# Better performance with low baud rate

**High transfer rates in fieldbus communication can cause networks to be more susceptible to physical disruptions. It is therefore not always sensible to use the highest baud rate. The motto here should be, "As fast as necessary, as slow as possible." Experts from Alpma, a specialist engineering company, have worked out the details of this using the analysis tool from Softing on a cheese cutting machine.**

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Profibus has become the standard architecture for the cyclic exchange of data between sensors and actuators in many fields of industrial control technology. Thanks to high-performance transfer rates, even time-critical communication processes can be carried out largely with the basic services of the DP protocol.

## Malfunction due to incorrect dimensioning

In applications with strict time requirements, the fieldbus is often identified as an apparent bottleneck.
To be on the safe side, the highest baud rate (12 MBaud with Profibus) is usually chosen to ensure short transmission times. If system tests run as expected, the baud rate is adopted for serial production. If malfunctions occur during production, technicians usually make short-term repairs in order to avoid interrupting the production process as much as possible. Since these technicians generally lack detailed knowledge of the machine, problems are corrected by trial and error. If disruptions continue to occur, external experts are brought in. They may be able to stabilize the machine in the medium term, but ultimately they, too, can only minimize the negative effects of the actual problem. Ultimately, the costs arising from the malfunction – for maintenance, production downtimes, reworking, etc. – will skyrocket for the operator. But the root of the problem will remain unaddressed: the high sensitivity of the fieldbus communication, which is due to the high transfer rate. This scenario may sound dramatic, but it is not uncommon. A solution is at hand, however. The baud rate is the most inexpensive key to robust data communication. In this case, it is possible to have too much of a good thing. „As fast as necessary, as slow as possible" is a much better approach here. But how fast is it necessary to be? And how slow is it possible to go?


*Image 1: CUT25 cutting machine from Alpma: Frequency converters and digital and analog IO are controlled synchronously with the control program via Profibus DP*

## Results of practical tests

These questions do not need to be answered by communication experts, as the specialist engineering company Alpma [1] has shown. With its three business divisions – process technology, cheese production technology, and cutting and packaging technology – the company is able to provide solutions for everything a cheese-making factory requires: from milk preparation, whey processing and cheese production, to cheese slicing and packaging.
From an automation point of view, the cheese portioning process – which involves cutting irregular blocks of cheese into pieces of the same weight – is particularly demanding as regards communication and data processing (Image 1). The profile of a block of cheese is measured on its way to the cutting installation so that the position of the cuts can be calculated. Since this process takes place on a moving belt, a high degree of temporal constancy is critical when measuring and processing the data to guarantee portion sizes of equal weight. With regard to control technology, it is important to have a temporally precise processing cycle. The highest Profibus baud rate (12 MBaud) was initially chosen here for trial purposes so that the time it took to communicate between the controller and I/O components would not negatively impact the cycle time. When the prototypes were examined with bus level measuring devices, however, there were large variations in the electrical characteristics of the Profibus network. Overall, the range of fluctuation was unacceptable. It worsened under regular production conditions, which meant that if this engineering plan had been adopted for serial production, it may have resulted in machine standstills, high maintenance costs and production downtimes.

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## Reducing the baud rate

The individuals responsible for planning the system wondered whether communication could be carried out using a considerably less sensitive baud rate of 1.5 Mbps, for example, while still meeting the time constraints. Would the cycle time for exchanging data as specified by the PLC be sufficient to transmit the same amount of data at a lower baud rate? (Image 2) Would a bus system that was less susceptible to disruption make the machine more reliable?

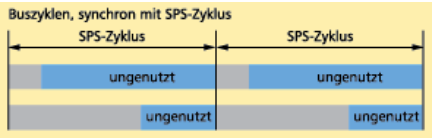


*Image 2: Schematic comparison of the degree of utilization of a bus cycle of a set length at a high (above) and low (below) baud rate)*

To answer these questions, the following questions had to be addressed first:

- How long does a data exchange cycl take at a high or low baud rate?
- Will the cycle time necessary for the machine to function reliably be excee ded?
- How much reserve time will there be in the cycle?

The answers were found by recording telegram traffic at various baud rates. To do this, Alpma used the Mobile Profibus Analyzer from Softing AG [2]. The analyzer non-reactively records all telegrams in a Profibus network and assigns them precise time stamps. These functions are indispensable when it comes to servicing a Profibus network, but they are also well-suited to analyzing the performance of a bus system. Filtering and analysis options made it possible to determine the relevant variables in the communication cycle when examining the recordings.

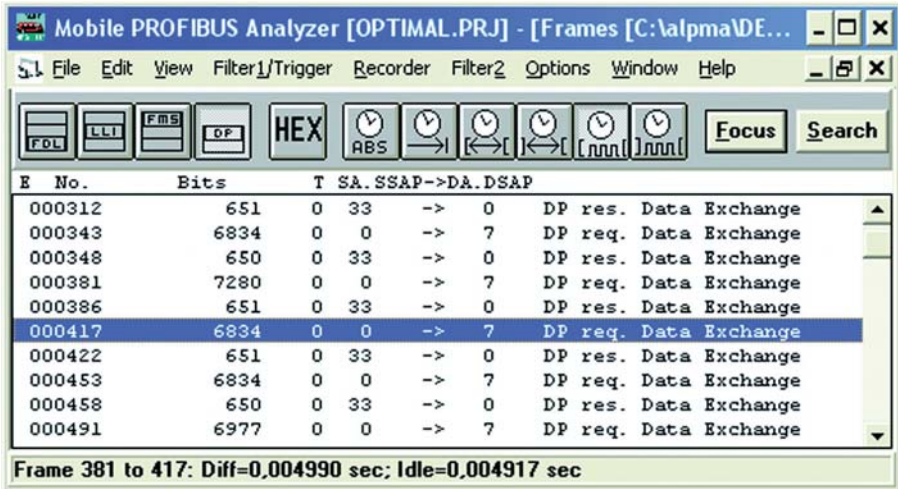


*Image 3: Representation of the temporal structure of the communication cycle of a network*

## Analysis tool delivers results promptly

For this particular communication situation, the designers determined the cycle time for exchanging data, the time slice for effective data transmission and the reserve time that remained. To do this, telegram traffic was recorded selectively between two stations. Since communication with field devices is carried out in recurring cycles with Profibus DP, the cycle time can be determined by calculating the time difference between two sequential telegrams to the same slave. Since the analyzer is intuitive to operate, very little knowledge of Profibus was necessary. Just a few clicks of the mouse were needed to analyze the individual cycles, which could be measured directly in the analysis window to determine the cycle times. It became apparent during the analysis that even after lowering the baud rate, 650 bit times (7: lowest address, 33: highest address) were needed for communication with all slaves. This was compared to the approximately 7,000 bit times of unused time, during which no useful data was transmitted. The total duration of the cycle which was examined was 4.99 ms, in accordance with specifications (Image 3).

But how could Alpma be sure that the single cycle which was measured was representative of the system? In order to arrive at reliable conclusions regarding the operating behavior of the machine, the analysis had to cover many data cycles so that all operating states were recorded. The analysis functions of the Softing tool were used for this as well. The integrated export function makes it possible to evaluate several thousand cycles. For a comprehensive evaluation, the filtered recording can be imported into a program like Excel for statistical analysis or conversion into a graph.

## Proven: Less is more

After a short investigation, the developer team from Alpma was confident that, with regard to data throughput, a lower baud rate could be used while still ensuring sufficient reserve time. Even at a reduced baud rate, a relatively small portion of the cycle time was used for communication in the test machine (Image 4). From a communication point of view, therefore, there was still sufficient capacity to expand the machine. Based on the analysis using the evaluation functions integrated in the tool, a lower baud rate was chosen for the serial machine. This was in line with the principle that the lower the baud rate, the less influence the disruptions which inevitably arise in a production environment – in the form of voltage fluctuations or electromagnetic effects – will have on fieldbus communication. Thanks to its robust communication behavior, the optimized machine has the same functions but is very stable when confronted with external disruptions. It also passed all of the company's quality tests. Stable communication and a high level of quality have made it possible to save money in assembly, commissioning and maintenance. These savings outweigh the price of acquiring the analysis tool. The machine has proven to be reliable and powerful in productive use for customers as well. Alpma, in turn, has benefited from shorter workshop times, simpler commissioning and fewer service calls. It is no surprise that the company is very happy with the Profibus Analyzer. Willi Gilch, head of the optimization project at Alpma, was particularly impressed with the high performance of the tool and the close cooperation with the Profibus specialists at Softing, who always responded quickly and competently to questions.

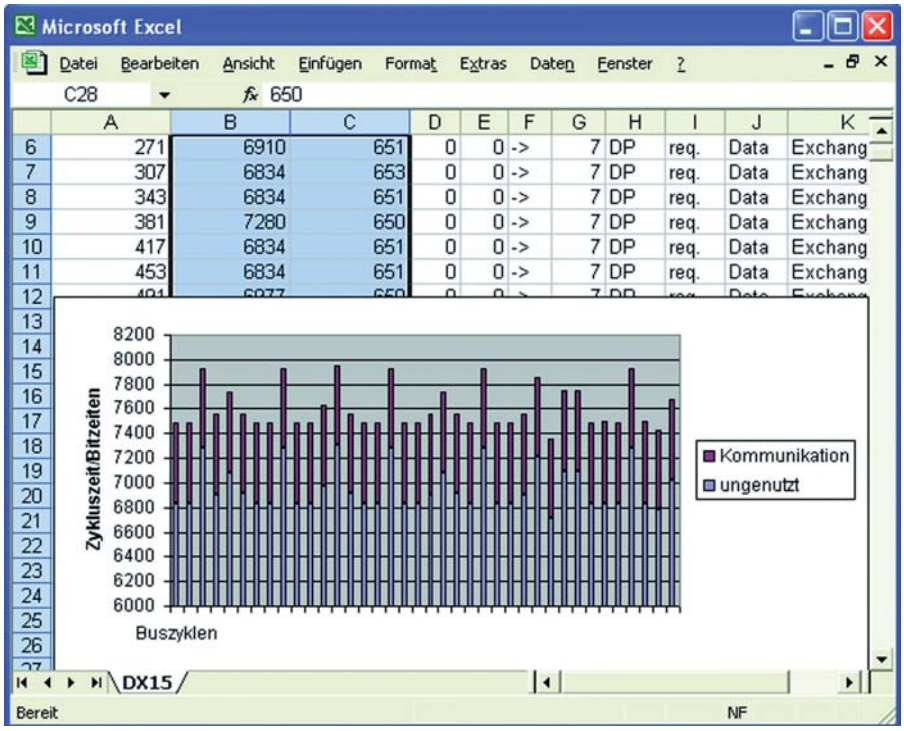


*Image 4: Evaluation of several communication cycles in Microsoft Excel. The reserve time is shown in column B, the communication time in column C. The graphical representation shows the temporal distribution of data communication and reserve time within the individual cycles*

**Literature:**

[1] Alpenland Maschinenbau GmbH, Rott/I.: www.alpma.de
[2] Softing AG, Haar: www.softing.com