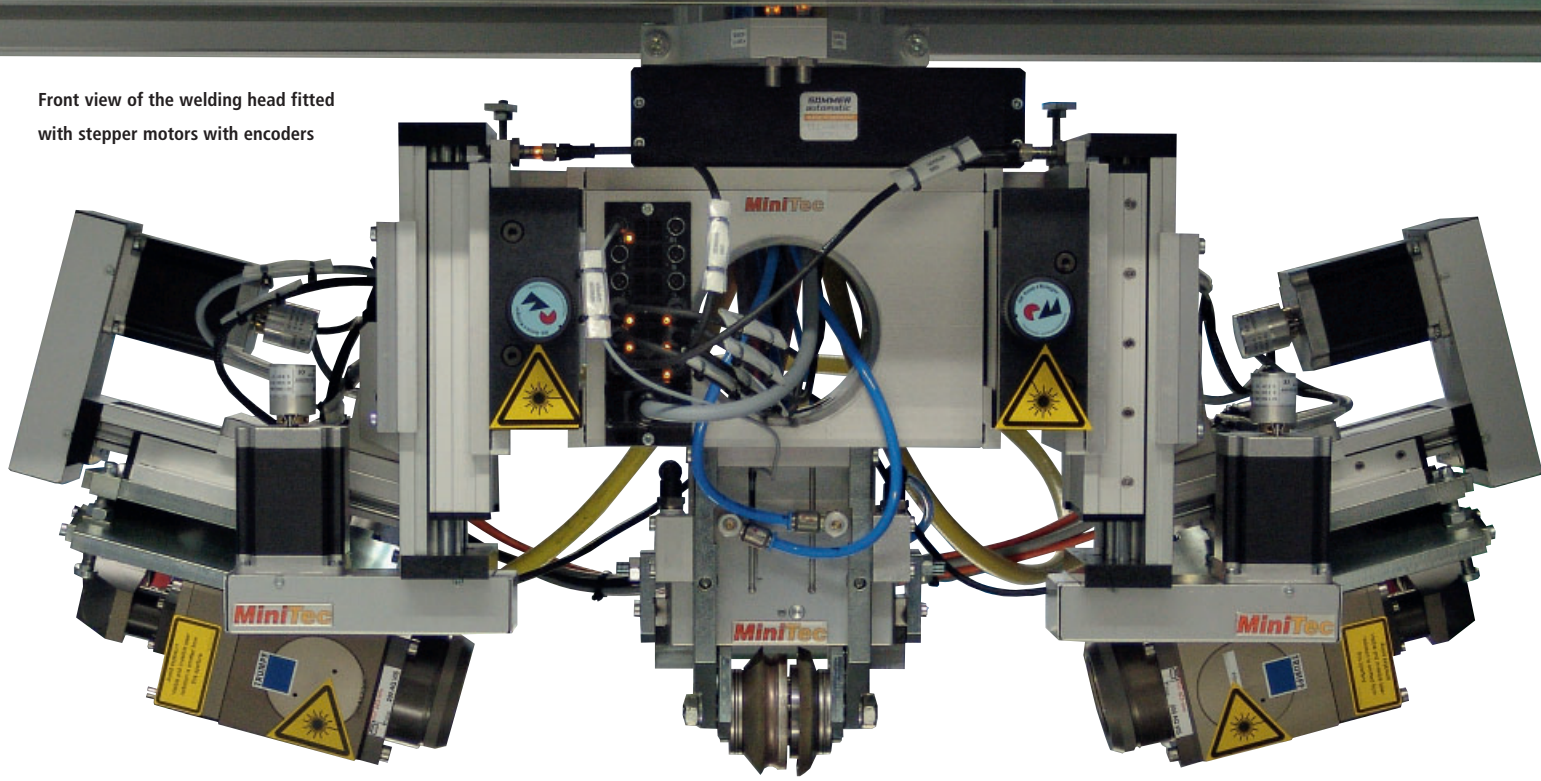


Front view of the welding head fitted  
with stepper motors with encoders



Laser welding system for maximum process safety and flexibility

## High-end production process for solar thermal absorbers

Solar thermal absorbers are necessary for the conversion of solar radiation into energy and the laser welding process is the most pioneering and commercially viable technology for their industrial mass-production. Laser welding offers excellent process safety plus increased production speed and efficiency compared to conventional methods. Specializing in this field is the Swiss Company MiniTec AG, with offices in Otelfingen near Zurich. It has developed the SunLaser® laser welding system which permits the fully automated production of full-surface absorbers for thermal flat-plate collectors. The system is controlled by a PC- and EtherCAT-based automation platform from Beckhoff.

The use of the sun's energy through special energy converters is well-established throughout the world, and the use of solar thermal energy now plays a major role alongside the photovoltaic conversion of the sun's radiation. The production plant for solar energy recovery systems must fulfill optimum demands of productivity and quality in order to meet the demand for maximum energy yield with realistic system costs and redemption periods.

### Pioneering technology

Full-surface absorbers for thermal flat-plate collectors are produced by welding tubes in harp or meander arrangements onto a baseplate. The laser welding process used by MiniTec solves the inherent problems of

welding the necessary material combinations, for example copper tubing and aluminum sheets. A pulsed laser melts and alloys small areas of tube and sheet metal, i.e. the exact amount of heat is applied to the absorber at the exact welding point. This minimizes the heat affected zone so that the absorber layer remains intact, which guarantees the optimum energy efficiency of the flat-plate collectors.

The SunLaser® flatbed laser welding system can be used to produce absorbers measuring 1,250 mm x 2,500 mm (4-ft x 8-ft). The tubing is primarily copper, measuring from 8 to 22 mm outside diameter with a 0.2 mm wall thickness. The base plate is usually made of a 0.3 to 0.5 mm aluminum sheet. The copper tubing is welded to the aluminum sheet by the smallest possible welding spot: four spots per cm, generated by a



Nd:YAG fixed-head laser at a welding speed of up to 25 m/min (82 ft/min). The laser can cover around two square meters of absorber surface in 60 to 120 s.

**Fully-automated process control with PC-based Control and EtherCAT**

The machine is controlled by a Beckhoff CP6222 Panel PC installed in the control cabinet door of the laser welding system. The system periphery is connected via Beckhoff Bus Terminal I/O. Communication between the Panel PC and the I/O system is handled via EtherCAT. The EK1100 Bus Coupler connects the EtherCAT protocol with the EtherCAT Terminals.

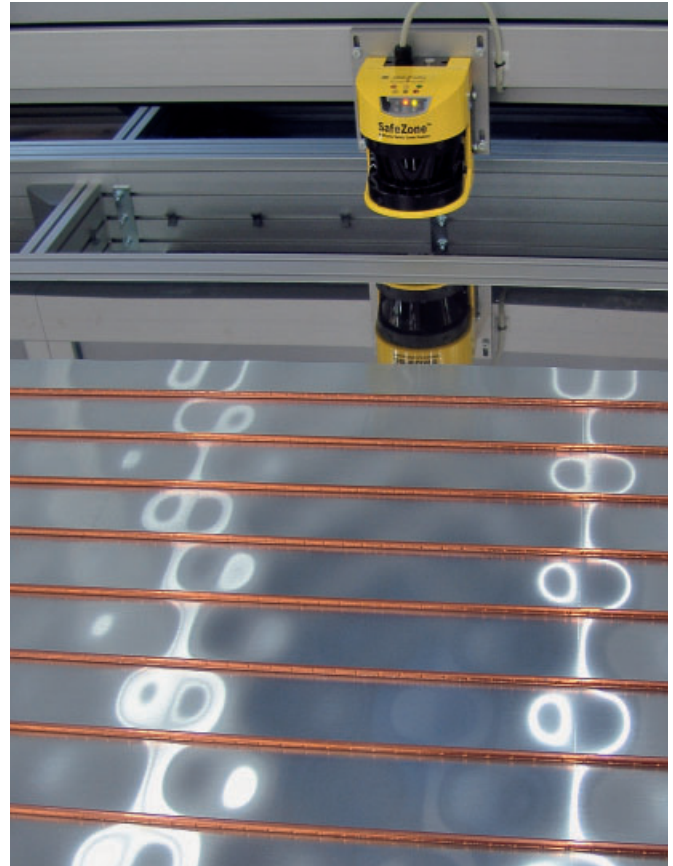
The SunLaser® has a multi-axis portal: the various axes are controlled throughout the whole operating range with Beckhoff Servo Drives. The drives are programmed and actuated via TwinCAT NC I automation software and another system servo drive controls the worktable's rotation axis. The system operator can load and unload the absorbers during the primary processing time of this swivel action.

The portal has a laser welding head on its Z-axis with two laser lenses and a feed roller for the tubing to be welded. The two laser lenses are focused and positioned by a stepper motor. The stepper motor carries out the adjustments within a mechanically pre-defined positioning range. To guarantee absolute precision during this process, each stepper motor also has an encoder that detects the action of the welding heads and facilitates monitoring by the axis controller through a feedback signal.

**Software as linking technology**

The MiniTec laser welding system currently uses three control systems: a controller for the Nd:YAG laser, a separate safety controller and the Beckhoff control platform which monitors the whole production process. The three control systems are interconnected.

All process sequences are monitored in compliance with IEC 61131-3 by the Beckhoff TwinCAT PLC automation software. "Since we drive several



Absorber made of copper tubing attached to aluminum sheet with precision welding points

interpolated axes and require a fully-programmable surface," says Philip Schwander, deputy managing director and technical director of MiniTec, "we use TwinCAT NC I and G-Code (DIN 66025). We have programmed our own graphical display in C#."

**Open automation platform permits variable operating concept**

The operating concepts of the laser welding machines vary depending on differing customer requirements, as described by Frank Weyermann, Managing director of MiniTec: "We have customers with just a few product variants



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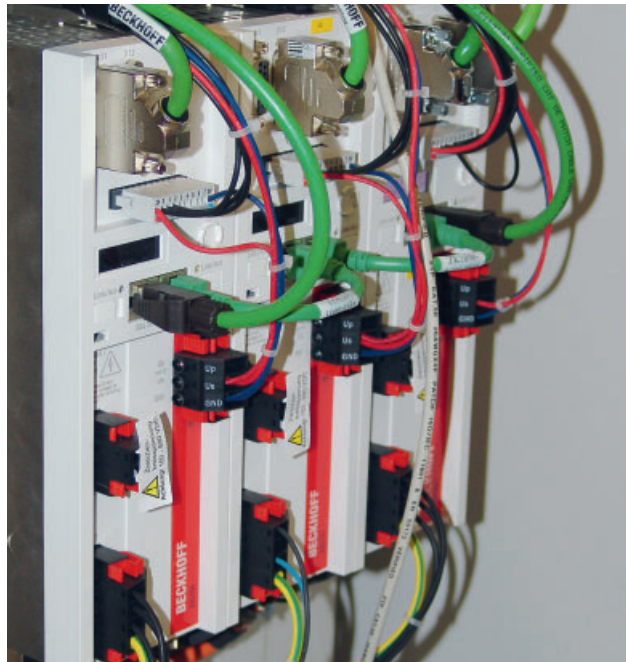
Frank Weyermann, managing director of MiniTec Schweiz

After being acquired by the German machine manufacturer, MiniTec GmbH & Co. KG, the Swiss Geiser Tech AG has operated since the start of 2009 under the name MiniTec Schweiz AG. The company, which has developed a pioneering technology in the manufacturing of solar thermal absorbers, now reinforces the involvement of MiniTec in the field of solar technology.

The SunLaser® laser welding system concept is almost an “inherited technology,” as Frank Weyermann, managing director of MiniTec, reports: “Its technological origins can be traced back to the company Sunlaser which developed the concept and made it viable. Sunlaser then sought a partner who could take and develop the concept further. This was initially GeiserTech and since its integration we have pursued the system concept further to turn it into a high-end production technology.” The internationally operational MiniTec group has acquired an excellent reputation in the last 10 years, predominantly for the construction of production plants for photovoltaic modules. The new company will also profit from its great experience in the industrial manufacturing of modules. Together with its partner, Sunlaser Consulting GmbH, MiniTec Switzerland AG has not only a wealth of expertise in the system engineering but also extensive knowledge in its application. In 2001 work began on the development of laser welding processes for the manufacturing of aluminum absorbers. Since then the process has proven to be commercially viable and is used in numerous turnkey production machines worldwide.



Frédéric Dollinger, project manager for laser applications at MiniTec



Control cabinet with Beckhoff AX5000 EtherCAT Servo Drives

who manufacture just one or two types of absorbers. Such customers operate three shifts per day – some handling parts manually, others with a fully-automated line. Other customer groups include, for example, OEM absorber producers who manufacture up to 40 or more different absorber types. To do this, the controller programs must be highly flexible, i.e. every aspect of the product must be adjustable. Our customers expect a shift worker to be able to carry out the adjustments. Therefore the graphical display-supported operation of the systems is becoming increasingly important.”

MiniTec feels that simply storing such individual programs as recipes in a database is inadequate. Frank Weyermann says: “Our customers have to and want to create their own recipe programs. The precondition for this however is an automation platform that will permit this, which is the great strength of the PC-based controller from Beckhoff.”

#### Function integration as a short-term objective

The openness of the Beckhoff control platform and its continuous refinement is reflected in the MiniTec Laser welding system concept. In the first

phase, the Swiss company integrated the servo drive technology into the control concept and thereby replaced the external CNC controller. Since then, the servo drives themselves have also been converted. “The AX5000 Servo Drives from Beckhoff have been in use for around two years,” says Frédéric Dollinger, who, as project manager for laser applications, looks after the system technology until it is transferred to the customer. Dollinger goes on to explain that the Servo Drive safety functions have also been integrated. “We have been using Safe Pause and Safe Stop functions.” MiniTec was able to repeat this approach with other safety aspects. The new integrated safety controller and the TwinSAFE safety terminals from Beckhoff have aided in the migration of the previously separate safety technology of the laser welding machine into the control concept. This way, new possibilities will continue to appear in the future for Philip Schwander and his team.