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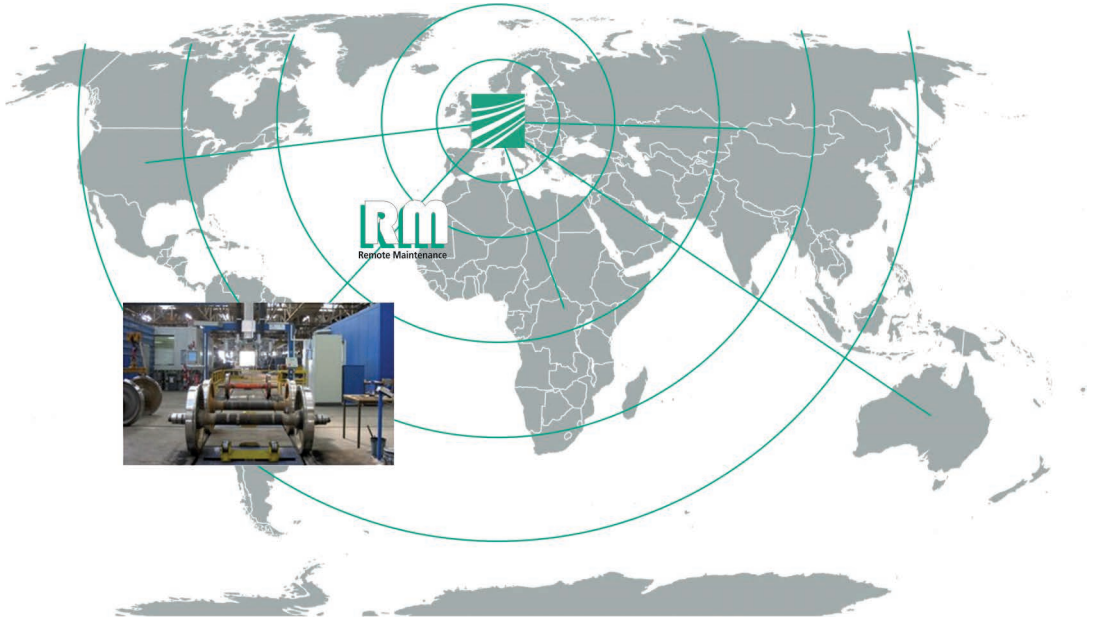
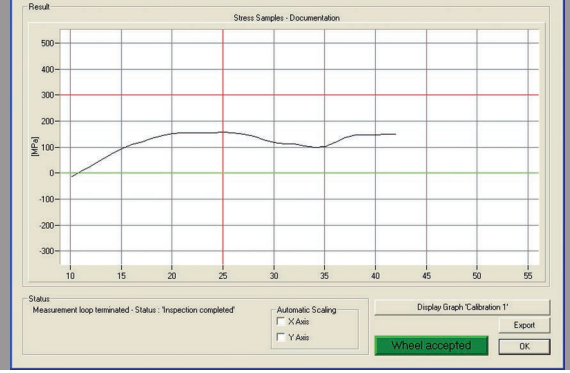
# UER SYSTEMS FOR STRESS MEASUREMENT IN THE RIM OF RAILROAD WHEELS



*UER system in operation*

*UER with pedestal base*




*Result representation*

## Situation

Brake shoes as used for braking wheels in freight cars cause frequently recurring heating and cooling processes in the rim of the wheels. Thermal and mechanical loads change the residual stress state of the rims by gradually transforming the production-induced compressive stress state into a circumferential tensile stress. Due to the wheel-rail contact small cracks are almost omnipresent in the tread. By the influence of the mentioned tensile stresses, these cracks can grow until the wheel breaks.

To determine the residual stress state of freight car wheel rims, the **UER** (**U**ltraschall-**E**igenspannungsmessung an **R**adkränzen) test systems use the so-called acousto-elastic effect, that is the influence of strain and stress states on the propagation velocity of ultrasonic waves. The magnitude of this effect depends on the propagation and vibration direction of the ultrasonic wave in relation to the principal directions of the strain or stress state. For stress measurement a linearly polarized shear wave is induced couplant-free by an electromagnetic acoustic transducer (EMAT) from the inner surface into the wheel rim. The EMAT is moved in radial direction along the rim height and a highly accurate time-of-flight measurement is performed in millimeter increments with the vibration direction of the polarized wave first tangentially, then radially. As the principal stresses in radial direction are small and not significantly influenced by the braking, the difference of the time-of-flight values together with the material-specific acousto-elastic constant yield the principal stress in the circumferential direction.

Since delivering the first units in 1992, until today a large number of stationary and portable UER systems of the Fraunhofer-Gesellschaft are operating worldwide in the workshops of railway companies, wheel manufacturers and service providers.

## Objective

In 2011, an elaborate redesign of the hardware and software has been started in order to take into account the steadily shortening innovation cycles and to guarantee a long-term service and support to the industrial customers. The objective was to improve the adaption of the software to the plants´ infrastructure while maintaining ease of use in application. Furthermore, the components of the purchased parts should be chosen in such a way that the longest possible availability can be ensured without resuming the development process.

## Realization

To reduce electromagnetic interference, the transmission path between base unit and manipulator was implemented entirely digitally. Therefore, it was necessary to integrate the ultrasonic electronics as a miniaturized frontend system into the manipulator. Ultrasonic transmitter and receiver, preamplifier, filters, digitization and FPGA unit for fast preprocessing of the signals have been specially developed for this application and adapted to the small space available in the manipulator housing.

When choosing the housing highly modular design was emphasized. The basic unit of the UER system comprises a terminal housing with integrated 19-inch TFT screen, the computer and the power supply unit. The result of the automatic stress evaluation is clearly displayed by signal lamps.

When ordering the system, the customer can choose which design of the terminal housing is best suited for integration into its working environment. A floor-mounted pedestal version, the attachment to a movable arm, or the delivery of the equipment on a mobile trolley are available. The trolley can be optionally equipped with a battery power supply, and thus flexibly be used in the plant at different locations.

Integrated into the network structure of the workshops, the system software allows a wide variety of documentation options. The log report can be generated customer-specifically with or without the display of the measured stress curves or as an XML log file on a server in the factory network.

## Results

Nowadays, considering practical experience the stress measurement systems are optimally adapted to the needs of modern workshop infrastructure. By miniaturization of electronic components, it was possible to integrate the basic unit into a terminal shell that is available with either pedestal, svivel arm, or a mobile trolley. While maintaining ease of use for the inspection personnel many opportunities for customer-specific documentation and log preparation were added. An optionally retrofittable software evaluation module specially designed for testing newly manufactured wheels in correspondence to DIN EN13262 is available.