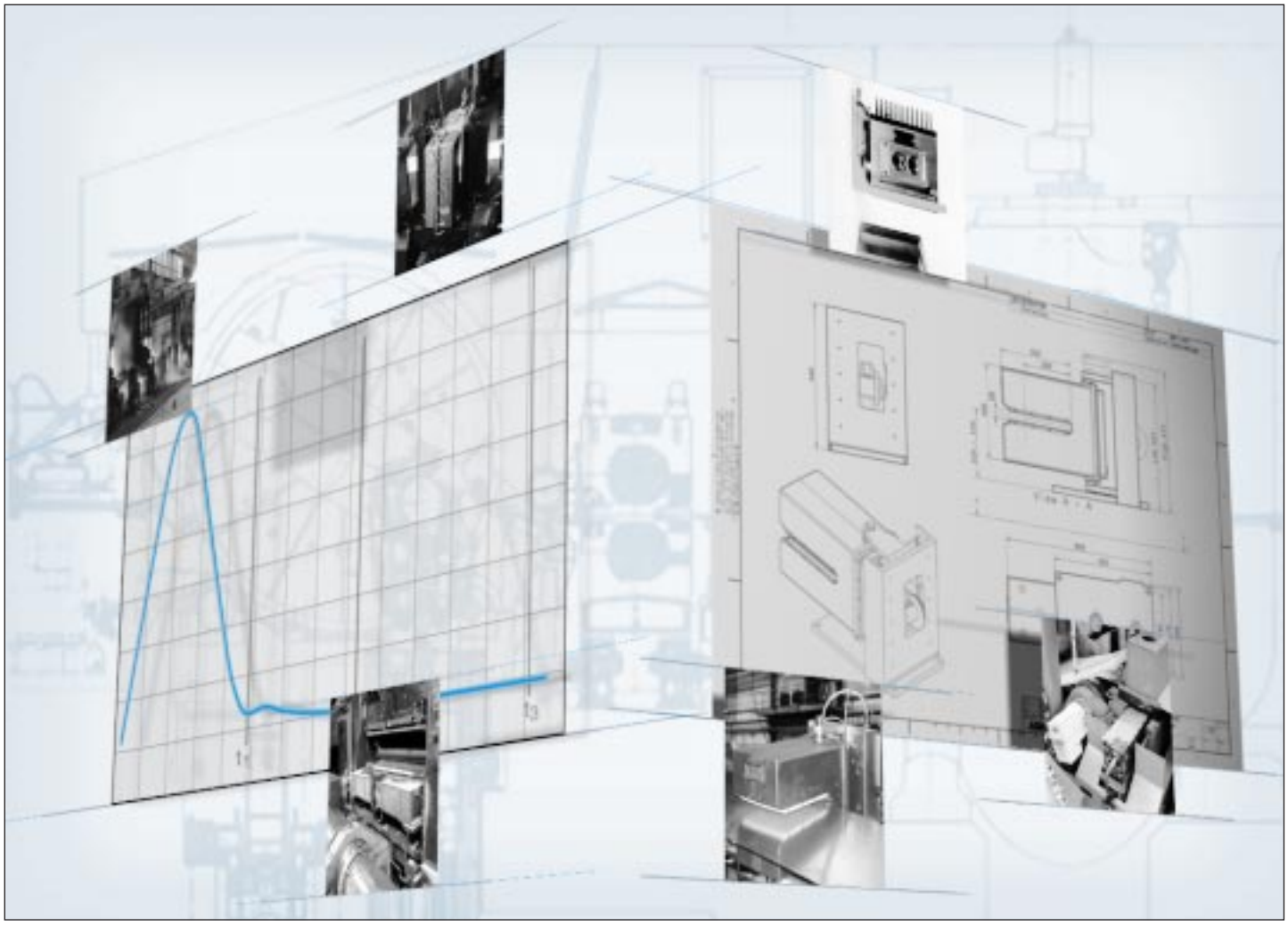
Measure[IT]
Pulsed Eddy Current technology



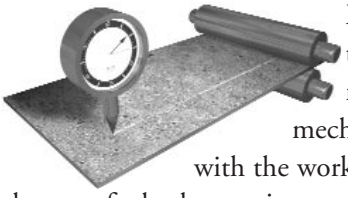
Operating principle

Different technologies for dimension measurement

ABB has developed a unique way of performing measurements with eddy current technology. It is a method that makes it possible to measure, in real time and in line, dimensions and other attributes with exceptional accuracy.

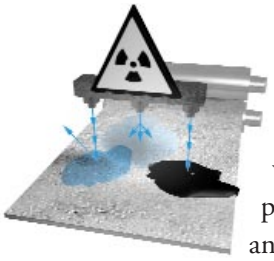
In the metals industries measurement conditions are frequently difficult. Still, the sensors are expected to perform flawlessly. Their reliability must be high, maintenance requirements must be low and measurement accuracy must never be compromised.

Mechanical contact technology



Measurement technology requiring mechanical contact with the workpiece – such as the use of wheels or points to measure dimensions – is too fragile to withstand the mechanically demanding conditions. In addition, its measurement accuracy diminishes at high speeds and when workpiece surfaces are less than perfectly smooth and clean.

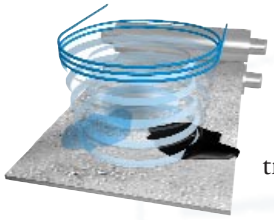
Optical and radioactive technology



Light has difficulty in penetrating airborne dirt and steam and is diffracted in water. Optical components, such as lenses and lamps, are mechanically sensitive and easily soiled.

Systems employing radioactive (and X-ray) radiation are commonly used. However, even radiation is reduced when penetrating water, particulates and steam and is also affected by dirty workpiece surfaces. Besides, the hazardous nature of radioactive radiation makes this technology particularly difficult to implement.

Eddy current technology



A low-frequency electromagnetic field penetrates everything but metal completely transparently.

However, the field induces electrical currents in the measured metal object. Changes in these currents can be measured via the voltage they induce in a coil.

This is eddy current measurement. The technology has been the subject of 50 years of development, all along demonstrating exceptional environmental tolerance. Systems installed on many production lines around the world provide reliable crack detection on bars, wires and tubes.

Pulsed Eddy Current technology

ABB's Pulsed Eddy Current (PEC) technology makes it possible to apply these fundamental physical principles also to the measurement of dimensions and material properties with exceptional accuracy.

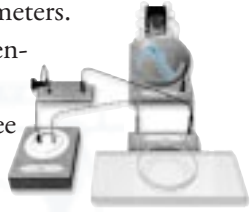
Pulsed Eddy Current technology evolves from Eddy Current principle

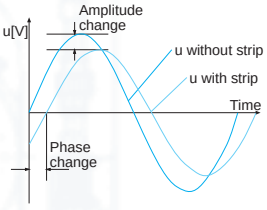
- *Non-contact technology*
- *Promotes material-independent dimension measurement*
- *Accurate measurements and unaffected by harsh environments e.g. fluids, steam and particles*
- *Enables a sensor design without fragile parts and with superior long-term stability*
- *Not hazardous to people*

The missing measurement parameter

In somewhat simplified terms, the traditional eddy current technology is based on a conventional alternating current (AC) operating principle. According to this concept, the material to be measured affects the amplitude and phase change of the electromagnetic field, yielding two parameters.

But to measure dimensions, for example, the thickness of a plate, three parameters must be taken into account: (1) the distance between the coil and the workpiece, (2) the electrical resistance, and (3) the thickness of the metal plate, strip or bar. When eddy current technology is applied to this type of measurement, one of the parameters must be kept constant. A design that would maintain the distance between coil and workpiece is one possibility. In reality, however, efforts of this type are rarely successful, especially in harsh environments and when the workpiece is moving.





AC gives only two parameters. One from the amplitude and the other from the phase shift.

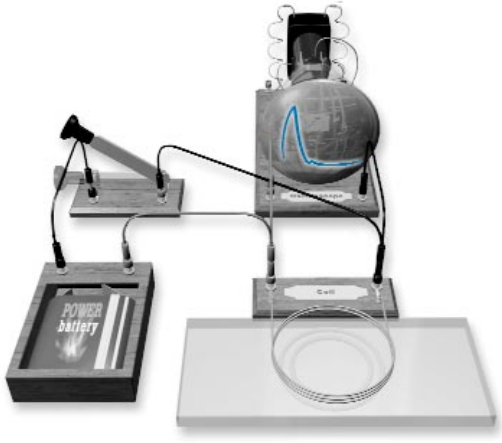
Measure after current interruption

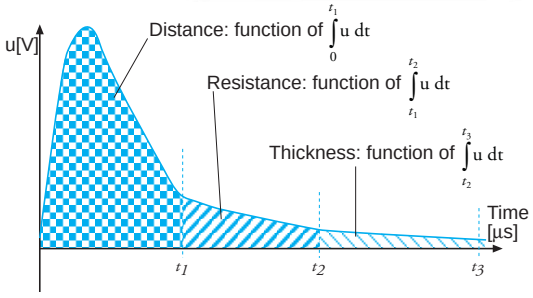
The ABB technology is based on the measurement of the voltage pulse induced in the coil when the current is suddenly interrupted. After the abrupt interruption of the constant excitation current fed to the coil, the magnetic field produced by the eddy current in the metal sheet is measured as a factor of the voltage it induces in the coil.

How does the eddy current disappear?

At the instant of the interruption, the eddy current is present only on the surface of the workpiece and has not yet penetrated deeper into the substrate.

By tracing the entire penetration sequence via the voltage induced across the coil, we can derive three unique signal values at three different times. In this way, the new measurement technique – known as Pulsed Eddy Current Technology – overcomes the limitation of the traditional design. Now all three parameters can be measured: the distance, the electrical resistance and the thickness.





Pulsed Eddy Current Technology gives three parameters in the pulse response.

Products using the Pulsed Eddy Current technology

Millmate Strip Scanner Systems

The first dimension-measuring product based on the PEC technology measures the width and position of a metal strip during rolling.

Its accurate measurement of the strip edges enables effective flatness control in the important edge zone of the strip.

Large quantities of emulsion may wash across the strip, and heat generation may be sufficient to produce steam. The sensors may even be mounted very close to the millrolls, where conditions are most severe. But due to the inherent immunity of the measuring principle and the rugged sensor housing that protects the coil from heavy impacts and shocks caused by the strip, high-precision measurement can continue undisturbed year after year.

U-gauge

The width and height of bars, wire and other long products can now be measured in real time after each mill stand.

The U-gauge has demonstrated that measurement with the new technology can be performed with exceptionally high accuracy, also under very difficult environmental conditions. The ability to measure width and height in real time provides opportunities to control dimensions and improve the tolerances of the finished bar and wire products. This type of measurement has been considered too difficult with other technologies.

Width, height and position of red-hot billets at a temperature of 1,000 °C shall be measured to an accuracy of about one-tenth of a millimeter. Water is continuously sprayed all around the billets, producing steam and consequently poor visibility. An oxide shell is constantly formed on the surface, which shall not be measured. Inevitable mechanical challenges include heavy impacts and considerable wear.

In this extremely demanding application, the U-gauge measures dimensions accurately and reliably without interfering with the process.

Millmate Thickness Gauging Systems

The latest application of the Pulsed Eddy Current technology is the thickness gauge for cold, non-ferrous strip and plate.

The gauge will measure true strip thickness unaffected by coolant, steam, dirt, etc. The measurement is material independent and the gauge does not require any information about the rolled alloy. Customers experience from maintenance is very close to saying “install and forget”.

The people behind the invention

With roots in the metals industry, the inventor Sten Linder saw the need for accurate measurement, even though the industry's environment is not conducive to the installation of sensitive instrumentation. He was convinced that eddy current technology was the one to use.

However, at that time existing eddy current technologies were all based on a sinusoidal current supply. Currents induced in the object being measured then became a diffuse history of the entire sine wave. When the response was analyzed, it became impossible to separate the influences from material properties and from dimensions.

But Linder and his group of enthusiastic scientists wanted to get more out of the technology. The way they found was to make a very sudden interruption in the current supply and then look at the history of this very sharp instance. History was now no longer diffuse, and influences from material properties and from dimensions could be clearly seen. The method was patented as Pulsed Eddy Current Technology, whose value was quickly recognized by ABB.

The work on integrating this new measurement technology with advanced computer functionality required mathematical descriptions of all the complex physical relations involved. A detailed understanding of all possible measurement situations and magnetic field interactions was necessary. The subsequent development efforts, calling on advanced knowledge of mathematics, physics, electronics, metallurgy and mechanical science, yielded numerous additional innovations that have also been patented.

With ABB's tradition of close co-operation with metals industry customers, many prototypes have been tested in the tough reality that only this industry can offer.

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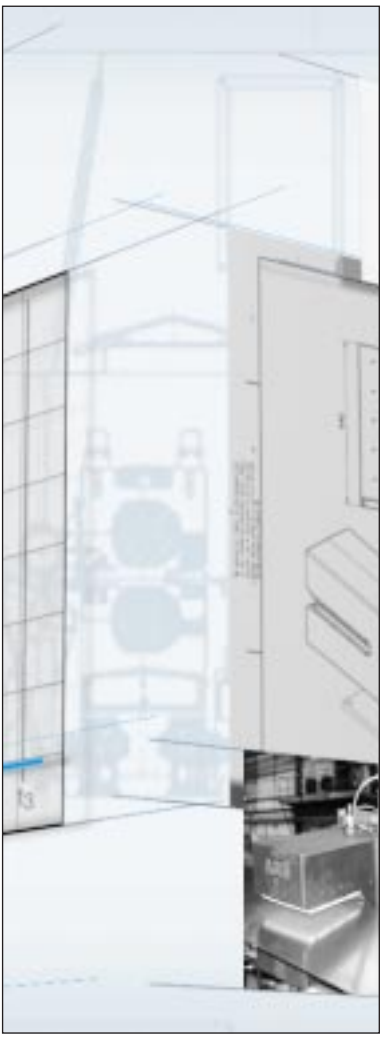

ABB is a global leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. ABB has some 115,000 employees in more than 100 countries.

ABB Automation Technologies is the global market leader in automation technology. We provide products, software and services for the automation and optimization of discrete, process and batch manufacturing operations. Key technologies include measurement and control, instrumentation, process analysis, drives and motors, power electronics, robots and low-voltage products, all geared toward one common Industrial IT architecture for real-time automation and information solutions throughout a business.

ABB Force Measurement is a business unit within ABB Automation Technologies. It provides equipment for accurate, reliable measurement and control in a broad range of applications from steelmaking to paper converting industries.

Measure^{IT} family – a part of ABB's comprehensive Industrial^{IT} portfolio.

Industrial^{IT} describes the ABB group commitment to bridging the gap between industrial and business assets and the information technology required to integrate these components in real time. The commitment encompasses a portfolio of compatible technologies for power, automation, and information; a robust, open architecture for integrated solutions; plus the domain expertise acquired through more than 100 years of meeting customer needs.

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