Manual control panel for servo welding units

In place of stationary, individual operator panels at each servo control module for its welding tongs, a leading German manufacturer is now using a mobile control panel with touch display for multiple units. This solution not only cuts costs: touch operation at the graphical display also makes the unit much easier to handle. And the interfaces provided with the device make the automation solution as a whole more open and flexible.

Servo-operated welding tongs with a proprietary, standardized servo control module (SCM servo box) increasingly define the state of the art at Nimak Automatisierte Schweißtechnik GmbH – and therefore in a growing number of automobile plants around the globe. With over 250 employees at its locations in Wissen and Nisterberg, Germany and in the U.S., U.K., South Africa, Spain, Sweden, Italy and Australia, Nimak enjoys worldwide renown as a partner of automakers as well as leading automotive systems suppliers.

Always a technology leader, the company has been at the forefront in the development leading from the simple stationary welding unit to today’s robotic welding tongs with precision positioning. Holder of the Ford Q1 Awards and the VW Q Trophy, the company is also known for high-performance arc welding and resistance welding machines. Nimak also supplies systems for reworking using welding tips, automated tip changers and standardized test stations for calibrating and referencing welding tongs.

Minimizing cycle times

"Servo systems are increasingly taking the place of conventional, pneumatic welding tongs," reports systems development engineer Hermann Stauserg, "because of their superior wear characteristics and lower costs." All opening and closing motions can be accurately and finely adjusted by means of a servomotor, with a precise velocity profile and the capability of adjusting forces to optimize process control. Greater, freely programmable opening strokes allow more flexible, closer, and therefore faster maneuvering to avoid obstacles in the path of the robot, and this minimizes cycle times.

With this system, the force build-up prior to applying a weld spot requires only one-fifth of the previously required time. An additional, electronic equalizer ensures a "floating" positioning of the welding tongs that prevents mechanical damage or other defects of the workpiece. Servo technology virtually eliminates spark formation, which in turn minimizes arc erosion of welding tips and consequently reduces the frequency at which these must be remilled.

To make setting up its servo tongs simple and convenient by an on-the-spot operator, Nimak has developed the SCM servo control module. Each SCM can control one stationary servo tong unit, or, with a selector system, up to six different, electrically coded servo tong units. Core components are a Simatic S7-300 DP programmable controller (PLC) and a Simovert Masterdrives converter with customized control software from Siemens. All internal units communicate with each other via Profibus. The servo boxes are connected via a fieldbus system to the proprietary microcontroller welding control by Nimak and to the robot control. The master in this arrangement is normally the robot control, which positions the robot, closes the tongs and then initiates the welding process.

Mobile control close to the process

The new interface between the operator and the servo control module is a Simatic Mobile Panel 170 from Siemens, a lightweight portable unit weighing only 1.3 kg with a 5.7" color touchscreen plus fourteen membrane keys and a connecting cable up to 10 meters in length. This mobile solution replaces the previous SCM control panel which used to be stationary mounted at each SCM.
"The enormous competitive and cost pressures in our industry mandate continuous innovation and a high degree of automation to improve the productivity and flexibility of our customers," notes Nimak General Manager Paul Gerhard Nickel. "We've therefore been relying on Siemens for many years as a preferred partner for our automation and drives technology, and we consider switching to the Mobile Panel a cost-effective and practical improvement."

This is particularly true if several welding robots are used in a single production line or manufacturing cell – as many as seven are not uncommon in the auto industry. With the Mobile Panel, the operator gets closer to the action and can obtain a clearer view of how the welding tongs respond to operator inputs. "This also minimizes the risk of inadvertent changes in system parameters or monitoring parameters," adds Nickel. "On top of that, there's the graphical interface of the panel and its intuitive, navigationally assisted touch operation. All these factors make the overall process much more reliable."

The junction box for the Mobile Panel is located in the front door of the SCM. In the configuration chosen by Nimak (with the Basic junction box and Mobile Panel without Emergency STOP button) the Mobile Panel is not integrated into the Emergency STOP circuit. So it can be plugged in or unplugged anytime without affecting the ongoing operation and therefore carried along from servo box to servo box. Its Windows CE operating system supports fast exchanges by minimizing power-up times.

The connecting cable to the junction box carries the Profibus communications to the PLC, the power feed and the signals of two enabling switches in the handle of the device. In accordance with the EN 60204-1 safety regulations, these switches are three-position switches with redundant circuits to ensure the safety of people and equipment in critical situations.

Versions of the Mobile Panel with Emergency STOP button or handwheel, key switch and an illuminated pushbutton meet even more stringent safety requirements (box). The Emergency STOP functionality in Nimak systems is always provided at the robot operator control (see above).

**Rugged and open**

The Mobile Panel fits seamlessly into the line-up of Siemens HMI devices and is configured with standardized tools of the ProTool series, just like any other Simatic Operator Panels and Panel PCs. As a result, it has once again been possible in this upgrade to utilize a part of the prior application and to rapidly generate a graphical-intuitive control for the touchscreen and membrane keyboard.

Nimak has arranged nine command groups on some 20 faceplates. Their functionality ranges from manual movement of the welding tongs and from specifying tolerances to accessing all variables such as forces, travel ranges, torques, penetration depths, wear factors, even motor parameters. Pressures and friction characteristics at the welding tongs can be scaled and optimized at the Mobile Panel 170 with the operator close to the process. And the forces of the servos are freely programmable, so that a customized force profile can be set up for each weld spot, which is then automatically executed by the welding tongs.

"The time-saving benefits of our servo technology furthermore include simple teaching of welding positions and their acquisition by the control," Stausberg emphasizes. "And that's become much more convenient with the graphical Mobile Panel, just like all other control actions. For time-critical switching and control processes with very short response times, it is also possible to configure the membrane keys of the mobile devices as DP direct keys. The functionality is rounded out by a user and error logbook and comprehensive fault analysis that includes the bus system.

Siemens has deliberately designed the Mobile Panel as a machine-level control unit for harsh conditions. The double-walled design and round shape of the housing render the unit extremely shockproof, so it can safely withstand a drop from a height of 1.5 meters. There's no hard drive or fan to be damaged. The protruding "protective collar" for the (here omitted) Emergency STOP button also serves to protect the display in the event of a crash. Both the housing and the junction box are designed to conform to degree of protection IP 65, i.e. they are dustproof and splashproof.
Vertical integration

Three serial interfaces, a multi-point interface (MPI) and a Profibus-DP interface capable of speeds of up to 12 Mbits/second provide ample opportunities for communications with the PLC and other equipment in the automation system. These interfaces also make it possible to program the Mobile Panel remotely in the event of software changes, while the previously used control panels had to be individually reprogrammed locally. Firmware updates too can now be performed from a central location via one of the bus systems – and in minimum time, since there is only one control device per manufacturing cell.

The multi-point interface (MPI) of the Simatic control can be used to consolidate and vertically integrate up to 30 Servo Control modules into a higher-level area control center. This control center manages all process variables and stores them in long-term archives. The center also collects operational and fault messages, which are consequently simple to use for statistical analyses and process optimization. About 100 values must be acquired and stored for each servo tong unit. Because of this large volume of data, the WinCC SCADA system is used for this task. The WinCC process visualization system runs on an industrial-quality Simatic Panel PC 670 and provides a highly perfected fault signalling system and long-term archiving functionality and also visualizes historical data. For even more demanding tasks, several area control centers can be interlinked through a variety of hardware channels via TCP/IP.

"This degree of uniformity, scalability and openness in automation technology is a key factor in the acceptance of Nimak servo welding tongs," notes Stausberg, "and it also reduces some of our engineering effort." Welding specialists at Nimak put the advantages of mobile touch operation to good use for internal tasks too, for instance at the test stand for the servos used in Nimak welding tongs. The stand includes a retrofitted Mobile Panel 170, which makes it easier than ever to establish the static and dynamic force characteristics of different motor types, and to compare them with the ratings provided by their manufacturers.

The higher-level control panel used in the development phase of the test stand has now been replaced by the more powerful combination of a Simatic Panel PC 670 and WinCC – full PC functionality combined with mobile touch.