

MEASUREMENT

Non-ferrous metal thickness gauges

ABB's Millmate thickness gapless gauges (MTG) based on pulsed eddy current technology ensure reliable and efficient thickness control under harsh mill conditions while eliminating health, safety and environmental concerns.



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ABB's Millmate thickness gauge (MTG) systems in combination with pulsed eddy current (PEC) technology provides customers with a choice of products tailor-made for non-ferrous strip production needs. Both the gapless MTG box gauge system and the MTG C-frame gauge system depend solely on strip thickness and are the ultimate sensors to ensure thickness control under harsh mill conditions while eliminating health, safety and environmental concerns associated with radiometric gauges. The MTG gapless gauge provides the ability to measure at the heart of the rolling process, where it is impossible for other gauges to operate. By developing state-of-the-art measurement sensors, ABB addresses the customer need to increase the reliability, efficiency and cost-effective production of non-ferrous metal strip products such as aluminum can stock and car body stock →1.

Low weight, recyclability and attractive material properties make aluminum ideal for many consumer and industrial processes. Currently, there is a worldwide market demand for and investment in aluminum production capacity. This demand has translated into an increased use of rolled aluminum products during the last decade. A greater production of aluminum is evident for both the canned drinks and automotive industries. This expansion is partly due to consumption of aluminum for car structural components and exterior panels for both high-end and high-volume vehicles →2.

Aluminum, due to its low density and relatively high strength, is particularly suited to replace steel in the car body. The resulting lightweight vehicle produces lower CO₂ emissions and consumes less fuel than conventional cars. To accommodate the increase in production of aluminum strip for these industries, improved production facilities

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and state-of-the-art measurement sensors are required. ABB has more than 15 years of experience in sensor development to ensure the accurate measurement of aluminum thickness and optimized production process costs.

Sensor significance

The use of sensors for accurate measurement has been indispensable for the control of industrial processes since the industrial revolution. Yet the facility constraints and environmentally harsh conditions within industrial environments, such as rolling mills, can affect sensors negatively, leading to production process delays and downtime,

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01 Operation of MTG Box gauge in an industrial setting.

which translates to increased production costs. ABB invests in the research and development of sensors that operate under a variety of mill spatial

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constraints and that are insensitive to production environmental conditions and variations in material composition, with a view to improving aluminum strip production and reducing cost.

Traditional measurement technology concept

In the aluminum industry, thickness is one of the most important properties to measure and control. Meeting tight strip tolerances is crucial for both the production process and the product itself. Radiometric gauges, ie, isotope and X-ray gauges, have been available for many decades and are commonly employed. X-ray gauges exploit the attenuation of radiation passing through the

metal strip. A detector measures the intensity of radiation emitted from a source on the other side of the strip. The thickness is calculated from the knowledge that the intensity is affected by density changes in the measuring gap.

There are advantages to this method, such as tolerance of large air gaps, but disadvantages exist too. In addition to health, safety and environmental issues, radiometric gauges are problematic for aluminum measurement accuracy. Aluminum has low density and therefore a low absorption coefficient. Consequently, environmental factors such as dirt, steam and air temperature impact thickness measurements and result in deviations, which must be corrected. Aluminum is also typically alloyed with other metals to create desired properties such as strength. The presence of other metals, such as copper, affects the absorption of aluminum thereby making thickness measurement using X-ray gauges challenging. The alloy dependency of X-ray gauge results necessitates thickness corrections of up to 50 percent, which can easily mean a thickness deviation of one percent, clearly a strong disadvantage for aluminum strip producers.



Innovations in measuring technology

In response to the problem of accurate measurement of aluminum strip using radiometric sensors, ABB has pursued the development of the perfect gauge for aluminum strip producers. In 2001, ABB introduced the MTG C-frame gauge for strip thickness measurement in non-ferrous cold rolling mills. This sensor addresses the needs of customers

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who wish to achieve accurate thickness measurements for aluminum, as well as copper, independent of rolling mill environment and alloy properties. The MTG C-frame gauge is based on patented PEC technology, as opposed to the radiometric gauges common in the past.

PEC technology uses electrical coils to create pulse-formed electromagnetic fields that result in a pulse response from the strip. A voltage pulse induced in the coil when the current is suddenly interrupted is measured. 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 transient voltage →3.

Customers can now measure distance, resistivity and thickness for non-ferrous strip with exceptional accuracies without the need for information about alloy properties or environmental conditions at the mill. Superior thickness accuracy is achieved.

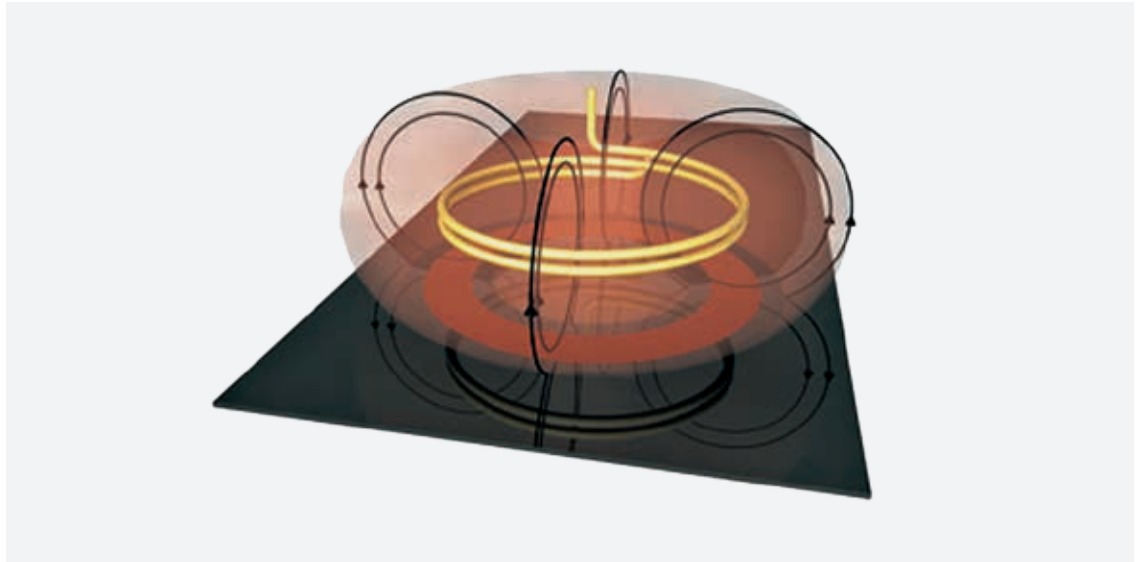
The use of MTG gauges instead of radiometric gauges also results in a safer work environment and eliminates the need to train or certify employees or dispose of radioactive waste material.



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02 Growth of aluminum bodied automotive vehicles is anticipated.

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03 The patented pulsed eddy current technology relies on weak magnetic fields for measurement.

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04 Accuracy levels attained in aluminum strip production.



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Calibration requirements and process

In an ideal world, manufacturers would like sensors to be ten times more accurate than the product process tolerances. Commonly used sensor accuracy is three to four times greater than product process tolerances. Reference material measurements must be at least three to four times more accurate than the sensor being utilized. Accordingly, calibration reference material measurements must be at least ten times more accurate than the product tolerances in can stock products as well as other types of aluminum strip →4. To achieve accurate sensor measurements ABB has invested in technology to perfect calibration by simplifying the related procedures.

MTG systems calibration processes

ABB provides aluminum producers with efficient, reliable and accurate sensors to compensate for the presence of various alloys and remove the need for extensive calibration materials and procedures, especially when using X-ray gauges. A variety of challenges are resolved by installing MTG systems based on PEC technology. The application of a weak magnetic field results in a contact-free thickness measurement and eliminates the disadvan-

tage associated with aluminum's low absorption coefficient. Because the thickness measurements are independent of environmental factors and material properties, there is no need for customer-specific calibration plates – making downtime due to calibration negligible. The MTG systems

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developed at ABB are delivered calibrated and ready to use. Calibration is conducted at intervals of six months and takes 20 minutes to perform. ABB delivers the system with the 12 site calibration plates that are required for traceability and accuracy of the gauge by calibration on-site.



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The calibration process is a two-step process →5: The first step is the calibration of reference plates maintained at ABB. The second step is the calibration of the site calibration plates that are included with the MTG system delivered to the customer.

Reference plates are calibrated at ABB by comparison with gauge blocks calibrated with traceability to national standard labs including NIST, PTG and NMJJ. ABB has developed and designed an accurate mechanical measuring machine for this purpose. Reference measurements are performed using a laser Hologage probe with a measuring resolution of 0.01 µm.

In the second step, the site calibration plates are calibrated by direct comparison with the calibration reference plates of similar thickness and equal material properties, using an MTG gauge that is both calibrated and temperature stabilized. Cali-

The MTG box gauge, invented and patented by ABB, is compact, robust and uses weak magnetic fields for measurement based on PEC technology.

bration accuracy of 0.3 to 0.5 µm is reached for site calibration plates. There is no need for customer specific plates or frequent calibration procedures to achieve the desired thickness tolerances so crucial for aluminum strip producers.

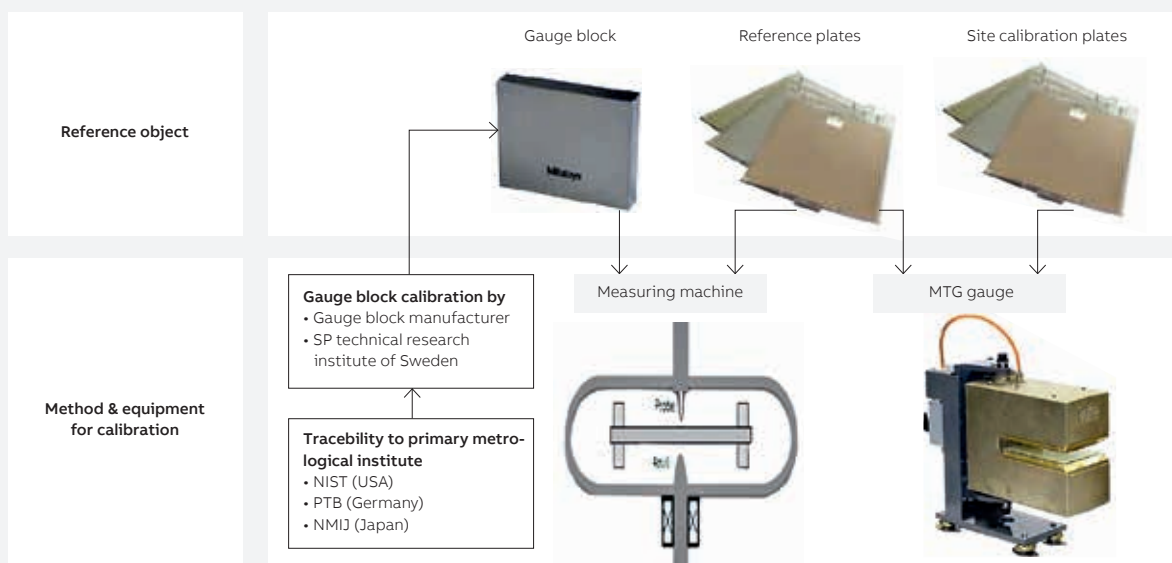
Unique gapless measurement solution

In 2016, ABB added the singular gapless gauge sensor to its palette of MTG gauge systems that measure aluminum strip in aluminum rolling mills and continuous casters →6. The MTG box gauge, invented and patented by ABB, is compact, robust and uses weak magnetic fields for measurement

This unique invention can be placed in the center of the production process.

based on PEC technology. The gauge is safe and survives mechanical impact. Most significantly, the new gauge sensor is gapless with nothing above the pass line that could obstruct the passage of the strip being measured. This unique invention can be placed in the center of the production process.

The MTG box gauge is usually installed below the mill table, which provides protection during threading, tail out and strip break. Like the MTG C-frame system, this new sensor is insensitive to anything located within the measuring area except for the metal strip. True aluminum strip thickness is measured from below with accuracy of 0.05 percent. The compact gauge can be placed close to the roll gap, or interstand, because it is independent of all environmental conditions. Considering the sensor is immune to material variations, the need to compensate for alloy content is eliminated and extensive calibration is unnecessary.





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— 05 MTG Site plate calibration process.

— 06 MTG Box gauge system including gauge head, hydraulics, air regulator, control and operator units and monitors.

A mere 20 minutes is required every six months for onsite calibration. The use of the MTG box gauge results in increased levels of aluminum strip thickness control and fast feedback for the strip producers.

The MTG box gauge system consists of the PMGG201-H gauge head with an aluminum-bronze housing mounted on a vertically mobile frame. This robust sensor automatically adjusts its position

— The presence of a hydraulic positioning system allows the gauge to measure instantly as soon as the strip tension comes on.

to optimize thickness measurements. The presence of a hydraulic positioning system allows the gauge to measure instantly as soon as the strip tension comes on. The control unit – the PMGA201 – is available either as a wall or floor cabinet and communicates with the gauge, thereby handling measurement data, error and status control. System interfaces using network communication with

VIP (vendor internet protocol), OPC DA, Modbus TCP and a Profibus-DP fieldbus communication are possible, thereby integrating the gauge with other control mill systems. Operators can observe and control functions including operation diagnostics, service and settings.

The ease of use of the control system combined with the benefits of the gapless MTG box gauge using the PEC technology for aluminum thickness measurements make this system ideal for use in aluminum rolling mills. The material independence, elimination of environmental influence, safety, fast commissioning and reduced on-site calibration translate to increased production time and higher yields with virtually no maintenance. ●