SERCOS interface

WHITEPAPER

# SERCOS ENERGY

SERCOS International e.V.

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## Short Overview of SERCOS Energy

The climate discussion has raised the public awareness of the energy efficiency topic. Within the scope of this increased attention, more and more products are being promoted with reference to their energy efficiency. In this connection, the green image is in the foreground but energy costs play an important role as well.

However, most current automation products only focus on the reduction of energy consumption through the permanent improvement of process chains, procedures and machine efficiencies via structural measures. Because machines and systems are operated under continuously changing requirements and boundary conditions, such "average optimization" only opens up a part of the energy efficiency potential. Thus, measures for energy-optimal operation and control of machines and systems are required for overall energy efficiency. These measures must optimize the energy consumption of machines and systems depending on the process and external influences as well as depending on the operational situation.

### About SERCOS

SErial Realtime COmmunication System, in short SERCOS, is amongst the leading digital interfaces for communication between controls, motors and decentralized peripheral devices. SERCOS has been used in machine engineering for more than 20 years and is implemented in over 2,5 million real-time nodes. With the open, manufacturer independent architecture on an Ethernet basis, SERCOS III is a universal bus for all automation solutions allowing for an intelligent control of loads.

SERCOS Energy – the Energy Profile for the SERCOS III Ethernet-based real-time communications system – allows the machine controls to switch connected components (drives, I/O, sensors) into energy-saving conditions, up to complete shut-down, in a targeted form, considerably reducing their energy consumption. For this purpose, SERCOS Energy makes the components' energy consumption transparent allowing for an intelligent control of loads.

SERCOS Energy considers energy-saving conditions for predictable breaks such as lunch breaks and plant holidays. At pre-defined times, SERCOS Energy components are brought into a standstill condition in order to save energy. Shortly before the end of the interruption, SERCOS Energy provides for the re-initialization of the components in stand-by condition in order to make them available again with utmost precision.

Apart from that, SERCOS Energy provides mechanisms for unintended breaks that may be caused by machine errors and missing parts. System components can be brought into energy-saving conditions in a targeted manner while the errors are being remedied or during a wait for new parts.

With SERCOS Energy, SERCOS III – as the only communication system in the production environment – offers the possibility of saving energy while still achieving full productivity. Using intelligent controls, axes and components that are not necessary in current production processes can be switched off. Especially with flexible production, the energy saving that can be achieved via SERCOS Energy is enormous.

SERCOS Energy commands for switching into energy-saving conditions are normally set by the control. This allows for integration of devices both with and without the SERCOS Energy profile into the same machine. The subsequent retrofitting of machines that are already in the field with SERCOS Energy is therefore possible and reduces the energy consumption in a sustainable form.

SERCOS Energy allows for the efficient, energy consumption-optimized activation of control components down to the single I/O terminal.

## Energy Efficiency in Figures

It is true that the primary energy consumption in Germany has remained almost constant since 1990 despite an increase in the gross domestic product by approximately 27%. This is, however, primarily attributable to a change in the economic structure. According to current figures of the Federal Statistical Office, in 2005 industry was responsible for 27% of the final energy consumption. In Germany, 528 TWh of electrical current were consumed in 2004, 47% (248 TWh) of which were attributable to industry. According to the VDW's stock information and average consumption information from the Ikarus database, installed metal-cutting machine tools account for a 10-15% share of energy consumption. Through its power consumption, an average metal-cutting machine tool emits as much $CO_2$ as 70 passenger cars per year. According to a study by ETH Zürich, 20% of the power consumption is lost in no-load operation (Figure 1).

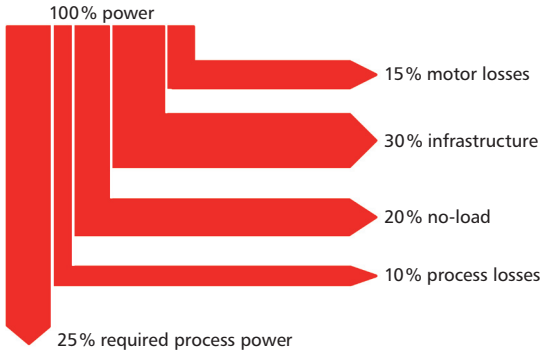


*Figure 1: Typical power distribution in production technology (source: IWF ETHZ)*

In the manufacturing industry, the energy intensity (kJ input per € value added) is much higher than the average of all economic areas. In the metal producing and processing industry, the energy intensity is even one scale higher and also has been increasing in the last few years. In this connection, the moving of energy-intensive production facilities to other countries with partially lower environmental standards is no solution for the problem.

The practical implementation of measures for increasing energy efficiency depends on their economic profitability. The exact prediction of the monetary consequences of energy efficiency measures is subject to fluctuations of energy prices. However, another long-term increase in energy prices can be assumed given the strongly increasing global demand, particularly by deve-

loping nations, and the decreasing energy offer. That means that measures for increasing energy efficiency that are profitable today are also suitable for the future. An energy-efficient production system must also be highly productive and able to flexibly react quickly to market requirements.

In order to reduce energy consumption in the manufacturing industry on a permanent basis – not only in individual solutions – a standardization of mechanisms for the situation-dependent reduction of energy consumption is necessary. Apart from that, energy control circuits have to be designed based on the provision of consumption values that lead to the efficient use of existing energy and production systems. Based on these basic ideas, SERCOS Energy has been developed by SERCOS International and made available to the SERCOS users by means of integration into the SERCOS III specification.

## Classification of SERCOS Energy

SERCOS Energy is an application layer profile and extends the existing SERCOS profiles by adding another profile that can be implemented in SERCOS components.

In this connection, SERCOS Energy connects the process know-how of the controls regarding the SERCOS communication with the connected SERCOS components. This interaction guarantees optimal energy utilization.

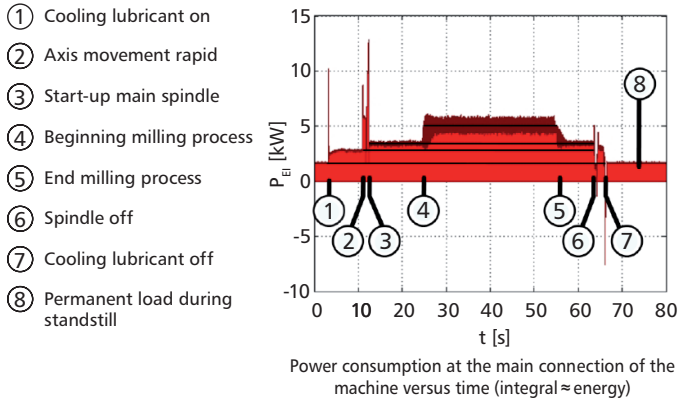


*Figure 2: Process power and power consumption of a machine (source: ISW)*

The control reads out standard parameters of each component that supports SERCOS Energy via the SERCOS communication bus receiving status information and detailed consumption values. This is all performed via the acyclic SERCOS communication channel – a standard SERCOS communication service that operates in parallel with the real-time communications – and is therefore already a part of the automation solution.

Depending on the situation, the control is able to issue commands to put SERCOS Energy components into energy-saving conditions. In this way, the permanent load can be considerably reduced in standstill during short or long breaks (Figure 2). Apart from that, the process load can be further reduced by the shut-down of machine components and/or their use in partial load operation depending on the situation.

## SERCOS Energy – Application scenarios

The SERCOS Energy application scenarios have been defined by the Institute for Control Engineering of Machine Tools and Manufacturing Units (ISW) of Stuttgart University based on results of research and feedback from manufacturers and end customers. In contrast to the energy profiles of other bus systems, the SERCOS Energy profile is divided into two levels. The upper level – from the plant management level to the machine control – provides information on longer breaks and failures (e.g., due to missing parts). The lower level – from the machine control to the load – reacts at short notice (control programs). In this way, you can react to machine-specific failures and current processes in order to reduce energy consumption.

Within the scope of the analysis, the following application scenarios for the **plant management level** have been defined for SERCOS Energy:

### › Short Breaks

With short breaks that are usually not longer than one hour, the machine usually is either brought into a standby operation or completely switched off by the machine operator. The majority of these short breaks can be scheduled, as in most companies there are regular lunch and coffee breaks.

Depending on the break period, SERCOS Energy puts components into an optimal energy consumption condition. For short breaks, this may mean that re-initialization would consume more energy than leaving the unit in a standby condition (ready for operation). SERCOS Energy provides mechanisms in order to be able to react to such boundary conditions and helps in this way to dramatically reduce costs.

### › Long Breaks

Long breaks usually range from several hours (e.g., overnight) to several days or even weeks (e.g., closing for Christmas). It is usually worth it to completely switch off some or even all components in the production system.

As with short breaks, SERCOS Energy puts components into the optimal energy consumption state.

### › Unscheduled Breaks

Unscheduled breaks often result from missing parts (e.g., due to delivery bottlenecks) or operator interventions. Unscheduled breaks cannot be predicted.

If the machine is put into a condition in which production is stopped, it is first of all in an energy saving condition that can quickly be exited again. If the machine operator identifies another problem, SERCOS Energy can bring the machine into other conditions in which even more energy can be saved. If, on the other hand, the end of the failure is foreseeable, the machine can also be put into a condition from which standby operation can quickly be reached again.

For the **machine level**, the following application scenarios could be identified for SERCOS Energy:

### › Partial Machine Operation

Especially with flexible production, a machine provides more functionalities than are required for every single production step. With large systems, some machine components are only needed at a later point in time in the production process or not at all in certain situations.

Based on its information, SERCOS Energy allows the control to switch off machine components and/or to throttle their energy consumption if they are currently not required in the process. The component is then reactivated by the control just in time and makes its functionality available again. The partial machine operation available in SERCOS Energy allows for the process-specific reduction of costs for the machine.

### › Partial Load Operation

If there is a desired completion time/date not requiring full-load operation of the machine, you can also save energy and protect the machine.

SERCOS Energy offers the possibility of reducing the energy consumption of components in operation, e.g., by field weakening of drives. In this way, reduced energy consumption is achieved.

In addition, SERCOS Energy provides generally valid interfaces in order to measure resource consumption, not just electrical, but coolant and compressed air for example, and draw conclusions for optimization of production. The measurement and visualization of consumption values are another application scenario for SERCOS Energy.

### › Measurement and Visualization

Measurement and visualization combines the data recording and data preparation. As mentioned, apart from electrical parameters, other information like coolant and compressed air consumption may also be relevant for the cost optimization.

SERCOS Energy provides mechanisms for recording the current consumption, visualizing it on the HMI and drawing conclusions for possible optimization, if applicable. The designers of SERCOS Energy tried to consider all measurable parameters and thus provide the characteristics in a flexible form.

## Advantages of SERCOS Energy

SERCOS Energy offers the following advantages:

- **During installation:** The use of SERCOS Energy causes no additional unit costs. Every functionality provided by SERCOS Energy is already integrated in the SERCOS components supporting SERCOS Energy. Furthermore, additional cabling is not needed for SERCOS Energy components.
- **During operation:** SERCOS Energy reduces energy consumption in three areas. First, the permanent load at standstill is reduced; second, the consumption depending on the process is dynamically adjusted considering the completion times/dates (partial load operation); and third, energy is saved during processing by switching off components that are not required at a particular time or point in the process (partial machine operation).
- **User friendliness:** Depending on the configuration, SERCOS Energy can independently determine which condition is optimal for maximum productivity at which point in time. Manual selection of energy saving modes and/or manual shut-down of the machine is no longer necessary.
- **Openness:** The openness of SERCOS gives different manufacturers the possibility to develop and sell products incorporating the SERCOS Energy profile. This quickly results in a broad product range covering all requirements of SERCOS Energy components. Interoperability is guaranteed by the certification of SERCOS components.
- **Future-proof:** SERCOS Energy provides future-proof mechanisms that – with growing experience on the part of the users – allow for an increasingly efficient use of SERCOS Energy. This allows for higher energy savings in the future.
- **Load management:** Due to the feedback of consumption data and its interpretation, processing steps with high energy consumption may be performed at times at which energy costs are low.
- **Cost reduction:** By saving 50% of the power costs alone in standstill via SERCOS Energy, the total energy costs are reduced by approximately 10%.
- **Green image:** The use of SERCOS Energy sustainably reduces $CO_2$ emission. Thus, on the one hand the user can support an environmental strategy and on the other hand avoid the purchase of expensive $CO_2$ certificates.