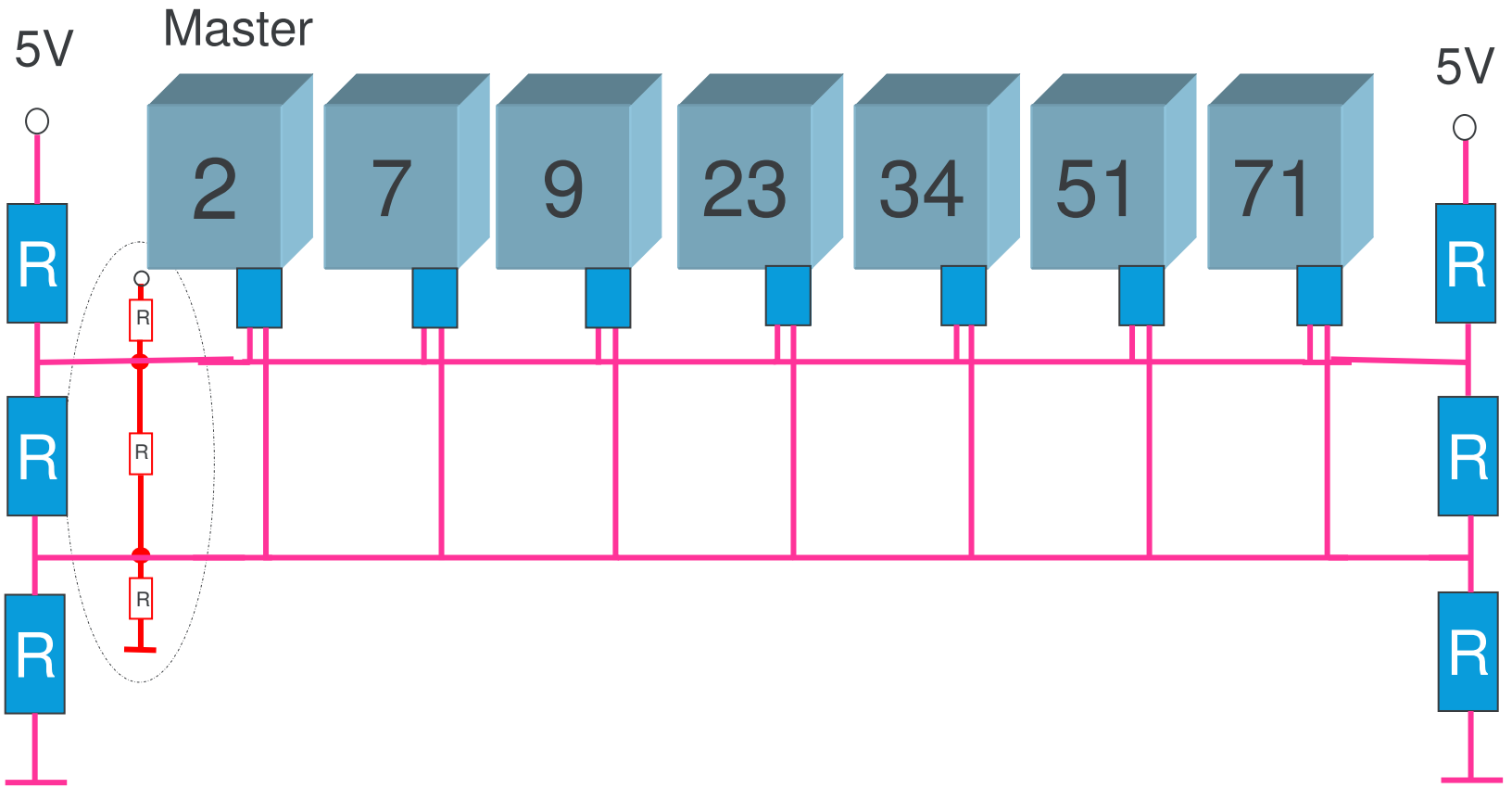
- An idle voltage of approx. 0.6 Volts indicates that only one bus-termination is powered correctly
  ⇒ communication may work, sporadic failures likely
- An idle voltage close to 0 Volts (both terminations not correctly powered or one termination missing/one not correctly powered ⇒ PROFIBUS will not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

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



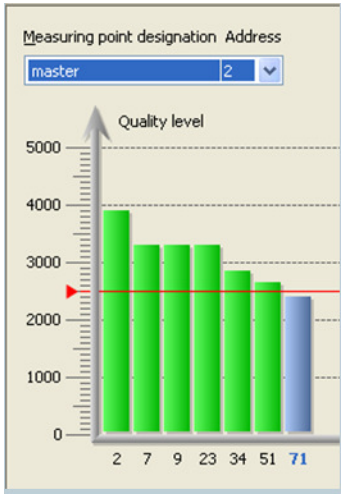
6. Typical Network Issues in a PROFIBUS Network

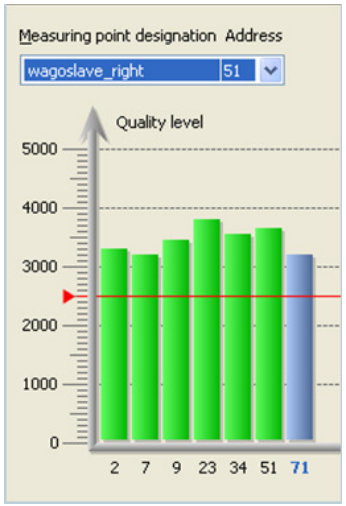
Case 6: Too many bus-terminations or additional electrical resistance



6.Typical Failure Cases in a PROFIBUS Network

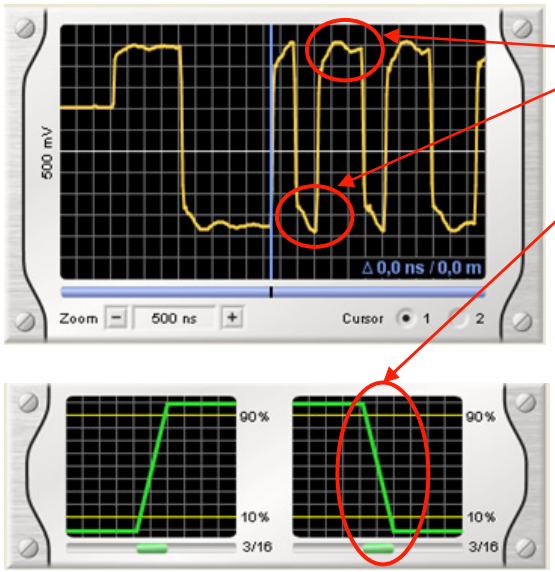
Case 6: Too many bus-terminations or additional electrical resistance





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

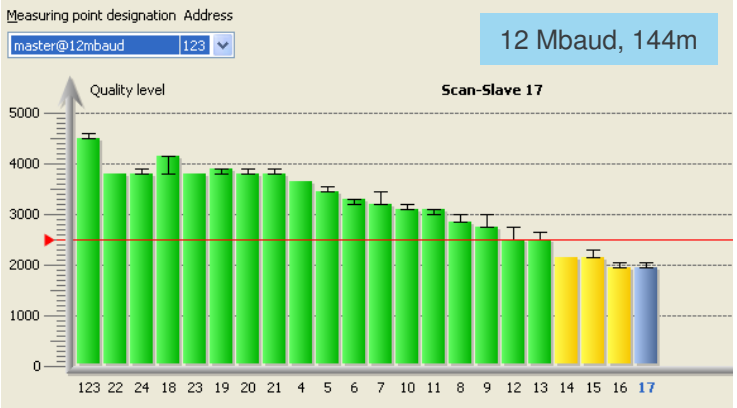
However, the signal quality level of the problematic station (Master #2) might be one of the best.
In this case the test results do not change as strikingly when dealing with too many bus-terminations as they do with missing bus-terminations. Additional resistance usually affects all stations.

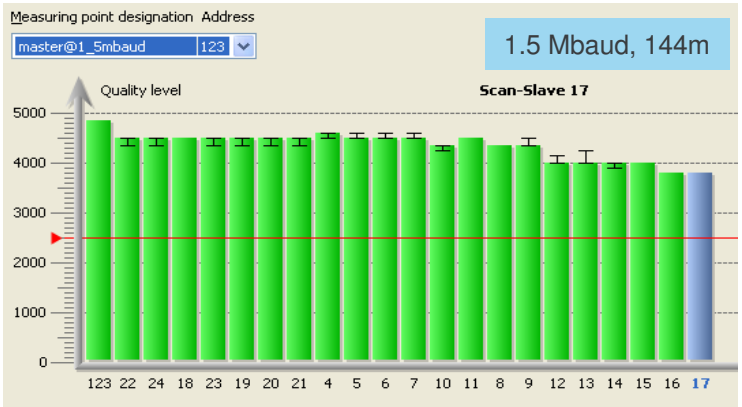


signal blurred
only some drops in signal due to reflections
bad signal edges

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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