

In-line measurement station ensures flawless production of the Audi A4 convertible at Karmann

A Fresh Breeze in Quality Control

For numerous car drivers, the name Karmann is not only a synonym for automobile dreams, but also a trademark for high-quality convertibles. In the production line of the new Audi A4 convertible in the Karmann plant in Rheine, an in-line measurement station ensures 100 % process control now.

In April, in time for the first warm spring days, the long awaited new Audi A4 convertible was launched. The "emotional spearhead" of the A4 series, as the Ingolstadt-based car manufacturer itself refers to this open-air model, is built by Wilhelm Karmann GmbH. This well-established company has reached a very high degree of competence in convertible manufacture. More than 12,000 cars of the predecessor model left the production lines of the Karmann plant in Rheine from 1997 until production was discontinued in 2000.

Today, the convertible body shop in Rheine produces up to 110 A4 cars a day in three shifts. Some 40 ABB industrial robots (IRB 6400R) equipped with tool changers are employed in semi-automatic production cells to perform tasks like shielded arc welding, gluing, handling, stud welding and bordering. Before the bodies are transferred from the body framing line to the finishing line, they all pass through an in-line measurement station first.

Absolute Process Control

„This gives us absolute process control“, says Günter Meyer, body shop production manager of the Rheine plant. Four ABB IRB 4400 industrial robots, each equipped with a laser triangulation sensor of the company Perceptron, carry out the measurements. „We chose the IRB 4400 because it offers the best repeatability for this type of application. We measured a repeatability of 0.1 mm. And we definitely need it for this task“, he stresses. To obtain highly repeatable measurement results, the robots calibrate themselves prior to each measurement cycle. For that purpose, they move their sensors to metal triangles with holes and measure these as a reference to adjust their position. Based on these known geometrical features, the robot + sensor system is re-calibrated each time.

Since robots warm up in the course of a work shift and the measurement results are subject to a certain temperature-induced drift as a result of different angular orientations of the robot axes, Karmann has integrated a temperature drift compensation method into the system as well. Via a software program written at the university of Munich in co-operation with Perceptron, the computer calculates each angular orientation separately, taking into account the temperature-induced longitudinal extension. To prevent that plant floor vibrations affect the measurement station and to isolate the robot base area from the plant floor, the machines stand on a float concrete base.

130 Checkpoints Are Measured

A ceiling-mounted conveyor places the car body into the 6 x 8 m cell, and removes it again after about 10 minutes. The measurement cycle itself takes not quite 3.5 minutes. After the calibration cycle, the four robots measure a total of approx. 130 checkpoints.

The measurement system makes use of the principle of triangulation. Carsten Kuhlemann, body shop production planner, explains this principle as follows: „The measurement instrument projects a laser line onto the surface which lights the feature to be measured in a characteristic way. Then, a camera acquires an image of the feature from a different angle, and this information is finally evaluated by algorithms.“ 2D features (e.g. edges) and 3D features (e.g. slots or threaded holes) are measured. Two thirds of the selected checkpoints are 3D features, one third are 2D features. All in all, this yields more than 350 evaluated

measurement results. If all checkpoints are within the defined specification limits, the system reads the ID number of the body and stores it.

Karmann has integrated one of a total of three body shop counting points in the in-line measurement station. The purpose of a counting point is to release cars which have been measured "okay". If the measurements show a deviation, the body is blocked. The blocked body moves on and is not reported at the last counting point. There, line personnel can check which points are not in order and decide whether the body must be reworked.

Fast Response Possible

Using in-line 100 % measurement equipment was a new approach for Karmann. So far, it had been necessary to take bodies out of production and measure them in an external station using conventional touch-probe measurement technology. The inline-measurement station was introduced in order to increase the sampling frequency. It ensures that measurement data is available for all key functions like door insertion, fender and trunk lid assembly or engine mounting. Günter Meyer explains the benefit of this approach: „We observe process developments across all vehicles and are thus in a position to react very much faster. An off-line CMM measuring only one or two vehicles per day does not offer these possibilities.“

Karmann took the decision to build a robot-based in-line measurement station in August 2000. The initial plan of using a rigid sensor mounting frame was dropped because it did not provide enough flexibility. Installation was completed in Mai 2001, and the station was commissioned in October. Series production was launched on January 14th.

Karmann considers this pilot installation in the A4 line a model project for other production lines. Following the decision of the company management, it is planned to install such in-line measurement stations for all bodies built at Karmann in the medium term. To quote Günter Meyer: „By the end of next year, we will have at least three, maybe even four of these stations.“

Facts:

Assembly in Rheine, painting in Osnabrück

For the new Audi A4 convertible, Karmann built an almost completely new plant in Rheine: All that was left of the original production buildings were the walls. 30,000 square meters of production area were emptied, and Karmann invested more than 100 million Euros in state-of-the-art production equipment. The Rheine plant houses the complete production of the A4 convertible – except for the paint shop. For that purpose, the bodies-in-white, sorted by colour batches, are trucked to the paint shop in the nearby Osnabrück plant. In this newly built paint shop, the bodies are coated with environmentally compatible, water-based paints. After the painting and cavity waxing operations, the bodies are trucked back to Rheine for final assembly. The total production time for an A4 convertible – from the first process step in the body shop to the final quality check of the finished car – is five days.