Laser-Assisted Weld Seam Inspection on Audi Sports Cars

1,500 reliably monitored welds per body

"Born on the racetrack. Built for the road." With this slogan Audi is promoting the R8 series sports car. In the body production of this basic 610 hp car, a laser projection system from the manufacturer Z-Laser in Freiburg assists the staff in the manual inspection of around 1,500 welds per body.

Before an Audi R8 sports car is released into the wild, 1,500 weld seems need to be thoroughly inspected. (Source: Audi Sport)

Manual production and quality inspection in the production of high-quality car bodies – this is what you find in the Audi Böllinger Höfe factory of Audi Sport. Here, the Audi R8 super car is built almost entirely by hand. The body construction is also a very special factory operation. The R8 factory is designed for small series production and great variety.

In the first step, specialists weld the front end, the center floor and the rear end from aluminum castings and extruded profiles, then connect the three modules to the substructure. Robots take over the cold connections. The subsequent quality control of the approximately 1,500 welds per R8 body is also carried out by the employees.

The fact that even with this procedure it was necessary to carry out a one hundred percent control of each individual weld seam with absolutely reliable detection of faulty connections is something that was indispensable according to Felix Knoll, head of body construction at Audi Sport: "A body with just one single unclean weld seam no longer meets our high Audi quality standards and is therefore not suitable for sale."

To answer the question of how to perform a one hundred percent check of all welds every day, a colleague of Knoll's conducted technology assessment and research across the group and investigated various technologies for this pur-

Company

Z-LASER Optoelektronik
Freiburg, Germany

Within the past thirty years, Z-LASER developed from a manufacturer of simple positioning lasers to the solution developing partner in the field of laser image processing and OEM in different industries. From Freiburg (Germany) the manufactured laser products are sold worldwide through a network of international distributors. Research, development and manufacturing of all components, and finally the whole laser is made 100 % in Germany. Therefore every Z-LASER is a real „Made in Germany" product. In the headquarter in Freiburg, about one hundred employees develop and create laser modules and innovative laser products and solutions.

www.z-laser.com

Company

Audi Group
Ingolstadt, Germany

The Audi Group with its Audi, Ducati and Lamborghini trademarks is one of the most successful manufacturers of automobiles and motorcycles in the premium segment. It is present in more than 100 markets worldwide and produces at 16 locations in twelve countries.
In 2017, the Audi Group delivered around 1,878 million Audi cars, 3,815 Lamborghini sports cars, and 55,900 Ducati motorcycles to customers. In the 2016 financial year, AUDI AG generated sales of € 59.3 billion and an operating income of € 3.1 billion. At present, around 90,000 persons work for the company worldwide, more than 60,000 of them in Germany. Audi focuses on sustainable products and technologies for the future of mobility.

www.audi.com

pose. The problem was clear: How to check an aluminum weld on an aluminum background? "In our experience, optical methods such as image processing systems which match the whole with a given image, have not been effective previously for this kind of task," says Knoll. "Other technologies such as computed tomography, MRI or augmented reality were also possible candidates, but in the end they also proved to be inappropriate. In the end we opted for a laser projection system from Z-Laser Optoelektronik, considering the many criteria that have to be met."

Numerous criteria

The criteria mentioned included the requirement that the system had to make it possible to check every weld of every single body within the cycle time in order to avoid delays in the production flow.

It was also neccessary for the implementation period to fit the conditions in the production of the R8 models, as Knoll explains: "The implementation of the system had to be feasible in terms of time and space. The space in such a plant is naturally always limited. The main difficulty here in our body construction was that we had to integrate the system into an existing plant, i.e. the space for such a laser cell was limited and we had to realize the system with the available space. That's why we installed suspensions, lifting platforms, and peripherals such as power and data cables so that Z-Laser would be able to put its laser system into operation without any problems."

In addition to these technical and space constraints, another prerequisite for the realization was that the system had to remain within a specified budget.

Felix Knoll: "The new laser system has helped to make our test procedures in body construction significantly more efficient." (Source: Audi Sport)

The Z-Laser laser system was integrated into the construction space of the plant. (Source: Z-Laser Optoelektronik)

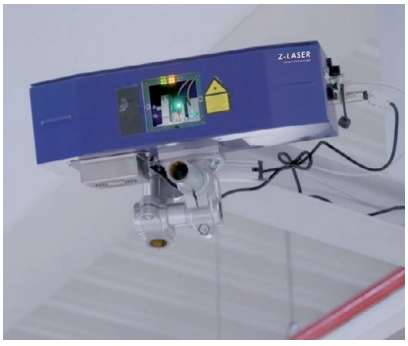
Using a defined, standardized test procedure each weld is always queried at the same time. (Source: Z-Laser Optoelektronik)

"However, in view of the large number of welds and the required reliability of the quality inspection we definitely wanted to provide our employees with assistance in testing all welds," emphasizes Knoll. Already in the technology search phase, he and his colleagues came across Z-Laser, which has specialized in the production of laser sources for innovative customer applications over several years. "At the beginning of 2016, Z-Laser was on-site with a test device for demonstration purposes, and we were quickly convinced that the system presented could meet our requirements." Detailed system feasibility studies were followed by final system selection and assembly, and in October 2016, Z-Laser received the order from Audi.

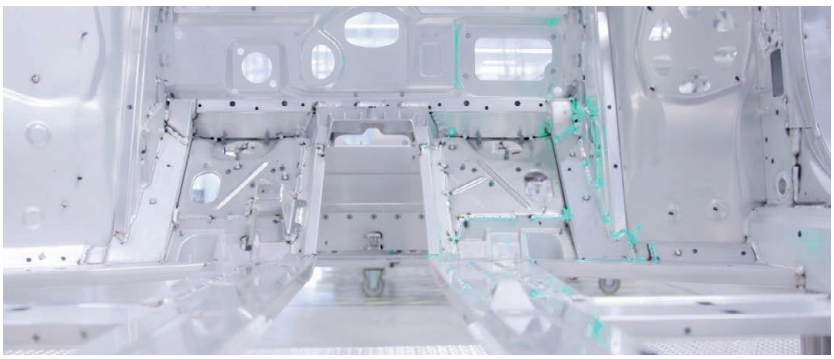
Subsequently, the Freiburg-based company assisted Knoll and his team with the integration of the laser system into the plant as well as with its programming. In April 2017, the system was put into operation for testing of bodies for Audi R8 Coupe as the first model variant. Only a short time thereafter, the complete series program could be displayed on this system.

Laser projection shows test points

The Audi engineer describes the course of the test as follows: "We map our 3D body dataset in the system, and the Z-laser system projects this dataset onto the actual body from different directions via a total of six LP-HFD2 laser projectors. For this purpose, the bodies to be checked are first sent to reference points via the provided conveyor equipment. The employee then selects the correct position and the current model and can then click through the steps of the inspection via a remote control of the laser system similar to a PowerPoint pre-



One of six laser projectors that indicate start and end points of a weld by projecting green laser lines onto the body. (Source: Z-Laser Optoelektronik)



A green laser source produces a maximum brightness impression on the viewer. (Source: Z-Laser Optoelektronik)

Display of welds on the body with one of the six laser projection systems in the background. (Source: Z-Laser Optoelektronik)

During the quality control, the employee in charge clicks on the remote control of the laser system through individual steps of the inspection, similar to a PowerPoint presentation. (Source: Z-Laser Optoelektronik)

sentation. Depending on the position of the weld, a suitable laser projector then shines green laser lines onto the body, thus indicating to the employee the target position with the start and end point of the welds. On this basis, he can compare the projection and the actual weld and easily recognize whether the single weld is present and whether the given length is correct. However, the quality of the weld must be assessed by the employee himself." A green laser source was chosen to produce a maximum brightness impression on the viewer.

In the production process, three employees are responsible for the visual inspection. One checks the welds using the Z-Laser projection system. The other two from the Quality Control Group (QCG) inspect these visually in different stages of production, so that each volume is covered in the 4-eye principle. According to Knoll, employees need to be very experienced in these tasks and not only have to know all production volumes, but also their location in order to be able to identify faulty processes and correct them if necessary.

Efficient solution

Knoll is very satisfied with the solution, which has been running smoothly for several months now: "We have become significantly more efficient with our test procedure and can now integrate more test volumes into the QCG employees' workflow, which were previously controlled elsewhere."

Among other things, the Audi engineer finds it very useful that thanks to this application, "we can decide with the help of software, at which time, in which position of which laser a certain weld seam position is displayed. We have thereby a defined, standardized test procedure, i.e. every weld is always queried at the same time. "In this way, it is possible to quickly and easily train new employees on this system, so that they can independently carry out the inspection of a body.

The system shows a high degree of flexibility for the adaptation of test procedures, e.g. if a new model or model changes lead to a change in the welds, according to Knoll: "The CAD data of the volumes to be tested serve as a basis. This dataset is assigned a time in the test procedure and defines in which position and from which laser the projection should take place. Using a small program, new data packets are converted into projection data. If they are small volumes, e.g. a modified weld, we are able to implement the corresponding change in the test procedure within a few minutes. "In a new model, the definition of the test procedure and the definition of the projection without fine-tuning requires a workload of about two to three weeks. "However, we can implement this without further external support," emphasizes the project manager on an important advantage of the system.

Knoll rated the collaboration with Z-Laser as very good and problem-oriented: "The project has been optimized with helpful suggestions from Z-Laser and is now an integral part of optimizing the manual inspection of welds in the production of our R8 models."

*

The article was written by Peter Stiefenhöfer, PS Marcom Services, Olching, Germany, on behalf of Z-Laser.

Z-LASER Optoelektronik GmbH
Merzhauser Str. 134
79100 Freiburg
Tel.: +49 761 296 44 44
Fax: +49 761 296 44 55
E-Mail: info@z-laser.de
www.z-laser.com