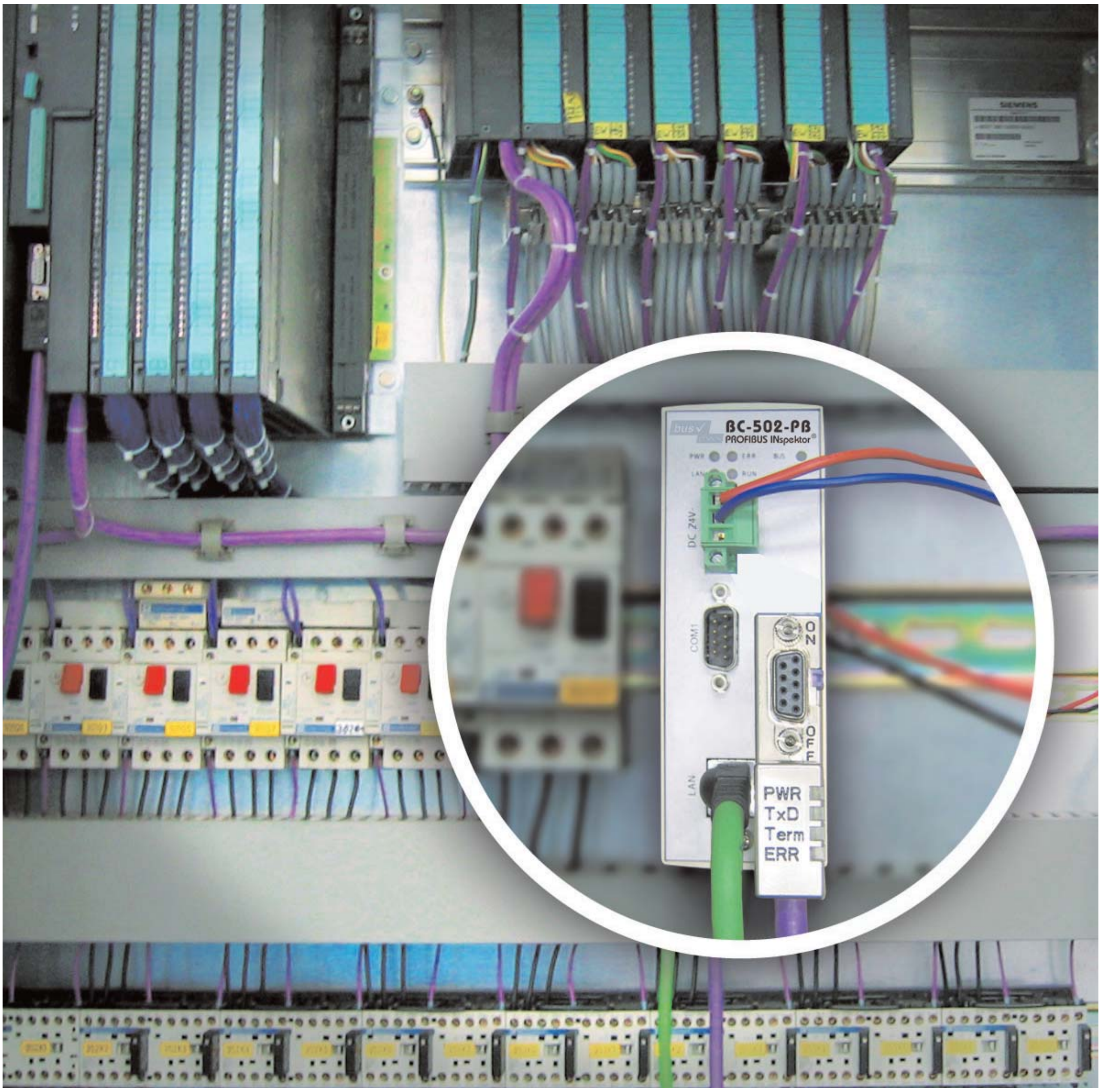
Early-warning system for PROFIBUS



Matthias Ziegel

Early-warning system for PROFIBUS

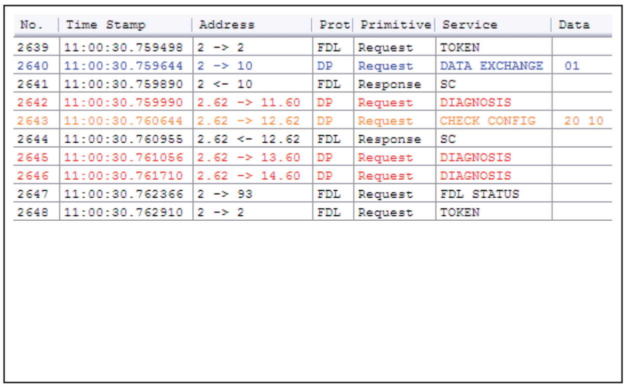
Fieldbus debugging with multimeters and oscilloscopes is a thing of the past. Modern diagnostic tools speak in plain text, enable preventive inspections, and make it possible to implement a condition-based maintenance strategy.

Production plants without fieldbuses are practically inconceivable these days. What's more, PROFIBUS and its like have become part of the very foundation of many companies. In spite of this, the upkeep of these bus systems is often neglected. The fact that fieldbuses are generally very stable can easily lead to a careless approach to maintenance. But the availability of an entire industrial installation can depend largely on the health and well-being of the fieldbus system. A "sick" fieldbus usually results in unplanned downtimes for large sections of a plant.

At best, a green LED on an operational controller indicates – but does not prove – that the controller has been properly installed, and it certainly offers no guarantee that the fieldbus will function correctly in the long term. Quantitative evaluations of the actual state of a fieldbus are carried out far too infrequently, and maintenance strategies are in short supply as well, even though they could significantly reduce the risk of a failure. Why is this?
Many users still think fieldbuses are too complex and can therefore only be dealt with by specialists. This stems from the early days of fieldbus technology, when such beliefs were not entirely unfounded. It is true that measurements used to be carried out with multimeters and oscilloscopes, so only a few experts could actually determine the condition of a fieldbus or field device. Maintenance was therefore restricted to finding and correcting faults – in other words, to repairs alone.

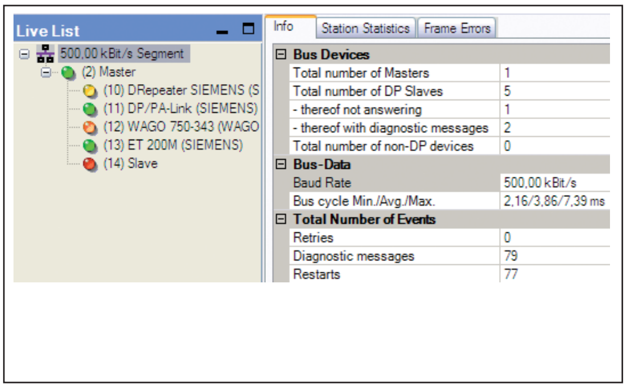
Diagnostic Tools

The first generation of special fieldbus diagnosis tools was launched on the market in the early 1990s. These comprised bus monitors for protocol analysis which were still oriented heavily on the requirements of specialists and on debugging. The current second-generation devices, which appeared around the turn of the millennium, were the first to be designed for a wider range of users in terms of both usability and how measurement results are displayed. All of the telegrams from an operational installation are monitored on the bus communication level, analyzed, and stored for more detailed evaluation if necessary. A solution like this covers not only the bus communication but also the bus physics, where line-related measurements and signal quality analyses play an important role. Even the topology of an existing installation can be ascertained and inspected using this type of monitoring solution.
Protocol analyzers have two modes of operation. In the first "classic" mode of operation, telegrams can be logged and displayed according to various trigger and filter settings relating to PROFIBUS services, addresses and data. Events such as missing telegrams, repeated telegrams, restarts and diagnoses are added up, and expert knowledge is usually required both to use the tools and to interpret the results. The second, more recent mode of operation is a diagnostic mode in which the condition of all bus stations is continuously analyzed and visualized. Useful information such as input and output data, parameterization and configuration data, and diagnostic reports are decoded. In combination with additional event and diagnostic histories, this type of diagnostic mode makes it largely unnecessary to deal with individual telegrams. The results are interpreted automatically using the expert knowledge in the software itself.



No.	Time Stamp	Address	Prot	Primitive	Service	Data
2639	11:00:30.759498	2 -> 2	FDL	Request	TOKEN	
2640	11:00:30.759644	2 -> 10	DP	Request	DATA EXCHANGE	01
2641	11:00:30.759890	2 <- 10	FDL	Response	SC	
2642	11:00:30.759990	2.62 -> 11.60	DP	Request	DIAGNOSIS	
2643	11:00:30.760644	2.62 -> 12.62	DP	Request	CHECK CONFIG	20 10
2644	11:00:30.760955	2.62 <- 12.62	FDL	Response	SC	
2645	11:00:30.761056	2.62 -> 13.60	DP	Request	DIAGNOSIS	
2646	11:00:30.761710	2.62 -> 14.60	DP	Request	DIAGNOSIS	
2647	11:00:30.762366	2 -> 93	FDL	Request	FDL STATUS	
2648	11:00:30.762910	2 -> 2	FDL	Request	TOKEN	

Example of telegrams recorded by a protocol analyzer for detailed analysis of bus communication by an expert.



Diagnosis of bus communication at a glance – the software itself is the expert.

Reasons for Errors

When analyzing possible functional errors and their potential causes, the likelihood of a fieldbus system failure increases with the age of the installation. Typical reasons for errors include:

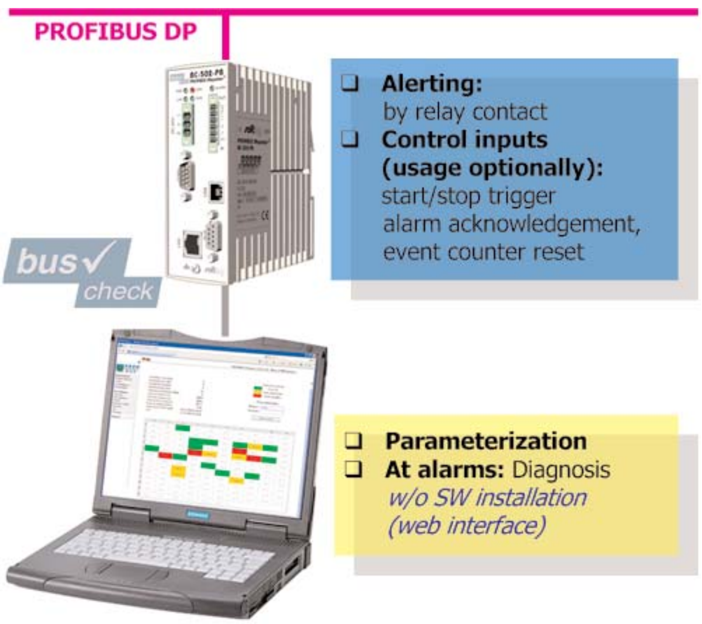
- Use of unsuitable cable types
- Permitted total length or spur length exceeded
- Insufficient distance between stations
- Incorrect mounting of connectors and shield
- Missing or redundant termination resistors
- Suboptimal bus speed or parameters
- EMC errors, e.g., due to frequency converters
- Alterations and extensions
- Temperature, humidity and corrosion
- Mechanical damage or stress
- Aging electronics at the bus interfaces

Continuous bus monitoring

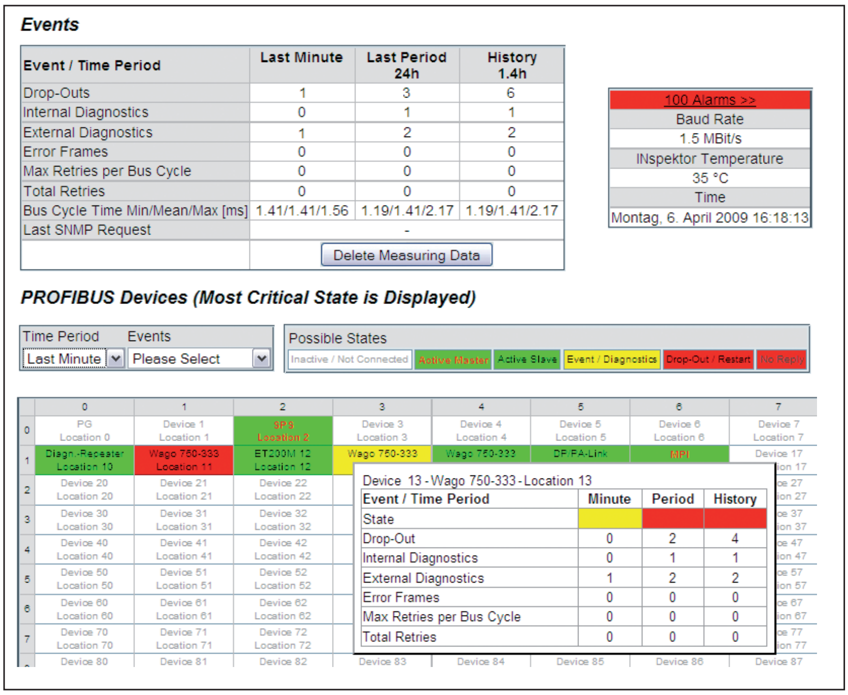
So much for the old status quo. Continuous bus monitoring is an entirely new approach which supports a condition-based maintenance strategy. A module like the BC-502-PB PROFIBUS Inspektor from Softing can be used to detect critical changes which indicate long-term trends. On the basis of protocol analysis, the device – which can be mounted on a top-hat rail – continuously monitors all data traffic on the bus and registers and counts all relevant errors. These include:

- Device errors/diagnoses
- Frame errors
- Retries
- Drop-outs/restarts
- Changes to bus cycle time

With this information, even the gradual physical deterioration of the fieldbus and the devices connected to it can be detected. If critical changes are identified which could lead to unplanned plant downtimes, the PROFIBUS Inspektor notifies the operators of the need for maintenance. The critical point is reached when a parameterized number of errors per unit of time is exceeded, for example, at which point an alarm is sent to the PLC via a signaling contact or to a central server via the network. In the event of an alarm, all diagnostic details can be retrieved locally at the device or via the network in a web browser; no additional software needs to be installed. The threshold values are also set in this way. In the network version, a server centrally manages all alarms and events from up to 80 inspectors in a database. This database also provides additional analysis functions and the option of logging excerpts of all the telegram traffic for selected errors. This type of bus monitoring offers a variety of advantages over previous solutions. For instance, only one Inspektor is needed per bus line, regardless of the number of physical segments. Furthermore, the device is completely non-reactive and can therefore be installed at any time - even temporarily – without affecting plant operations. There is no need for a bus address or any modification to the PLC program, and the functionality is entirely vendor-neutral, meaning that it does not depend on the type of controller used or the other bus stations. The network version even enables centralized alarms for different fieldbus systems.



The PROFIBUS Inspektor makes it possible to “eavesdrop” on the PROFIBUS – in other words, it enables continuous monitoring with alarms



Events

Event / Time Period	Last Minute	Last Period 24h	History 1.4h
Drop-Outs	1	3	6
Internal Diagnostics	0	1	1
External Diagnostics	1	2	2
Error Frames	0	0	0
Max Retries per Bus Cycle	0	0	0
Total Retries	0	0	0
Bus Cycle Time Min/Mean/Max [ms]	1.41/1.41/1.56	1.19/1.41/2.17	1.19/1.41/2.17
Last SNMP Request		-	

Delete Measuring Data

100 Alarms >>
Baud Rate
1.5 MBit/s
INspektor Temperature
35 °C
Time
Montag, 6. April 2009 16:18:13

PROFIBUS Devices (Most Critical State is Displayed)

Time Period: Last Minute | Events: Please Select | Possible States

Device 13 - Wago 750-333 - Location 13

Event / Time Period	Minute	Period	History
State			
Drop-Out	0	2	4
Internal Diagnostics	0	1	1
External Diagnostics	1	2	2
Error Frames	0	0	0
Max Retries per Bus Cycle	0	0	0
Total Retries	0	0	0

Bus state at a glance in the integrated web interface of the PROFIBUS Inspektor; can also be retrieved remotely via Intranet/Internet.

Is there an optimal maintenance strategy?

The remarks above have shown which tools are currently available to users. The variety of options inevitably leads to the question of which maintenance strategy is best for each situation.

One of the main goals of maintenance is to prevent unplanned plant downtimes and the production losses and other negative consequences associated with them. The starting point for this is correct installation and commissioning as well as a final functional test, such as in the context of an acceptance procedure. This test should quantitatively evaluate and document the condition of a fieldbus. A quantitative evaluation determines not just whether a fieldbus is working or not, but rather how good or bad its condition is. With modern mobile diagnostic tools, PROFIBUS networks can be surveyed quickly, easily, and with little expert knowledge. Tools like the PB-T3 signal tester and the BC-400-PB protocol analyzer from Softing also generate high-quality test protocols. Most common problems can be detected in time by regularly taking measurements with diagnostic devices like these.

In practice, inspection intervals of 6 to 12 months have proven to be reasonable for most plants.

In contrast, with a condition-based maintenance strategy involving the PROFIBUS Inspektor, the fieldbus state is continuously monitored and action is taken only when needed. This increases plant availability and conserves scarce maintenance resources. Another critical advantage is that it makes the best use of a plant's down-times because maintenance activities can be planned in advance.

A combined maintenance strategy can also be used when different parts of a plant are of varying importance to plant availability as a whole. In this case, stationary Inspektors are used on the bus lines in particularly critical areas, while regular measurements are carried out in the rest of the plant with the mobile diagnostic tools.

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