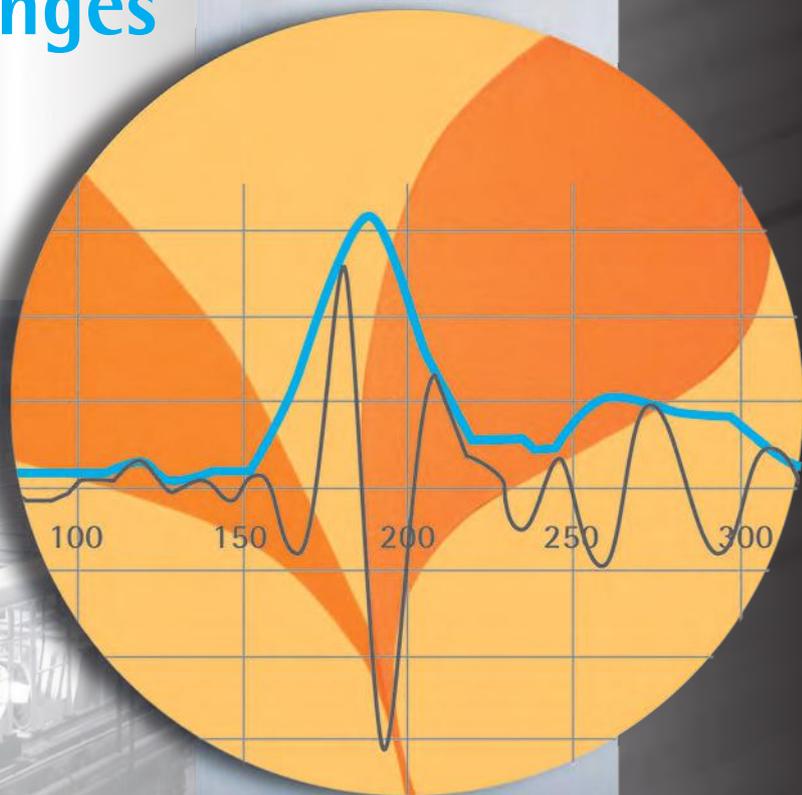


## Innovative strip centre measurement in high temperature ranges



- ▶ measuring through gas-tight furnace wall
- ▶ higher accuracy and operating security
- ▶ maintenance-free / no installations inside the furnace

# EMG-Vivaldi®

• measuring through gas-tight furnace walls

## Challenges and operating principle:

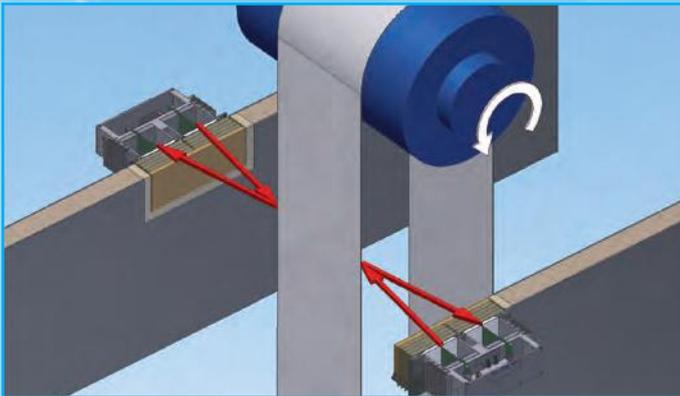
Determining the strip centre position is the most important goal for all strip guiding solutions. Traditionally, this is achieved via optical, capacitive, or inductive sensors. A particular challenge is to measure the strip centre in extreme environments, such as in annealing furnaces. EMG has many years of experience with inductive strip centre measuring systems in furnaces with temperatures of up to 1100 °C. Nevertheless there has been the request, however, to determine the strip centre position in furnaces without having any active or interfering sensor elements inside the furnace itself. This is reminiscent of the childhood dream of being able to see through walls!

This dream has finally become a reality thanks to EMG-Vivaldi®; the limits of inductive sensor technology now belong to the past!

The EMG-Vivaldi® sensor is located outside the furnace and conducts its measurements through the gas-tight enclosed furnace wall. The sensor system, which is mounted externally on the furnace wall, focuses electromagnetic waves onto the edge of thin metal strips through the non-conductive insulation of the furnace.

As a result, cooling systems for the sensors within the furnace are no longer required. As the furnace wall is completely enclosed, the strip is not able to damage the sensor itself.

The system is calibrated via simple reference measurements. The EMG-Vivaldi® technology can replace other systems.



Functional principle of EMG-Vivaldi®



Exterior view of the EMG-Vivaldi® sensor

EMG Automation GmbH specialises in the automation of continuous production processes in the metal, paper and plastics industries as well as in the foil and tyre industries. The company, which was established in 1946, is a leading provider of electro hydraulic control systems. Furthermore, EMG provides quality assurance systems for the manufacturing industry.

Based on the combination of more than 60 years of experience, the quality of our products and complete solutions as well as our advisory skills, our customer, by his trust, makes us the market leader. By working in close co-operation with our customers, research facilities and universities we are continuously searching for innovative solutions to promote our new and enhanced products and therefore to actively shape the market as a leader in innovation.

## Features of EMG-Vivaldi®:

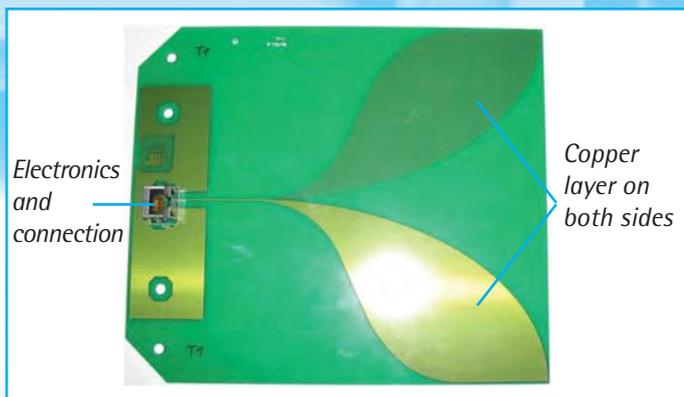
- ▶ the measurement is performed through the furnace insulation and through an enclosed, gas-tight plate on the furnace wall
- ▶ only one sensor type for all kinds of strips (sensor is independent of strip width, temperature and material grade)
- ▶ no special cooling is required for temperatures up to +70 °C on the outer furnace wall and for ambient temperatures up to +50 °C (air or water cooling is optionally available for higher temperatures)
- ▶ low space requirement outside the furnace

## The Vivaldi technology:

In contrast to other radar-based measuring systems, EMG-Vivaldi® relies on the principle of so-called Vivaldi antennas. The EMG-Vivaldi® system consists of two pairs of antennas, each of which is positioned on one side wall of the furnace. One antenna serves as a transmitter, while the other functions as a receiver in this setup. The antennas transmit and receive linearly polarised electromagnetic waves (EMW). These waves are reflected by the strip edge and transmit the edge position by means of an optimized digital runtime measurement. Evaluation of the data, and thus the determination of the strip centre position, is conducted within the control cabinet via an RPU (Radar Processing Unit) and an IPC. The furnace wall is covered in a non-metallic insulating material, which exhibits a low absorption rate of electromagnetic waves in the Vivaldi frequency range of 0.8 to 4 GHz. No sensor element extends into the interior of the furnace and both

the electronics and the antennas on the outside of the furnace wall can be cooled with air (or water) if required. Only the radar windows (metal flanges with a special cover that are penetrated by the electromagnetic wave) are installed in the furnace wall with a particularly high quality, thermal heat insulation.

An additional advantage is that the actual sensor can be removed from the furnace without having to open the furnace itself, which enables the furnace wall to retain its gas-tight seal. This feature significantly simplifies the process of replacing an antenna or the sensor electronics, as the furnace does not have to be cooled down beforehand. An unforeseen strip crack cannot damage the sensor – therefore additional strip deflectors in the furnace are not necessary.



Vivaldi antenna structure



Interior view of the EMG-Vivaldi® sensor housing

## Features of Vivaldi antennas:

- ▶ Ultra-wideband slot antenna (UWB) or Vivaldi antenna
- ▶ transmits and receives a linearly polarized electromagnetic wave
- ▶ co-planar parallel structure on a double-sided metallized dielectric substrate
- ▶ operating frequency 0.8 – 4 GHz enables measurement through the insulation material
- ▶ large electromagnetic range and thus stable measuring signals as well as higher measuring resolution
- ▶ simple electrical connection
- ▶ simple replacement of the antennas in the housing

## Customer benefits:

- ▶ no sensor parts inside the furnace
- ▶ measurement from outside through the furnace wall, which consists of furnace insulation and enclosed gas-tight plate
- ▶ no direct contact between the antenna housing and the interior of the furnace
- ▶ no installation in the furnace necessary
- ▶ no deformation of the antennas possible
- ▶ no damage to the sensor caused by the strip possible
- ▶ no contamination of the furnace interior or the antenna housing
- ▶ no cleaning of the antennas necessary

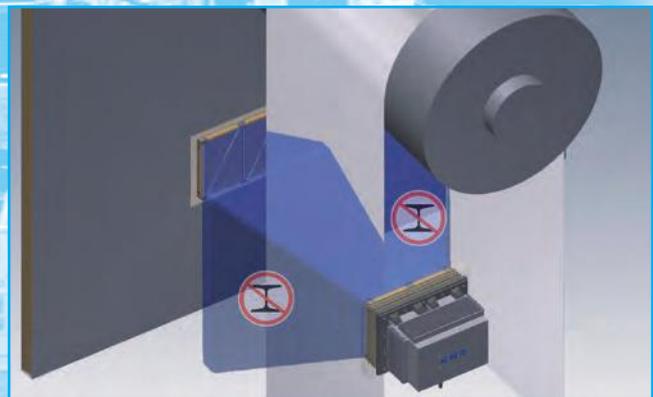
# • maintenance-free / no installations inside the furnace

## Customer benefits (continuance):

- ▶ no need for cooling systems for sensors inside the furnace
- ▶ the antennas or sensor electronics can be replaced without stopping the line
- ▶ low total costs of ownership (TCO)
- ▶ calibration via simple reference measurements
- ▶ only one type of sensor for all kinds of strips (sensor is independent of the strip width, temperature and material grade)
- ▶ EMG-Vivaldi® can replace other systems
- ▶ particularly high quality, thermal furnace wall insulation on the sensor



Particularly high quality thermal furnace wall insulation



Schematic view of the required clearances to metallic parts inside the furnace

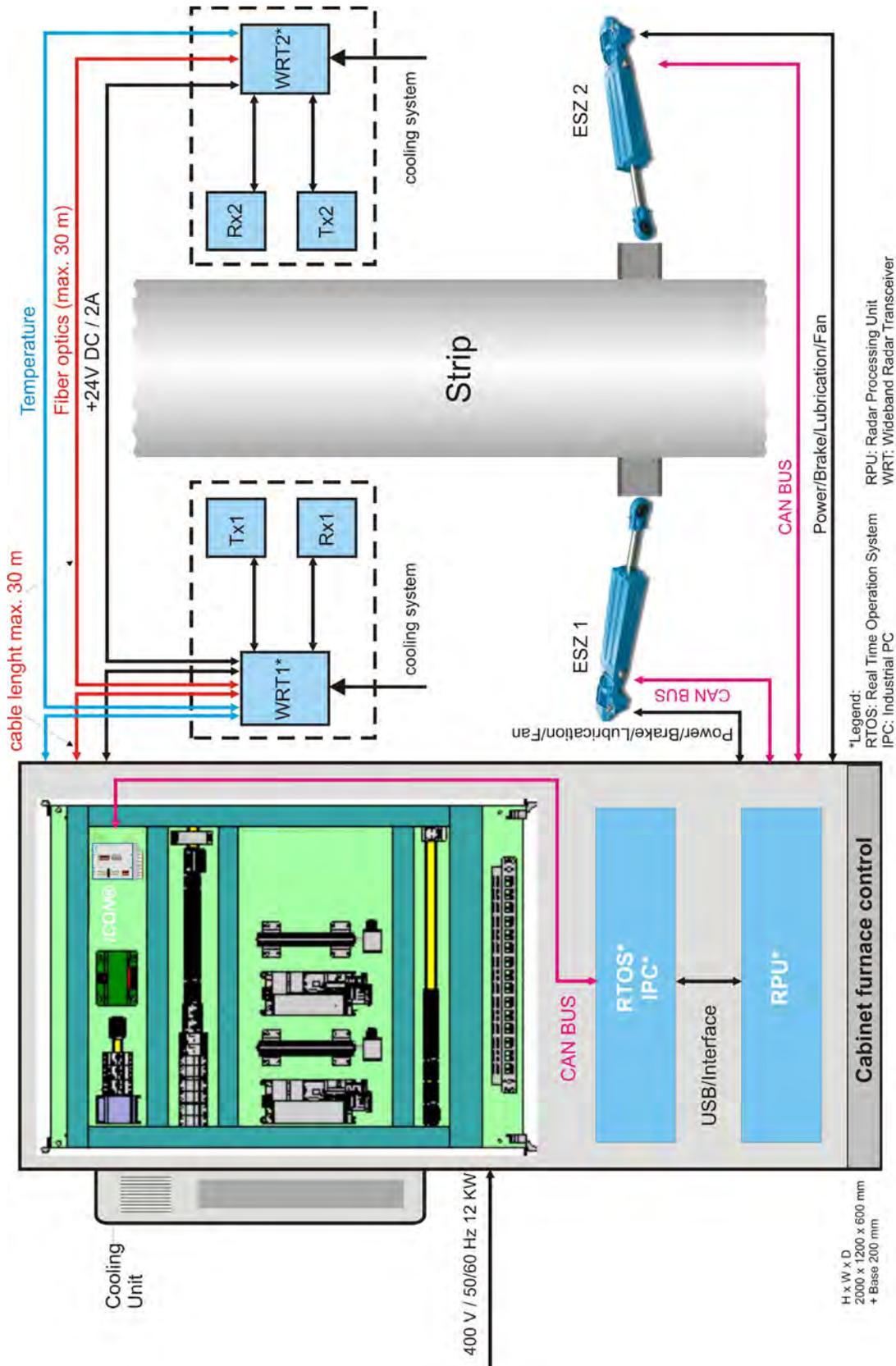
## Technical data:

Strip thickness	min. 0.1 mm
Strip temperature	independent
Strip position sample rate	50 Hz / 20 ms
Centre position accuracy	up to $\pm 1$ mm
Cooling	no cooling is required for temperatures up to +70 °C on the outer furnace wall and for ambient temperatures up to +50 °C (optional air or water cooling)
Installation position	observe the required clearances to metallic parts in the furnace; the exact dimensions depend on the individual line conditions (especially furnace width and minimum strip width)
Sensor cable	fibre optic cable (max. 30 m) between antenna boxes and control cabinet

## System architecture:

The sensor electronics and the antennas on the outside of the furnace wall can be cooled with air or water if required. They are connected to the control cabinet via fibre optics, which exhibit a maximum length of 30 m.

The other electronics, which provide the control signals for the electric servo cylinder (ESZ) to regulate the guiding frame, are accommodated in the conditioned control cabinet.



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