



Inspection systems for the metal industry



References (extract)



AMAG
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Constellium



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Innovative laser line measurement

**Innovative laser line**

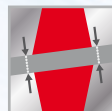
Non-contact thickness measurement with 1280 discrete measuring points

**Lateral micrometer resolution**

Measuring close to the edges of narrow strips combined with a large measuring range

**Highly dynamic measurement**

128,000 measuring points/sec provide high precision even for structured material such as button plate and checker plate

**Recognition and compensation of strip tilting**

Particularly suitable for cut-to-length shears

**No alloy compensation required**

Real geometric, material-independent thickness measurement

**Cost-effective service-lifecycle-management**

Innovative measurement technology without isotopes or X-rays and thus low consequential costs

Overview

Measured features

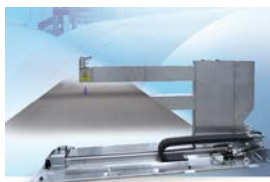
- Thickness
- Center thickness
- Edge drop
- Thickness profile
- Wedge and crown bow
- Width



Metal thickness measurement for non-critical ambient conditions
thicknessCONTROL MTS 7202.T/8202.T
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Powerful C-frame for harsh environments
thicknessCONTROL MTS 8202.LLT
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C-frame thickness measurement systems in hot rolling mills
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C-frame systems for highest precision on shiny surfaces
thicknessCONTROL MTS 8202.K
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O-frame systems for profile thickness measurement
thicknessCONTROL MTS 8201.LLT
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Special systems for special fields of application
thicknessCONTROL MTS 9201.LLT
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Dynamic width measurement with discrete laser line technology
thicknessCONTROL MWS 8201.LLT
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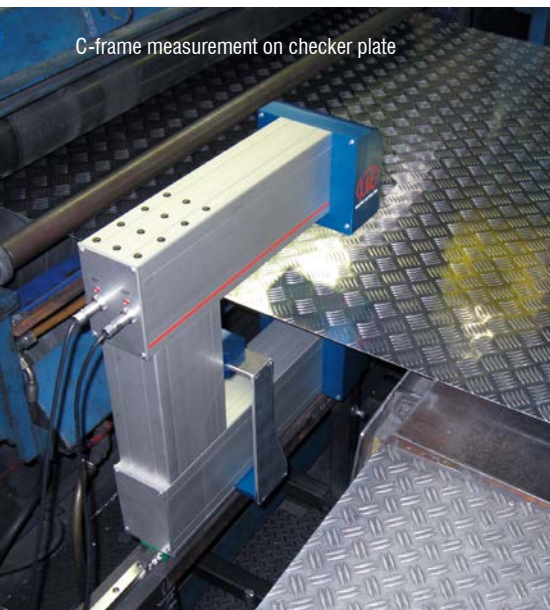
thicknessCONTROL MTS

More Precision

Fields of application

- Hot rolling mills
- Cold rolling mills
- Processing plants
- Service centers

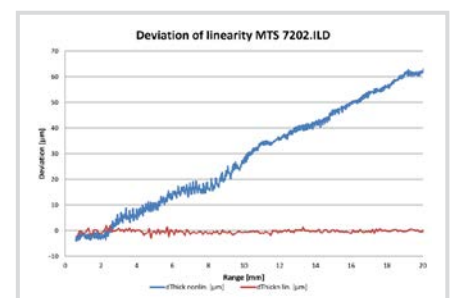
C-frame measurement on checker plate



Operating principle of thickness measurement

The principle of dimensional, geometric thickness measurement is based on one optical distance sensor on each side of the material. The distance (=operating range) of both sensors is determined in a calibration process based on a certified measurement standard of which the thickness is added to the sum of the sensor signals in order to determine the current operating range. A 2D sensor not only processes one measuring point.

In the calibration process described above, the coordinate systems of the sensors installed in the upper and lower belts are synchronized. For thickness measurement during production, the difference between the sum of the distance signals and the value of the operating range is determined. The systems are mechanically designed in C-frame or O-frame shape. Both lasers must be projected congruently onto the top side and the rear side of the material in order to achieve an accurate thickness measurement. The sensors are factory-calibrated using an optoelectronic tool and a patented procedure, i.e. the linearity deviation is determined across the entire working range and a correcting function is calculated.



Linearity deviation (accuracy) before and after factory calibration



Point cloud diagrams of two laser line sensors

"Discrete laser line" innovation

When talking about optical thickness measurement, conventional laser point sensors, confocal chromatic point sensors and laser line sensors (=profile sensors/laser scanners) have to be distinguished. Unlike point sensors, laser line sensors use a static laser line which they project onto the surface of the measurement object. A high quality optical system projects the diffusely reflected light of this laser line onto a highly sensitive sensor matrix which detects during one measurement, depending on the sensor, a profile with 640 or 1280 measuring points. From this matrix image, the integrated controller calculates the distance information (z-axis) and the position alongside the laser line (x-axis) in a two-dimensional coordinate system.

Resolution and measuring range

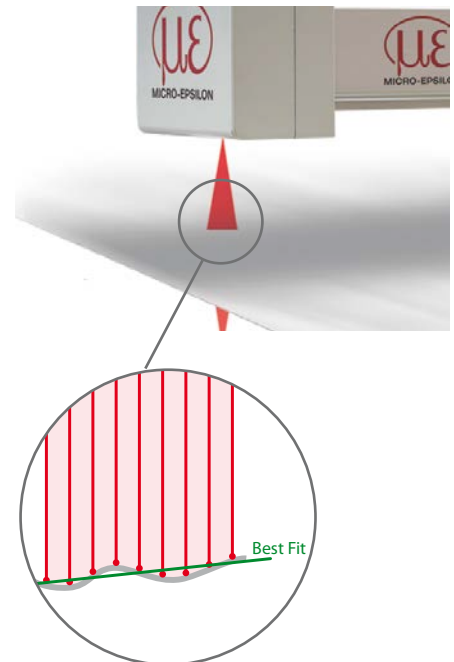
While the resolution of point sensors corresponds to the smallest measureable thickness change, laser line triangulation is much more complex. Here, the resolution is not determined by evaluating one single point but several points or rather an entire profile is taken into account and a reference line is fitted into the point cloud (best-fit-line). Therefore, the resolution is the smallest measureable thickness change between two corresponding reference lines and is consequently higher compared with the point triangulation method using the same optical system, i.e. the same measuring range size. With this effect, thicknessCONTROL MTS 820X.LLT provides a large measuring range at extremely high resolution which is particularly beneficial in slitting line applications.

Robust in difficult, industrial environments

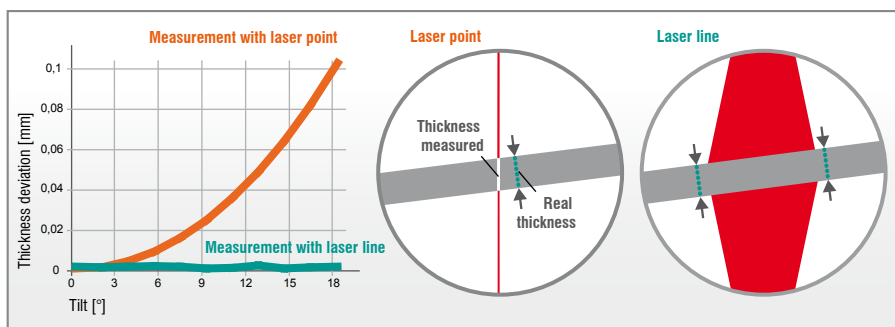
Due to their high data rates, laser line sensors have proven to be very stable in harsh environments. In situations where there is a loss of 50% of the measuring points, e.g. due to steam, residual contamination with mill emulsion or reflections on shiny surfaces, the reference line of the usable point cloud still generates very stable measurement values and is thus superior to laser point technology.

Compensating for strip movement

Compared to laser point sensors, laser line triangulation measurement offers improved accuracy and stability. Tilt angles, warping and deformation of the material is recognized using profile sensors and is considered in the measurement results. This enables thicknessCONTROL MTS 820X.LLT to provide high quality thickness measurements with accuracies in the micrometer range, even when the metal sheet to be measured is several mm thick and tilted.



Calculation of the measured value using a reference line



Thickness deviation with tilted strip using laser point or discrete laser line



Fully automatic calibration enables long-term measurement stability

Automatic calibration and temperature compensation

thicknessCONTROL MTS systems are equipped with in-situ calibration in order to compensate e.g. for the effects of temperature fluctuations. Depending on the respective application, with this calibration either the reference/calibration piece or the C-frame can be positioned. Furthermore, the correct functioning of the system can be cyclically proven at any time. The analysis software enables easy, fast verification of the measuring system's capability, which can be automated depending on the application.

thicknessCONTROL MTS 7202.T / 8202.T

Metal thickness measurement for non-critical ambient conditions



The thicknessCONTROL MTS 7202.T measuring system is beneficial in simple applications due to its excellent price/performance ratio, its C-frame design and is available in two performance classes. Both operate using optoNCDT LL line triangulation sensors where the precision to range ratio is optimized. This means that the lower sensor has a smaller range as the material thickness increases only in the upper direction.

The integrated controller of the thicknessCONTROL MTS 7202.T system calculates and visualizes the measured values. The display is equipped with multi-color background lighting and changes color if limit values are exceeded. All controller functions selectable by the user can be displayed and saved using a web browser without having to install additional software. thicknessCONTROL MTS 7202.T is installed on a linear axis, which enables semi-

automatic calibration and manual adjustment of the measuring position. For fully automatic calibration and positioning on three adjustable positions, the linear axis can be enlarged using a DC motor.

Higher precision and more functionality

The thicknessCONTROL 8202.T variant differs from the thicknessCONTROL MTS 7202.T entry level version due to its higher precision sensors. Furthermore, it includes an IPC with a comprehensive software package for analyzing the measured data. thicknessCONTROL 8202.T can be retrofitted with two different drive variants. The DC motor version enables movement to any position for a fixed track measurement, a cross-sectional measurement can be achieved using a position-controlled servo motor.

Special features:

- Simple mounting
- IPC not required
- Modular extension
- Access to controller via Internet browser



optoNCDT LL laser line technology

The thicknessCONTROL MTS 7202.T/8202.T C-frame is equipped with optoNCDT LL laser line technology. Unlike conventional laser point sensors, the LL technology generates an oval-shaped light spot whose average value is determined with an algorithm. Due to the filter effect, these sensors are insensitive to interferences from reflecting surfaces and therefore ideally suited to applications in the metal processing industry.



Controller for thickness measurement



Thickness measurement in a forming line

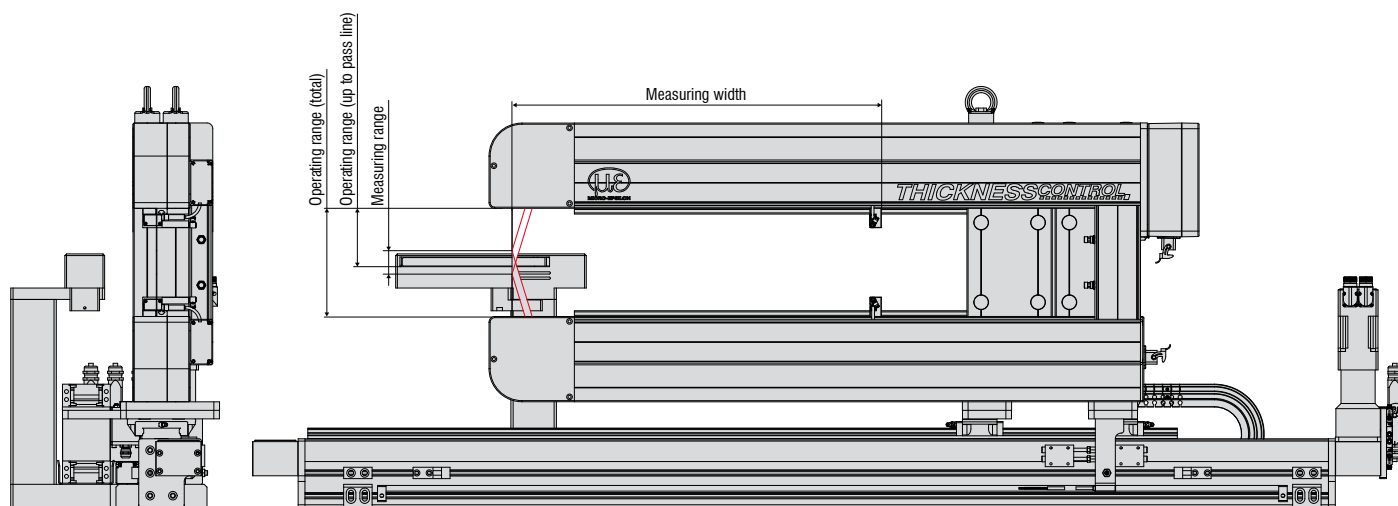
thicknessCONTROL MTS 7202.T

Description	-2/250	-10/250	-20/250	-40/250	-2/500	-10/500	-20/500	-40/500
Article no.	4350127.11	4350127.12	4350127.13	4350127.14	4350127.15	4350127.16	4350127.17	4350127.18
Measuring width	250 mm				500 mm			
Operating range (total)	30 mm	44 mm	70 mm	235 mm	30 mm	44 mm	70 mm	235 mm
Operating range (up to pass line) ¹⁾	14 mm	20 mm	40 mm	205 mm	14 mm	20 mm	40 mm	205 mm
Measuring range	2 mm	10 mm	20 mm	40 mm	2 mm	10 mm	20 mm	40 mm
Resolution	0.2 μm	0.6 μm	2 μm	5.5 μm	0.2 μm	0.6 μm	2 μm	5.5 μm
Accuracy ²⁾	$\pm 2 \mu\text{m}$	$\pm 3.5 \mu\text{m}$	$\pm 6 \mu\text{m}$	$\pm 12 \mu\text{m}$	$\pm 2 \mu\text{m}$	$\pm 3.5 \mu\text{m}$	$\pm 6 \mu\text{m}$	$\pm 12 \mu\text{m}$
Repeatability ²⁾	$\pm 0.4 \mu\text{m}$	$\pm 0.8 \mu\text{m}$	$\pm 1.6 \mu\text{m}$	$\pm 2.4 \mu\text{m}$	$\pm 0.4 \mu\text{m}$	$\pm 0.8 \mu\text{m}$	$\pm 1.6 \mu\text{m}$	$\pm 2.4 \mu\text{m}$
Material temperature ³⁾	up to 40 °C							

¹⁾ from upper belt²⁾ 2 σ ³⁾ without additional cooling

thicknessCONTROL MTS 8202.T

Description	-2/250	-10/250	-20/250	-50/250	-2/500	-10/500	-20/500	-40/500
Article no.	4350127.01	4350127.02	4350127.03	4350127.04	4350127.05	4350127.06	4350127.07	4350127.08
Measuring width	250 mm				500 mm			
Operating range (total)	30 mm	44 mm	70 mm	235 mm	30 mm	44 mm	70 mm	235 mm
Operating range (up to pass line) ¹⁾	14 mm	20 mm	40 mm	75 mm	14 mm	20 mm	40 mm	75 mm
Measuring range	2 mm	10 mm	20 mm	50 mm	2 mm	10 mm	20 mm	40 mm
Resolution	0.06 μm	0.18 μm	0.45 μm	1.1 μm	0.06 μm	0.18 μm	0.45 μm	1.1 μm
Accuracy ²⁾	$\pm 0.5 \mu\text{m}$	$\pm 0.9 \mu\text{m}$	$\pm 3 \mu\text{m}$	$\pm 4 \mu\text{m}$	$\pm 0.5 \mu\text{m}$	$\pm 0.9 \mu\text{m}$	$\pm 3 \mu\text{m}$	$\pm 4 \mu\text{m}$
Repeatability ²⁾	$\pm 0.1 \mu\text{m}$	$\pm 0.2 \mu\text{m}$	$\pm 0.4 \mu\text{m}$	$\pm 0.6 \mu\text{m}$	$\pm 0.1 \mu\text{m}$	$\pm 0.2 \mu\text{m}$	$\pm 0.4 \mu\text{m}$	$\pm 0.6 \mu\text{m}$
Material temperature ³⁾	up to 40 °C							

¹⁾ from upper belt²⁾ 2 σ ³⁾ without additional cooling

Example illustrating the dimensions

thicknessCONTROL MTS 8202.LLT

Powerful C-frame for harsh environments



The C-frame systems of the thicknessCONTROL MTS 8202.LLT series are equipped with discrete laser line technology. They are suitable for harsh environments and complex (highly reflective) surfaces. The redundancy of the high data rate provides reliable measurements, even when interferences due to steam, emulsion and high gloss surfaces are present.

The control and analysis software of thicknessCONTROL MTS 8202.LLT is multi-touch capable and provides comprehensive visualization possibilities which can be easily operated by swiping. The user can choose between different working modes. Furthermore, a fully automatic gauge capability management is integrated.

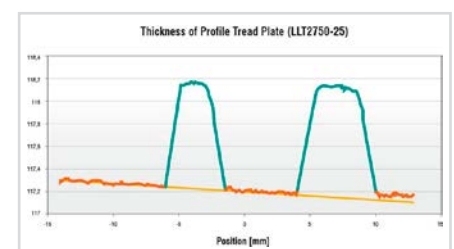
Two C-frames can be easily operated via a computer. thicknessCONTROL can be equipped with a motion controlled servo drive to automatically position the C-frame or to perform cross profile gauging.

Measurement of profile characteristics

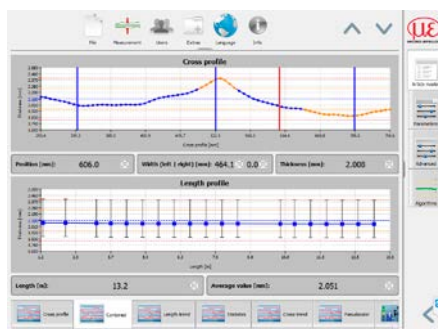
The high information density of the discrete laser line can be used to achieve improved robustness of the system and measurement of profile information. This technology is currently the only system that can accurately measure the internal and total thickness of checker or button plate during production. Furthermore, the high lateral resolution enables high precision views of the edge thickness.

Special features:

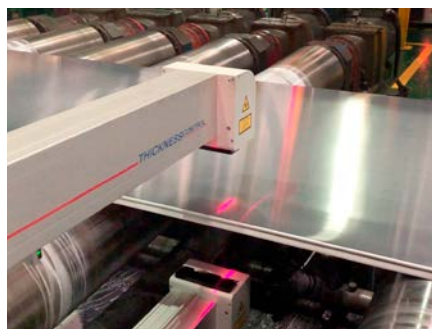
- Large choice of different measuring ranges to optimize for any application
- Proven protection and cleaning concepts for harsh ambient conditions
- Control and evaluation of two C-frames using an IPC



Profile of the top and bottom side of button plate



Screenshot combining cross-sectional and longitudinal trend



Thickness profile measurement in the hot mill



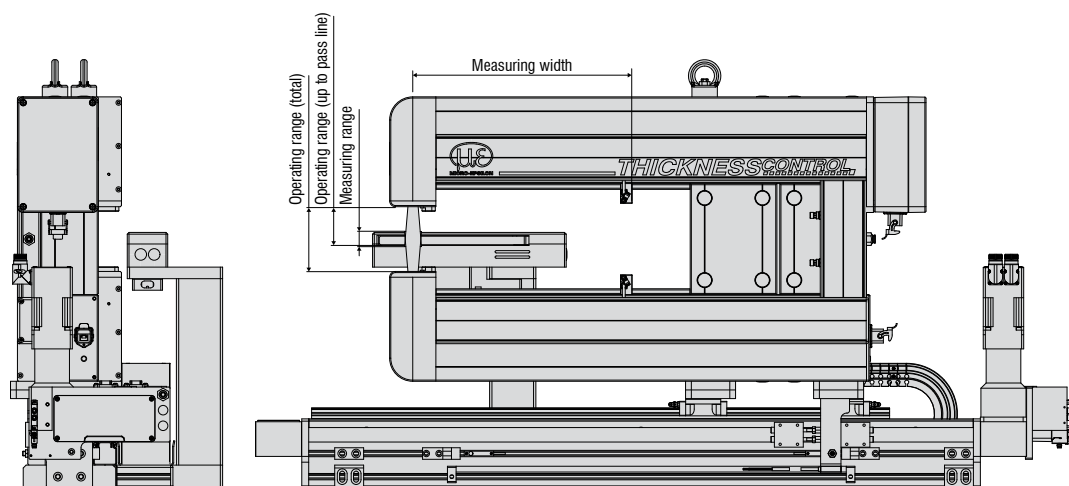
Discrete laser line on button plate

thicknessCONTROL MTS 8202.LLT-60

Description	-60/250	-60/500	-60/1000	-60/1500	-60/2000	-60/2500
Article no.	4350127.21	4350127.23	4350127.71	4350127.326	4350127.318	4350127.343
Measuring width	250 mm	500 mm	1000 mm	1500 mm	2000 mm	2500 mm
Operating range (total)	170 mm			138 mm		
Operating range (up to pass line) ¹⁾	85 mm			71 mm		
Measuring range	60 mm					
Resolution	0.2 μm					
Accuracy ²⁾	± 2 μm					
Repeatability ²⁾	± 0.5 μm					
Material temperature ³⁾	up to 40 °C					

thicknessCONTROL MTS 8202.LLT-400

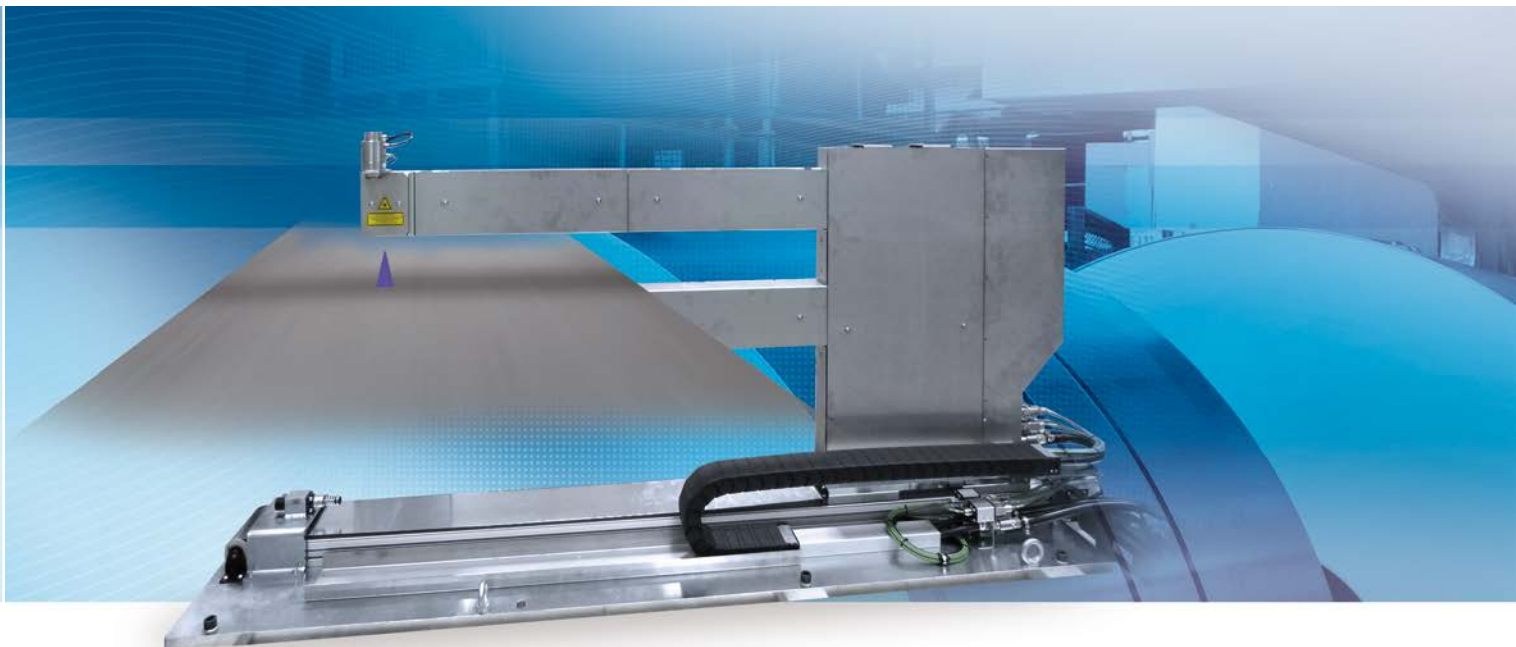
Description	-400/250	-400/500	-400/1000	-400/1500	-400/2000	-400/2500
Article no.	4350127.22	4350127.24	4350127.72	4350127.344	4350127.345	4350127.346
Measuring width	250 mm	500 mm	1000 mm	1500 mm	2000 mm	2500 mm
Operating range (total)	771 mm					
Operating range (up to pass line) ¹⁾	673 mm					
Measuring range 1	100 mm (pass line to (pass line + 100 mm))					
Resolution 1	0.5 μm					
Accuracy 1 ²⁾	$\pm 5 \mu\text{m}$					
Repeatability 1 ²⁾	$\pm 1 \mu\text{m}$					
Measuring range 2	300 mm ((pass line + 100 mm) to (pass line + 400 mm))					
Resolution 2	2 μm					
Accuracy 2 ²⁾	$\pm 20 \mu\text{m}$					
Repeatability 2 ²⁾	$\pm 5 \mu\text{m}$					
Material temperature ³⁾	up to 40 °C					

¹⁾ from upper belt²⁾ 2 σ ³⁾ without additional cooling

Example illustrating the dimensions

thicknessCONTROL MTS 9202.LLT

Thickness measurement in hot rolling mills



thicknessCONTROL MTS 9202.LLT

The new generation of thickness laser gauges, the thicknessCONTROL 9202.LLT stands for exceptional performance and overcomes the challenges of one of the most difficult applications for optical thickness measurements. The C-frame-shaped systems are designed for use in hot rolling mills. They are resistant to harsh environmental conditions and provide high precision results in different operating modes.

Intelligent measuring mechanics for high temperatures

The mechanics of the MTS9202.LLT series is designed to partially compensate for changes induced by temperature gradients. In addition, a network of temperature sensors controls the state and stabilizes the measuring range using powerful signal processing. An additional, regulated cooling register and deflector plates even enable use in steel hot rolling mills at material temperatures of 1200 °C.

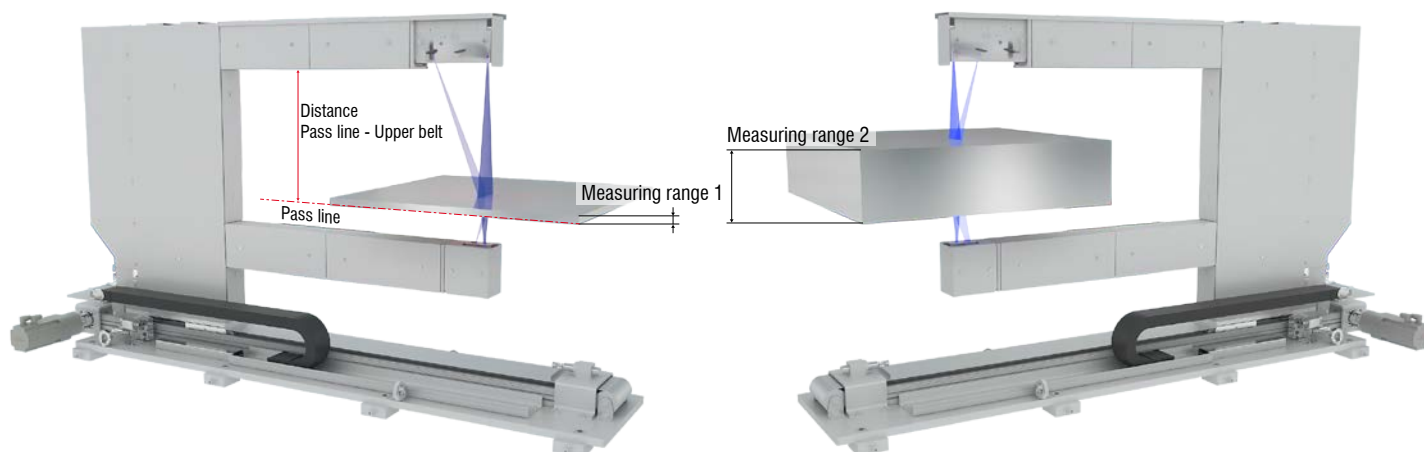
Sequential measuring ranges for more precision and process reliability

The thicknessCONTROL MTS 9202.LLT-400/xxx models are equipped with a special blue laser triangulation sensor which provides two sequential measuring ranges. This perfectly covers the varying thicknesses of the rolled material enabling increased measurement accuracy with thinner material. In addition, this innovative approach ensures significantly increased process reliability due to a very large distance between the pass line and the upper belt.



Patented Blue Laser Technology for hot rolling

Measurements using Blue Laser scanners on red-hot glowing metals with more than 700 °C are patented and only permissible using measuring systems from Micro-Epsilon.

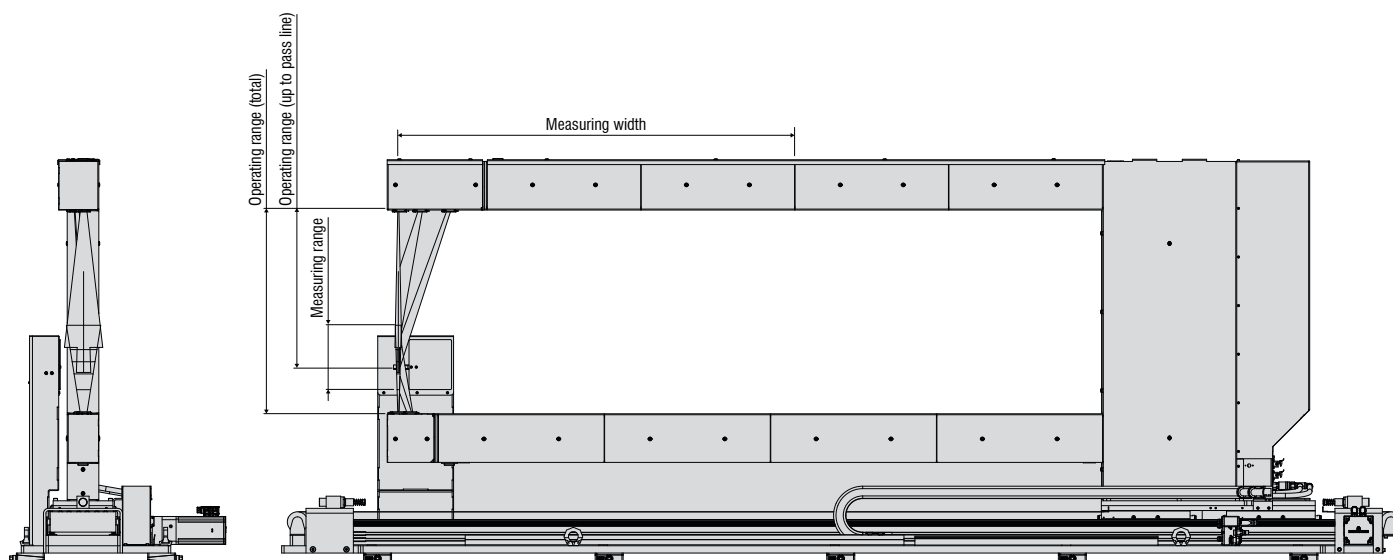


thicknessCONTROL MTS 9202.LLT-60

Description	-60/250	-60/500	-60/1000	-60/1500	-60/2000	-60/2500
Article no.	4350127.301	4350127.302	4350127.303	4350127.304	4350127.305	4350127.306
Measuring width	250 mm	500 mm	1000 mm	1500 mm	2000 mm	2500 mm
Operating range (total)	138 mm					
Operating range (up to pass line) ¹⁾	71 mm					
Measuring range	60 mm					
Resolution	0.2 μm					
Accuracy ²⁾	$\pm 2 \mu\text{m}$					
Repeatability ²⁾	$\pm 0.5 \mu\text{m}$					
Material temperature	up to 1200 °C					

thicknessCONTROL MTS 9202.LLT-400

Description	-400/250	-400/500	-400/1000	-400/1500	-400/2000	-400/2500
Article no.	4350127.334	4350127.335	4350127.336	4350127.337	4350127.338	4350127.339
Measuring width	250 mm	500 mm	1000 mm	1500 mm	2000 mm	2500 mm
Operating range (total)	850 mm					
Operating range (up to pass line) ¹⁾	700 mm					
Measuring range 1	100 mm (pass line to (pass line + 100 mm))					
Resolution 1	0.5 μm					
Accuracy 1 ²⁾	$\pm 5 \mu\text{m}$					
Repeatability 1 ²⁾	$\pm 1 \mu\text{m}$					
Measuring range 2	300 mm ((pass line + 100 mm) to (pass line + 400 mm))					
Resolution 2	2 μm					
Accuracy 2 ²⁾	$\pm 20 \mu\text{m}$					
Repeatability 2 ²⁾	$\pm 5 \mu\text{m}$					
Material temperature	up to 1200 °C					

¹⁾ from upper belt²⁾ 2 σ 

Example illustrating the dimensions

thicknessCONTROL MTS 8202.K

C-frame systems for highest precision on shiny surfaces



Operating principle of thickness measurement

In the thicknessCONTROL MTS 8202.K C-frame, two confocal chromatic sensors are integrated. The sensors focus polychromatic light (white light) onto the target surface through a multilens optical system. The lenses are arranged so that the white light is dispersed into a monochromatic light by controlled chromatic aberration. A specific distance to the target is assigned to each wavelength by a factory calibration. In the sensor system, this wavelength of light is used for the measurement, which is exactly focused on the target.

An optical arrangement images the light reflected onto a light sensitive sensor element,

on which the corresponding spectral color is detected and evaluated.

Both confocal sensors are synchronized with one another during the in-situ calibration in order to detect the thickness of the material to be measured according to the difference principle (difference between the sum of the sensor signals and the mouth width). Both laser lines must be projected congruently onto the top side and the rear side of the material in order to achieve an accurate thickness measurement. This is ensured by exact factory calibration and adjustment using an opto-electronic tool.

Special features

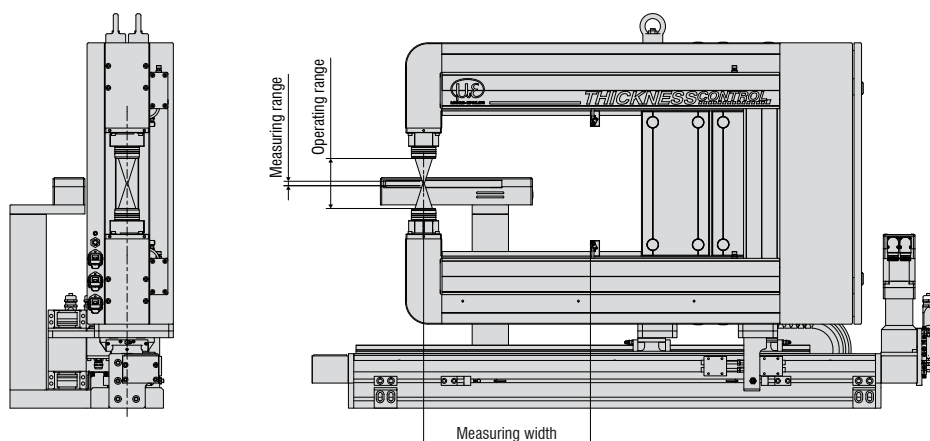
Measurements are also possible on reflective and shiny surfaces such as, e.g., copper strips, coated metals and high-gloss polished metals. The exposure time regulation of the confocal sensors enables reliable measurements even on changing surfaces. The measurement is carried out without contact and is therefore reactionless which enables that even sensitive materials can be reliably measured using the thicknessCONTROL MTS 8X02.K. The high measuring rates also allow for dynamic processes to be detected reliably.



Thickness measurement

thicknessCONTROL MTS 8202.K

Description	-3/250	-10/250	-30/250	-3/500	-10/500	-30/500	-10/800	-30/800
Article no.	4350127.410	4350127.41	4350127.44	4350127.411	4350127.42	4350127.45	4350127.43	4350127.46
Measuring width	250 mm			500 mm			800 mm	
Operating range (total)	43 mm	110 mm	230 mm	43 mm	110 mm	230 mm	110 mm	230 mm
Operating range (up to pass line) ¹⁾	21.5 mm	55 mm	115 mm	21.5 mm	55 mm	115 mm	55 mm	115 mm
Measuring range	3 mm	10 mm	30 mm	3 mm	10 mm	30 mm	10 mm	30 mm
Resolution	0.07 μm	0.12 μm	0.36 μm	0.07 μm	0.12 μm	0.36 μm	0.12 μm	0.36 μm
Accuracy ²⁾	$\pm 0.4 \mu\text{m}$	$\pm 0.7 \mu\text{m}$	$\pm 2.5 \mu\text{m}$	$\pm 0.4 \mu\text{m}$	$\pm 0.7 \mu\text{m}$	$\pm 2.5 \mu\text{m}$	$\pm 0.7 \mu\text{m}$	$\pm 2.5 \mu\text{m}$
Repeatability ²⁾	$\pm 0.3 \mu\text{m}$	$\pm 0.5 \mu\text{m}$	$\pm 2 \mu\text{m}$	$\pm 0.3 \mu\text{m}$	$\pm 0.5 \mu\text{m}$	$\pm 2 \mu\text{m}$	$\pm 0.5 \mu\text{m}$	$\pm 2 \mu\text{m}$
Material temperature ³⁾	up to 40 °C							

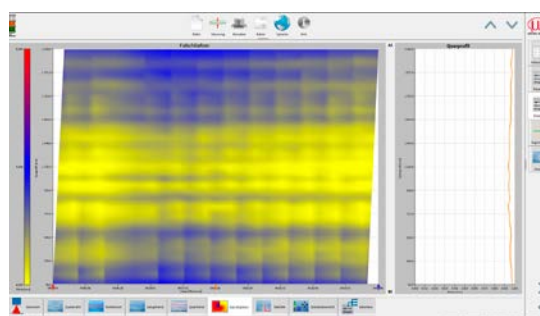
¹⁾ from upper belt²⁾ 2 σ ³⁾ without additional cooling

Analysis and control software

The thicknessCONTROL MTS data collection and analysis software provides fully automatic documentation and control of the production process by offering

- article database
- production archive
- statistical evaluations
- limit value monitoring with return back to production (optional fieldbus interfaces).

Interfaces



The C-frame includes a multi-touch capable software package for analysis, presentation and archiving of monitored production data. It enables different measurement modes such as fixed track thickness measurement at any position, measurement of the thickness profile, measurement of several longitudinal trends, a SPC package and automated verification of the measuring system's capability.

thicknessCONTROL MTS 8201.LLT

O-frame systems for profile thickness measurement



Due to its O-frame design, thicknessCONTROL MTS 8201.LLT is ideally suited to large widths and environments where there is insufficient space to position a C-frame alongside the production line. As well as the upper and lower belts, a linear axis is also integrated, on which a laser line sensor is installed. Both axes are mechanically coupled and move the sensors perpendicular to the strip run direction in order to measure the thickness profile. The measuring system is particularly suitable for slitting lines.

The high lateral resolution of the laser line enables high precision thickness measurements of each strip up to the edge. This is how every coil produced, even with very small widths, are evaluated and documented.

The large operating range of the thicknessCONTROL MTS 8201.LLT combined with high precision is important just after the cutter spindle, as the cutting process initiates vertical movements. Laser point sensors would not be able to provide the high precision at the measuring ranges required here.

From the different measurement techniques based on laser triangulation, the discrete laser line technology is the only method that compensates for tilt angle errors. This characteristic is a further, critical factor that ensures the outstanding accuracy of the system in such applications. Also with

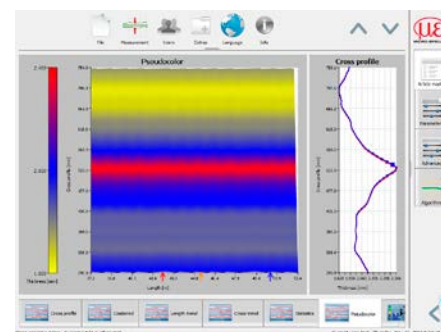
measurements in front of the cutter, evaluation and documentation of individual stripes can be made when transmitting the cutter position.

Industry 4.0 for complex temperature requirements

thicknessCONTROL MTS 8201.LLT is equipped with a patented temperature compensation feature. The machine includes a special, thermally-stable frame as reference. With additional sensor technology, the changes of the measurement frame caused by temperature fluctuations are measured and compensated for using special algorithms. This is how the operating range of the system – of which the real, temperature-dependent, geometric change simulates a change in thickness – is kept virtually constant. This approach, which relies on the philosophy of Industry 4.0, is one of several features that make the thicknessCONTROL MTS 8201.LLT an extremely reliable and robust measuring system.

Special features:

- Patented compensation of parasitic, thermal effects
- Variable HMI positioning (integrated - standalone)
- Up to 60 m/min traversing speed for large widths



Screenshot false-color-representation



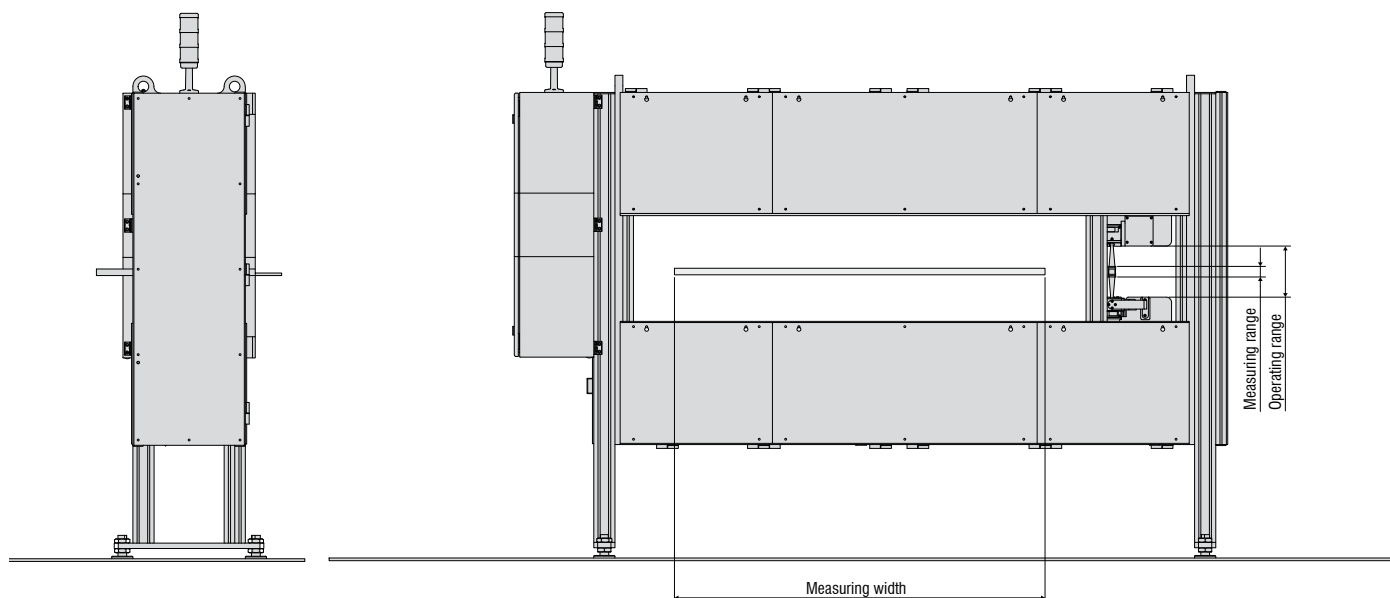
Thickness measurement in a milling line

thicknessCONTROL MTS 8201.LLT-60

Description	-60/500	-60/1000	-60/1500	-60/2000	-60/2500	-60/3000
Article no.	4350006.10	4350006.12	4350006.14	4350006.16	4350006.32	4350006.43
Measuring width	500 mm	1000 mm	1500 mm	2000 mm	2500 mm	3000 mm
Threading gap	400 mm					
Operating range (total)	190 mm					
Operating range (up to pass line) ¹⁾	110 mm					
Measuring range	60 mm					
Resolution	0.2 μm					
Accuracy ²⁾	$\pm 2 \mu\text{m}$					
Repeatability ²⁾	$\pm 0.5 \mu\text{m}$					
Material temperature ³⁾	up to 40 °C					

thicknessCONTROL MTS 8201.LLT-400

Description	-400/500	-400/1000	-400/1500	-400/2000	-400/2500	-400/3000
Article no.	4350006.11	4350006.13	4350006.15	4350006.17	4350006.33	4350006.35
Measuring width	500 mm	1000 mm	1500 mm	2000 mm	2500 mm	3000 mm
Threading gap	1060 mm					
Operating range (total)	850 mm					
Operating range (up to pass line) ¹⁾	700 mm					
Measuring range 1	100 mm (pass line to (pass line + 100 mm))					
Resolution 1	0.5 μm					
Accuracy 1 ²⁾	$\pm 5 \mu\text{m}$					
Repeatability 1 ²⁾	$\pm 1 \mu\text{m}$					
Measuring range 2	300 mm ((pass line + 100 mm) to (pass line + 400 mm))					
Resolution 2	2 μm					
Accuracy 2 ²⁾	$\pm 20 \mu\text{m}$					
Repeatability 2 ²⁾	$\pm 5 \mu\text{m}$					
Material temperature ³⁾	up to 40 °C					

¹⁾ from upper belt²⁾ 2 σ ³⁾ without additional cooling

Example illustrating the dimensions

thicknessCONTROL MTS 9201.LLT

Special systems for special applications



thickness CONTROL MTS 9201.LLT is specially designed for applications in harshest environments for example aluminum hot rolling mills.

These systems stand out due to their solid steel frame. The optical sensors are water-cooled in order to ensure a longer service life. The integrated, electronic components remain in the specified temperature range, as the frame is purged with cold air. Another special feature is the patented, fully automatic monitoring of the linearity in the 'parked' position using a certified calibration standard. In this way, not only are thermal effects on the mechanics of the measuring frame are monitored but also the factors affecting the sensor electronics, which are corrected automatically using a patented linearization process.

Extended measuring range with unchanged precision

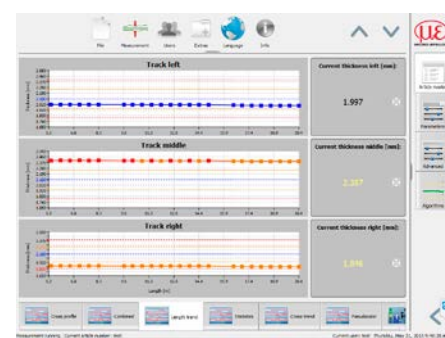
All O-frame systems, particularly the HME variant, can be retrofitted with a vertical linear axis in the upper belt.

This is how the measuring range of the machine can be extended significantly without changing the sensor measuring range and the accuracy.

The axis is also considered in the temperature compensation management and can be regulated in its position to the line with reference to the expected thickness via the interface.

Offline tools for comprehensive analyses

As well as comprehensive visualization possibilities, thicknessCONTROL MTS offers an offline tool that enables detailed analyses of production and its optimization based on SPC functionality.



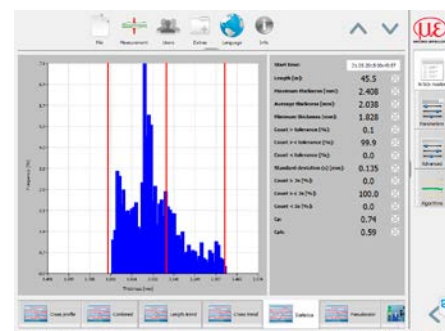
Screenshot trend for edge and center thickness



Thickness measurement in an aluminum hot rolling mill



Center thickness & thickness profile in the hot mill



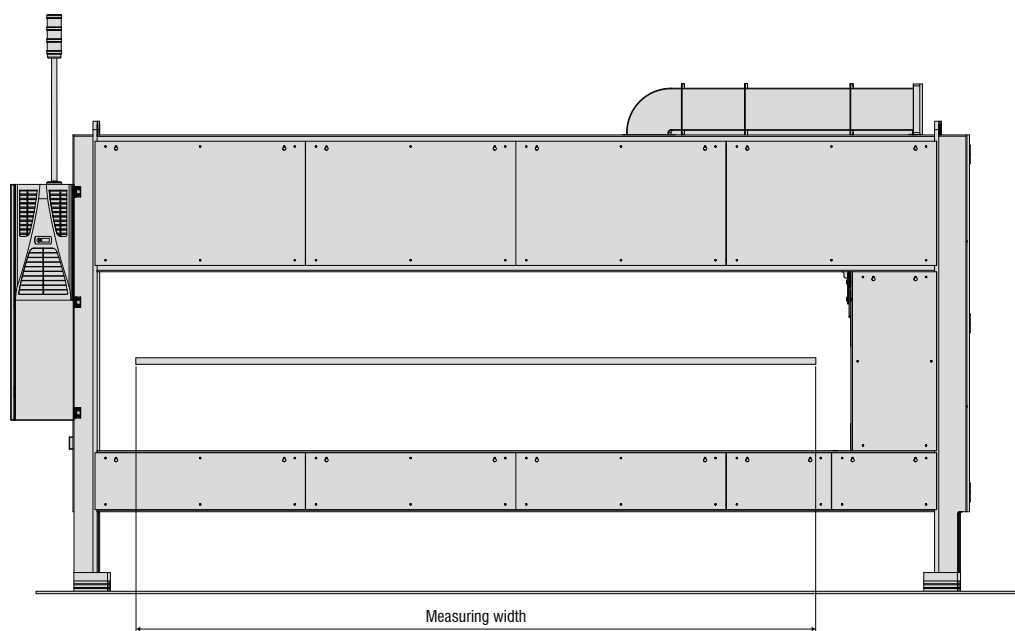
Screenshot statistical evaluation of production

thicknessCONTROL MTS 9201.LLT-60

Description	-60/500	-60/1000	-60/1500	-60/2000	-60/2500	-60/3000
Article no.	4350006.10	4350006.12	4350006.14	4350006.16	4350006.32	4350006.43
Measuring width	500 mm	1000 mm	1500 mm	2000 mm	2500 mm	3000 mm
Threading gap	400 mm					
Operating range (total)	190 mm					
Operating range (up to pass line) ¹⁾	110 mm					
Measuring range	60 mm					
Resolution	0.2 μm					
Accuracy ²⁾	$\pm 2 \mu\text{m}$					
Repeatability ²⁾	$\pm 0.5 \mu\text{m}$					
Material temperature	steel up to 100 °C/aluminum up to 530 °C					

thicknessCONTROL MTS 9201.LLT-400

Description	-400/500	-400/1000	-400/1500	-400/2000	-400/2500	-400/3000
Article no.	4350006.11	4350006.13	4350006.15	4350006.17	4350006.33	4350006.35
Measuring width	500 mm	1000 mm	1500 mm	2000 mm	2500 mm	3000 mm
Threading gap	1060 mm					
Operating range (total)	850 mm					
Operating range (up to pass line) ¹⁾	700 mm					
Measuring range 1	100 mm (pass line to (pass line + 100 mm))					
Resolution 1	0.5 μm					
Accuracy 1 ²⁾	$\pm 5 \mu\text{m}$					
Repeatability 1 ²⁾	$\pm 1 \mu\text{m}$					
Measuring range 2	300 mm ((pass line + 100 mm) to (pass line + 400 mm))					
Resolution 2	2 μm					
Accuracy 2 ²⁾	$\pm 20 \mu\text{m}$					
Repeatability 2 ²⁾	$\pm 5 \mu\text{m}$					
Material temperature	steel up to 100 °C/aluminum up to 530 °C					

¹⁾ from upper belt²⁾ 2 σ 

Example illustrating the dimensions

thicknessCONTROL MWS 8201.LLT

Dynamic width measurement using discrete laser line technology



Using discrete laser line sensors, the thicknessCONTROL MWS 8201.LLT enables the inspection of the strip edges due to the high lateral resolution. Width can be measured using one sensor on every edge of the strip. Both sensors are mounted onto mechanical carriages on a portal, and can be positioned independently from one another. The position/distance of the mechanical carriages can be detected using a linear encoder.

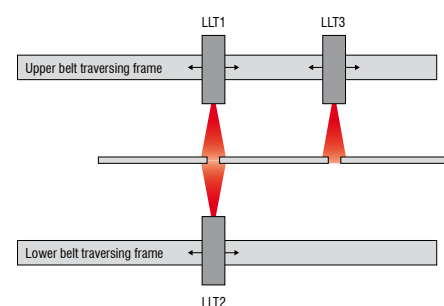
The arrangement of the sensors in the mechanical carriages is determined during a calibration procedure. The encoder value and the sensor signals in the x-axis amount to the strip width. As laser line sensors deliver a two-dimensional signal, the material tilt angle can also be taken into account and compensated.

Combined measurement technology for thickness and width

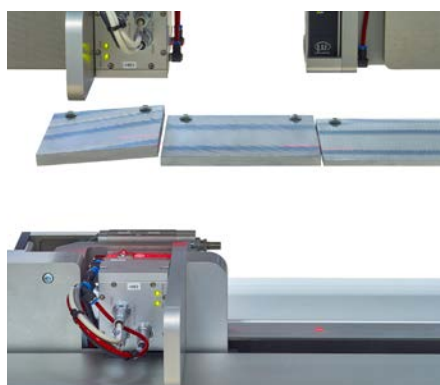
thicknessCONTROL MWS 8201.LLT combines thickness and width measurement in an O-frame system which is equipped with three laser line sensors. Two sensors are integrated into the upper belt and one in the lower belt. However, one sensor in the upper belt is used for both measurement tasks. While the sensor technology of the thickness measurement continuously detects the thickness profile while traversing, the width is always measured when both sensors are positioned in the upper belt on one edge. This system architecture is predestined for monitoring and process optimization of slitting lines, as the thickness and the width can be continuously monitored and documented for each individual ring.

Integrated width measurement for slitting lines

The third LLT3 laser scanner traverses independently of both thickness measurement scanners (LLT1 and 2) and therefore provides the exact width value of the individual rings.



Functional principle of combined thickness and width measurement



Combined thickness and width measurement



Calibration of sensor position



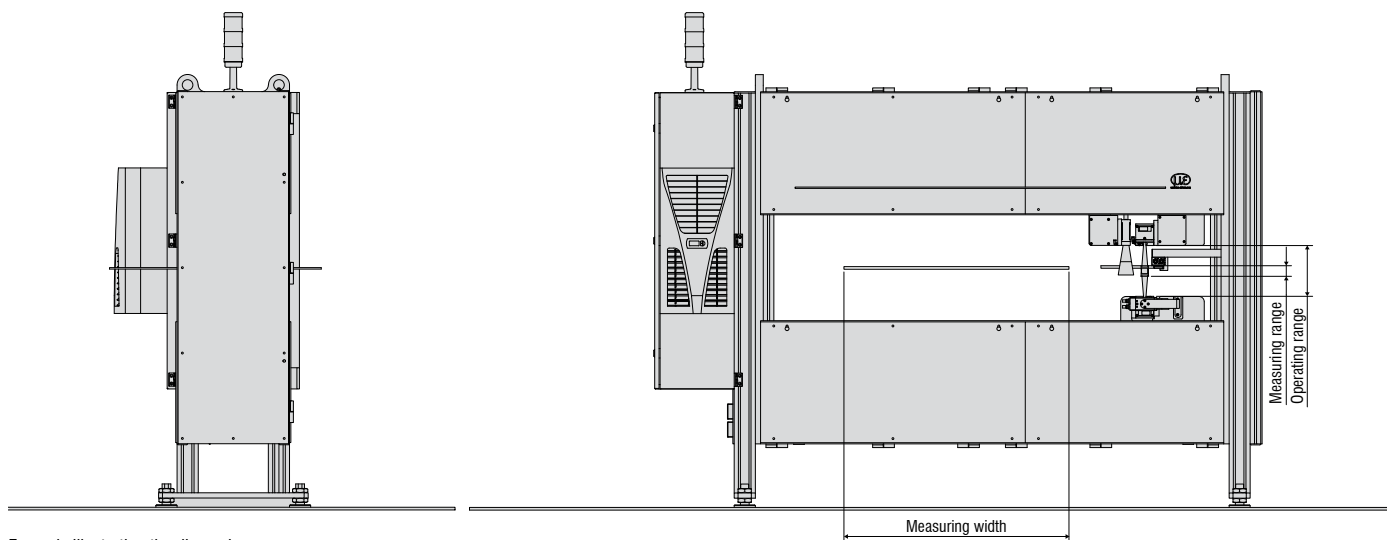
Measurement after slitting shears

thicknessCONTROL MWS 8201.LLT

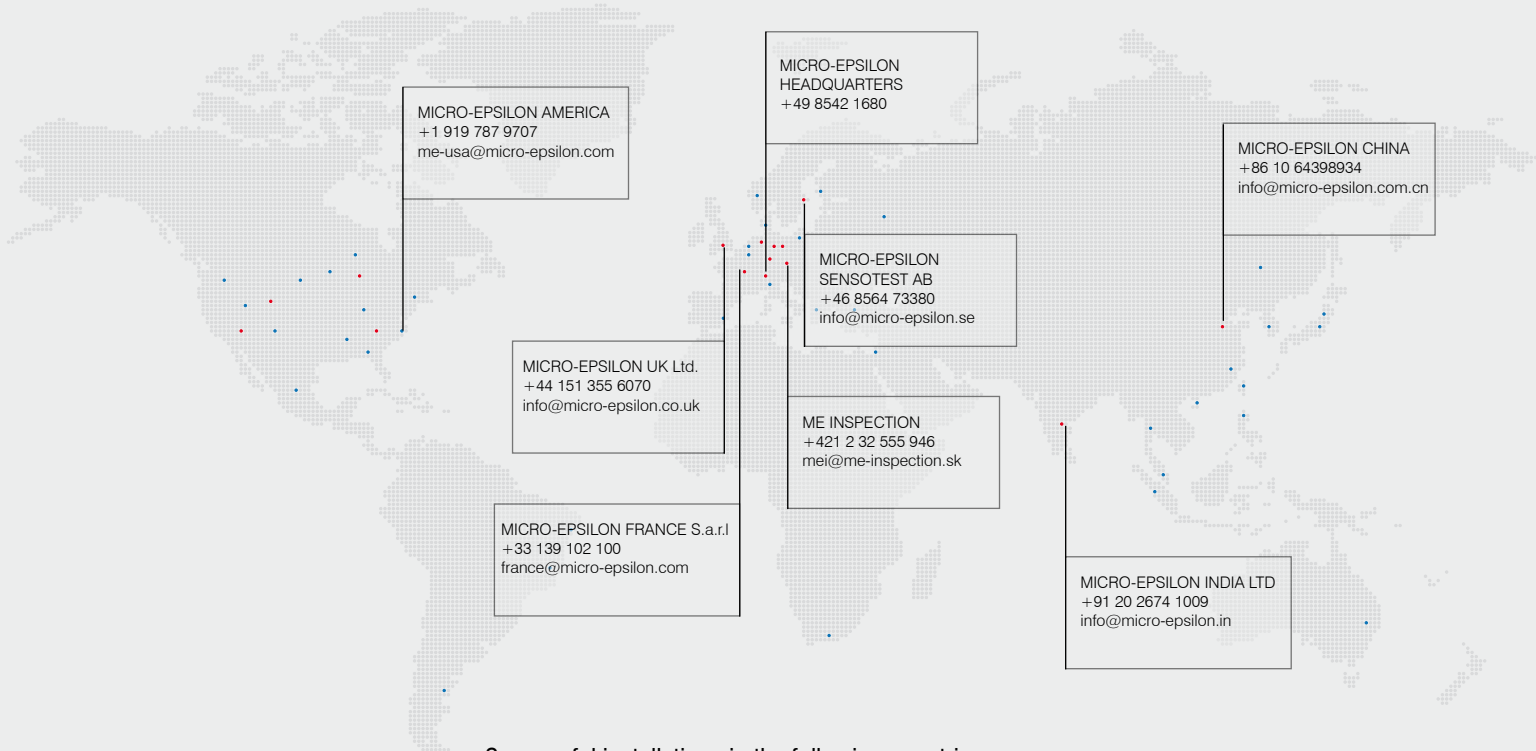
Description	-60/500	-60/1000	-60/1500	-60/2000	-60/2500	-60/3000
Article no.	4350282.01	4350282.02	4350282.03	4350282.04	4350282.05	4350282.06
Width measuring range	500 mm	1000 mm	1500 mm	2000 mm	2500 mm	3000 mm
Width resolution	40 μm					
Width accuracy ^{1) 2)}	$\pm 100 \mu\text{m}$	$\pm 200 \mu\text{m}$	$\pm 300 \mu\text{m}$	$\pm 400 \mu\text{m}$	$\pm 500 \mu\text{m}$	$\pm 600 \mu\text{m}$
Width repeatability ¹⁾	$\pm 50 \mu\text{m}$					
Threading gap	400 mm					
Thickness/Operating range (total)	190 mm					
Thickness/Operating range (up to pass line) ³⁾	110 mm					
Thickness measuring range	60 mm					
Thickness resolution	0.2 μm					
Thickness accuracy ¹⁾	$\pm 2 \mu\text{m}$					
Thickness repeatability ¹⁾	$\pm 0.5 \mu\text{m}$					
Material temperature ⁴⁾	up to 40 °C					

dimensionCONTROL MWS 8203.LLT

Description	-60/500	-60/1000	-60/1500	-60/2000	-60/2500	-60/3000
Article no.	4350292.01	4350292.02	4350292.03	4350292.04	4350292.05	4350292.06
Width measuring range	500 mm	1000 mm	1500 mm	2000 mm	2500 mm	3000 mm
Width resolution	40 μm					
Width accuracy ^{1) 2)}	$\pm 100 \mu\text{m}$	$\pm 200 \mu\text{m}$	$\pm 300 \mu\text{m}$	$\pm 400 \mu\text{m}$	$\pm 500 \mu\text{m}$	$\pm 600 \mu\text{m}$
Width repeatability ¹⁾	$\pm 50 \mu\text{m}$					
Material temperature ⁴⁾	up to 40 °C					

¹⁾ 2 σ ²⁾ without long-term compensation of the thermal expansion³⁾ from upper belt⁴⁾ without additional cooling

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Performance and quality, as well as reliability of products and services have made Micro-Epsilon Messtechnik GmbH & Co. KG one of the leading suppliers of inspection systems for optical thickness measurement used in the metals industry. Numerous, successful installations in 13 countries around the world in milling lines and processing lines speak for themselves. Developing and producing all the necessary core components such as sensors, software and measurement-specific machine building inside the company group provides unique innovative skills that are mirrored in the product portfolio of Micro-Epsilon.

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