AMEPA
Process Measurement Systems

Perfect Surface with Online Waviness Measurement

WMS 100



Measure it. Control it.

AMEPA
WMS Online waviness measurement

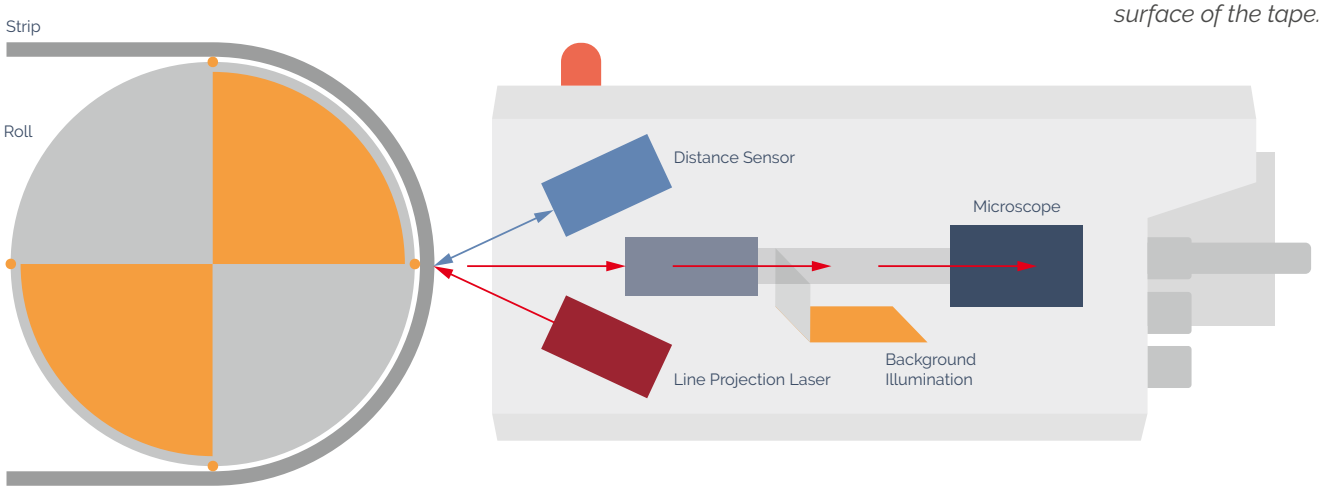
More and more automotive manufacturers are requiring steel producers to guarantee waviness in addition to roughness when it comes to the fine surface finish of galvanised strip.

If the waviness of a steel sheet is above the specified limits, the steel user generally does not accept the annealed and galvanised product for high value-added applications. Subsequent processing steps, especially painting, can lead to poor quality and thus downgrading. As a result, direct online measurement is required to fully assess surface quality along the entire coil.

Basically, surface topography refers to the horizontal and vertical information about the height change of the surface and can be divided into (micro-) roughness and waviness. Unlike roughness, which only includes the height variations with a horizontal spacing or wavelength of up to 0.8 mm or 2.5 mm in the case of steel, waviness refers to structural components with longer wavelengths.

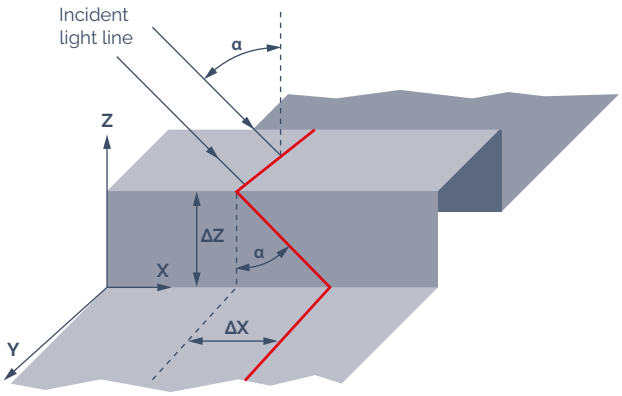
Waviness generally means the shape deviation of a surface in the wavelength range above the roughness, which leads to clearly visible distortions in the reflection of a high-gloss painted surface. The WMS 100 waviness measuring system is based on the SRM surface roughness measuring system, which works on the basis of a line projection, a two-dimensional laser triangulation method.

The laser projects a line onto the tape, the microscopic resolution high-speed camera „sees" the image on the surface of the tape.



Measuring principle of the online waviness measurement

Based on light-section measurement, a two-dimensional laser triangulation patented by the Centre for Metallurgical Research (CRM Centre de Recherches Métallurgiques, Liège) for online waviness measurement and industrially implemented by AMEPA GmbH, an optical measurement is performed on metal strips. In this non-contact measuring method, an extremely fine laser line is projected at a defined angle onto the surface to be inspected. An image of the line is taken with a high-resolution industrial microscope. The surface profile of the strip can be determined directly from the distortion of the laser line.



α: Angle of incidence
Z: Height axis
ΔZ: Height variation (to be calculated)
ΔX: Line position variation (measured)
$\Delta Z = \Delta X \cdot \cot \alpha$

Measurement of Change in Altitude

The future: Targeted control of waviness on the basis of concrete data.

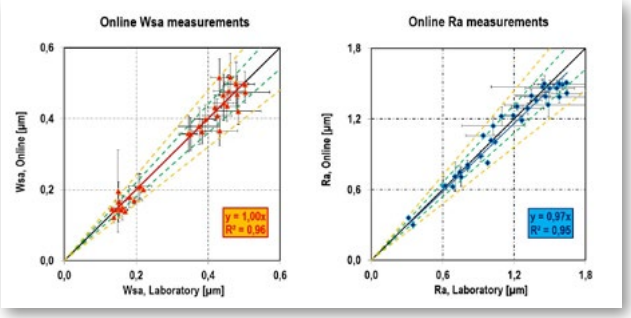
Waviness with poor quality

Advantages of the online waviness measurement

AMEPA online measurements of the surface profile bring fundamental advantages for the customer:

- Visualization and documentation of the waviness and roughness distribution over the entire strip length
- Timely detection of waviness and roughness values outside the tolerance, e.g. caused by
  - Roughness of the starting material
  - Wear of work rolls
  - Inadmissible/incorrect process parameters
- Provision of online data to determine the optimum time for changing the work rolls
- Provision of the waviness value Wsa and the roughness value Ra as input for process control
- Reduction of the number of offline measurements with stylus instruments

The figure illustrates the good correlation of the parameters determined by the WMS waviness measurement system with values for waviness and roughness measured in the laboratory.



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Versatile

- Non-contact measurement on all quality surfaces, made of aluminum (Millfinish and EDT) or steel (GI, EG, GA, ZM), each EDT, EBT or PRETEX texturing.
- Acquisition of Wsa, Ra, RPc and Rz in one measurement recording, adjustable to traversing measurement tracks (e.g. for strip centre or strip edges)
- Automatic adaptation to the strip thickness
- Measurement independent of lighting conditions

/02

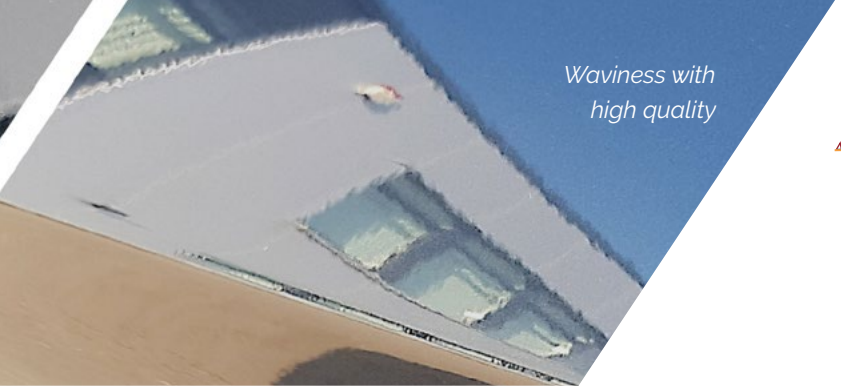
Efficient

- Reduction of time-consuming stylus measurements in the line and in the laboratory
- Wsa measurements up to a strip speed of 180 m/min possible
- Early detection of waviness values outside the tolerances, for optimal process control, short response times, high dynamics

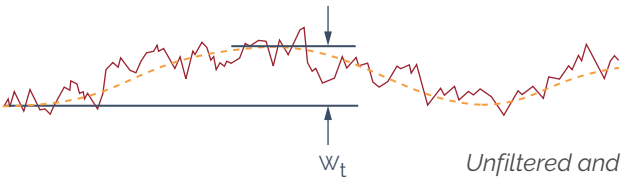
/03

Informative

- Documentation of measurement data of waviness and roughness parameters with picture evidence over the entire length of the coil
- Microscopic image of the surface structure
- Validation unit for checking the measuring system
- Versatile visualisation options of the WMS system



Waviness with high quality



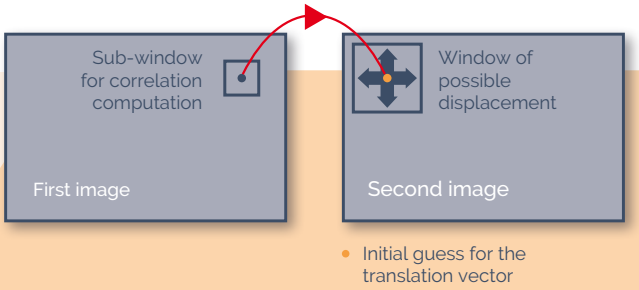
Unfiltered and filtered profile display

WMS Visualization

The visualization for the waviness measurement is structured in the same way as that for the roughness measurement. In addition to the waviness values Wsa and Wa 0.8, the roughness values Ra, Rz, RPc and other values can be calculated and displayed. The WMS system thus offers versatile visualization options for the data.

The example screenshot shows the online Ra, Rz, RPc and Wsa results over the coil length, with the last microscopic image. As soon as the waviness or roughness moves outside the tolerance of the customer-specific tresholds, warnings and alarm signals are displayed. The operator can immediately take necessary measures without notable loss of time.

Microscopic online triangulation by projection of micro-lines in combination with image stitching to achieve large measurement lengths (European Patent EP2517799, 26/04/2011)



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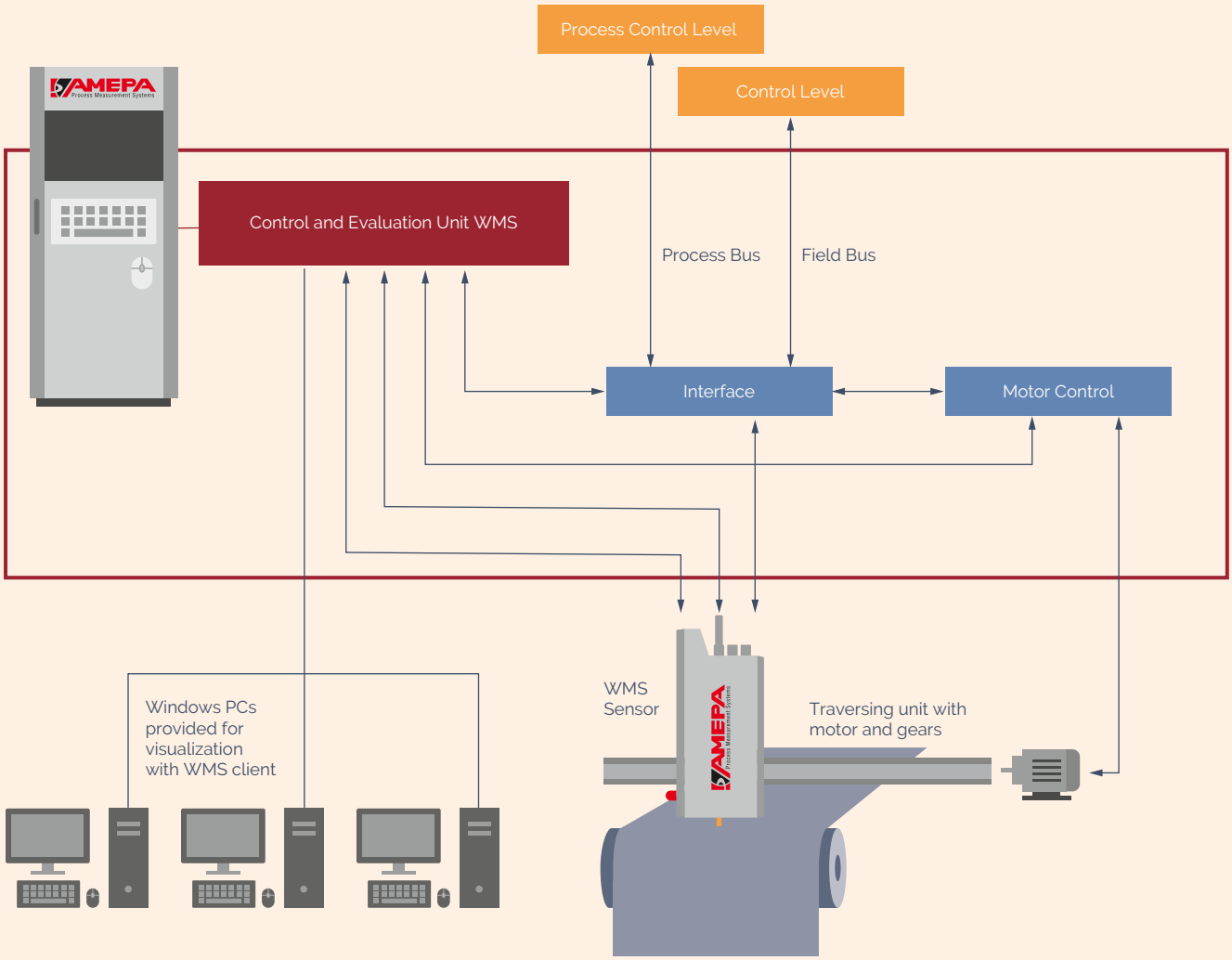
Precise

- Measuring range for Wsa 0.1 to 1 µm, Measuring range Ra 0.3 to 3 µm, RPc 30 to 120 cm^{-1}
- Resolution Wsa 0.001 µm, Resolution Ra 0.01 µm
- Measuring frequency Wsa measurement up to max. 1 Hz
- Ra measurements with selectable cut-off of 0.8 or 2.5 mm
- WMS measuring direction parallel to the rolling direction
- Measuring line 1200 x 3.5 µm (local resolution like stylus tip)

The Stitching Procedure

In order to achieve the measuring length of 30 or 50 mm required for the waviness measurement, the microscopic individual images are taken in an overlapping manner. The stitching algorithm determines the alignment and the displacement of the individual images, thus they can be combined to form a long image strip.

Thus obtained laser line, extended across all recorded images, can be detected and evaluated to determine the waviness and roughness parameters.



WMS Technical Specifications

- Measuring range for Wsa 0.1 to 1 µm, measuring range Ra 0.3 to 3 µm, measuring range RPc 30 to 120 cm^{-1}
- Resolution Ra 0.01 µm
- Resolution for Wsa 0.001 µm
- Strip thickness 0 to 6 mm
- Working distance sensor - strip 25 mm
- Maximum strip speed up to 180 m/min
- Measuring frequency max. 1 Hz due to image stitching
- Measurement for Ra with selectable cut-off of 0.8 or 2.5 mm
- Field of view 1.2 x 0.4 mm, measuring line 1200 x 3.5 µm (≈ spatial resolution like stylus tip)
- Automatic mechanical adjustment to the strip thickness
- Motor-controlled positioning and alignment of the sensor
- Measurement independent of lighting conditions
- Fast emergency or escape speed; typically 1 m/s (max. approx. 2 m/s)
- Sensor dimensions approx. 240 x 280 x 480 mm
- Sensor weight approx. 22 kg

Components and interfaces

The measuring device is controlled via a control cabinet with 19“ racks. The control cabinet has the dimension 800 x 600 x 2000 mm³ (W x D x H) with an additional base of 200 mm for the installation of the supply cables.

The control cabinet has an air-conditioning unit and covered swing frame. The pre-assembled cabinet wiring is designed according to DIN. Furthermore, the computer control unit (CCU), the motor control and the customer interface (ProfiNET, Profibus and others) are located in the control cabinet, which provides power supply of 230 V, 3.5 kW. A built-in monitor with keyboard and mouse enable operation of the measuring set-up and visualization software.

The WMS waviness sensor is mounted on a traverse in the plant.

A linear drive traverses the sensor over the entire width of the coil..

Online measurement of waviness - contactless over the entire length and width of the finished strip surface in routine operation - is one of the industry-typical pioneering achievements of AMEPA GmbH.

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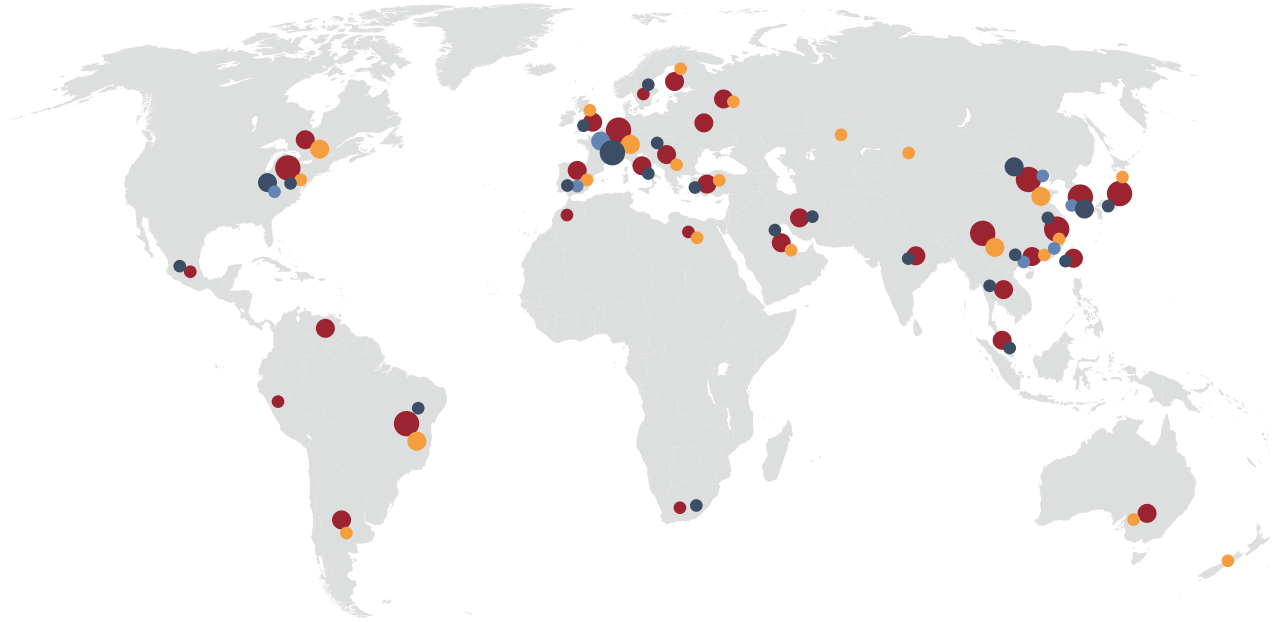
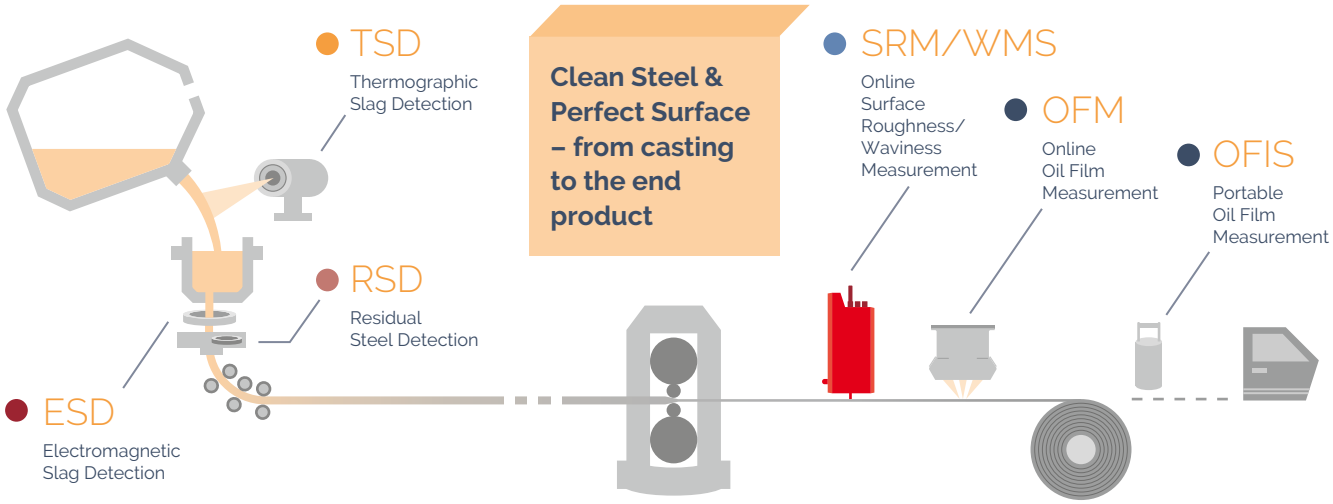
Worldwide successful





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