

INDUSTRIAL AUTOMATION

How to Optimize your Schneider PROFIBUS Network with PROFIBUS Tester 4

The easy Approach for Beginners and Professionals

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1. Introduction

The intention of this document is to provide an easy approach to all who need to optimize or debug a PROFIBUS network made of Schneider Automation components.

- Softing Industrial Automation GmbH is specialized in diagnosis tools for PROFIBUS and PROFINET.
- PROFIBUS Tester 4 of Softing is a modern and easy-to-use „All-in-One“ tool to detect most typical problems in Profibus networks (as listed in the next slide)
- PROFIBUS Tester 4 is listed in the CAPP programme of Schneider Automation
- PROFIBUS Tester 4 supports you to
 - reduce network downtime
 - increase network reliability
 - reduce maintenance costs of your Profibus networks

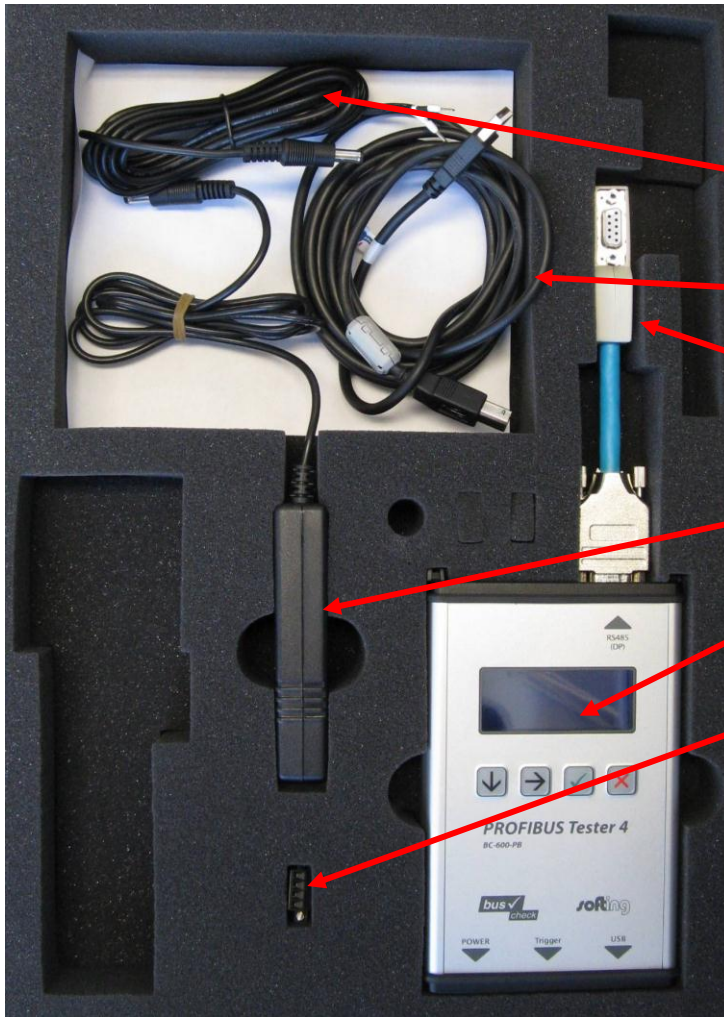


PROFIBUS Tester 4
was elected into the List of TOP10-products
of the AUTOMATION AWARD
of German SPS-MAGAZIN

Here is a list of issues commonly found in PROFIBUS networks

Missing, unpowered, or surplus bus-terminations	Bus cable too long
Dead-end branches	Wrong cable types
Damaged or defective bus drivers (RS 485 components)	Aging/corroding connectors and cables causing excessive transmission resistance
Cable-routing in environments subject to strong interference	EMC impacts
Network and node configuration errors, Data rate too high	Wrong GSD Files, and more...

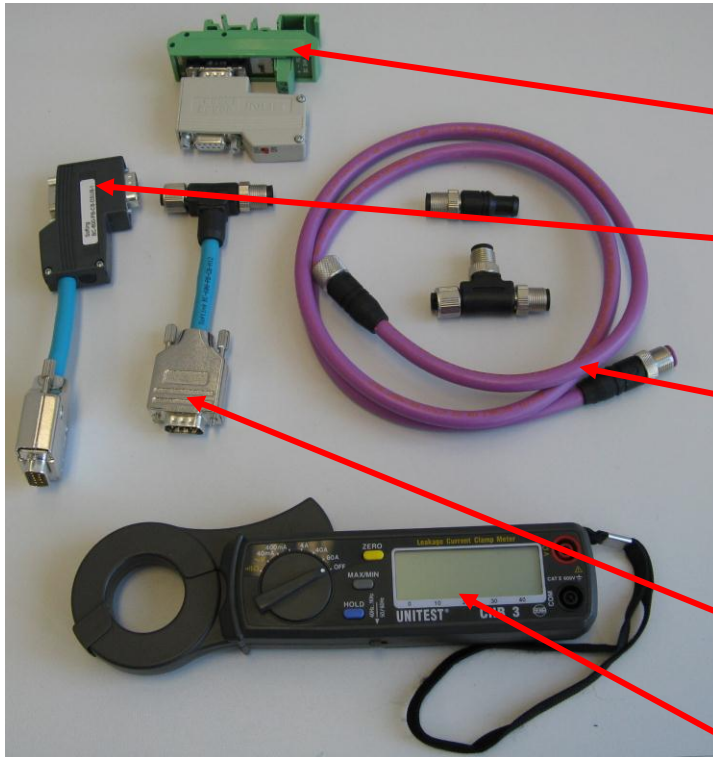
2. Scope of Delivery



PROFIBUS TESTER 4:

What's in the box:

- ▶ Power cable for external 24 V power supply
- ▶ USB cable to connect PB-T4 with PC
- ▶ DSUB standard connection BC-600-PB-CB-DSUB2
- ▶ Power supply 240 V AC
- ▶ *PROFIBUS Tester 4*
- ▶ Connector for oscilloscope trigger output
- ▶ not shown on the photo:
 - CD-ROM with PROFIBUS Diagnostic Suite software
 - Manuals



Optional Equipment:

- ▶ DSUB service connector interface for connecting the tester to the network
- ▶ Low impact connector cable for sensitive and safety critical networks
- ▶ M12 service connector interface with cable, T-junction and termination
- ▶ M12 Connector cable
- ▶ Current leakage clamp meter LSZ-CHB3
- ▶ BC-MOST PB: external accu

3. Installation

- ▶ Supported operating systems: Windows XP, VISTA (32 Bit) and Win 7 (32+64 Bit).
- ▶ Before installing the PROFIBUS Diagnostics Suite, please ensure that your PC or notebook meets the following minimum hardware requirements:
 - RAM:
 - ≥ 500 MB for Windows XP
 - ≥ 1 GB for Windows VISTA
 - Screen resolution $\geq 1024 \times 768$ pixels (XGA)
 - USB interface 2.0
 - For recording at baud rates up to 1.5 Mbit/s: CPU speed ≥ 1 GHz
 - For recording at baud rates over 1.5 Mbit/s: CPU speed ≥ 2 GHz
- ▶ The above system requirements are only general guidelines.
If more than the typical programs
- ▶ and services are loaded during Windows system startup or if they are very CPU intensive, the
- ▶ requirements given above might not be sufficient

► Installation of PB-Diag-Suite from the Supplied CD-ROM

Install PB-DIAG Suite software prior to connecting PROFIBUS Tester 4 to PC!

Setup should normally start automatically when you insert the CD-ROM supplied with your test tool. If it doesn't, the "start.exe" file provided on the CDROM needs to be run manually. A dialog box appears where you can choose a language for the installation by selecting the corresponding national flag.

The CD-ROM also includes the ".NET-Framework" and the Microsoft Installer, which will be installed on Windows XP systems, if required, before installation of the PB-DIAG-Suite starts.

You can also install Acrobat Reader manually from the CD-ROM if you do not already have it. Acrobat Reader is required to display user manuals and test reports being exported to pdf-format.

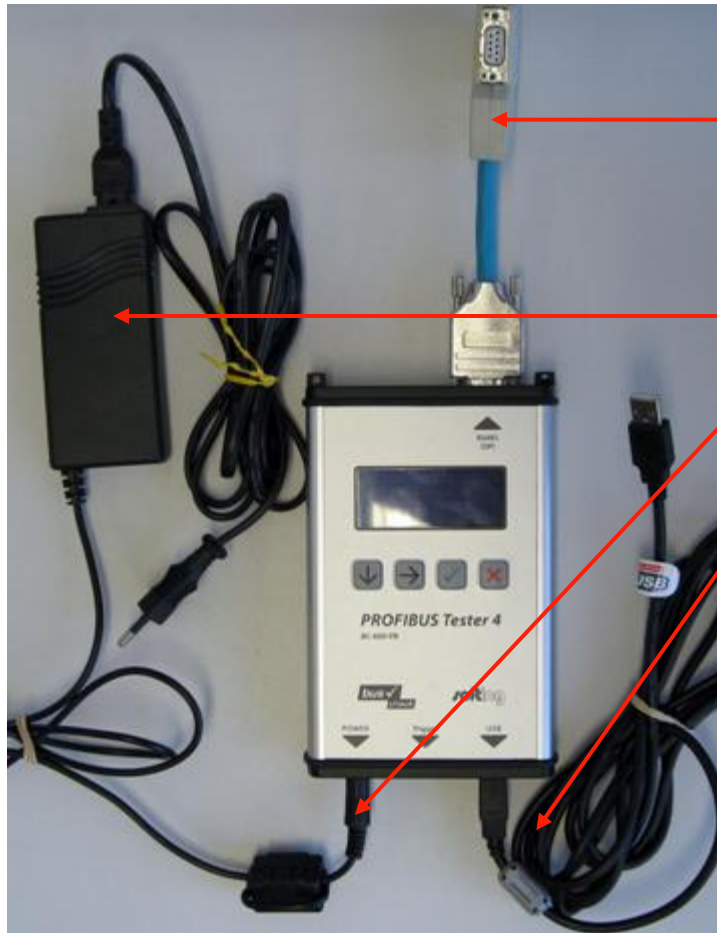
(For further details **please refer page 8 of manual)**

Installation of latest Update from Softing's Web Site

Please install the software from your CD-ROM first before downloading and installing any updates.

Download the update of latest version of PB-DIAG Suite Software from www.softing.com

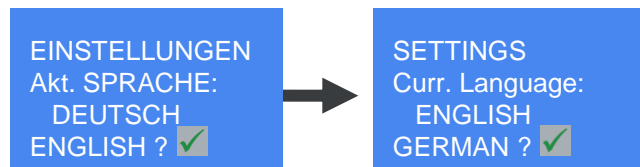
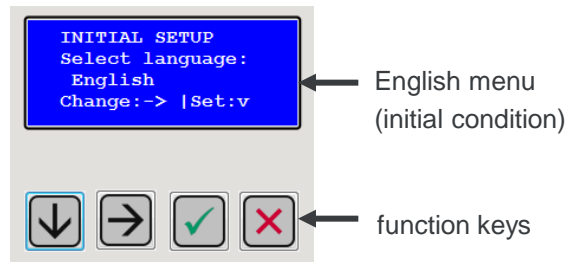
How to connect PROFIBUS Tester 4



- ▶ DSUB cable to connect PB-T4 to PROFIBUS network
- ▶ 240 V AC power supply
- ▶ USB cable to connect to PC (not required in Stand-Alone-Mode)

Please note:





Install PB-DIAG-Suite software prior to connecting PROFIBUS Tester 4 to PC!

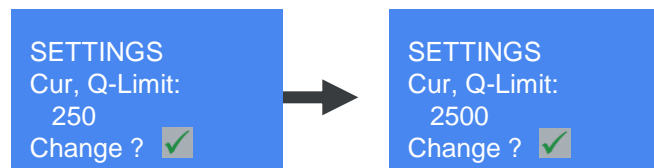


Normally, on first-time operation PROFIBUS-Tester 4 requests the operator to select GUI language.





If not, you can easily change the settings of PB-T4 as follows:

Change language from German to English:

- ▶ connect PB-T4 to the power supply, no PC connected!
- ▶ press  5x to get „EINST. & BEDIEN.“ menu
- ▶ press  2x to „Akt. Sprache“
- ▶ press  to change from German to English
- ▶ press  2x to return to the main menu



Change Limit for Quality-Level:

- ▶ connect PB-T4 to the power supply, no PC connected!
- ▶ press  5x to get „Settings & HELP“ menu
- ▶ press  3x to „Cur. Q-Limit“
- ▶ press  to change to 2500 (recommended value)
- ▶ press  2x to return to the main menu

4. Strategy for analyzing 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

We recommend the following initial steps:

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 (or in stand-alone mode for later download on your PC)

This way you can store up to 10 measurements on the PB-T4 without a PC. Make notes, which measurement location refers to which memory location on PB T4

We recommend the following initial steps:

Step 3

Now you can analyse the recorded measurements in your PC in a comfortable way. The advantage is that you do not need to do this in the plant (load, dirty, uncomfortable,...)

Just take your PC to a comfortable place and proceed as follows:

- ▶ Connect PB-T4 to USB-port of your PC and start PB-DIAG-SUITE software
- ▶ Download the measurements from PB-T4 to your PC. Please take care to allocate the measurements to the correct test location in your network
This is important for the interpretation
- ▶ 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

5. Stand-Alone Mode

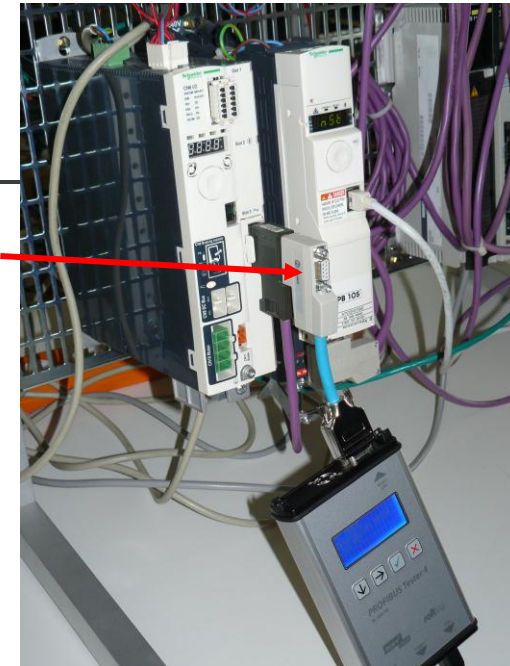
Rapid Network Analysis without a PC



Use the Live-Status with **Stand-Along-Mode** for a first simple test of

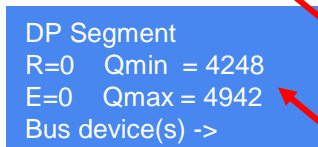
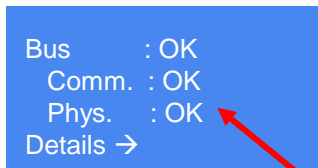
- communication (R= frame repetitions, E= error frames)
- signal quality (Qmin and Qmax of total network)

from **both** ends of a network:



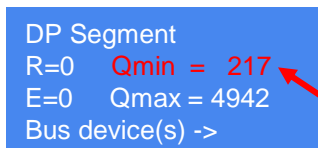
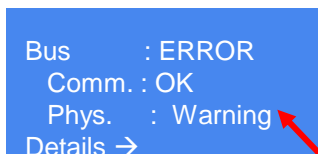
Step 1:

- ▶ connect PB-T4 to one end of your PROFIBUS network
- ▶ press - button once to get „Live-Status“ menu
- ▶ press - button to start „Live-Status“
- ▶ read the results (in this case everything OK)
- ▶ press for details
- ▶ All details are good from this end



Step 2:

- ▶ connect PB-T4 to **other** end of your PROFIBUS network
- ▶ carry out „Live-Status“
- ▶ read the results (in this case there are problems)
- ▶ press for details
- ▶ There are poor signals from this end



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.

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

→ Connect your PB-T4 with your PC and start PB-DIAG-SUITE for further tests or store recordings with „Quick-Test“ on PB-T4 and download them to your PC later for comfortable analysis in your office.

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

Here is a unique case:

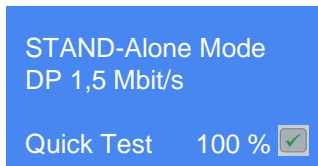
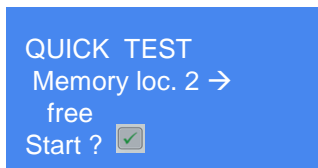
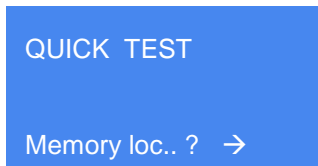
- Communication indicates „ERROR“
- R=0, E=0, all signals are OK

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

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

→ Connect your PB-T4 with your PC and start PB-DIAG-SUITE to identify the missing node(s) or store recordings with „Quick-Test“ on PB-T4 and download them to your PC later for comfortable analysis in your office.

Easy Storage of Measurements on PB-T4



Quick-Test:

With the „Quick-Test“ function you can store up to 10 measurements on your PB-T4. You can download these measurements later to your PC for analysing in a comfortable working atmosphere:

- ▶ Connect PB-T4 to one end of your DP segment and note the Profibus address of the device to which you are connected
- ▶ Go to main menu
- ▶ Press - button 2x to get „Quick-Test“ menu
- ▶ Press - button 1x to select memory location
- ▶ If location „1“ is occupied continue with to find the next free memory location
- ▶ Press to start the „Quick-Test“, wait until 100 % is reached
- ▶ Please note which Profibus address belongs to which memory location. You need this later to understand which measurement was made from which position in your segment
- ▶ Press to go back to main menu. Data are stored also if unpowered!

Download of measured Data from PB-T4 on your PC

Download of Data from PB-T4 on your PC:

- ▶ Connect PB-T4 with PC via USB cable
- ▶ Open PB-DIAG-Suite on your PC and wait until PB-T4 is recognized by PB-DIAG-Suite
- ▶ If you have got test data stored on PB-T4 the „Import Test Data“ window opens automatically
- ▶ Select your required action (e.g. „import“)
- ▶ Select the network name from the list or add a new network name

Import Test Data

Active Device: BC-600-PB Serial Number: 95100102

Status	Memory Location	Start Time	Duration	Action	Network	Project	Test Location
	Quick Test 1	9/13/2012 09:49:49.000	00:00:11	Import & Delete	Default Network	<NONE>	
	Quick Test 2	9/13/2012 09:50:43.000	00:00:11	Import & Delete	Default Network	<NONE>	
	Quick Test 3			None			

Select Test Location

Network

Name: Default Network Project Name: -

Test Locations

Auto sort by location column


#	Designation	Addr.	Q.I.	S/N	Trend
1		60	-	-	-
2		80	X	X	-

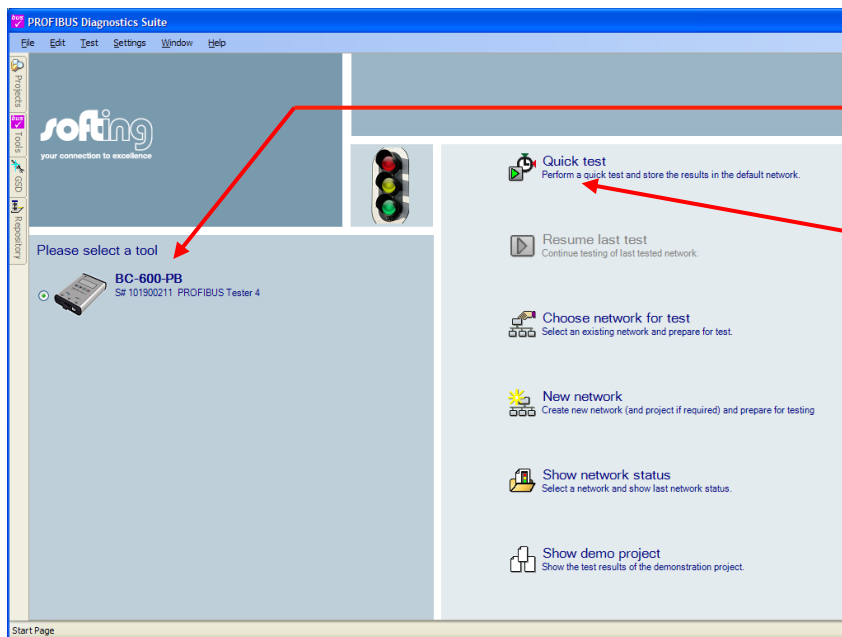
- ▶ Click on selection mark for „Test Location“
- ▶ With a slow doubleclick on the default „Designation“ you can edit the name of the station to which your measurement belongs
- ▶ Enter the DP-address of the station
- ▶ Press ok to close the window
- ▶ Press „Start“ to start the download

6. The PROFIBUS Diagnostic Suite software

Step 1: Getting Started

- ▶ Connect PB-T4 to the PROFIBUS network at the location that indicated a network issue (as described in the previous 2 slides)
- ▶ Connect PB-T4 to your PC using the USB-cable
- ▶ Follow the installation wizard for the hardware installation

After a successful hardware installation click on  to start PB-DIAG-SUITE on your PC



- ▶ Check if your PB-T4 is recognized by PB-DIAG-SUITE
- ▶ Click on „Quick Test“ for starting a measurement. After this the „Overview Window“ will open automatically

Step 2: Overview Windows

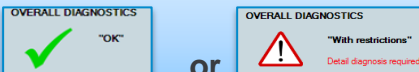
The Overview Window indicates:

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

4 tabs for easy operation:

- Overview
- Protocol,
- Signal Quality
- Topology

First indication:



Green light indicates:

„Communication is okay“

yellow light indicates:

„Problems with the electrical signal quality“

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

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

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	
Topology	1/26/2010 7:21:2

All values are OK
=> Traffic light is green

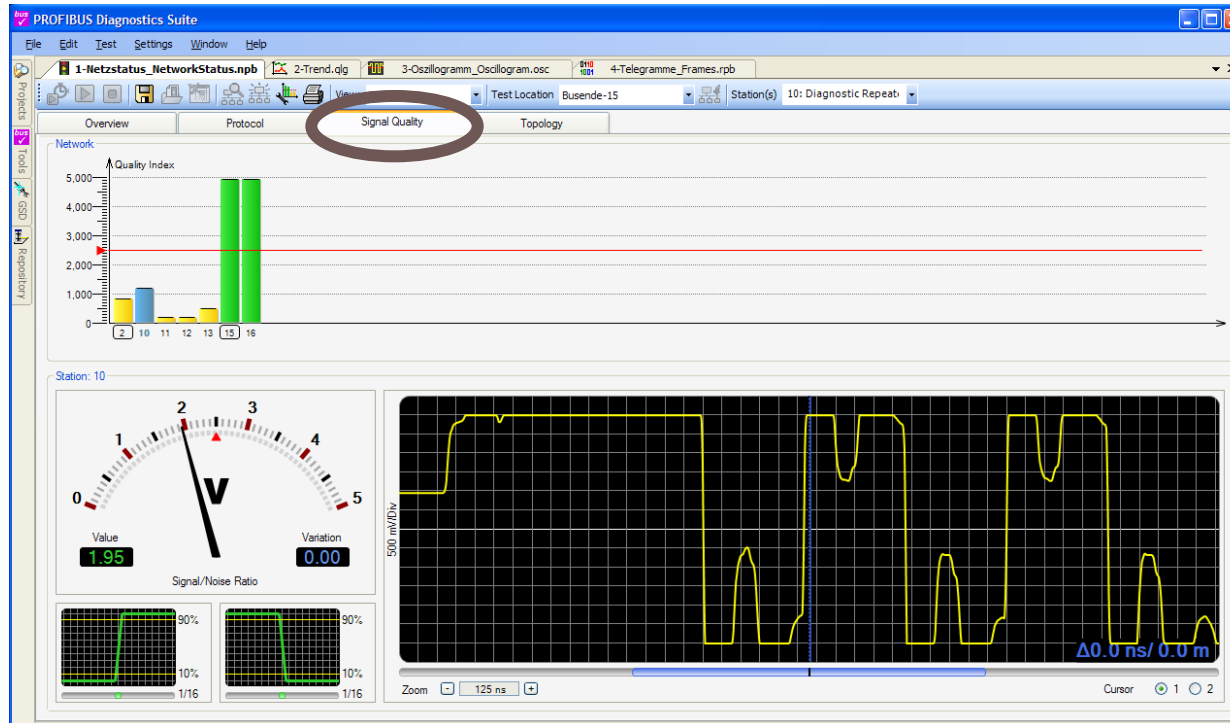
All critical values are marked by red ink:
In this case 5 out of 7 Stations show bad quality
=> Traffic light is yellow

Result:

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

Step 3: Signal Quality Window

- ▶ 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.

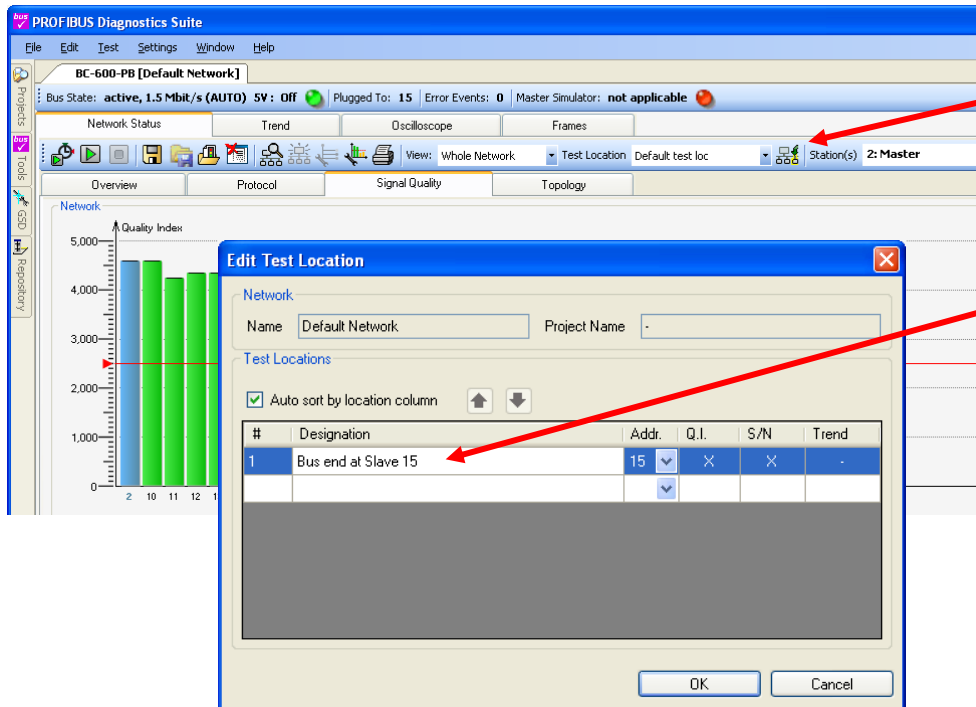


Step 4: Signal Quality Window

name test locations

Why should you name your test locations?

As already stated in the „Stand-Alone-Mode“ slides, test results may vary depending on the test location. In order to easily compare the results later-on we recommend to associate a symbolic name with each test location.



Click on „Edit Test Locations“ button  to open corresponding menu

Highlight „Default Test loc, then double click, then type in a name and the respective bus address

It is recommended to define at least two locations at the ends of each network or segment

Step 5: Signal Quality Window

sorting of bar graphs

By default the signal quality bars are sorted by node address. However, most of the time the physical location of a node with a specific address on the network does not follow this rule.

To make the interpretation easier it is highly recommended to sort the bars according the correct topology (their correct physical order).

You can achieve this

- manually as described below
- or automatically by a topology scan (see chapter 7)

Manual sorting of bar graph:

Click on „Signal Analysis Settings“ for sorting bar graph

Click on „Stations“

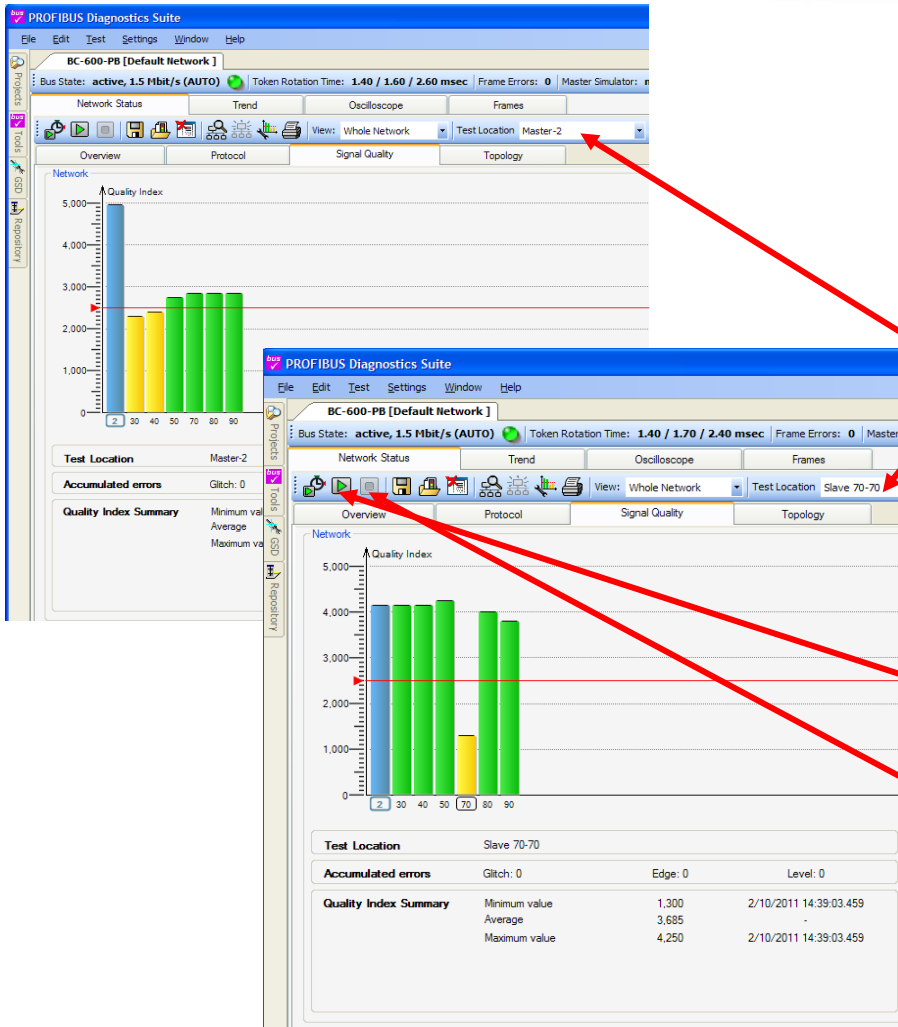
De-select (!) this check mark

Mark a station and change position in the list with these buttons

The screenshot shows the PROFIBUS Diagnostics Suite interface. The main window displays a bar graph of signal quality for various stations. The 'Signal Analysis Settings' dialog box is open, showing the 'Stations' tab. The 'Auto sort by distance column' checkbox is unchecked. The 'Stations' list is sorted by distance, with the Master station at distance 0 and other stations at increasing distances. The bar graph shows signal quality bars for stations 10, 11, 12, 13, 16, and 15. The bottom of the window shows test location 'Busende-15' and various error and quality index statistics.

Station	Address	Id. No.	Distance (m)
all Stations			
<input checked="" type="checkbox"/> Master	0	0x0000	0
<input checked="" type="checkbox"/> LULC07 - TeSys U Profibus (Telemecanique)	89	0x094C	3
<input checked="" type="checkbox"/> LEXIUM32-PROFIBUS-DPV1 FW V01.10 (Schneider Ele...	102	0x089D	6
<input checked="" type="checkbox"/> ATV32 (Schneider Electric)	105	0x0C95	11
<input checked="" type="checkbox"/> LULC07 - TeSys U Profibus (Telemecanique)	118	0x094C	17
<input checked="" type="checkbox"/> Station	125	0x0B48	25

Step 6: Signal Quality Window making further measurements



For a clearer picture of your network health you should run the same test at multiple test locations.

Select test location

Click on „Start Test“  for starting and wait until all stations have been scanned

Click on „Stop Test“  to stop the test

Step 7: Signal Quality Window

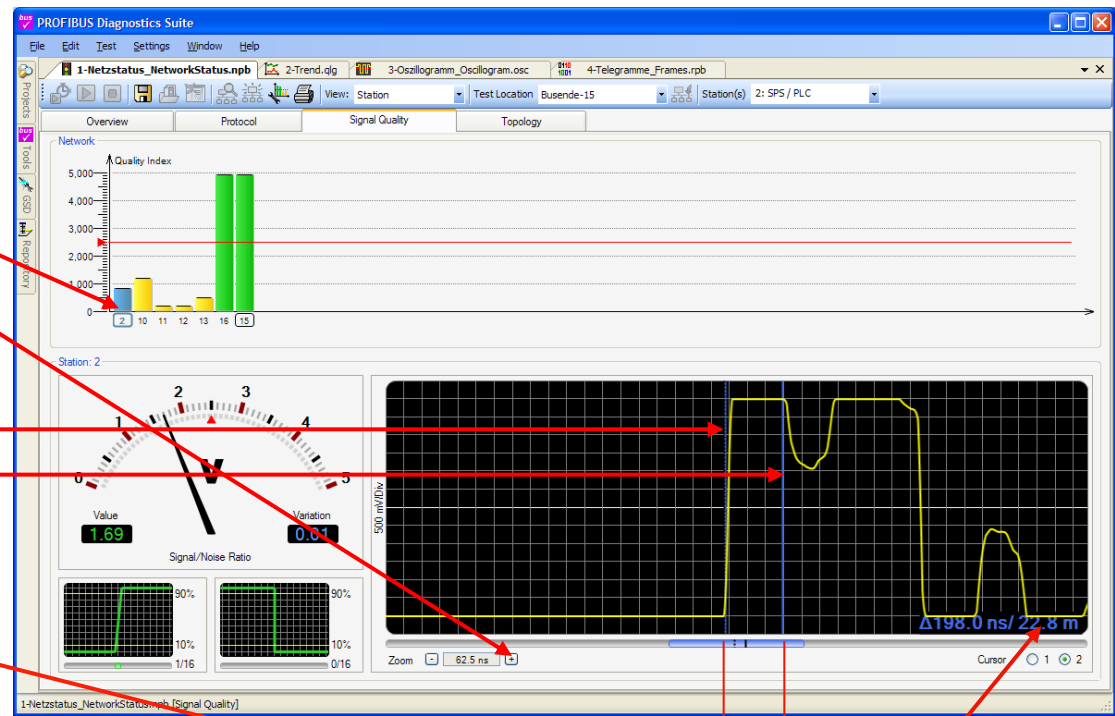
Oscilloscope

Localize the failure with the Oscilloscope:

Click on bar #2

increase zoom to 62,5 ns

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



Distance 22,8 m

Step 7: 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

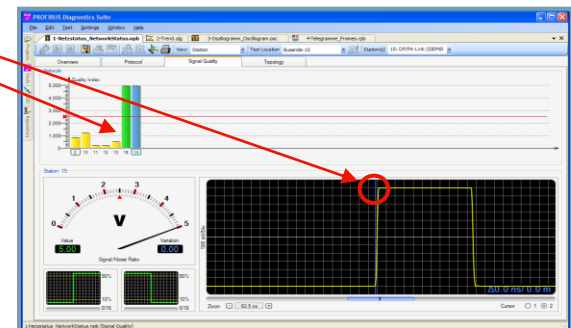
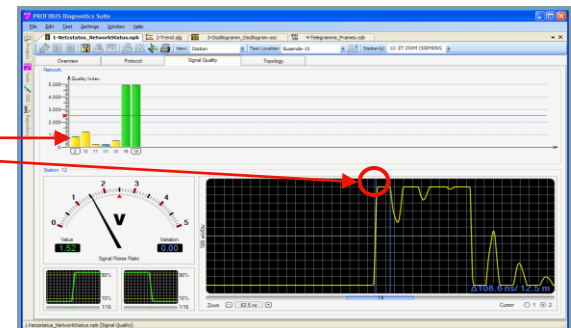
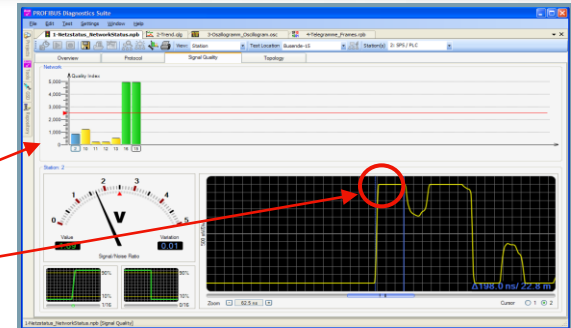
Now distance to problem is only 12,5

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.



Step 8: 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

Default Network.120425-115556.npb

Overview Protocol Signal Quality Topology

Info Station Statistics Frame Errors

1.5 Mbit/s Segment

- (0) Master
 - (89) LULC07 - TeSys U Profibus (Telemecanique)
 - (102) LEXIUM32-PROFIBUS-DPV1 FW V01.10 (Schneider Electric)
 - (105) ATV32 (Schneider Electric)
 - (118) LULC07 - TeSys U Profibus (Telemecanique)
 - (125) Station

Bus Data

Baud Rate	1.5 Mbit/s
Current Bus Cycle	20.959
Duration of Last Bus Cycle	10.15 ms
Bus cycle (min/ava./max.)	0.50/13.09/51.455.95 ms

Bus Devices

Total number of Masters	1
Total number of non-DP devices	0
Total number of Slaves	5
- thereof not answering	0
- thereof with diagnostic messages	1

Identification

Segment Name	
Test Location	Default test loc

Total Number of Events

Retries	1
Diagnostic messages	41
Restarts	11

Bus Data

Transmission speed in the PROFIBUS network

1.5 Mbit/s Segment

Date and Time	Message
4/25/2012 11:53:53.2321593	Station (89) Not responding to Master requests
4/25/2012 11:53:53.2321593	Station (89) Not responding to Master requests
4/25/2012 11:53:53.2422113	Station (89) Slave State Need New Prm
4/25/2012 11:53:53.2422113	Station (89) Slave State Need New Prm
4/25/2012 11:54:44.7184848	Station (89) Slave reports diagnosis
4/25/2012 11:54:44.7184848	Station (89) Slave reports diagnosis
4/25/2012 11:54:44.7289494	Station (89) Data Exchange
4/25/2012 11:54:44.7289494	Station (89) Data Exchange
4/25/2012 11:54:46.8469410	Station (89) Slave reports diagnosis(Data Exchange)

Default Network.120425-115556.npb [Protocol] Processing Lag: -

Step 8: Protocol Window

Clicking on a node (or station) will display its specific information.

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 BUS Diagnostics Suite interface. The main window displays a network topology with a 1.5 Mbit/s segment containing a master and several slave stations. A pop-up window shows the status of these stations, with a red light indicating a stop state for station (89). The right-hand pane shows the configuration for station (89) LULC07 - TeSys U Profibus (Telemecanique), including identification details, station delay times, and a log of messages.

Color	Master state	Slave state
Red	Stop	No response or failure
Orange	-	Parameter or configuration error
Yellow	Clear	Diagnostic message
Green	Operate	Correct cyclic operation
Blue	(MPI device)	Not configured in the master (PLC)

Identification	Value
Station Type	"Slave"
Station Name	LULC07 - TeSys U Profibus (Telemecanique)
Station Address	89
Vendor	Telemecanique
Model	LULC07 - TeSys U Profibus
GSD File	TELE094C.asa
Ident Number	094C
Number	094C
Data Exchange	
Master	0
Cycle	20.958
Last Poll Cycle	20.949

Station Delay	
Last Station Delay Time	12 bit times = 0.0080 ms
Station Delay Time	11..13 bit times = 0.0073..0.0087 ms

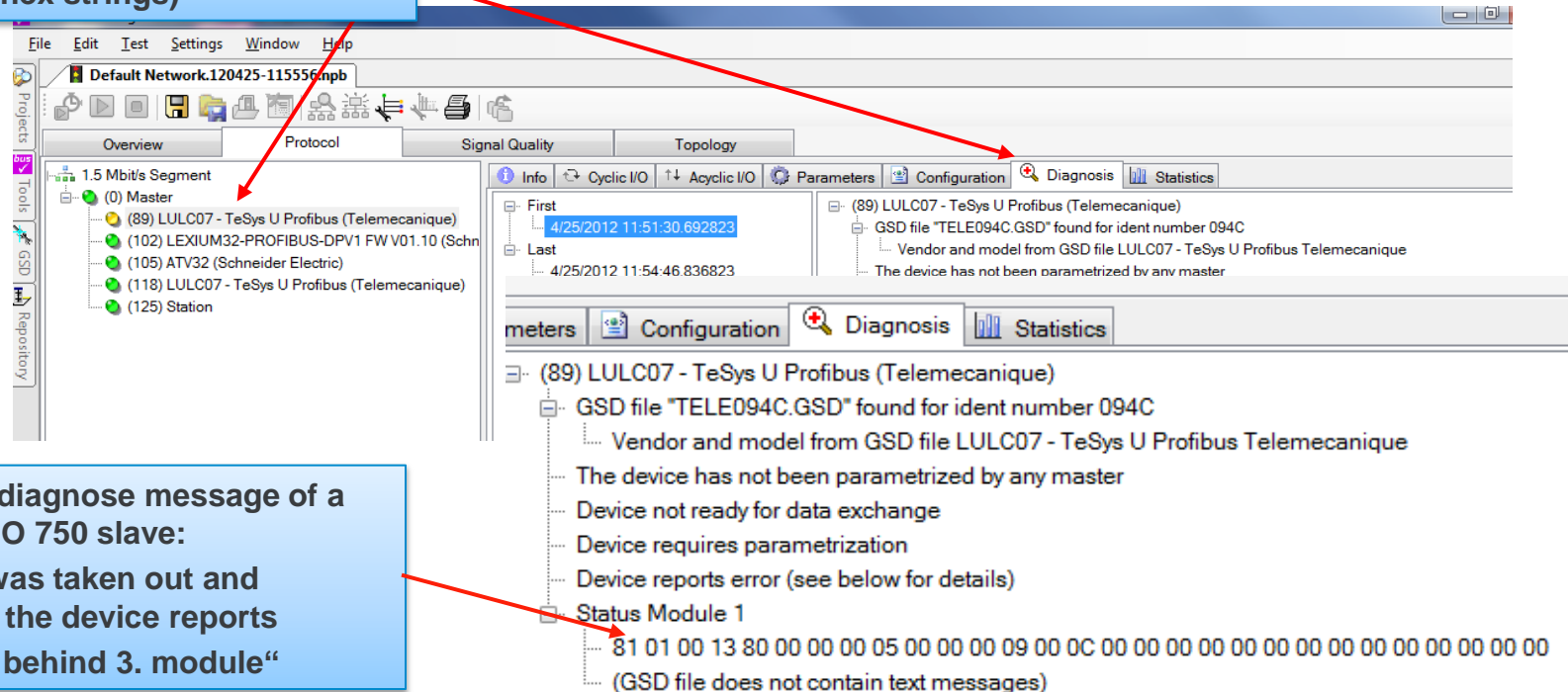
Identification	
Master station or slave station	
(89) LULC07 - TeSys U Profibus (Telemecanique)	
Date and Time	Message
4/25/2012 11:53:53.2422113	Station (89) Slave State Need New Prm
4/25/2012 11:53:53.2422113	Station (89) Slave State Need New Prm
4/25/2012 11:54:44.7184848	Station (89) Slave reports diagnosis
4/25/2012 11:54:44.7184848	Station (89) Slave reports diagnosis
4/25/2012 11:54:44.7289494	Station (89) Data Exchange
4/25/2012 11:54:44.7289494	Station (89) Data Exchange
4/25/2012 11:54:46.8469410	Station (89) Slave reports diagnosis(Data Exchange)
4/25/2012 11:54:46.8469410	Station (89) Slave reports diagnosis(Data Exchange)

Step 8: Protocol Window

Diagnose Messages in Plain Text:

If a device reports problems you can read the respective diagnose telegrams in plain text.

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“**

Step 8: Protocol Window

If you prefer the matrix overview, you may use this as well:

- Click on segment
- Select „Station Statistics“
- You can display all events or select „retries“, „diagnose“, „set parameters“ for each station

Total	0	1	2	3	4	5	6	7	8	9
0	M	1	2	3	4	5	6	7	8	9
10	10	11	12	13	14	15	16	17	18	19
20	20	21	22	23	24	25	26	27	28	29
30	30	31	32	33	34	35	36	37	38	39
40	40	41	42	43	44	45	46	47	48	49
50	50	51	52	53	54	55	56	57	58	59
60	60	61	62	63	64	65	66	67	68	69
70	70	71	72	73	74	75	76	77	78	79
80	80	81	82	83	84	85	86	87	88	8
90	90	91	92	93	94	95	96	97	98	99
100	100	101	7	103	104	31	106	107	108	109
110	110	111	112	113	114	115	116	117	7	119
120	120	121	122	123	124	6	126			

Step 9: Frame Window

Detailed Information for Professionals:

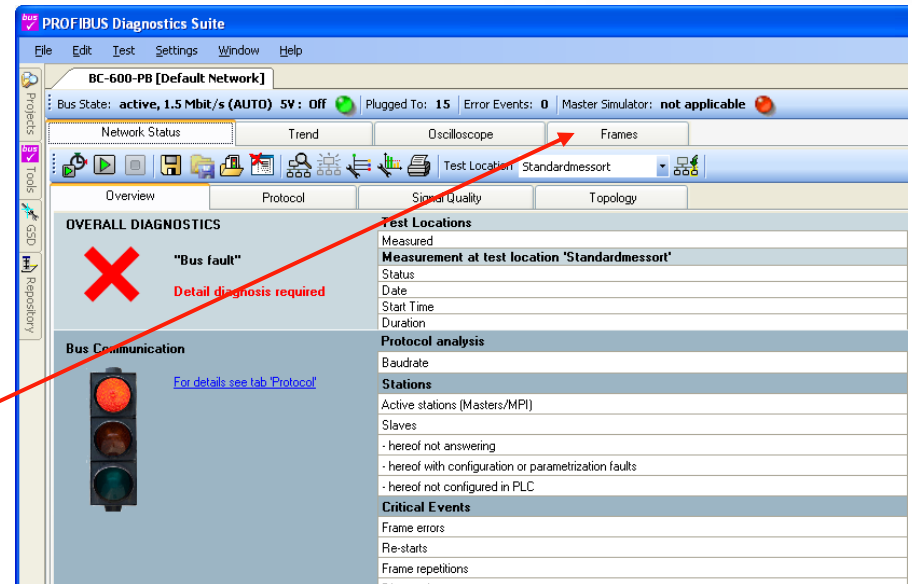
The Frames display allows you to record and analyze the entire communication down to a single bit:

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

click on „Frames“ tab to open the frame window

click on „Start Test“ button to start recording

click on „Stop Test“ button to stop recording



No.	Time Stamp	Address	Protocol	Primitive
5	00:00:00.131897	2 -> 13	DP	Request
6	00:00:00.132000	2 <- 13	DP	Response
7	00:00:00.132122	2 -> 15	DP	Request
8	00:00:00.132270	2 <- 15	DP	Response
9	00:00:00.132524	2.62 -> 10.60	DP	Request

Step 9: Frame Window



You may define individual color coding for each type of frame

click on a single frame to get the decoded contents

The screenshot shows the PROFIBUS Diagnostics Suite interface. At the top, the title bar reads "PROFIBUS Diagnostics Suite". Below it, the menu bar includes "File", "Edit", "Test", "Settings", "Window", and "Help". The main window displays the "BC-600-PB [Default Network]" status, with "Bus State: active, 1.5 Mbit/s (AUTO)", "SV: Off", "Plugged To: 15", "Error Events: 0", and "Master Simulator: not applicable".

The main area is divided into tabs: "Network Status", "Trend", "Oscilloscope", and "Frames". The "Frames" tab is active, showing a table of network frames. The table has columns for "No.", "Time Stamp", "Address", "Protocol", "Primitive", "Service", and "Data". The frames are color-coded: blue for "DATA EXCHANGE", red for "DIAGNOSIS", and white for "FDL STATUS" and "TOKEN".

No.	Time Stamp	Address	Protocol	Primitive	Service	Data
5	00:00:00.131897	2 -> 13	DP	Request	DATA EXCHANGE	00 00 00 00
6	00:00:00.132000	2 <- 13	DP	Response	DATA EXCHANGE	00 03 00 03
7	00:00:00.132122	2 -> 15	DP	Request	DATA EXCHANGE	00 00 00 00 01
8	00:00:00.132270	2 <- 15	DP	Response	DATA EXCHANGE	00 00 00 00 01
9	00:00:00.132524	2.62 -> 10.60	DP	Request	DIAGNOSIS	
10	00:00:00.132816	2 -> 3	FDL	Request	FDL STATUS	
11	00:00:00.133068	2 -> 16	FDL	Request	TOKEN	
12	00:00:00.133118	16 -> 40	FDL	Request	FDL STATUS	
13	00:00:00.133392	16 -> 2	FDL	Request	TOKEN	
14	00:00:00.133441	2 -> 11	DP	Request	DATA EXCHANGE	03
15	00:00:00.133522	2 <- 11	FDL	Response	SC	
16	00:00:00.133556	2 -> 12	DP	Request	DATA EXCHANGE	55
17	00:00:00.133641	2 <- 12	DP	Response	DATA EXCHANGE	55
18	00:00:00.133740	2 -> 13	DP	Request	DATA EXCHANGE	00 00 00 00
19	00:00:00.133843	2 <- 13	DP	Response	DATA EXCHANGE	00 03 00 03
20	00:00:00.133965	2 -> 15	DP	Request	DATA EXCHANGE	00 00 00 00 01
21	00:00:00.134113	2 <- 15	DP	Response	DATA EXCHANGE	00 00 00 00 01
22	00:00:00.134367	2.62 -> 10.60	DP	Request	DIAGNOSIS	
23	00:00:00.134658	2 -> 4	FDL	Request	FDL STATUS	
24	00:00:00.134910	2 -> 16	FDL	Request	TOKEN	
25	00:00:00.134960	16 -> 41	FDL	Request	FDL STATUS	
26	00:00:00.135234	16 -> 2	FDL	Request	TOKEN	
27	00:00:00.135283	2 -> 11	DP	Request	DATA EXCHANGE	03
28	00:00:00.135364	2 <- 11	FDL	Response	SC	
29	00:00:00.135398	2 -> 12	DP	Request	DATA EXCHANGE	55
30	00:00:00.135482	2 <- 12	DP	Response	DATA EXCHANGE	55
31	00:00:00.135582	2 -> 13	DP	Request	DATA EXCHANGE	00 00 00 00

Below the table, a detailed view of a selected frame is shown. The frame is identified as "PROFIBUS Frame" with "Time: 00:00:00.134113". The details include:

- Frame Type: SD2
- Source Address: 15
- Destination Address: 2
- FDL Service: Service: DL, Primitive: Response, Type: Slave
- DP Service: Data Exchange - Input Data: 00 00 00 00 00 00 00 00 00 00 00 00 00 41 B3 87 80 80 41 B3 C7 40 80

Project Window

The „Project Window“ offers an easy filing of your records

You will find *further record files* for demonstration in the „Project View“

- Place the cursor on „projects“ tag:
=>The project view opens
- you may lock the window to avoid automatic closing
- open „Projects“-file to view saved records

Please note:

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

The screenshot shows the PROFIBUS Diagnostics Suite interface. The left pane displays a tree view of projects and network components. The right pane shows diagnostic data for a test location named 'Busende-15'.

Projects

- Default Network
 - Event Logs
 - Frame recordings
 - Reports
 - Scopes
 - Network status
 - Trends
- Projects
 - Ar Anlage1_Ort1(Beispiel)
 - SPS1_Busstrang1_Segment1
 - Event Logs
 - Frame recordings
 - Beispiel_100126-194002.rpb
 - Busanlauf.rpb
 - Diagnose-Repeater.rpb
 - DP_PA-Link.rpb
 - Profibus PA.rpa
 - Reports
 - Scopes
 - Network status
 - Trends
- Plant1_Location1(example)
 - PLC1_Bus1_Segment1
 - Event Logs
 - Frame recordings
 - Reports
 - Scopes
 - Network status
 - Trends

Measurement at test location 'Busende-15'

Status	Test finished!
Date	4/26/2010
Start Time	3:35:12 PM
Duration	00:00:10

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

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

Topology	1/26/2010 7:21:28 PM
----------	----------------------

Automatically generated Test Report



click on:
Test / Create Report

click on „Cover Page“ to type in your company data

click on „continue“ to create the report

The screenshot shows the PROFIBUS Diagnostics Suite interface. The main window displays test results for 'Busende-15'. The 'OVERALL DIAGNOSTICS' section shows a warning icon and the text 'With restrictions' and 'Detail diagnosis 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 'Report Settings' dialog box is open, showing the 'Cover Page' tab. The 'Cover Page' tab has the following settings:

- Address field with customer data (Customer Details ...)
- Contact details of tester (Tester Details ...)
- Approval**
 - Evaluation/remarks (Enter your remarks...)
 - Conclusions
 - Signatures

At the bottom of the dialog box, there are 'Continue' and 'Close' buttons. Red arrows point from the text boxes on the left to the 'Test / Create Report' menu item, the 'Cover Page' tab, and the 'Continue' button.

Automatically generated Test Report



Toggle between protocol and signal quality report by selecting pages

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

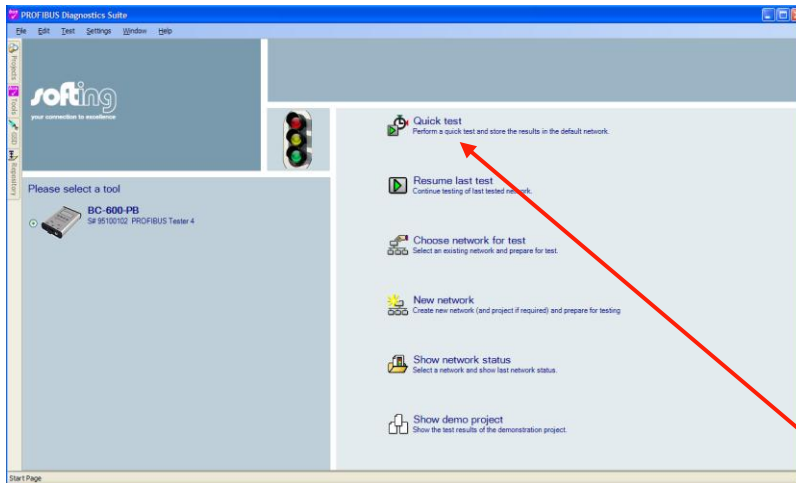
The screenshot displays a software interface for generating test reports. The main window is titled "1-Netzstatus_NetworkStatus.npb". The interface is divided into several sections:

- Header:** Includes the "bus check" logo and the text "Test Report".
- Company Information:** PROFITEST Inc., 1 Fieldbus Plaza, 12000 Profibus City.
- Tester Information:** Softing AG, Bernie Buscheck, Richard-Reitzner-Allee 6, 85540 Haar.
- Test Details:** The test was performed by Tom Tester. Address: PROFITEST Inc., 1 Fieldbus Plaza, 12000 Profibus City. Telephone, E-mail, Creation Date (7/21/2010), Tool, Device Type, and Serial Number are listed.
- Protocol Report:** A table showing a live list and status of stations, including retries and diagnostic information.
- Signal Quality Report:** A section containing bar graphs showing min, max, and avg values per station, and oscilloscope charts.

Red arrows point from the callout boxes to the corresponding sections in the screenshot. A blue line connects the callout boxes to the bottom of the screenshot.

7. Topology Scan

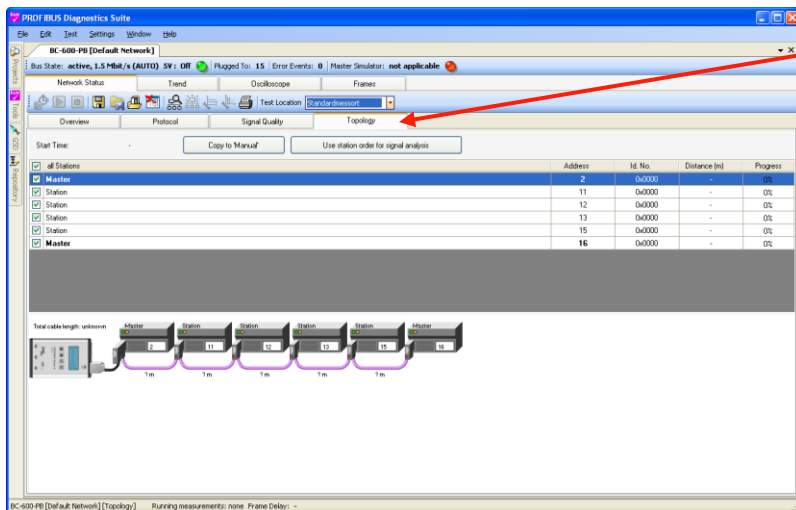
Step 1: Start with a Quick-Test of your network to scan all devices



For best-results, the network should be “healthy” before starting the topology scan. Please verify the health of your network by using the this suite as shown on the previous slides.

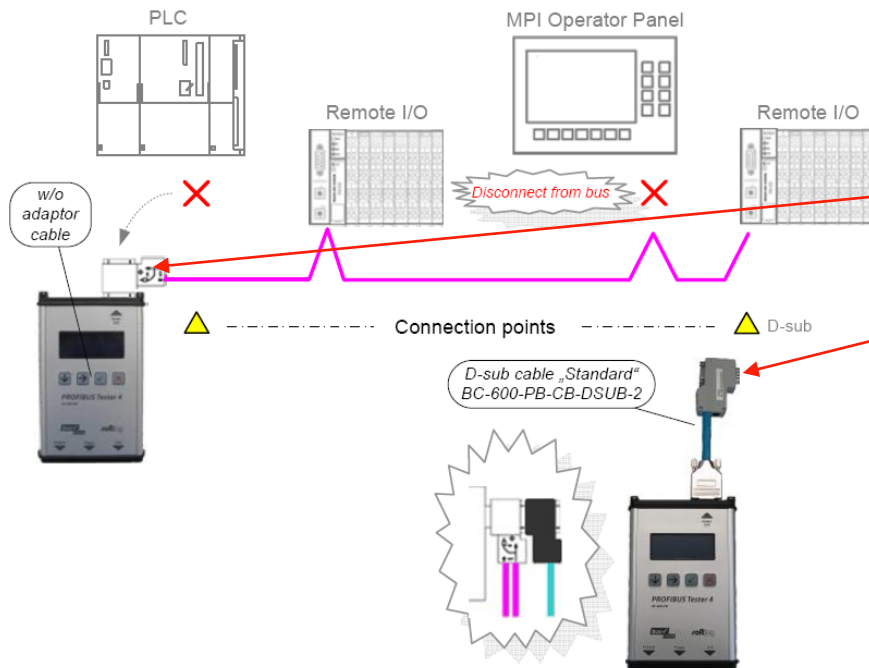
As a first step you need to scan for all slave devices in your network (if not already done).

- ▶ Connect your PB-T4 to a running network
- ▶ Start Quick Test with a click
- ▶ After completing the Quick Test open the window for topology scan



⇒ PB-T4 shows all detected devices in the numerical sequence of the PROFIBUS addresses (most of the time the physical sequence is different)

Step 2: Disconnect masters and connect PROFIBUS Tester 4 instead



A true and correct Topology Scan can only be done with no active PROFIBUS master attached to the network.

Therefore you need to disconnect any masters in your network and then connect PB-T4 as shown.

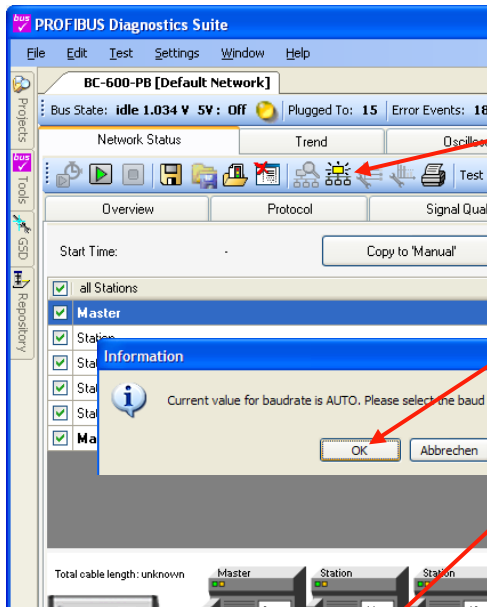
Please only use **BC-600-PB-CB-DSUB-2** cable that is included in the standard scope of supply.

Disconnect every single active device (PLC, MPI and, if necessary, diagnostic repeaters) from the power supply or the bus.

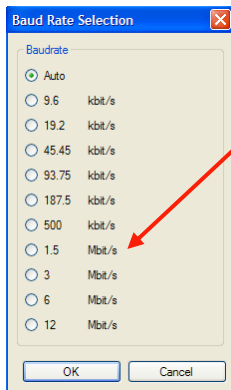
Connect the PROFIBUS Tester 4 to one end of your network. Typically, you would remove the connector for your PLC and plug it directly into the Tester 4.

The PROFIBUS Tester 4 will provide the necessary power for the bus termination.

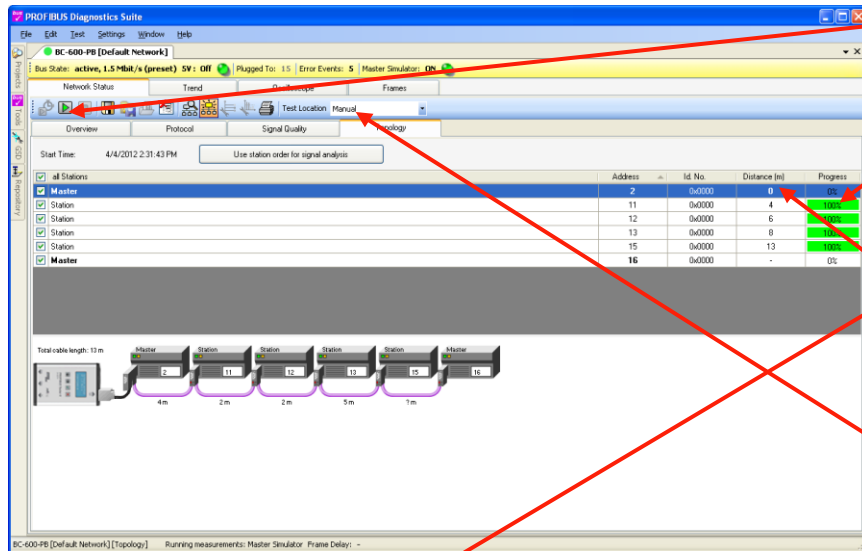
Step 3: Activate Master Simulator in PB-DIAG-Suite on your PC



- ▶ Click on this button to activate the „Master Simulator“
- ▶ Accept manual setting of baudrate
- ▶ Select the correct baudrate of your system



Step 4: Perform the topology scan



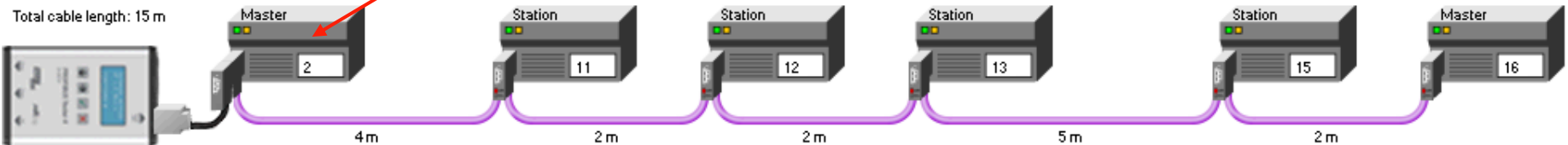
Start topology scan by a click on the „Start-Test“ button

Wait until progress of scan has reached 100% for all stations

since the master is disconnected it cannot be located.

Double click on master's „Distance (m) and type in „0“ to locate the master correctly.

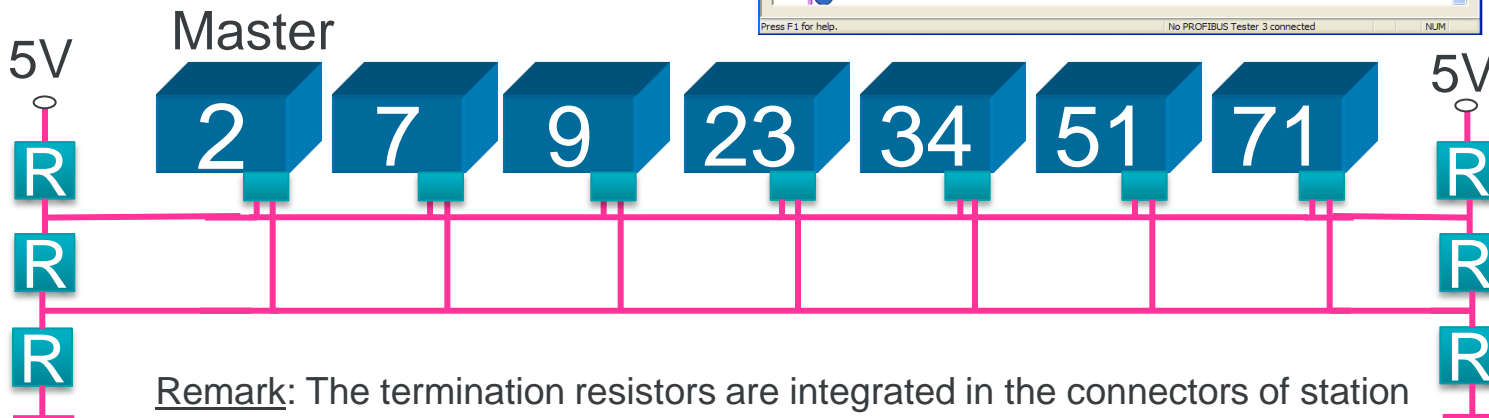
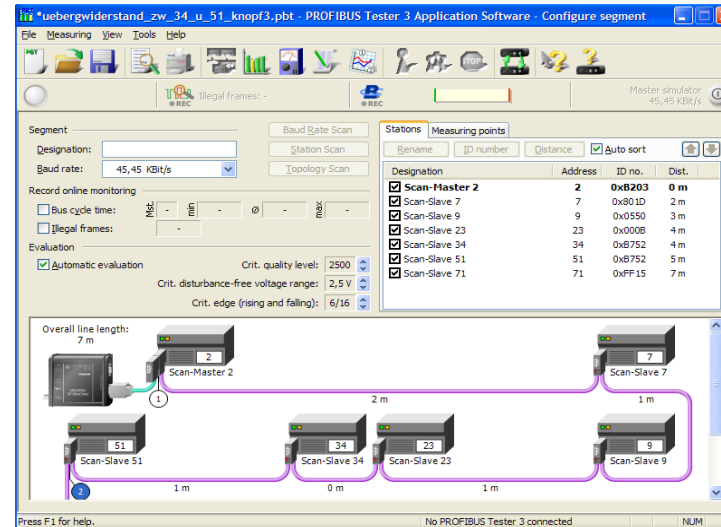
Please note: Editing distance-values is only possible when test location „manual“ is selected.



8. 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.

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:

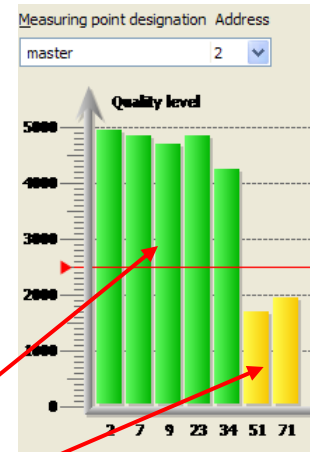
Test results on the left end:

- 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)

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.



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 reversal of Q-level between left and right side
- Instead, the Q-level for all stations generally declines from one station to the other.

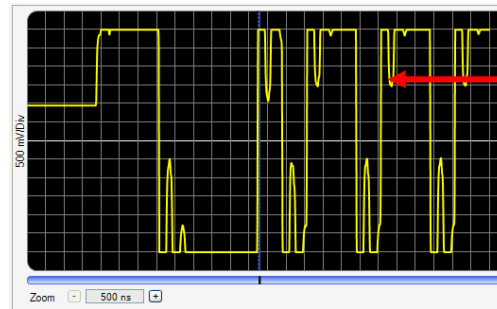


Case 2: Q-level becomes worse from one measuring point to the next

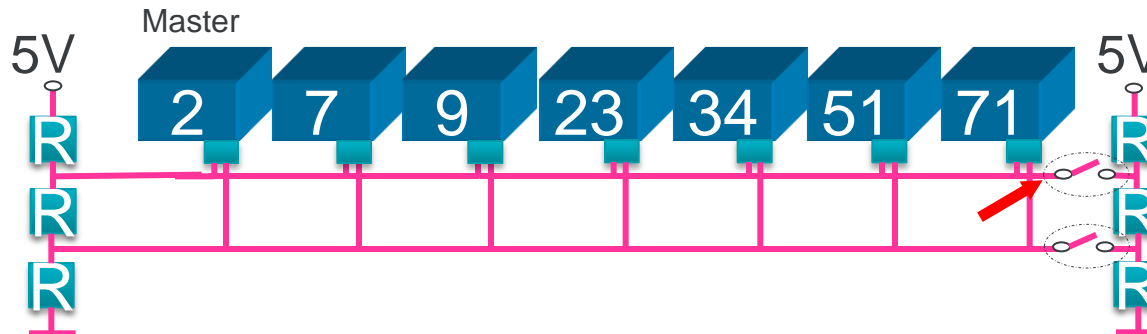
Interpretation:

- 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.



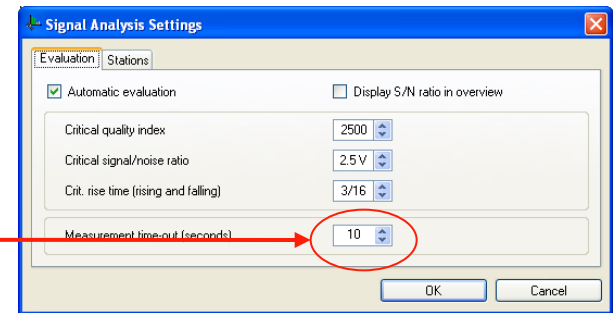
You can see the reflections in the oscilloscope display of master 2 while connected at test point Slave 71.



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

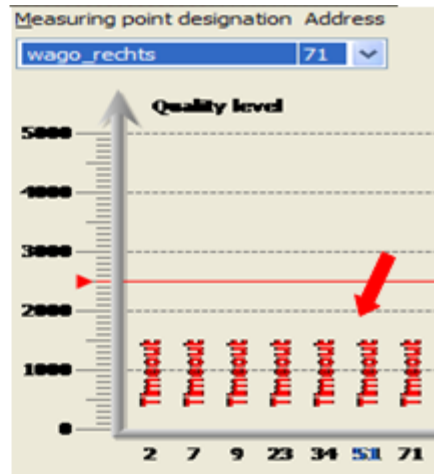
Case 3:

- 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



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

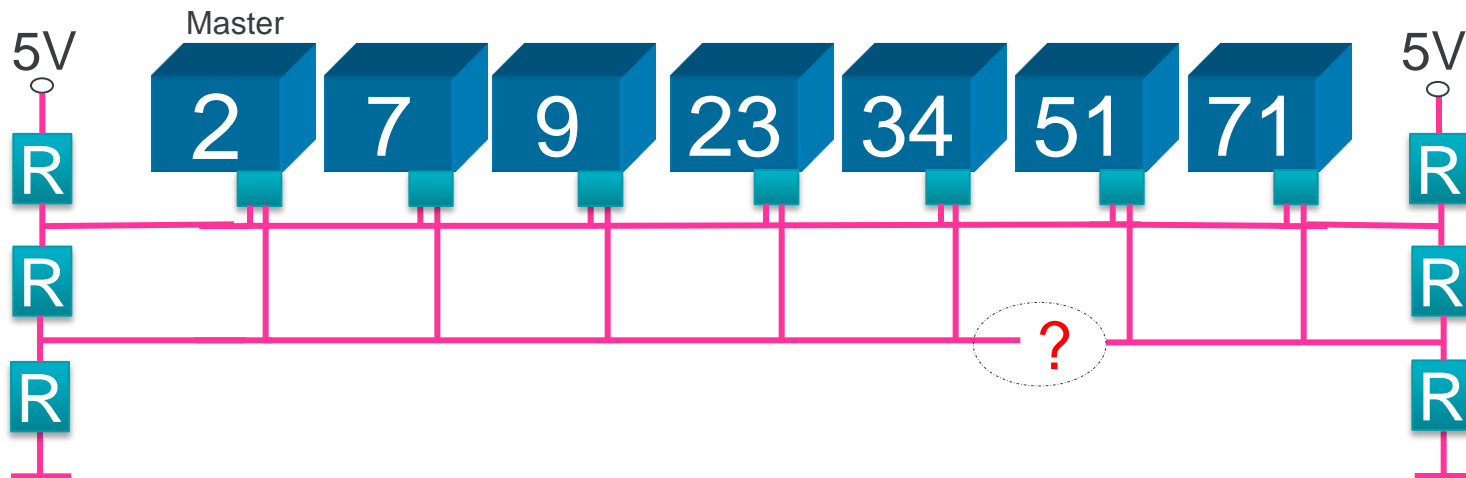
► **Interpretation:**

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.



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)

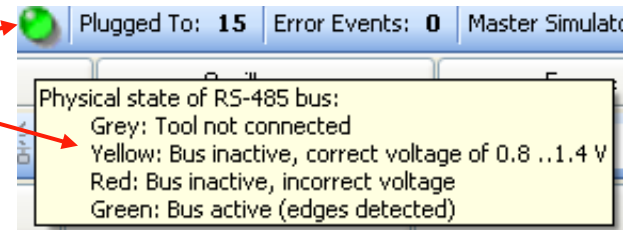


Case 5: Bus-termination is not powered correctly

Indication of idle voltage:

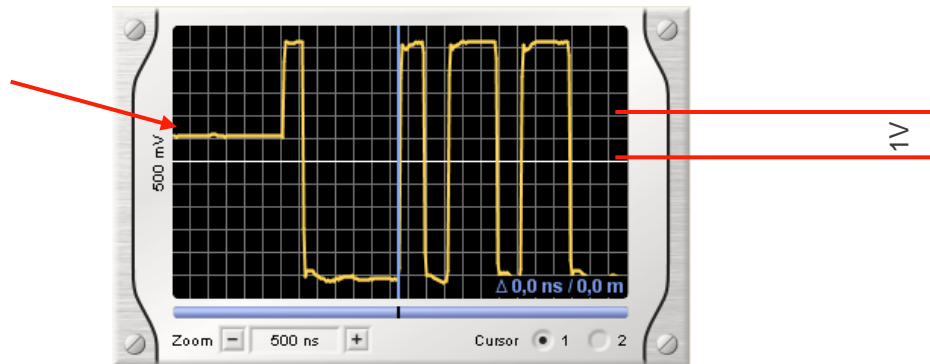
The correct idle voltage is supposed to be between 0.8 and 1.4 V.

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

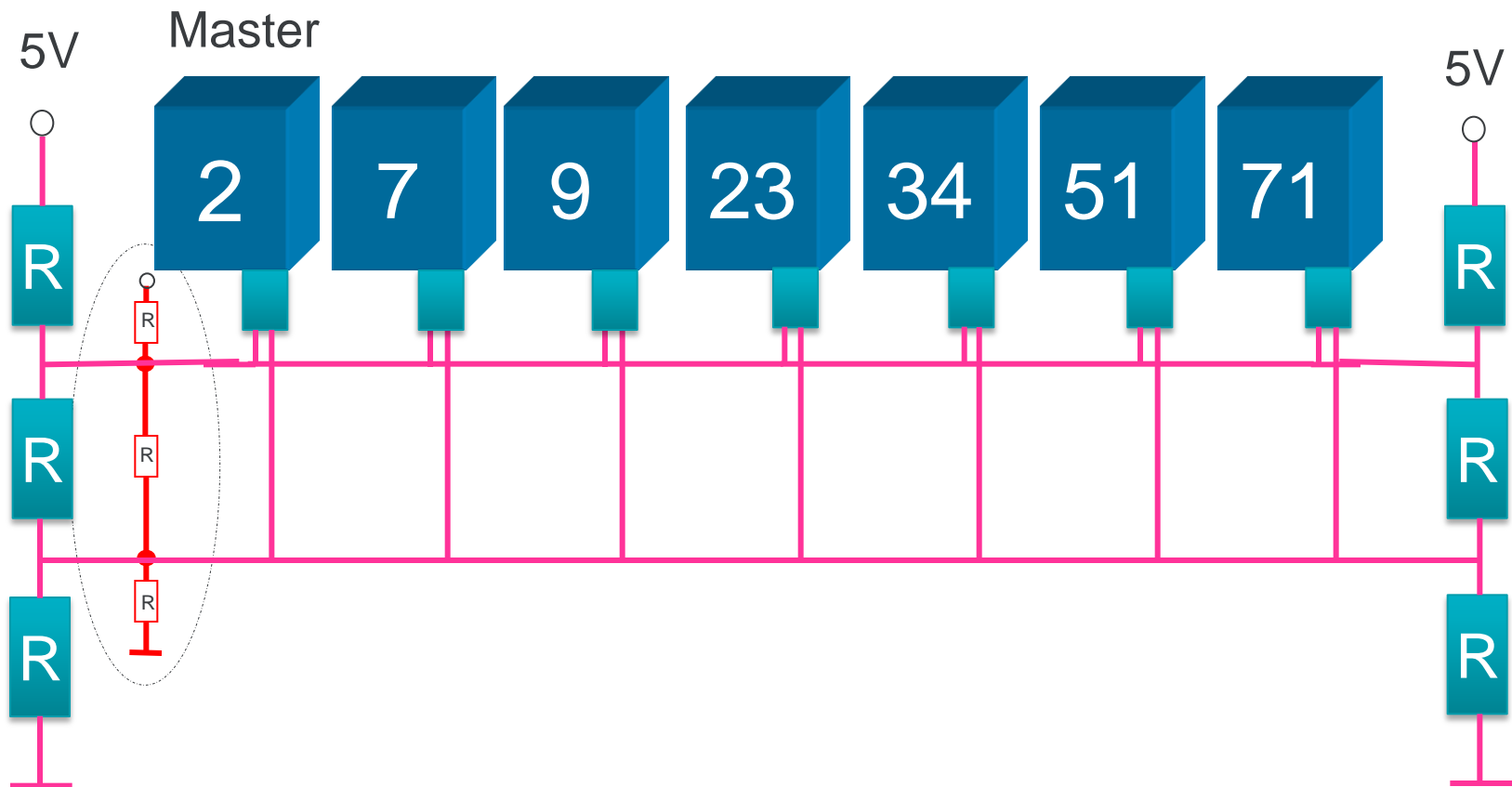


- An idle voltage of approx. 0.6 Volts indicates that only one bus-termination is powered correctly
⇒ communication may work, sporadic failures likely
- An idle voltage close to 0 Volts (both terminations not correctly powered or one termination missing/one not correctly powered ⇒ PROFIBUS will not start

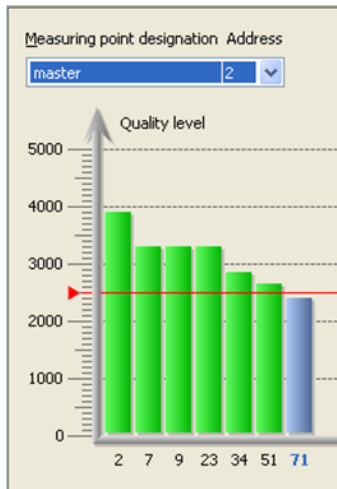
In addition, you can detect a low idle-voltage in the oscilloscope (in this case approx. 0.5 V)



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



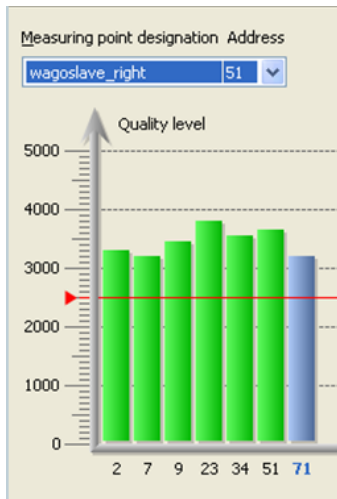
Case 6: Too many bus-terminations or additional electrical resistance



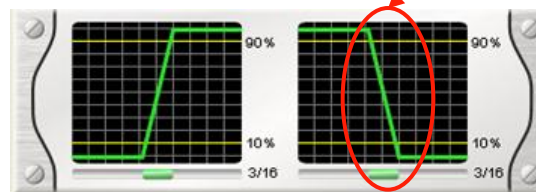
Note: The test results get worse the closer the PBT-4 is connected to the location of the problem (Master #2).

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

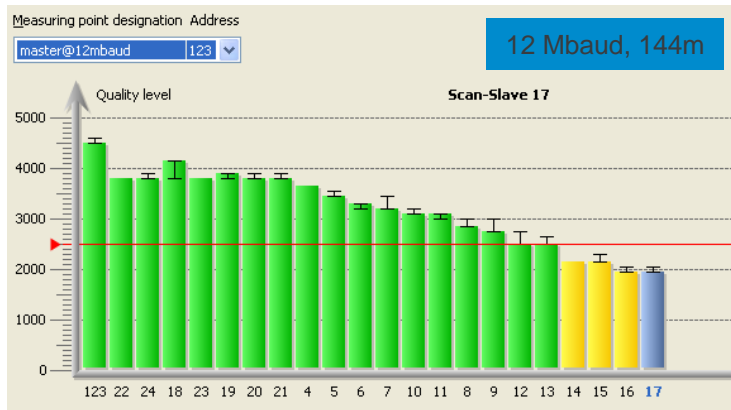
Unfortunately, the test results do not change as strikingly when dealing with too many bus-terminations as they do with missing bus-terminations. Additional resistance usually affects all stations.



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



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



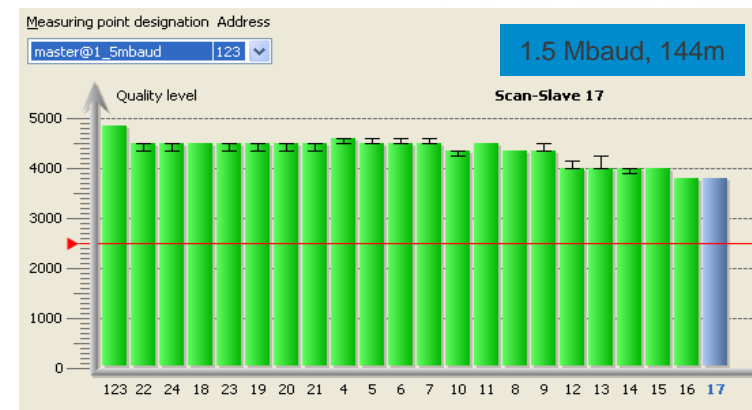
Note 1:

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.

9. Best-Practice for a stable PROFIBUS network

► PROFIBUS RS-485

Layout: terminated line, branch (or stub) lines < 0.3 m (1 foot) !!

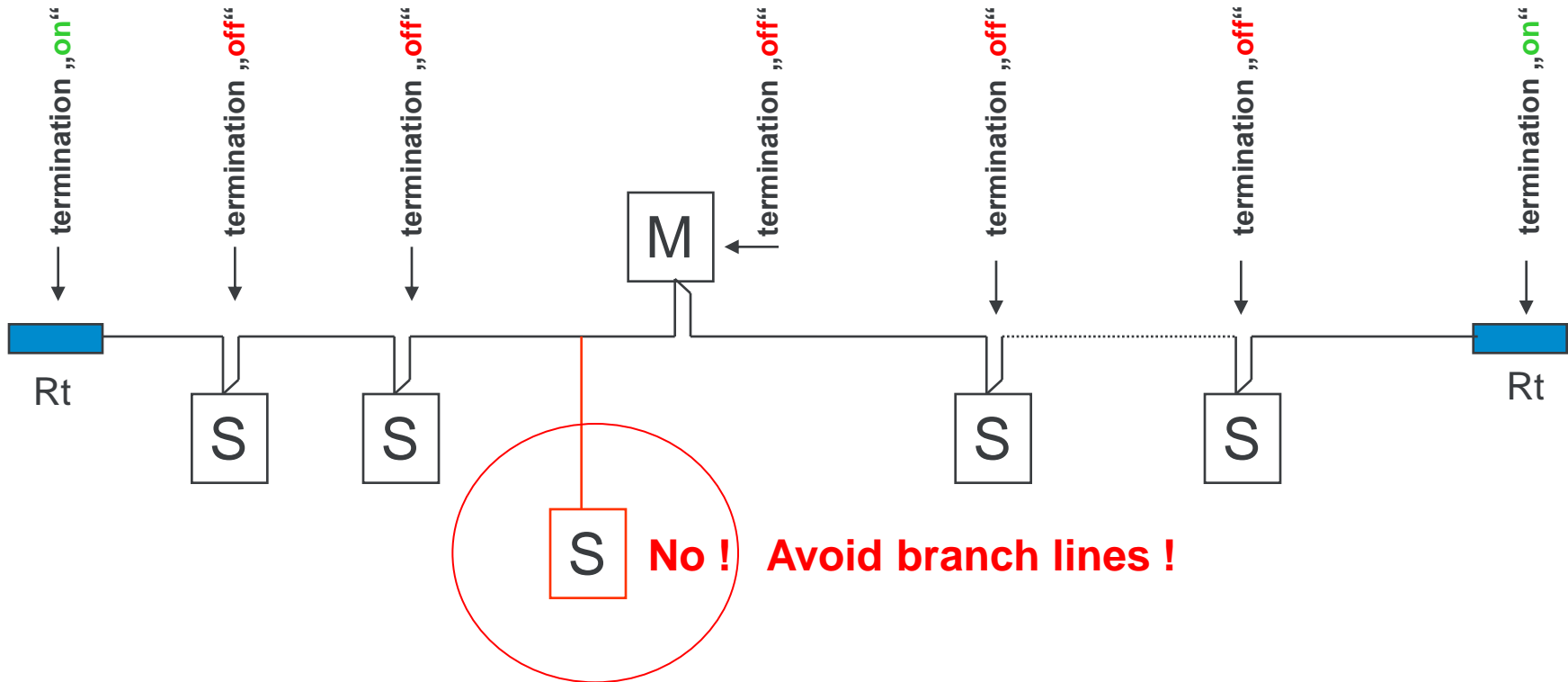
Cable type: shielded twisted pair cable acc. to PROFIBUS specification

Number of stations: max. 32 w/o repeater, 127 using repeaters

Max. cable length (applies to cable type A only):

Baud Rate		Max. Cable Length
9.6, 19.2, 31.25, and 45.45Kbit/s		1200 m (3940 ft)
93.75 and 187.5	Kbit/s	1000 m (3280 ft)
500	Kbit/s	400 m (1310 ft)
1500	Kbit/s	200 m (656 ft)
3000, 6000, and 12000	Kbit/s	100 m (328 ft)

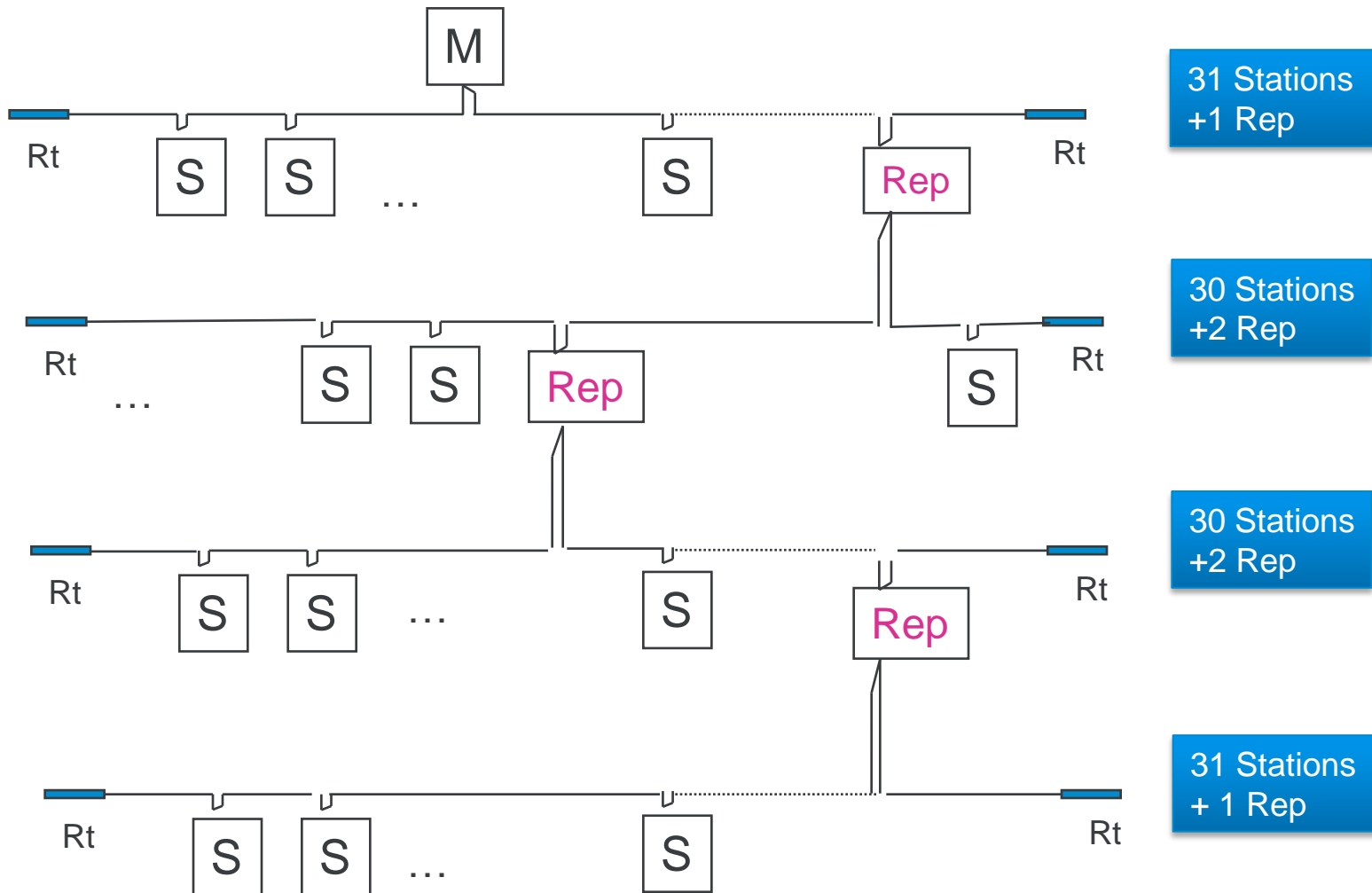
Correct line topology, setting of bus termination



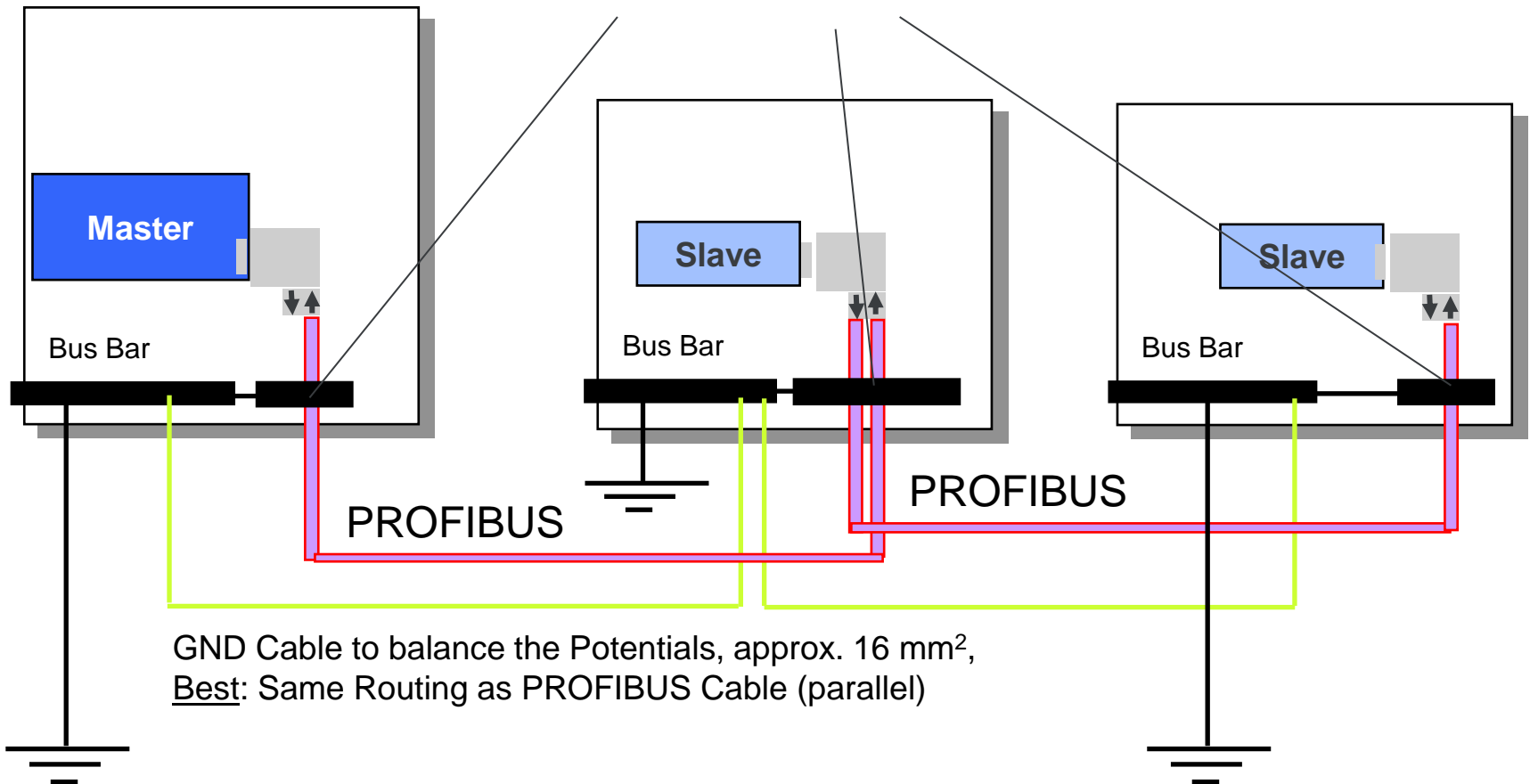
Copper cable 0.22 mm², twisted pair, shielded, AWG 24*

Max. 32 stations (Masters and Slaves) in one segment without repeater

Correct line topology with repeaters



Planar Connection of the PROFIBUS Cable Shielding to the Ground Potential, e.g. through special Clamps



GND Cable to balance the Potentials, approx. 16 mm²,
Best: Same Routing as PROFIBUS Cable (parallel)

Thank you for your attention!

industrial.softing.com