VERWER TRAINING AND CONSULTANCY LTD
Supporting the PROFIBUS Group UK & PROFIBUS International

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Tutorial – What can I do with ProfiTrace 2?

Introduction

An analyser is an essential tool for fault-finding, monitoring and health-checking networks. It allows you to see the actual telegrams transmitted from device to device. Analysers for PROFIBUS are available from several manufacturers. However they vary enormously in capability, ease of use and price.

A basic PROFIBUS analyser should have the following features:

- Message capture and display with the ability to "trigger" on particular telegrams or conditions. This allows us to catch telegrams that occur only occasionally (once every few seconds is very occasionally on a high-speed network!). This is the "needle in a haystack" problem.
- Message filtering to allow display of only wanted telegrams. This allows us to hide the telegrams that we might not be interested in. This is the "let the dog see the rabbit" problem.
- A "Live list" overview showing all devices that are taking part in communications. A quick look at the devices that are on the network and their state.
- In order to diagnose cabling problems (i.e. caused wiring, connectors or faulty device bus interface etc), we need to be able to see the actual waveform on the bus. Some analysers have built-in waveform visualisation, but many do not! Further, being able to trigger the waveform display to see the signal from a particular device is essential.
- To make the analyser useful in a real situation in a factory or plant, it is essential that the analyser is portable and can run without a mains supply (i.e. from your laptop battery!). We used to use an analyser and separate oscilloscope, needing a separate bus connection and separate mains supply and a rats nest of cables. We could have done with a supermarket trolley to wheel the kit around the plant!
- Finally, in order to be able to connect the analyser to a working network without crashing the bus it should provide a minimum load on the cable and, very importantly, not require a "stub" or "spur" line to be used. A stub line is simply a cable that connects the analyser to the network! Why? Well, stub lines can cause reflections in the cable and thus can corrupt the high-speed messages that are travelling from device to device along the cable.

You will see that ProfiTrace 2 is much more than a basic PROFIBUS analyser and contains many useful features that are not provided on other analysers:

- High-speed, full-featured PROFIBUS Analyzer with minimum bus loading.
- Full decoding of the telegrams (including DP, PA and DPV1)
- Network statistics, for health checking;
- Built-in triggered oscilloscope for waveform visualisation;
- Bar graph, overview of device signal strength;
- Direct connect to PROFIBUS DP or non-Ex PA segments;
- Topology Scan, layout of devices on the cable;
- Automated report generation for reference and documentation.

Now we will explore some examples of network problems that can be diagnosed and located with ProfiTrace Ultra.

Communication faults

When we use ProfiTrace 2 to a working network, we do not need a spur line, this is because the hardware for ProfiTrace 2 (called ProfiCore) is a self-contained box of electronics that communicates with ProfiTrace 2 (running on your laptop) via a high-speed USB cable. Further the box, which fits in your pocket, takes its power from the laptop battery via the USB cable.

Normally we use a small "tap connector", which is actually a 100mm stub line to connect ProfiCore to the network. This may sound strange, but actually is very useful as we can see the very small reflection caused by the tap connector and with this make cable length measurements (see example below).

OK, we can now run ProfiTrace 2 software on our laptop, but what should we look at? The staring point is usually to examine the "Live list", which is an overview of the network showing the devices connected and their state:
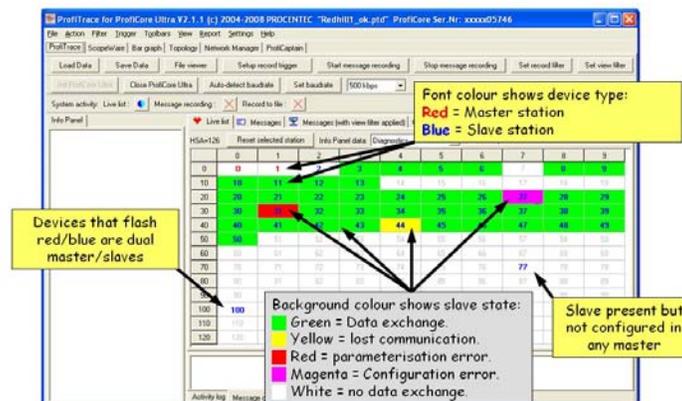
The vivid colours in ProfiTrace 2 immediately give us a picture of the network state. They are simply a colour code for the standardised diagnostics that are reported by every PROFIBUS slave. We can quickly diagnose some simple problems as follows:

- Slaves and masters can be differentiated on the live list by the font colour. Don't think that devices that flash between red and blue font are faulty; it just means that they are dual master/slave devices. Some PLCs and HMI devices behave that way.
- Slave devices shown with a red background on the live list indicate a "parameterisation error". This is often caused by the wrong device (GSD file) being configured in the controlling master. ProfiTrace 2 makes the diagnosis even simpler because the live list shows us the actual device identification (ID number) and model name together with the configured ID number and model name. Easy!
- Slaves with a magenta or purple background indicate a "configuration error". Configuration errors are caused by the wrong modules being configured in the device, or perhaps by the wrong modules being plugged in on the physical device. ProfiTrace 2 can even show us the actual modules that are configured in the master and so allow us to quickly spot the problem. Further if you have a licence for the integrated ProfiCaptain package – a class1/class2 master, you can even remotely read the modules that are plugged in to the physical device. Even easier!
- Slaves that are not present on the bus, even though we know they are configured, show a total blank in the live list. This can be caused by a faulty device, the device having no power, or perhaps the wrong address being set in the device. Perhaps it has just not been installed yet? Unfortunately, to find out which of these, you have to get up and walk to the device and look, sorry!
- Slaves that just show a blue font, but have a white background are actually present on the bus, but they are not in data exchange. Why? Well it could be that they have not been configured in the controlling master, or it could be that the device has an incorrect address, and this is it! Easier than we initially thought!

Some problems are more difficult, like duplicate addressing, intermittent wiring problems and faulty devices. But with a little training, you can quickly learn to recognise, diagnose and locate such problems. Our one-day Commissioning and Maintenance course covers these techniques and gives you practice at finding such faults on a real system. If you want to go further, the flagship Certified PROFIBUS Engineer course covers these and many other faults in detail and the practical test ensures you can do it in a real network.

Peripheral errors

PROFIBUS devices not only have diagnostics to tell us about communications faults, but also many devices also have "extended diagnostics" to tell us the details of peripheral errors.
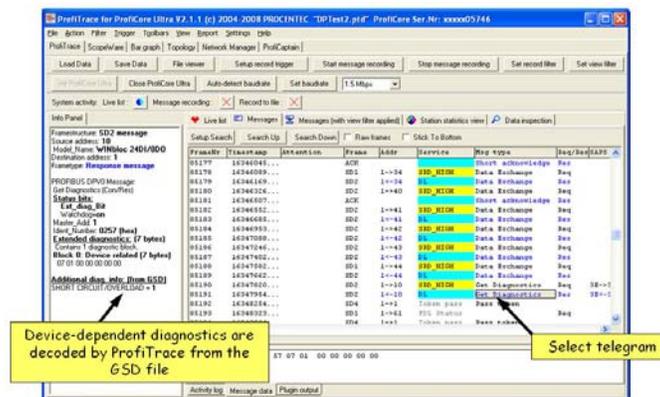
What is a peripheral error? It is an error to do with the sensor, actuator or IO wiring.
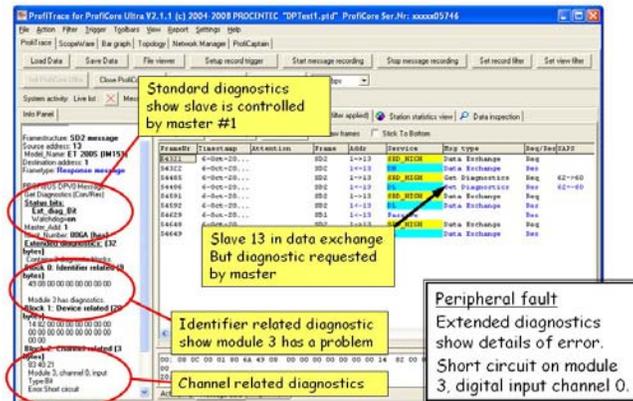

Communication faults   Peripheral faults
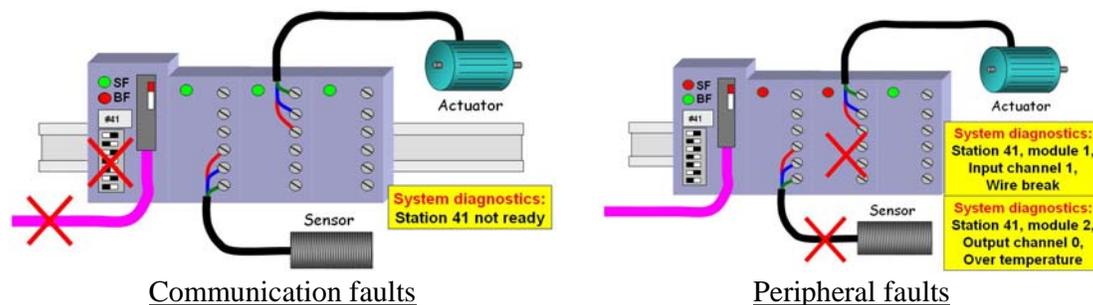
ProfiTrace 2 indicates extended diagnostics in the live list with a small flashing red indicator:
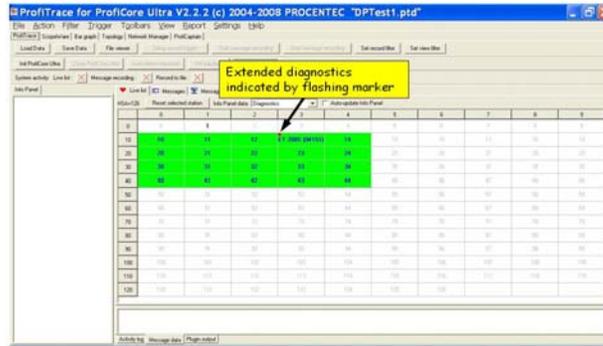
We can also capture the diagnostic telegram from the device using the extensive triggering capability of ProfiTrace 2:

ProfiTrace 2 interprets device-related diagnostics

Also module and channel diagnostics

The Certified PROFIBUS Engineer course examines all the types of diagnostics that we find on DP and PA devices and gives you practice at finding such faults on real systems.
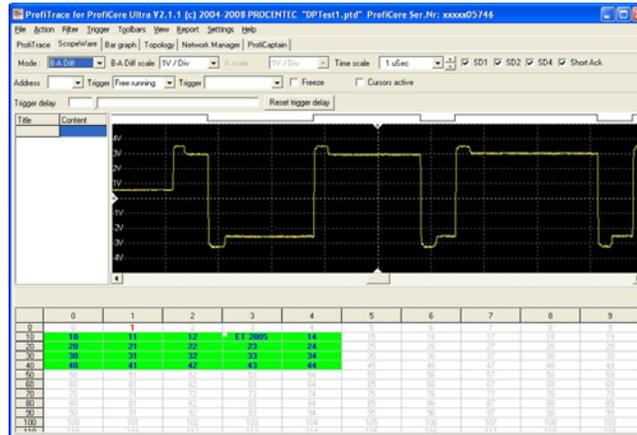
Reflections

Reflections are the number-one problem on high-speed networks such as PROFIBUS. Reflections can be caused by any electrical discontinuity along the PROFIBUS cable, such as stub line or the end of the cable. PROFIBUS uses termination networks to stop the reflection

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at the end of the line, but many things can go wrong! We teach what can go wrong on our one-day the Certified PROFIBUS Installer course.

Can ProfiTrace 2 help us find this type of fault? – you bet.

The built-in high-speed oscilloscope can be easily triggered to show the waveform from each device connected to the cable (segment). We can see weak devices, corruption caused by double addressing and yes, reflections.


Reflections can be easily seen on the ProfiTrace oscilloscope (ScopeWare)

Not only can we identify the reflection but using a simple technique, we can quickly measure the distance from any device on the segment to the source of the reflection, so rapidly homing in on the problem.

Without ProfiTrace 2, the location of the reflection is really difficult. Why? Because the devices that are most affected by the reflection are often those that are furthest away. Very confusing!
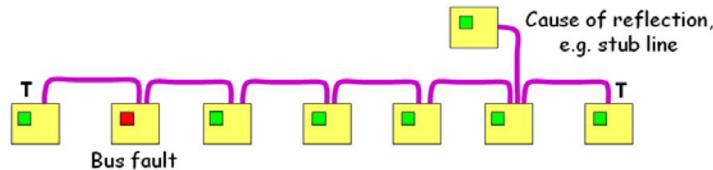
With ProfiTrace 2 and a little training, you can learn to locate such faults along the cable to within +/- 1m.
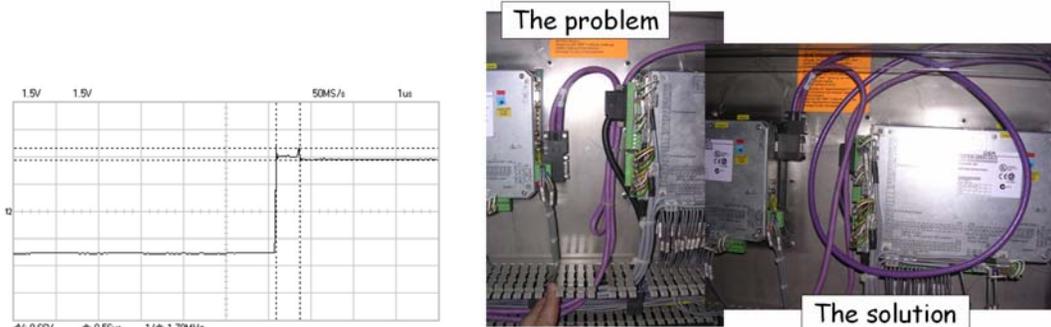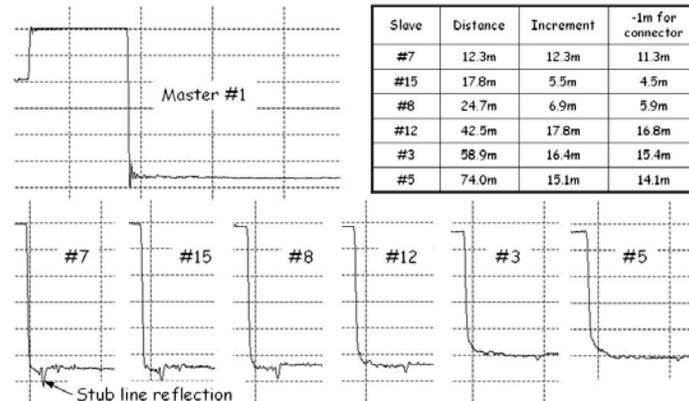

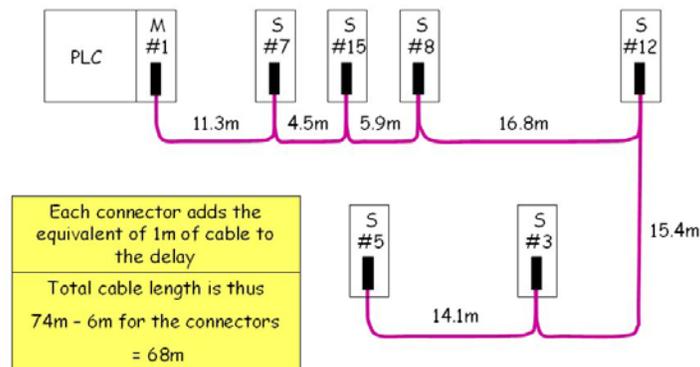Location of bent cable using the oscilloscope trace

Cable length measurement

We saw earlier that we normally connect ProfiTrace to our network via a small tap connector. This is actually a small stub line, which causes a small reflection. However, the reflection is of very small amplitude and will certainly not cause problems when running at less than 12Mbit/s. The reflection from this stub line can be useful for measuring the cable length to each device on the segment. Now, that is a bonus!

The technique is based on spotting the small reflection from the tap connector as we trigger the oscilloscope from each slave on the segment.

Slave	Distance	Increment	-1m for connector
#7	12.3m	12.3m	11.3m
#15	17.8m	5.5m	4.5m
#8	24.7m	6.9m	5.9m
#12	42.5m	17.8m	16.8m
#3	58.9m	16.4m	15.4m
#5	74.0m	15.1m	14.1m

The tap connector reflection can tell us the cable lengths between devices

Final topology of the segment
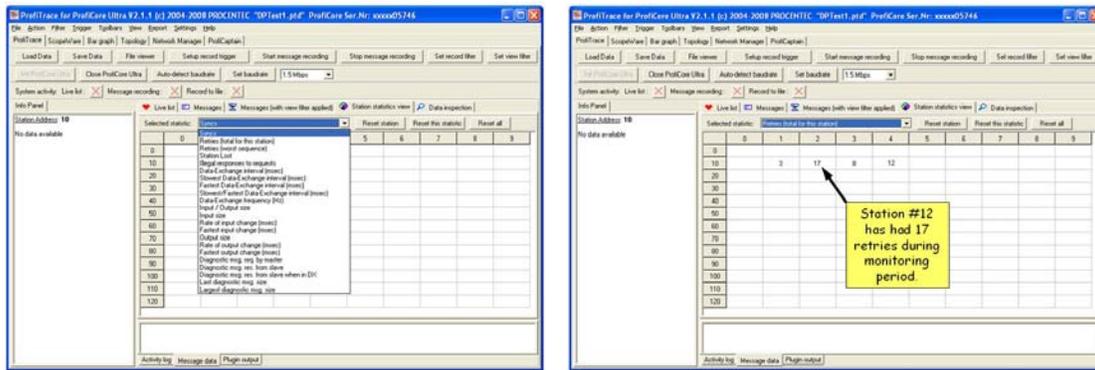
Health Checking

Some Commissioning Engineers think that their job is done when they have no more "red lights". Although the absence of a red Bus Fault (BF) shows that the slave is in data exchange with the master, we really do not know the quality of the communications. It is quite possible (and also quite common) that slaves have problems, even with no Bus Fault light showing. This is because PROFIBUS is very robust and keeps going in the event of occasional errors. The master will just repeat a request should no response be received within the required time. Only when the "retry limit" is exceeded, does the master give up and indicate that a fault has occurred. Even then the master will attempt to re-establish communications with the missing slave on the next bus cycle, and it may be successful, in which case we still do not see a red BF on the slave!

So you can see that we need to check that the communication is reliable and we do not have errors on the bus. ProfiTrace 2 to the rescue!

ProfiTrace 2 has a large number of statistical measures that can show whether there are any faults on the bus and even rare errors will be caught in the net. The most important of the ProfiTrace 2 statistics include:

- Retry count total – total retries for each slave;
- Retry count worst sequence – maximum number of consecutive of retries for each slave;
- Sync count – the number of times the master tries to establish contact with a particular slave;
- Count of the number of illegal or corrupted telegrams for each slave;
- Diagnostic message count – indicates whether there have been any diagnostic requests from the master, possibly indicating peripheral errors.
- Minimum and maximum cycle time – indicates jitter in the cycle time for each slave, possibly indicating a problem.

ProfiTrace 2 statistics work in the background, even when making other measurements. So, you can go back to check the statistics after say 10 minutes of checking other bus characteristics such as waveforms etc. The statistics page tells us whether any faults have been recorder since we initialised or reset ProfiTrace 2.

ProfiTrace 2 statistics

Health checking should also involve looking at the quality of the waveform transmitted by each device on the bus. This can be easily done using the triggered oscilloscope function in ProfiTrace 2. However, we must be aware that the signal we see on the screen is the signal at the point where ProfiCore is connected. Devices on the other side of a repeater will show a waveform on the oscilloscope, but this is actually the signal transmitted by the repeater and not the original signal transmitted by the device.
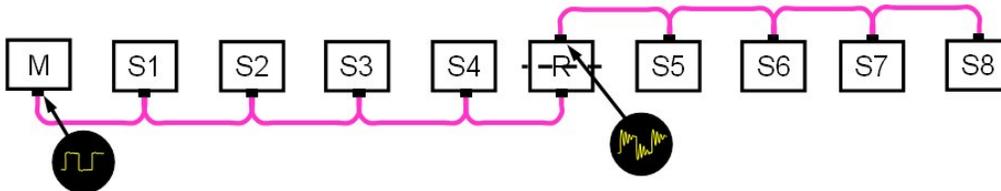
Waveform corruption on the other side of a repeater is hidden from us

It is quite possible that the signal on the other side of a repeater is of poor quality due perhaps to interference or reflections, but the signal we see in the screen is good because the original signal is cleaned up by the repeater.

So, in summary, we should carry out a check of the waveforms on every segment (i.e. up to the repeater or optical link module (OLM). We should check the amplitude and quality of the waveform of every device on the segment. We should also check the repeater/OLM waveforms by triggering on a device which is on its far side. This should be done in addition to the statistics check described above.

Note that our Certified PROFIBUS Installer course teaches the correct way to layout and install PROFIBUS networks to allow easy health checking to be carried out.

PA segments

ProfiCore Ultra has an RS485 interface built in for direct connection to DP segments. So how can you do a health check about PA?

The answer is to use the PA Probe Ultra. This device, which is part of the ProfiTrace pro kit, provides a transparent interface to the Manchester Bus Powered (MBP) signal that is used on PA segments and devices.

The PA Probe Ultra not only allows us to read the telegrams and statistics directly from the PA cable, but also provides clever electronics to allow us to use the built-in ProfiTrace 2 oscilloscope to see the actual PA signal:
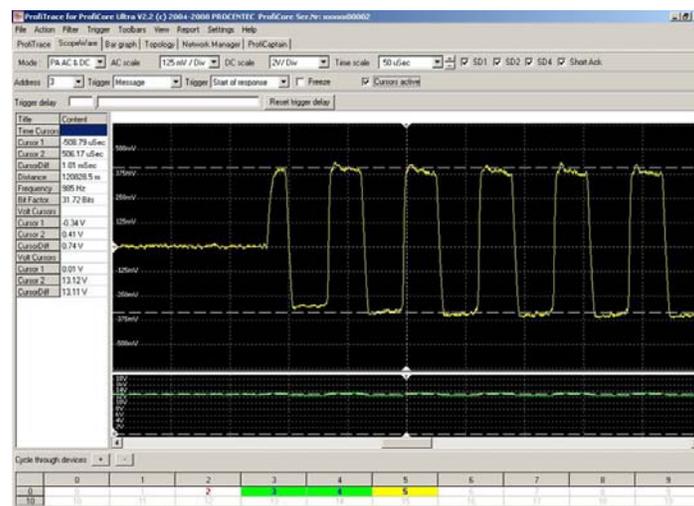
So now you can have a tool that can be used to do a thorough health check on the whole PROFIBUS system, including all DP and PA segments

Our PROFIBUS Commissioning and Maintenance course and our Certified PROFIBUS Engineer course both cover the details and practice of proper health checking on DP and PA systems.