

Genius HWI IQR - a state-of-the-art Inverter Power Supply with Adaptive Regulation System to Assure the Quality of Resistance Spot Welding

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Abstract

There is a new procedure and regulation system that assists the user of the resistance welding process to weld a consistently “safe spot” weld and, at the same time, helps to stabilize the welding process.

With the electrical sizes welding current and welding voltage there are two relatively easy to ascertain values available in correlation to the welding quality. By the high time scale of the medium-frequency technology the regulation speed at resistance welding can be adjusted to the real welding process. New algorithms developed by extensive testing series in the laboratory and in practise assure a constant welding quality under highly varying conditions of the surroundings. Depending on the application the user can upgrade the inverter GeniusHWI with this IQR regulation.

In the report this inverter generation GeniusHWI and the regulation system IQR is described with an outlook towards new technologies of fast parameter setup systems.

SYSTEM GeniusHWI AND XPEGASUS

Behind every system the user will find a powerful tool to use. In this case the system consists of two core components where one does the job and the other is the interface to the user. The component doing the job is called GeniusHWI and the user interface is called **X**Pegasus.

GeniusHWI is a new hardware platform for medium frequency welding which is based on a complete new internal structure compared with earlier systems. It co-exists with the other known inverter series of Harms & Wende. The core is an integrated control panel in the upper front of the inverter where system boards are inserted into slots (PC-like). Behind this backplane control panel stands an operative system which is also used in aerospace as well as in military applications. The system has been extensively tested under hard conditions over a longer period of time.

The heart of the inverter is the welding board, of course. On this board new powerful functions working together and giving the inverter unique functionality which opens new possibilities in resistance spot welding. Since different software components run on the same board and the board rack is inside the inverter, we talk about a fully integrated system.

One possible software component is the welding part in constant current mode CCR or the adaptive welding package IQR. Others are the process monitoring PQS^{weld} [5] or the archiving of process data.

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Figure 1: GeniusHWI inverter

Since a number of years Harms & Wendt provides successfully its adaptive welding package IQR. This regulation system IQR is a tool box which uses different strategies to achieve constant spot diameter sizes. By setting just a few parameters the user adjusts his program and lets the inverter do the work. IQR is suitable for robot applications as well as for manual gun operations. Since a manual gun is positioned at different welding tasks depending on the user, this is the most demanding application with respect to the gun.

The tool box has been extended by monitoring on different levels like current, voltage, displacement (existence) and other levels.

GeniusHWI provides up to 512 weld schedules in adaptive welding mode IQR or in constant current mode CCR which enables many possibilities to the user. Most useful is this feature for users making a number of different products in one production cell.

The combination of GeniusHWI and X Pegasus offers different levels of monitoring and database handling for archiving. Basic parameter monitoring up to complete process monitoring: the user has the choice. In other words the functionality of the inverter can be configured on the demands of the user. The top end of the line of monitoring is the real inline process monitoring system PQS^{weld}. This system offers functions for quality assurance of the welded spots with powerful analysis functions. It is not a statistical process control (SPC) rather SPC is a subset within PQS^{weld}. Originally these sophisticated analysis functions are developed on the PC platform and are now ported to the embedded environment of the welding controller.

On the same welding board PQS^{weld} runs now in simultaneously. We have now a full operating welding along with a full process monitoring in one inverter unit. This is unique on the market.

Full Data Integration

The focus of our development was to speed up the time-to-target, means to shorten the time until suitable weld schedules are achieved and to make parameter finding easier.

Full integration of all process data in the welding schedule:

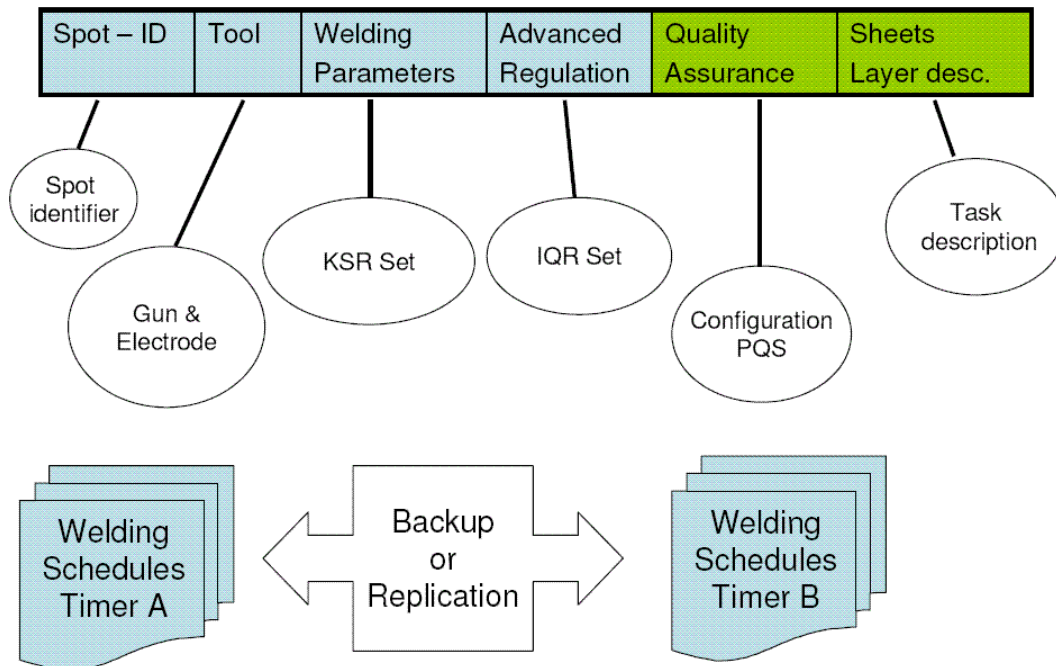


Figure 2: Full data integration in the welding schedule

We integrate quality assurance configuration and sheet layer descriptions to our welding schedule. As extension to this additional data is saved during backup then just the welding parameters and tool description. Other relevant data is saved also to copy to other parts of the production line or to restore data after a tool change.

This speeds up the reconfiguration process and reduces fault probability.

IQR Regulation System

The IQR regulation system handles variable disturbances inline during the welding. One important issue is tool life quantity managing the electrode degradation. Other issues are misfit of the sheets, bypass of current, warming up of tool and varying material properties.

IQR measures the resistance change during the process and follows a complex rule system to get ideal resistance time behaviour.

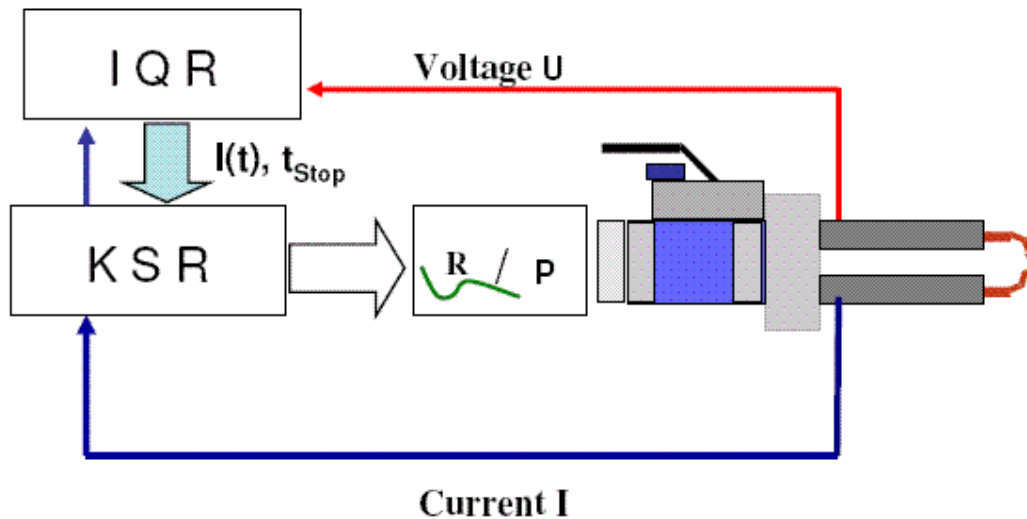


Figure 3: IQR technical principle

IQR contains a special rule system for fine tuning based on the analysis of the resistance signal and on a coarse granularity a rule system based on power heat balance and minimal needed energy. Over 8 years of experience with IQR enables us to fix the configuration of the rule system.

As a result the user has to fix only 3 parameters in the welding schedule starting from an existing CCR schedule or from a fixed table we support by our service. The Rapid Setup system will support IQR in future to get a fast time to target.

Analysis Results Concerning Disturbance Variables

Most important disturbance factors during welding are misfit of sheets and bypass current. The following welding results



Figure 4: Regulation of bypass and misfit [1]

shows the positive effect of the regulation system. Both sheets were separated by a 3 mm Cu space holder and the distance between space holds was varied between infinity, 40 and 25 mm. In CCR the spot diameter decreases with decreasing distance between space holders. IQR is able to compensate the effect of massive misfit and bypass current.

Looking at the tool life quantity and electrode degradation the positive influence of the regulation system is reported in a public study by an independent welding institute [1]. In this study the time between welds was strongly varied. It results a tool heating up and cooling down. The tool life quantity for the CCR welds shows the expected decrease in the spot diameters.

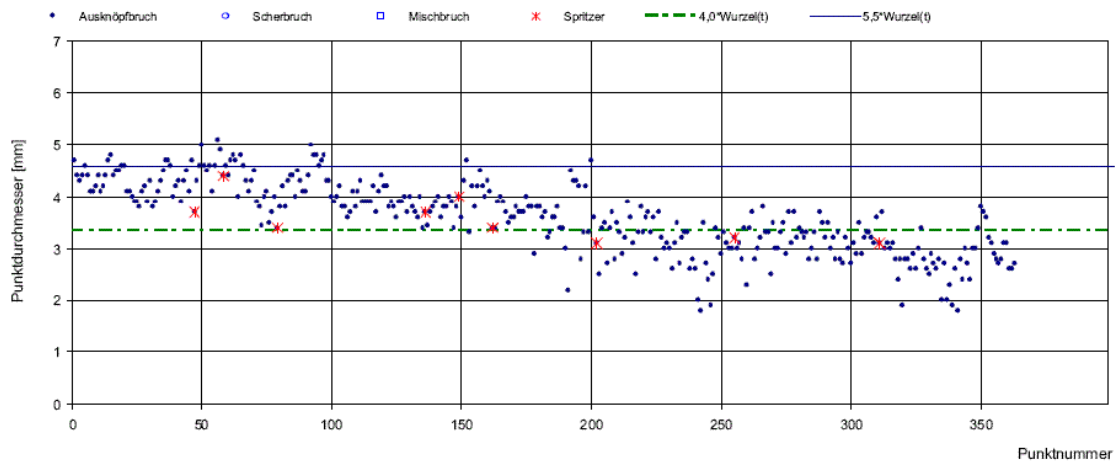


Figure 5: Tool life quantity with CCR

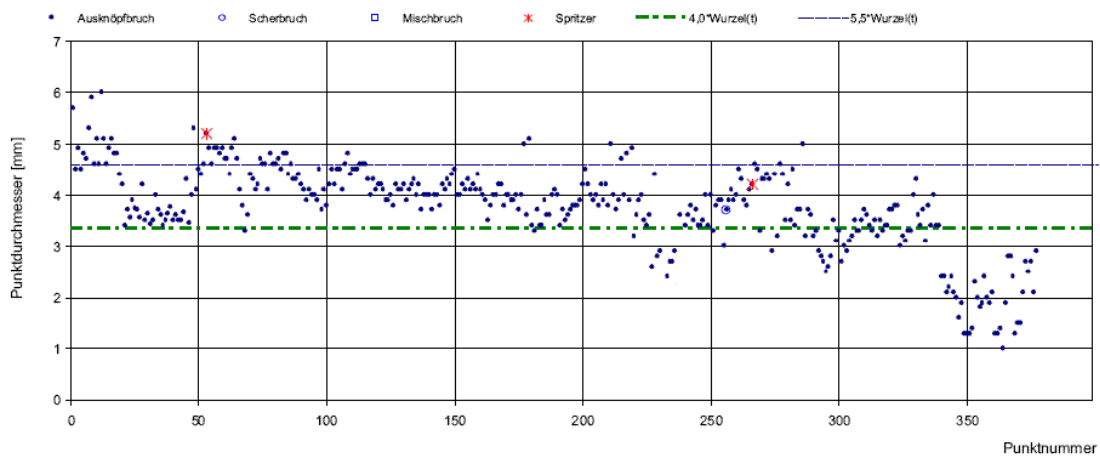


Figure 6: Tool life quantity with IQR

The IQR regulation system improves the situation and is able to compensate the situation.

At some points IQR isn't able to compensate strong disturbances. IQR has a configurable splash detection system directly acting on the output current. Depending on the material the behaviour after the splash with higher or lower current can be configured. The other situation is expiration of time with minimal energy not reached. Splashes and time expiration are marked in the archive records of the weld.

More sophisticated monitoring systems like PQS^{weld} are able to monitor process drift to a statistical reference weld ensemble.

Fast Time To Target

To shorten time-to-target we present you in this procedure a new functionality which are results of the international research projects MyCar [2] and XPRESS [3]. The results presented below are evaluated by a consortium of several partners and take many different views and experiences from our collaborators into account.

For the traditional way of welding schedule determination a lot of knowledge about the spot properties of the welding task is required. Using the new technology by GeniusHWI to determine the electrode properties and an innovative way of welding schedule prediction a PC based knowledgebase allows the input from CAD data and robot spot sequence. For the user a new way of parameter setting is possible.

Speedup Time to Target:

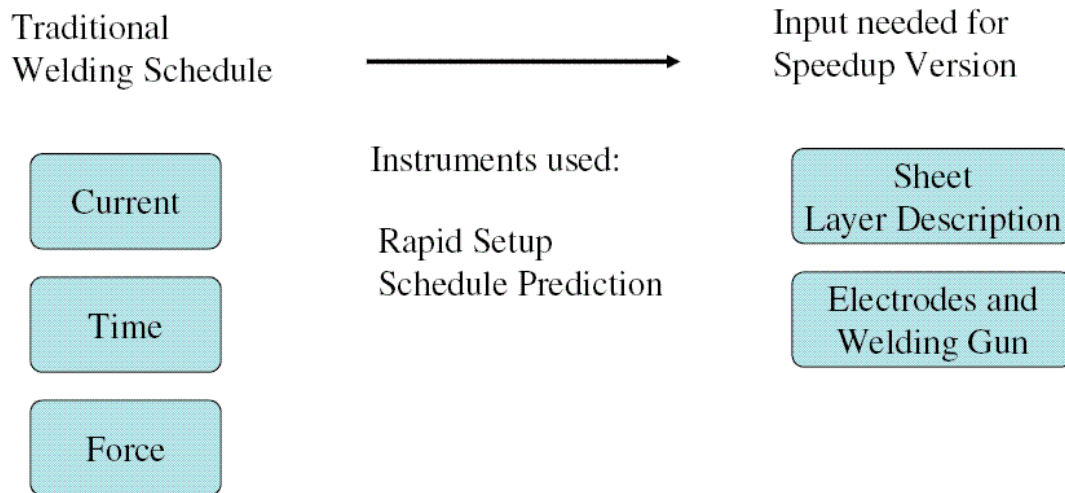


Figure 7: Speedup timer-to-target

One working package of the international research project MyCar results in the Rapid-Setup technology of the GeniusHWI. Rapid-Setup analyzes the measured resistance curve from a welding and suggests a new parameter set.

Typically by 3 iterations the algorithm is able to result suitable spot diameters. Rapid-Setup needs a sheet layer description and electrode properties as input. Output is a final validated welding schedule and property factors describing the electrodes. These factors are usable for other welding tasks, too. The validation has to be done by measuring the spot diameter.

The customer is automatically directed through the setup workflow.

Rapid Setup Workflow:

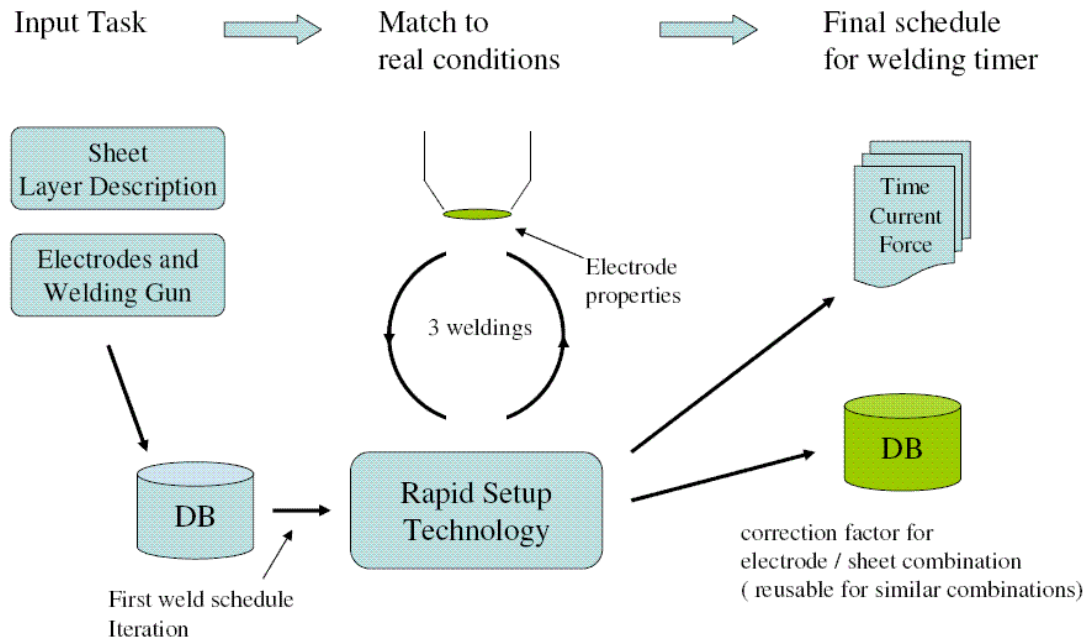


Figure 8: Rapid-Setup workflow

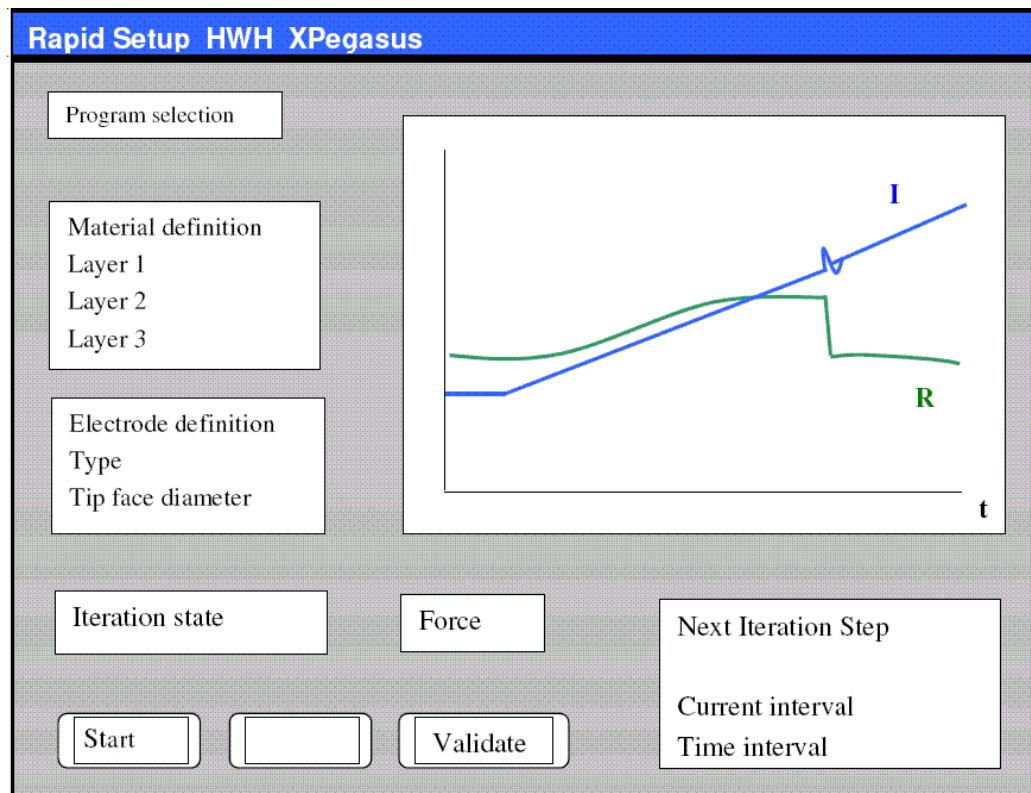


Figure 9: Rapid-Setup user interface

The other working package from the research project XPRESS [3] allows an extrapolation to diversified welding tasks and sheet layer combinations (TDD ‘Task description document’). It depends highly on knowledge bases build up by known welding schedules, material, gun and electrode descriptions. The XPRESS project results in a schedule prediction (Welding Experton) system. The XPRESS schedule prediction package will coordinate the knowledge base access and batch task preparation of the SORPAS [4] simulation package.

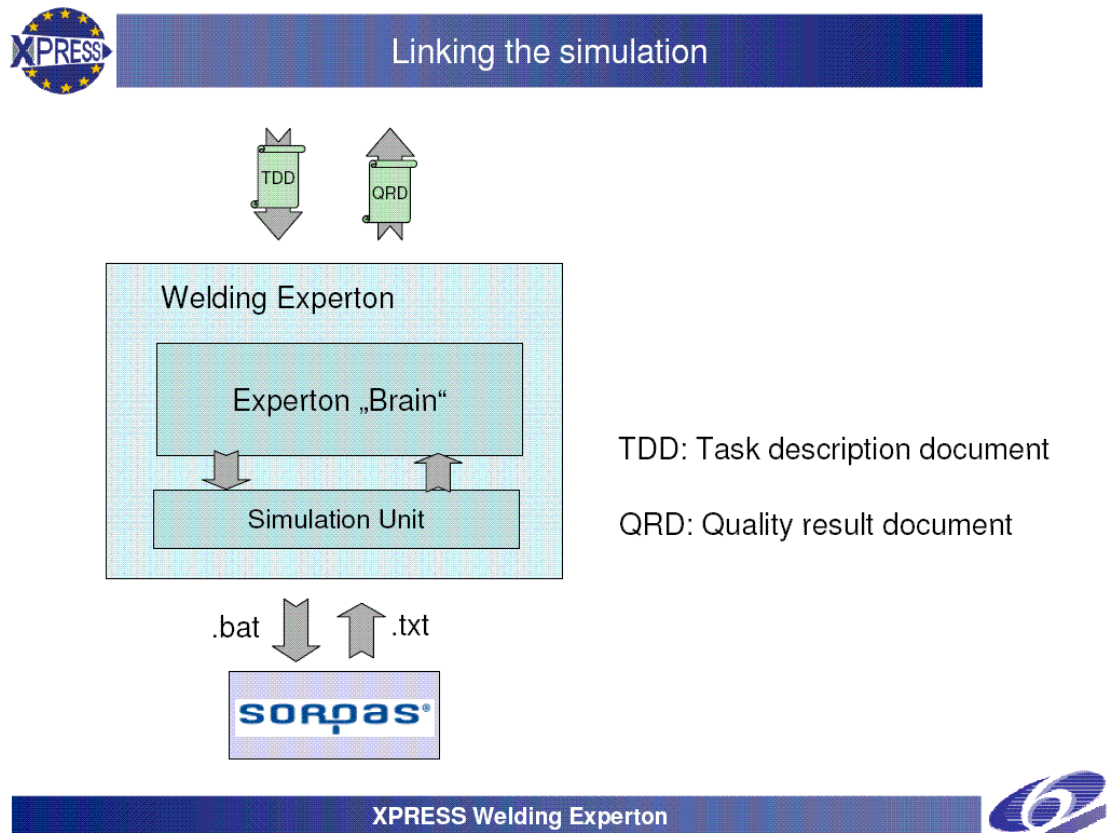


Figure 10: Linking the simulation package SORPAS to the schedule prediction system

In future it will be embedded in the XPEGASUS framework. The end user will be in a position to configure a GeniusHWI welding schedule directly with a sheet layer and an electrode description.

Summary

With the GeniusHWI system you have a powerful resistance welding system with a great future at hand, which enables the user to meet even future requirements in the joining technology. The integrated IQR regulation module is a very versatile and powerful tool of a new quality for process stabilizing in spot welding. This tool enables the user to adapt very fast to new welding tasks, in automated or robot systems as well as manual spot guns.

The new Rapid-Setup system leads to faster and more reliable commissioning of plants and results in a high quality level. The GeniusHWI system is capable to activate the process monitoring system (PQS^{weld}). Beside the stabilization of the process through the IQR

regulation an online monitoring of all welding spots is guaranteed. With the possibilities of the inverter system GeniusHWI you achieve an economic and high-quality production fast and safe. The applications can be seen in automotive body plants over automated welding machines and white ware fabrication even in manual resistance welding systems.

References

1. Untersuchung innovativer Geräte zur Qualitätssicherung beim Widerstandspunktschweißen, Abschlussbericht , SLV Duisburg, Forschungsvorhaben AiF – Nr. 13.568N
2. EU Project: MyCar, Flexible assembly processes for the Car of the Third Millennium FP6-026631-2
3. The consortium includes major stakeholders of the European automotive industry, system suppliers, ICT providers, SMEs and R&D performers.
4. EU Project: XPRESS, FleXible Production Experts for reconfigurable aSsembly technology IP.
5. The IP Consortium includes major stakeholders from the relevant branches like automotive, aeronautics and electronics, end users and production system suppliers, ICT providers, SME and RTD performers,. Harms & Wende GmbH acts as the IP Coordinator.
6. Both XPRESS and MyCar are co-funded by the European Commission as Integrated Projects (IP) under the 6th Framework Programme.
7. SORPAS, simulation package for resistance welding (www.swantec.com)
8. PQS^{weld}, real inline process monitoring system (www.hwh-qst.de)