SIMPLIFIED CONTROL OF HIGHLY DYNAMIC SCANNING MIRRORS

THE TASK

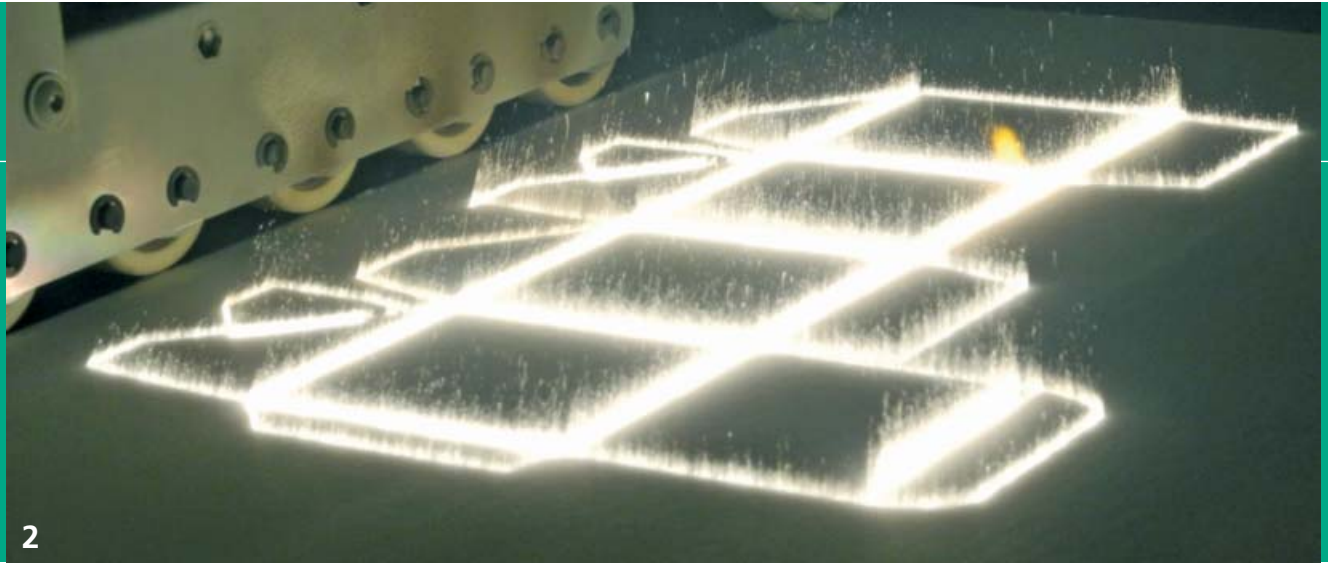
Highly dynamic galvanometer scanners, which, as a function of their optical design, can generate lateral spot velocities of several meters per minute, are used to implement rapid motions of a laser beam. These scan systems are applied in a wide variety of ways in the laser machining of materials, in which specific manufacturing tasks must be executed through rapid contour motion capacities. Recently, galvanometer scanners have also been used more and more for high-frequency beam oscillation processes to influence the dimensions and dynamics of the molten bath. To implement and direct more and more complex technological techniques in the fields of remote laser cutting, welding and cladding, it is necessary to link the trajectory of the scan systems with the machine control, the laser beam sources, and, if applicable, available sensors and actuators. Furthermore, the demands of efficient production, short manufacturing cycles and automatic chaining of sequential manufacturing steps, make it necessary to develop paradigms for holistic interconnections that include the control of galvanometric scanners.

OUR SOLUTION

At the Fraunhofer IWS Dresden, the so-called ESL2-100 modules (see Fig. 1) were developed for the integration of highly dynamic galvanometer scanners into machine controls. The real-time capabilities, the open structure and the flexibility of available field bus systems are used to extend the control of the galvanometer scanners. The ESL2-100 module functions as a gateway between the Ethernet-based field bus system EtherCAT and the SL2-100 report to trigger scanners. This setting ensures cyclical and synchronous communication between the scan system and the machine control, as well as the sensors, in the process. Furthermore, the flexibility of the field bus system makes it possible to distribute the scan systems in space in almost any chosen position. As a result, scanners can be employed in various positions in production equipment and can be synchronized with one another. Not only are Ethernet-based field bus systems (EtherCAT) in use, but also additional industrial Ethernet standards, such as Profinet. It may also be possible in the future to support the XY2-100 protocol for control of scan systems.

Modules for digital control of galvanometer scanners (scanner report: SL2-100) via EtherCAT (left) or Profinet (right)

1



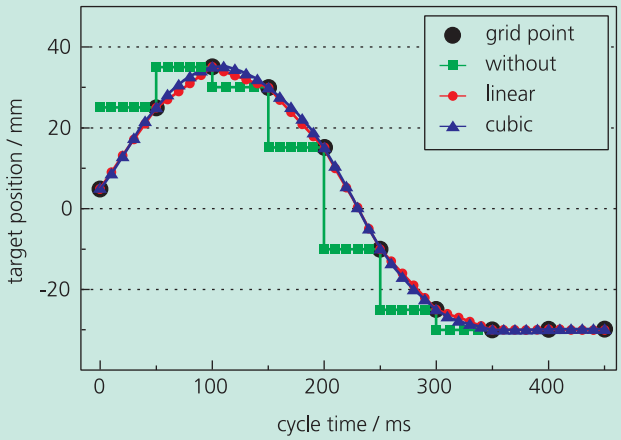
2

RESULTS

Scan systems for laser materials processing can be integrated into existing field bus systems by means of the ESL2-100 modules (see Fig. 4). Discrete nominal position values are cyclically transmitted to the scanner for control. The position values are calculated in a programmable controller (PLC) and can be connected with various sensors installed in the process. Additionally, the dynamic characteristics of the scanner, analogously to an NC axis, are either considered when selecting the position or chosen as a function of the manufacturing process.

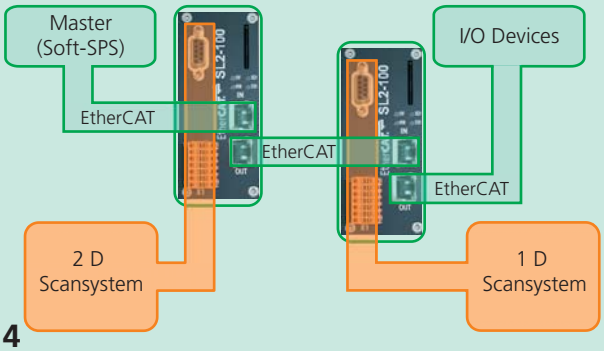
The ESL2-100 module provides the option of choosing among several types of interpolation, which enable fine interpolation (without, linear, cubic) depending on the PLC cycle time (see Fig. 3). An oversampling function is implemented to improve the time resolution; as a result, several grid points can be transmitted with each EtherCAT cycle.

4-fold oversampling function and fine interpolation of ESL2-100 modules, which can be selected depending on the task



3

Principle for integration of several scanning systems in the machine control (Field bus system EtherCAT)



4

The required image field correction is calculated in the ESL2-100 module and can be loaded via SD card. The system created by the IWS is in use 24/7 for laser processing of electrical steel. Thanks to the high coil speed feed rate of max.150 m min^{-1}, up to 12 individual axes are in use. The control of all scanners is performed as a function of the coil speed. For this purpose, the machine control synchronizes the manufacturing process including the scanner motion related to the coil speed. Other ranges of application include technologies in which the scanner motion must be directed in real time, such as in high-frequency beam oscillation.

2 Highly dynamic remote laser cutting of fiber reinforced composites and cardboard

CONTACT

Dipl.-Ing. Peter Rauscher
☎ *+49 351 83391-3012*
✉ *peter.rauscher@iws.fraunhofer.de*