

More Economical Welding with Ethercat-Based Robots

The use of industrial robots is the current trend, for autonomously active systems raise productivity and lower piece costs. The combination of an automatic installation with a robot based on open PC and Ethercat technology also brings cost advantages in welding processes.

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ARC Specialties are based in Houston, Texas, and are considered specialists in welding and cutting installations. About 90% of these are for use the oil and gas industry. Customers include oil and gas OEM providers of the surrounding area with worldwide operations. ARC informs us that the automation systems on offer are based on the standard technology on the market,

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which guarantees long-term availability. In their choice of installation controls, ARC relies, in contrast to their competitors, largely on open systems, since these will be less problematic than individual conceptions as far as future repairs and maintenance are concerned, they are convinced.

Fast plasma welding process meets automation technology

Many customers of ARC Specialties have already been using plasma welding systems for some time: these are substantially cheaper compared to laser welding but cannot,

however, achieve the same short cycle times. The reason for this is that the conventional plasma welding systems, while providing high-quality performance, work very much more slowly and require a higher heat input than is the case with laser systems. For higher performance in plasma systems, ARC have developed, in their own laboratories, a new welding process, the Tripulse. It is based on the well-known wolfram inert gas process (WIG). The basic idea of Tripulse is the use of three different current strengths, which provides a higher application rate for only a minimal increase in heat input. The new process thus raises plasma welding installations to a new level very close to that of laser systems and is, furthermore, substantially cheaper.

The automated welding robot system ARC-11 RB is used in the assembly of fluid-cleaning installations and was developed to order for a major customer in Texas. The Tripulse welding system was integrated there for the first time. The ARC-11 RB is equipped with a Beckhoff CX1010 Embedded PC with Windows XP Embedded as operating system and TwinCAT NC PTP. This compact embedded PC, mounted on a top-hat rail, controls the entire installation, including a hall portal crane, the robot functions, the operator surface, the induction heater, the parts feed and also all compressed-air driven applications.

As a result, the processes were accelerated, with the steps running in the following automated sequence: The hall portal crane

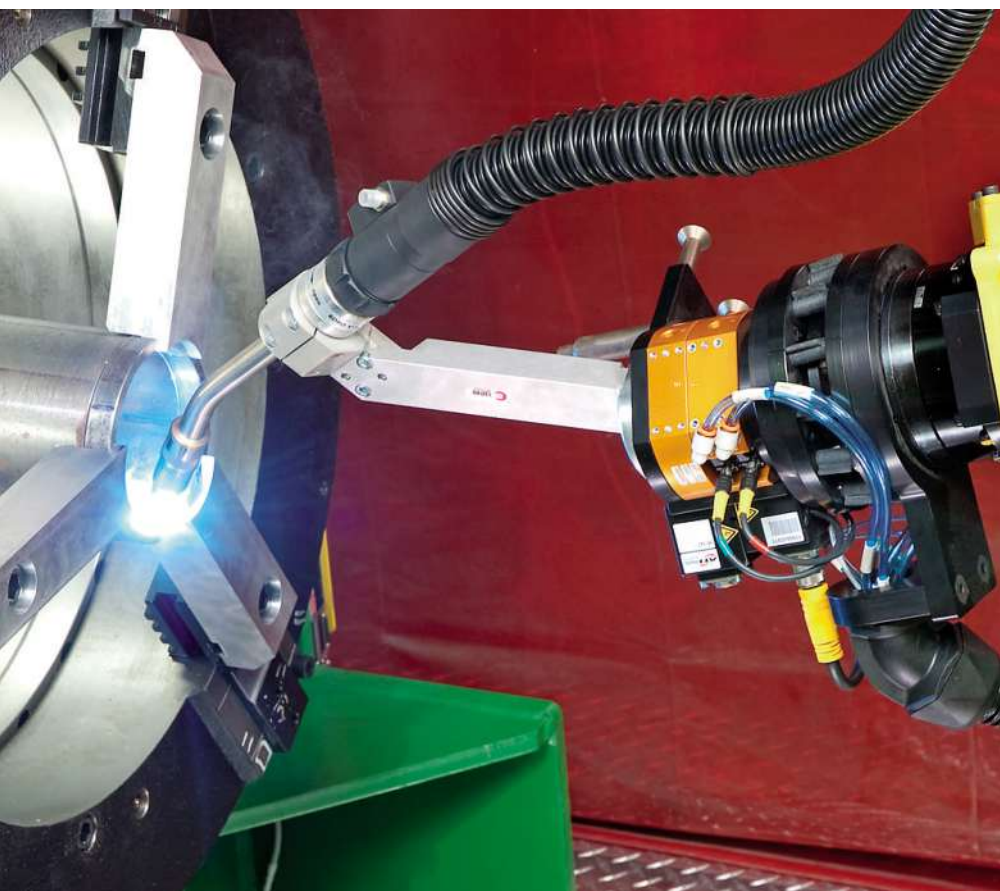


Photo: Beckhoff

The robot has moved from the gripper equipment to the welding torch and welds the end-ring onto the cylinder.

picks up the tube, cut to the specified length, and carries it to a clamping device. Simultaneously, the robot picks up an end-ring from a feed conveyor belt and places it in a second set of clamping jaws. The robot changes from the gripping equipment to the welding torch and connects the end-ring to the cylindrical tube. The two clamping devices open and the hall portal crane removes the component. Then the tube is turned through 180°, the other end is introduced into the clamping device and the process is repeated. The finished product is transported to a deposition frame by the hall portal crane. Practice has shown that the procedure described lasts one to two minutes, depending on the component.

The CX1010 from Beckhoff controls a Fanuc robot of type Arcmate M7 10 IC-50 and a Lincoln Powerwave R350 welding power supply; these are both connected directly to the Beckhoff Embedded PC via a Devicenet Master Module. As I/O system, Ethercat connector modules are used directly in series with the CX1010. With welding power supplies without a DeviceNet interface, or in applications which require an extremely short reaction time, ARC Specialties use the analog Ethercat EL403x output module.

Important robot functions run on a PC CPU

ARC wrote the entire visualisation software for the operator interface themselves, as required for industrial controls. As a result, the machine operator has the accustomed sur-



Photo: Beckhoff

The ARC-11RB is an automated welding robot system for assembling equipment needed in fluid cleansing.

face of a conventional Windows PC in front of him, which simplifies the handling of the system substantially. Communication between operator interface and controller is entrusted to Twincat ADS. Twincat Kinematic Transformation integrates the robot controls into the Twincat automation suite.

Twincat Kinematic Transformation is integrated transparently into the existing motion control world: robotics and motion control functions can be synchronised optimally with Twincat NC PTP (point-to-point axis positioning) or NC I (axis interpolation



Photo: Beckhoff

The robot is seen here at the gripper equipment, shortly before the position change to the welding torch.



The end-ring is located in the second set of clamping jaws.



The robot picks up an end-ring from the feed conveyor belt.



Via a hall portal crane, the tube, cut to the specified length, is picked up and introduced into the servo-controlled clamping device.

in three dimensions). All NC characteristics, such as “cam profile” or “flying saw” (synchronisation of a slave axis to a traversing master axis), for example, can be combined at will on a shared hardware/software platform. It supports various parallel and series kinematics: 2D parallel kinematics, 3D delta, scissors kinematics, scara, Cartesian portals and also crane and roller kinematics.

The programming in these cases is, as a rule, done on the Cartesian coordinate system, with the control system calculating the inverse kinematics for the relevant motor positions. The choice and configuration of

the kinematics is carried out in the Twincat System Manager. There the bar lengths and offsets are parameterised in the kinematics channel – type Delta, for example. For dynamic pilot control, masses and inertial masses are set in advance.

With the help of the “cam profile” and “flying saw” functions, it is possible for the user to synchronise with conveyor belts, for example, so that workpieces can be taken up or deposited there problem-free. The Twincat Kinematic Transformation is optimised for Beckhoff drives of the AX 5000 series. The functions PLC, motion control, HMI and



The Beckhoff CX1010 Embedded PC with Twincat NC PTP software controls the complete ARC 11 RB welding process.



A selection of PC and Ethercat control technology by Beckhoff for robots in handling, production and assembly.

robotics can therefore run on a single industrial PC CPU. This brings the user clear advantages:

- ▶ saving an additional CPU for the robot controls;
- ▶ reduction of engineering costs: configuration, parameterisation and diagnosis in one system;
- ▶ Twincat as well-known and uniform tool for configuration, programming and diagnosis;
- ▶ no frictional losses due to the interaction of different CPUs for PLC, motion and robotics;
- ▶ higher performance and precision due to direct interfaces – complicated communication between the CPUs is eliminated.

Automatic workpiece clamping raises output by 30%

Due to the efficiency of the Ethercat protocol, it is basically possible to monitor all drive parameters of the ARC-11RB, as experience has shown. With Ethercat, the code for customer-specific applications can be written more easily, since everything can be parameterised from a central point – a very significant fact, as most orders at ARC are special constructions.

Despite the complexity of the application, the control concept of the new ARC-11 RB welding robot was ready in only four weeks. Construction and fitting was finished in only three weeks. With the automatic workpiece clamping, ARC Specialties achieves a production output increase of 30% compared to manual assembly. Only loading and unloading of the workpieces is still carried by hand. Ethercat furthermore saves, because of the simple topology, almost one hour in wiring up a single axis. In addition, fewer components and compact dimensions mean that the size of the switching cubicles can be reduced.

Windows-based PC control offers option of remote access

A further advantage, in ARC's view, is the Windows-based PC control, for customers can link into their local network and have the option of remote access or of applying services such as Webex. Remote Control gives support in problem analysis to machine operators throughout the world in finding installation faults and correcting these by changes in the software. This reduces sub-



Photo: Beckhoff

The robot in transition from the gripping equipment to the welding torch.

stantially maintenance and upkeep costs. With the release of TwinCAT 3, the Texas firm sees further potential for cooperation between ARC Specialties and Beckhoff: the advantage is in the integration of the machine programming and the HMI visualisa-

tion into Visual Studio as the only software environment needed. In view of the increase in performance and price advantages achieved so far, ARC tell us that they intend having further machines and robots equipped with Beckhoff controls. **MM**