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WHITEPAPER

SENSOR SOLUTIONS FOR FOILS AND THIN STRIP MATERIALS

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IPF ELECTRONIC

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1 INTRODUCTION

Manufacturers of films and similar thin strip materials are usually faced with global competition, which presents each individual entrepreneur with numerous production-related and therefore also economic challenges. Against this backdrop of high energy and raw material prices, it is becoming increasingly important to manufacture and process specific products with a high degree of process reliability. However, a high level of process reliability can often only be achieved at many production levels with sensor technology that is optimally adapted to the respective application, if not specialized.

Plastic and aluminum foils as well as comparable products have very different material and surface properties: transparent, opaque, high-gloss, matt, monochrome, multicolored, light, dark, extremely thin, embossing with fine or rough surface structures, special coatings, and, and, and. The list could probably be continued at this point with a whole series of other features.

It is these properties in particular that repeatedly make the detection of different materials difficult and often place demanding requirements on the sensor technology in practice. In this context, very fast-running processes in production and further processing usually have to be taken into account, which demand a great deal from the corresponding sensor solutions in terms of precision and response time alone. In view of the complex tasks associated with this for sensor technology, be it presence monitoring, web edge control, thickness measurement, diameter determination, length measurement, etc., it is not always easy to find a truly optimal solution for a specific application.

One advantage of ipf electronic as a sensor specialist that should not be underestimated in this context is its extremely diverse range of very different technologies. Whether optical scanners, ultrasonic sensors, line cameras, contrast sensors, light barriers or displacement measuring systems, with the comprehensive portfolio of proven solutions, almost every task and real challenges in all conceivable processes can be mastered. Added to this are decades of application experience in various industries and thus valuable know-how from which customers can benefit in numerous applications.

This white paper provides a representative overview of ipf electronic‘s sensor solutions for monitoring a wide range of processes in the production of films and other thin strip materials.

2 PRESENCE MONITORING: SOLUTIONS FOR WEAR-FREE DETECTION

Many processes are only truly safe if it can be guaranteed at all times that material is present in a system. In particular, optical sensors and ultrasonic sensors from ipf electronic in a wide variety of designs offer a wealth of advantages for contactless and therefore wear-free presence monitoring.

2.1 OPERATING PRINCIPLE OF OPTICAL SENSORS

The basic function of optical sensors is based on the transmission and reception of light. A distinction is made here between sensors with background suppression, retro-reflective sensors and retro-reflective light barriers. Scanners with background suppression for almost surface-independent object detection integrate transmitter and receiver in one device. They do not require a counter element and detect the light beam reflected by the object. The receiver elements of the scanner evaluate the object position from which the incident transmitted light is reflected. Scanning retro-reflective barriers and retro-reflective light barriers also combine transmitter and receiver in one compact device. In this context, scanning retro-reflective barriers can work with any reflective reference surface (e.g. a machine part), while retro-reflective light barriers require a reflector as a counter element. Both technologies evaluate the interruption of the light signal.

2.1.1 OPTICAL SENSORS WITH SPECIAL PROPERTIES

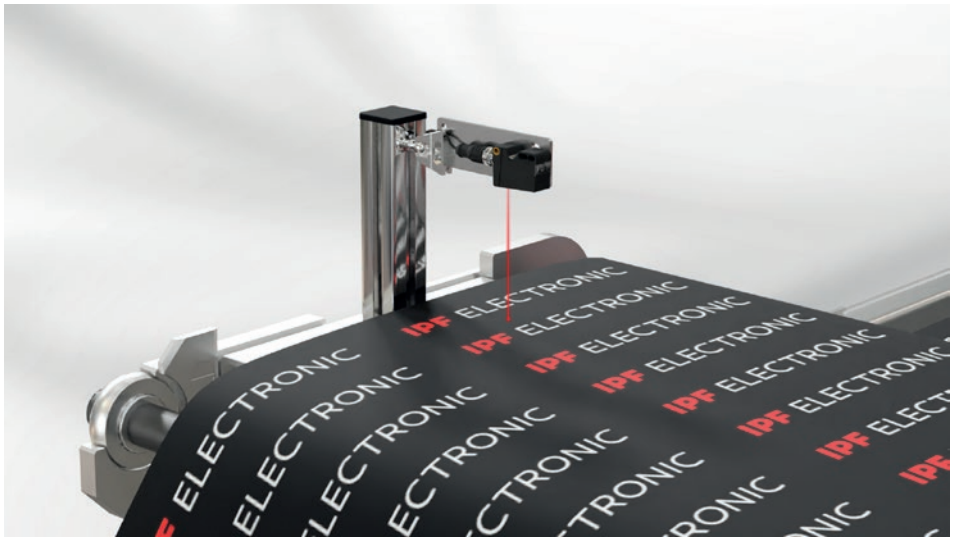
Examples of optical sensors for presence detection from the ipf electronic product portfolio are the **ON450522**, a solution specially developed for the detection of transparent materials, the **OR450521** for the detection of objects with reflective surfaces and the **OT450520** for high-precision, color-independent detection.

The **ON450522** was specially developed for the detection of transparent materials. Due to its high switching frequency and short response time, the sensor is suitable for use in high-speed processes. (all pictures: ipf electronic gmbh)

The **ON450522** (auto-reflective light barrier) with switching output can be flexibly parameterized thanks to the IO-Link interface and achieves a range of up to 1,000mm. Due to the high switching frequency of 2,000Hz and a short response time ≤0.25ms, the **ON450522** is suitable for use in high-speed processes. As already emphasized, this optical sensor was specially developed for the detection of transparent objects. The sensitivity of the sensor can be easily adjusted via teach-in depending on the transparency and nature of the material or object to be detected, whereby a total of three sensitivity levels are available, e.g. for detecting clear films or less transparent materials as well as opaque objects.
The **OR450521** (retro-reflective light barrier) impresses above all with its long range of up to 7,500mm. The sensor with integrated switching output has a maximum switching

frequency of 1,000Hz and a response time of 0.49ms.

Like the **ON450522**, the **OT450520** (diffuse-reflection) with switching output has an IO-Link interface and detects objects almost independently of their surface due to the background suppression through a precisely definable sensing range. This solution with a maximum switching distance of 600mm is therefore particularly suitable for high-precision, color-independent detection, whereby no counter element is required. Like the **OR450521**, the **OT450520** has a maximum switching frequency of 1,000Hz and a response time of 0.49ms.



The **OT450520** with IO-Link interface detects objects almost independently of their surface due to background suppression and has a maximum switching frequency of 1,000Hz and a short response time of 0.49ms.

2.1.2 KEY ADVANTAGES OF OPTICAL SENSORS FOR PRESENCE MONITORING

Optical sensors enable non-contact and therefore wear-free sensing. They are particularly suitable for transparent or reflective materials, achieve long ranges and also impress with high switching frequencies and short response times for fast-running processes. Other advantages of optical sensors include easy installation thanks to visible red light, simple sensitivity adjustment using the teach-in procedure and, in the case of some devices, an IO-Link interface for flexible, application-oriented parameterization.

2.2 FUNCTIONALITY OF ULTRASONIC SENSORS FOR PRESENCE DETECTION

Ultrasonic sensors detect all materials, media and objects that are capable of reflecting ultrasound to a sufficient degree. Ultrasound is defined as sound with frequencies above the audible frequency range of the human ear. Ultrasound covering frequencies from 20kHz to 1GHz is therefore not perceptible to the human ear. Sound above 1GHz is referred to as hypersonic, while sound below the human hearing threshold (<16Hz) is known as infrasound.
Ultrasonic sensors work according to the so-called echo transit time method (transit time measurement) and integrate a transducer that acts cyclically as a transmitter and receiver. The transducer emits a certain number of sound waves that are reflected by the material to be detected, regardless of its shape, color or transparency. The transducer then switches to receive and detects the signal echoes.

The time that elapses from sending to receiving the signals is proportional to the distance between the sensor and the material surface.

The formula for distance measurement is as follows:

L = ½ x T x C

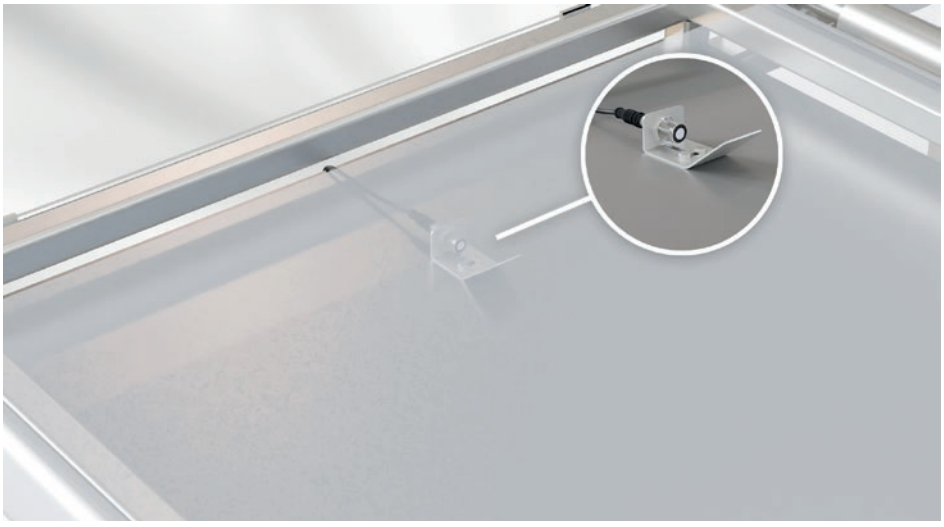
(L = distance, T = the time between sending and receiving, C = speed of sound)
The value from T x C must be multiplied by ½, because T defines the time that the sound waves need from the sensor to the object and back to the device.

Ultrasonic sensors are available as disposable systems, probes and ultrasonic forks. Ultrasonic forks always integrate optimally aligned transmitters and receivers in one device. Disposable systems consist of a separate transmitter and receiver. With both solutions, the interruption of the ultrasound is evaluated. Ultrasonic diffuse-reflection sensors have a transmitter and receiver in one solution and evaluate the sound reflection on a material surface.

2.2.1 ULTRASONIC SENSORS FOR FLEXIBLE USE

The **UG800170** ultrasonic fork in a robust aluminum housing (protection class IP67) has a fork width of 74 mm and is ideal for checking the presence of transparent plastic films, among other things. Thanks to the integrated amplifier, the **UG800170** has a high sound intensity. An LED in the housing signals the switching status and also indicates whether operating voltage is applied to the device. The maximum switching frequency of the **UG800170** is 300kHz.

The **UY210100** through-beam sensor in a robust industrial plastic housing from ipf electronic has a maximum switching distance of 300mm and, like the **UG800170**, an integrated amplifier for high sound intensity.



An ultrasonic diffuse-reflection sensor **UT189523** for checking the presence of film. A mounting bracket with deflection function directs the ultrasound in the direction of the object to be detected and enables installation below the film despite the limited installation space. The sensor is also protected from potential contamination in this installation position.

The **UT189523** ultrasonic diffuse-reflection sensor achieves long ranges of up to 1,500 mm and enables flexible configuration of the switching output thanks to the IO-Link interface. For example, the **UT189523** can be converted from a push-button to an auto-reflective light barrier. This allows the push-button to be set to a background instead of an object and thus reliably detects all deviations from the background, e.g. when a transparent

object passes through the detection area. Thanks to its metal housing (protection class IP67), the diffuse-reflection sensor is suitable for use in harsh environmental conditions.

2.2.2 KEY ADVANTAGES OF ULTRASONIC SENSORS FOR PRESENCE DETECTION

Ultrasonic sensors in all their forms enable the non-contact, wear-free detection of all materials regardless of surface, color or transparency. Such solutions are therefore ideal for the precise detection of highly transparent, thin strip materials, even from greater distances. Ultrasonic sensors are easy to set using teach-in. Sensors with an IO-Link interface can also be flexibly configured and easily switched from scanning to reflex mode, which can be crucial for presence detection in some applications.

3 WEB EDGE CONTROL: HIGH-PRECISION AND ALWAYS RELIABLE SENSOR TECHNOLOGY

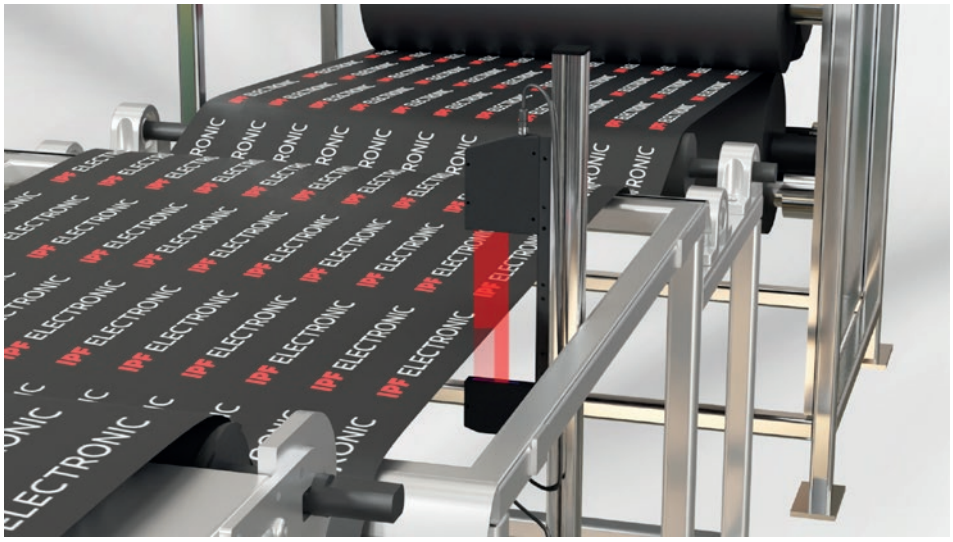
Guided material webs must always remain within their predefined limits during a process. This requires a web edge control system that uses sensors to continuously monitor the alignment or guidance of a material web running over a roller, for example. Actuators use the sensor signals to exert a corrective influence on the path of the web. The laser line sensors and line cameras from ipf electronic have proven their worth for high-precision web edge control.

3.1 FUNCTIONALITY OF LASER LINE SENSORS FOR WEB EDGE CONTROL

As through-beam sensors, laser line sensors consist of a transmitter and receiver in separate housings. The receiver of this system integrates a CCD line detector with closely spaced receiver elements or pixels. The transmitter in turn generates a homogeneous linear laser light beam. If a material web is located in the light beam of the sensor system, it partially or completely covers the light, whereby the shadow image is imaged on the individual pixels or receiving elements of the receiver CCD line and converted into a continuous analog signal (0...10V or 4...20mA). This analog signal can now be used for web edge control. The level of the respective signal level makes it possible to determine exactly where the web edge is located in the detection range of the light barrier and therefore whether it is moving within its defined limits or not.

3.1.1 LASER LINE SENSORS: HIGH RANGES AND ACCURACY

One example from the product portfolio of laser line sensors from ipf electronic is the through-beam sensor consisting of **PS500046** (transmitter) and **PE500146** (receiver). The transmitter fulfills the conformity criteria of laser protection class 1, meaning that no special protective measures are required when handling the system solution. Thanks to its long range of up to 2,000mm, the **PS500046/PE500146** through-beam sensor enables reliable web edge control even from greater distances. The measuring width of the homogeneous laser beam is up to 50mm. The transmitter and receiver have a robust aluminum housing. The electrical connection is made via an M9-connector.



The through-beam sensor consisting of **PS500046** (transmitter, top) and PE500146 (receiver, bottom) enables reliable web edge control even from greater distances thanks to its long range of up to 2,000 mm.

3.1.2 KEY ADVANTAGES OF LASER LINE SENSORS FOR WEB EDGE CONTROL

Laser line sensors can be easily installed and adjusted as through-beam sensors thanks to the visible red light (laser diode) during installation. Due to the linear light beam, the position of the web edge can be anywhere between the transmitter and receiver when mounting the sensor. System solutions such as the through-beam sensor **PS500046**/ **PE500146** are ideal for web edge control of very thin materials, whereby any fluctuations in the height of the web, for example due to low material tension, have no influence on the accuracy of the measurement results.

3.2 FUNCTIONALITY OF LINE CAMERAS FOR WEB EDGE CONTROL

Line cameras work in a similar way to laser line sensors. A cuboid housing with a C-mount lens connection also contains a certain number of receiving elements (line detectors). An LED line light serves as a counter element for the camera. If a web of material is in the light beam of the LED light, the shadow image of the web is displayed on the receiving elements of the camera and converted into a continuous analog signal (0...10V or 4...20mA). Because the number of line detectors is fixed, the resolution of this system solution depends primarily on the width of the measuring range (depending on the choice of lens). The wider or larger the detection or measuring range, the lower the resolution of the line camera.

3.2.1 PROVEN COMBINATION OF CAMERA, LENS AND LED LIGHTING

As an example of web edge control with a line camera, a specific system solution from ipf electronic is described here, which is based on a camera (**PYSI0317**) with a C-mount lens connection, a lens (**AO000406**) and line lighting (**AO98E124**).
The **PYSI0317** camera in an aluminium housing has an analogue output (0...10V, 4...20mA) and is offered with free software for parameterization. The **AO000406** entocentric lens with C-mount thread has a focal length of 6mm and can be focused. The **AO98E124** LED light (dimensions: 30x60x497mm) in an aluminum housing with an acrylic glass front panel has a colour temperature of 5,000K and an average service life of 50,000 hours. The electrical connection is made using an M8 plug connector.

The large measuring range (measuring width approx. 400mm) makes it particularly suitable for monitoring larger web edge areas with a high resolution: A system solution consisting of a **PYSI0317** line camera with C-mount lens connection, an **AO000406** lens and an **AO98E124** line-shaped illumination below the web material.

3.2.2 KEY ADVANTAGES OF LINE CAMERAS FOR WEB EDGE CONTROL

The system solution described is particularly suitable for monitoring larger web edge areas with a high resolution of <0.5mm due to the large measuring range (measuring width approx. 400mm). Using the free PC software, the camera can be conveniently parameterized and thus the corresponding web edge control can be optimally adapted to the respective application.

4 LENGTH MEASUREMENT: PRECISE OVERVIEW OF PRODUCTION QUANTITIES AND EXACT POSITIONING

By measuring the length of material webs, the exact production quantity of a system can be determined over a previously defined period (e.g. daily production). In addition, length measurement can be used for exact positioning, e.g. of roll knives for material cutting. For precise length measurements, ipf electronic provides magnetic distance measuring systems, a non-contact optical distance measuring system and flexibly parameterizable rotary encoders.

4.1 FUNCTIONALITY OF MAGNETIC DISPLACEMENT ENCODERS FOR LENGTH MEASUREMENT

A magnetic distance measuring system consists of a sensor (probe) and a measuring wheel, on the circumference of which north and south poles alternate in the longitudinal direction with an exact pole width. The sensor detects the magnetic fields of the north and south poles without contact and generates encoder-like signals for precise displacement and length measurements, which can be further processed on a higher-level controller (PLC).

4.1.1 MAGNETIC DISPLACEMENT MEASUREMENT: SIMPLE, ROBUST AND FAST

As with all the products mentioned above, the magnetic distance measuring system described here is an exemplary selection from the ipf electronic product portfolio.

The system consists of the **MW100100** sensor and an **AM000057** measuring wheel. The **MW100100** sensor in a plastic housing (protection class IP67) has a resolution of 0.1 mm and achieves a maximum travel speed of 25 m/s. The **AM000057** measuring wheel made of aluminum has a total of 250 poles, each with a length of 3.2mm.

An extremely robust solution from ipf electronic for magnetic displacement measurement with a sensor **MW100100** (resolution 0.1mm) in protection class IP67 and a measuring wheel **AM000057**.

4.1.2 KEY ADVANTAGES OF MAGNETIC DISPLACEMENT ENCODERS FOR LENGTH MEASUREMENT

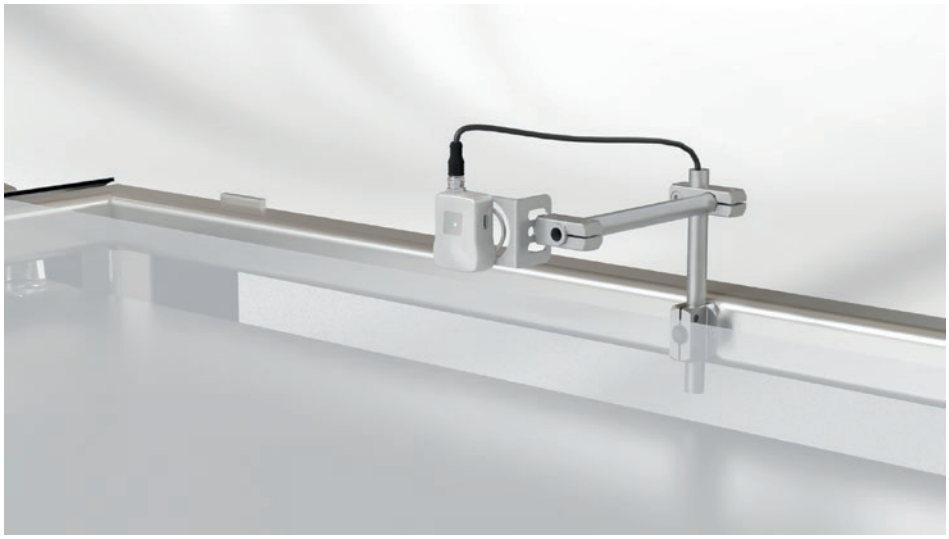
Magnetic displacement measuring systems in a robust industrial design from ipf electronic provide an extremely simple solution for measuring the length of strip materials. The process is wear-free and reliable, as there is no slippage that could falsify measurements. A further advantage of magnetic displacement measuring systems such as the combination of measuring wheel and sensor presented here is that they are largely insensitive to dirt and moisture, making them suitable for use in more demanding environmental conditions. Due to the high travel speed of up to 25m/s, the magnetic distance measuring system from ipf electronic can also be used for the exact length measurement of strip materials in high-speed processes.

4.2 FUNCTIONALITY OF THE OPTICAL DISTANCE MEASURING SYSTEM FOR LENGTH MEASUREMENT

The solution from ipf electronic for non-contact optical displacement measurement has a laser (laser class 1) that works with infrared light and periodically emits light pulses that are reflected by the surface of moving objects (e.g. a continuous film). A photosensor integrated in the device receives the reflection signals and records the pixel changes that occur from image to image due to the moving object surface. These pixel changes can be used to determine, among other things, the distance traveled by the object to be detected.

4.2.1 OPTICAL DISPLACEMENT MEASUREMENT: HIGHLY FLEXIBLE PARAMETERIZATION VIA SOFTWARE

The **VO330570** from ipf electronic is an optical and therefore non-contact and completely wear-free displacement measuring system with a scanning distance of 15mm to 60mm. The incremental sensor is parameterized via free PC software, with a free choice between the units pulses/mm, m/min and mm. If the **VO330570** remains connected to a PC during operation, the software also determines the travel speed of the detected object. The sensor also integrates a rotary encoder output, which supplies two square-wave signals A/B with a 90 degree phase shift, so that the travel distance can be displayed with a connected counter. An additional switching output can also be used to parameterize a zero point for a predefined distance, e.g. to reset a counter or to process the sensor signal in a PLC, for example to control an automated belt cutter. The second device output can also be parameterized as an alarm output, which further increases process reliability for angle and distance measurement.



The **VO330570** is an optical and therefore non-contact and completely wear-free incremental position measuring system with a maximum scanning distance of up to 60 mm, which can be parameterized very flexibly using free software.

4.2.2 KEY ADVANTAGES OF AN OPTICAL DISTANCE MEASURING SYSTEM

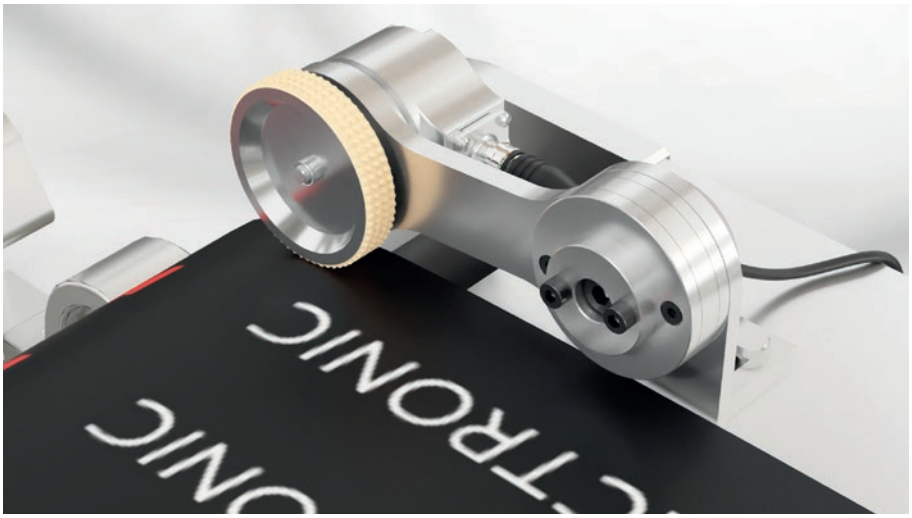
Whether measuring distance or angle, displaying travel speed or travel distance, configuring an alarm output or a zero point according to a predefined distance, the **VO330570** from ipf electronic proves to be an extremely versatile solution for the detection of thin strip materials thanks to its software-supported flexible parameterization. As the optical sensor has no mechanical components, it operates without contact and therefore without slippage. In addition, the sensing distance can be variably adjusted within a range of 15mm to 60mm.
The possible applications for this solution are extremely diverse, e.g. in paper machines, slitter rewinders or packaging machines, to name just a few examples. The **VO330570** is equally flexible when it comes to detecting a wide variety of materials such as plastics, films, textiles, etc. Optical measurement with this device is even suitable for reflective or very smooth surfaces. Due to its very high sampling rate of 0.9ms, the sensor is particularly recommended for the detection of thin strip materials in high-speed processes.
The **VO330570** has two mutually monitoring photo sensors as receiving elements, although only one sensor is used for signal output at any one time. However, the redundant design of the photosensors makes it possible, for example, to send a corresponding signal to the alarm output if the optics become increasingly dirty, which significantly increases process reliability in a wide range of applications.

4.3 OPERATING PRINCIPLE OF ROTARY ENCODERS

Rotary encoders detect rotational movements and convert them into evaluable digital output signals for processing in a control system (PLC). Rotary encoders from ipf electronic work according to the principle of optical scanning. For this purpose, the devices have a pulse disk with a repeating (incremental) graduation. This graduation is scanned by an optical system and converted into encoder-specific output signals (multiturn, RS422, etc.) by integrated electronics.

4.3.1 PARAMETERIZABLE ENCODERS: MORE FLEXIBILITY IN USE

The incremental encoders in the **VD58982x**-series from ipf electronic can be freely parameterized using free PC software and can therefore be flexibly set on site to the required number of pulses per revolution (between 1 and 65,536 pulses). For length measurement, the encoder shaft can be connected directly, e.g. to a material deflection roller. Alternatively, a measuring wheel can also be mounted on the encoder shaft. The parameterizable encoders with integrated USB interface for PC connection have a torque of 0.01Nm to 0.02Nm and a maximum speed of 6,000rpm. There is a choice of three device versions: with 6mm solid shaft (**VD589820**), with 10mm solid shaft (**VD589821**) and with 12mm hollow shaft (**VD589822**).



The parameterizable encoders of the **VD58982x**-series can be flexibly set on site to the required number of pulses per revolution. For length measurement, a measuring wheel can be mounted on the encoder shaft, as shown here, or the encoder can be connected directly to a deflection pulley, for example.

4.3.2 KEY ADVANTAGES OF PARAMETERIZABLE ENCODERS FOR LENGTH MEASUREMENT

Parameterizable encoders can be set to the required resolution for length measurement directly on site. The devices can also be used flexibly for length measurement in other processes as required, as the number of pulses required per revolution can always be adjusted as required. Due to their high speed, the encoders are suitable for length measurement in very high-speed processes and impress with their high resolution. The parameterizable encoders are also very robust and have a high resistance to shock and vibration (up to 100g / 16- 2,000Hz).

5 THICKNESS MEASUREMENT: EXACT VALUES THANKS TO VERY PRECISE SENSOR SOLUTIONS

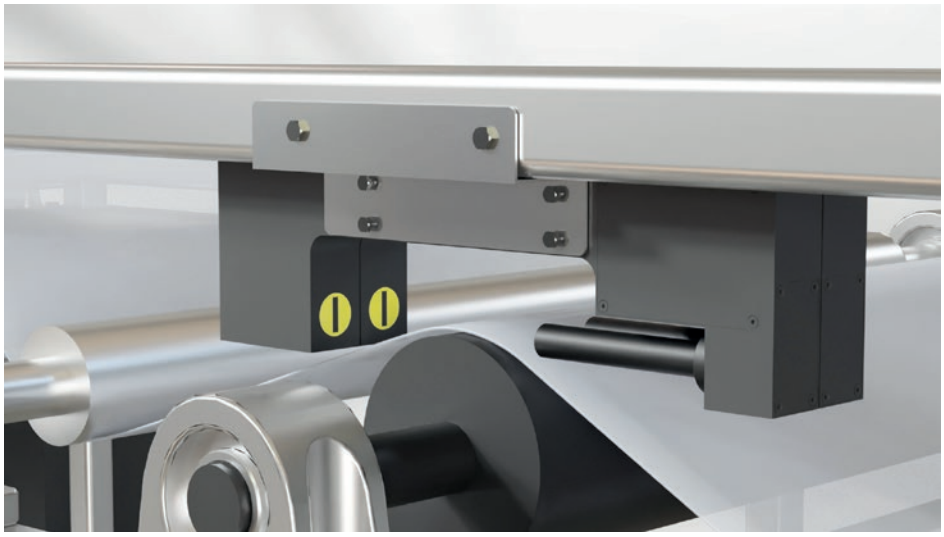
High-precision sensor technology is required for the exact thickness measurement of ultra-thin strip materials such as plastic films. This is an essential requirement that is met, for example, by the extremely precise laser through-beam sensors from ipf electronic.

5.1 FUNCTIONALITY OF LASER THROUGH-BEAM SENSORS FOR THICKNESS MEASUREMENT

The special laser through-beam sensors or laser fork light barriers from ipf electronic consist of a transmitter with a homogeneous linear laser light beam and a receiver with closely spaced receiver elements (CCD line detector). The resolution of the system is additionally increased by macro lenses for the receiver.
If an object is located in the light beam of the fork light barrier, its shadow image is displayed on the individual pixels of the receiver's CCD line. As the number of pixels on the CCD line is known, the size of the shadow image and therefore the diameter of a measurement object, for example, can be determined precisely.
For high-precision thickness measurement, two coupled systems are used that are positioned on a material deflection roller, with the laser beam positioned tangentially above the roller. One photoelectric sensor acts as a slave and detects the deflection roller, for example, while the second system acts as a master and detects the strip material on the deflection roller. The master generates an analog signal (0...10V, optionally 4...20mA) for the system control (PLC) from the difference between the measurement results of the two light barriers, which is proportional to the thickness of the belt material.

5.1.1 LASER FORK LIGHT BARRIERS: HIGH-PRECISION THICKNESS MEASUREMENT WITH A HOMOGENEOUS LIGHT BEAM

The system solution for thickness measurement presented here consists of two **PGSI0302** fork light barriers and macro lenses (**AOSI0303**). Both photoelectric sensors have a fork width of 150mm and a measuring range of 2mm. The solution works with a visible laser line (red light) with laser class 1, so no special precautions are required for mounting and installing the fork light barriers. The laser fork light barriers have an analog output (0...10V) for high-precision thickness measurement with a resolution of typ. 0.25µm. Optionally, the devices are also available with an output voltage of 4...20mA.



High-precision solution for measuring the thickness of very thin strip materials with a resolution of typically 0.25µm: **PGSI0302** laser fork light barriers (fork width 150mm) with macro lenses (**AOSI0303**) (right).

5.1.2 KEY ADVANTAGES OF LASER FORK LIGHT BARRIERS FOR THICKNESS MEASUREMENT

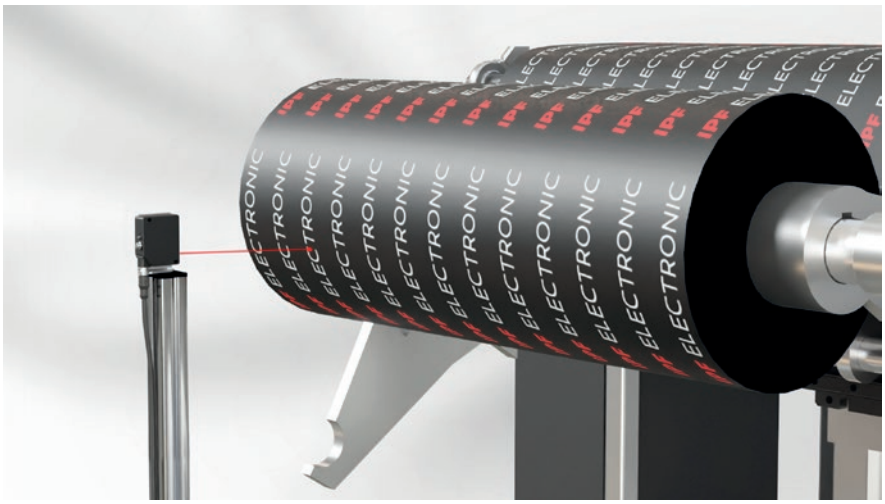
When it comes to optical sensors, nothing is more precise than solutions that work with laser light. The system presented here, consisting of two through-beam sensors including macro lenses for the receivers, enables high-precision thickness measurements of very thin strip materials with an extremely high resolution of 0.25 µm. As both fork light barriers are connected to each other during operation according to the master-slave principle, the control system (PLC) only has to process one signal. Thanks to the visible red light (laser class 1), both light barriers can be easily installed and adjusted without the use of additional technology, especially as the transmitter and receiver of fork light barriers are always perfectly aligned with each other.

6 DETERMINING THE DIAMETER OF FOIL COILS

When processing strip materials, it is often necessary to determine the diameter of coils. Non-contact systems for distance measurement, such as the laser triangulation probes and ultrasonic sensors from ipf electronic, are particularly suitable for this task.

6.1 FUNCTIONALITY OF LASER TRIANGULATION DIFFUSE-REFLECTION SENSORS FOR DIAMETER DETERMINATION

One example from the product portfolio of diffuse-reflection laser sensors is the **PT64** series (laser class 2). The functionality of the sensors is based on the high-precision triangulation method, in which the distance to a material surface is measured indirectly via the angle of incidence of the light reflected from a coil surface.
To determine the angle of incidence, the receiver of the sensor has a line detector with a large number of individual receiver elements, which together form a receiver line. The position within this line at which the light reflected from a material surface hits a receiving element or several receiving elements depends on the angle of incidence of the light beam.
This angle of incidence can ultimately be used to determine the distance and thus the distance to a coil surface. The smaller the measured distance, the larger the diameter of a coil.
During the measurement, an intelligent control circuit regulates the power of the **PT64** probe series' transmission signal depending on the reflective properties of a coil surface. Dark surfaces increase the power of the transmitting diode, while lighter surfaces reduce the power.



Determining the diameter of coils with high-precision laser triangulation probes from the **PT64**-series. Here a device (**PT640026**) with point-shaped laser light for smooth surfaces. A variant with a linear laser beam is available for rough or structured surfaces with rather unfavorable reflection properties.

6.1.1 DIFFERENT TRANSMITTED LIGHT FOR DIFFERENT SURFACES

For the thickness measurement of coils made of thin strip materials, for example, the **PT640026** laser triangulation sensor with point-shaped transmitted light or the **PT643026** with line-shaped transmitted light are available. While the **PT640026** with a dot-shaped laser beam enables the high-precision detection of smooth surfaces, the PT643026 is particularly suitable for the extremely precise detection of rough or structured surfaces with rather unfavorable reflection properties due to its linear laser beam. Several solutions optimally adapted to diameter detection are therefore available for different coil surfaces. The diffuse-reflection laser sensors in a robust, anodized aluminium housing (protection class IP67 or IP54) have a measuring range of 200mm to 1,000mm, integrate two analogue outputs (0...10V and 4...20mA) and can be used at ambient temperatures of-10°C to +50°C.

6.1.2 KEY ADVANTAGES OF DIFFUSE-REFLECTION LASER SENSORS FOR DIAMETER DETERMINATION

Laser triangulation diffuse-reflection sensors such as the **PT640026** and **PT643026** enable virtually color-independent, non-contact detection of strip materials for determining the diameter of coils with a high resolution of up to 0.25mm. Thanks to the visible transmission light and two tricolor LEDs integrated in the housing as status indicators, the solutions are easy to install and adjust. Installation in virtually any position is also made easier by an M12 plug for the electrical connection that can be rotated through 180 degrees. All device types in the **PT64**-series are available with either a laser dot or laser line as a transmitted light. The measuring ranges can be freely parameterized.
In some applications, it is sometimes advantageous to see exactly how strong or weak the reflective behavior of an object surface is in order to be able to assess the signal quality of a laser triangulation sensor for distance measurement more accurately.
The free software for the **PT64** is particularly helpful here, as it visualizes, among other things, the reflection signal from a surface that hits the line detector of a probe. Thanks to the exact “optical feedback” to the receiver side of the device, the user can always see immediately how good or bad the signals to be processed are and can adjust the signal strength if necessary.

6.2 OPERATING PRINCIPLE OF ULTRASONIC DIFFUSE-REFLECTION SENSORS FOR DIAMETER DETERMINATION

Like all ultrasonic diffuse-reflection sensors (see chapter 2.2), ultrasonic diffuse-reflection sensors work on the principle of time-of-flight measurement and integrate a transducer that works cyclically as a transmitter and receiver. The transducer emits a certain number of sound waves, which are reflected by the material to be detected. The transducer then switches to receive and records the signal echoes. The time that elapses between sending and receiving the signals is proportional to the distance between the sensor and the material surface. The shorter the elapsed time, the larger the diameter of a coil.

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6.2.1 IO-LINK ULTRASONIC DIFFUSE-REFLECTION SENSORS: LONG RANGES AND FLEXIBLE PARAMETERIZATION

The **UT309520** with IO-Link interface from ipf electronic's broad portfolio of ultrasonic diffuse-reflection sensors is presented here for measuring the thickness of coils. Despite its compact design, the interface provides the sensor with a range of practical additional functions, such as temperature compensation that can be activated as required to guarantee constant measurement accuracy at all times. Thanks to IO-Link, the device also provides valuable information and enables individual settings, e.g. operating hours counter, time functions, recording of the current and maximum device temperature, minimum and maximum object distance and hysteresis setting.
The flexibly parameterizable UT309520 in a robust metal housing (protection class IP67) has a range of 300mm to 3,000mm and a response time of 10ms.

Ultrasonic diffuse-reflection sensors such as the **UT309520** for measuring the thickness of coils impress with a long range of up to 3,000mm and can be flexibly parameterized via the IO-Link interface.

6.2.2 KEY ADVANTAGES OF ULTRASONIC DIFFUSE-REFLECTION SENSORS FOR DIAMETER DETERMINATION

Ultrasonic diffuse-reflection sensors determine the diameter of coils without contact and completely independently of the color, transparency and reflective properties of a strip material. The measuring range can be freely parameterized, and the coil surface can also be detected from greater distances, as ultrasonic sensors such as the **UT309520** can reach scanning ranges of up to 3,000mm. The robust ultrasonic diffuse-reflection sensors (brass housing material) are also suitable for determining the diameter in high-speed processes thanks to their short response time of just 10ms. Simple commissioning is carried out either via teach-in or by parameterizing the device via the integrated IO-Link interface.

7 PRINT MARK DETECTION ON FOILS OR SIMILAR TAPE MATERIALS

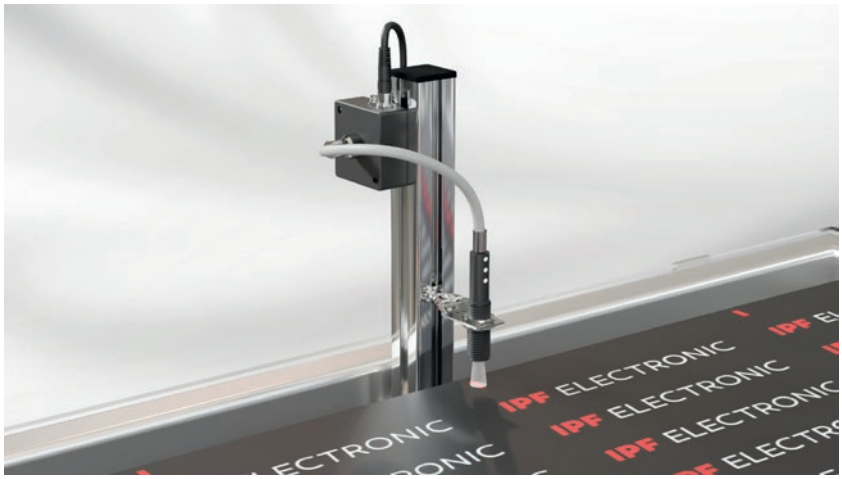
Color imprints on films or similar tape materials must always be perfect. In order to be able to apply all colors congruently on a material surface, it is necessary that the printing units of printing machines work absolutely synchronously with each other. For this purpose, print marks are scanned at the edge of the material, the detection of which ultimately serves as a control signal for the respective printing units. Optical contrast sensors from ipf electronic fulfill all the necessary requirements for this task. The sensors are extremely responsive and, thanks to the combination with various fiber optics and attachment optics, enable very high precision in print mark detection.

7.1 FUNCTIONALITY OF CONTRAST READERS FOR PRINT MARK DETECTION

Contrast readers detect the visual differences (e.g. reflectivity, differences in brightness) between directly adjacent areas on a material surface. Free parameterization software is available so that the switching threshold of the sensor can be optimally set under the specific operating conditions. If the amount of light reflected during operation reaches or falls below the threshold previously set using the software, the sensor emits a switching signal. However, if more light is reflected and the predefined switching threshold is therefore exceeded, the sensor does not generate a switching signal.

7.1.1 SYSTEM SOLUTION CONSISTING OF CONTRAST SCANNER AND FIBER OPTIC LIGHT GUIDE WITH ATTACHMENT OPTICS

A specific system solution from the ipf electronic portfolio for print mark detection is presented here as an example. It consists of the **OK630180** contrast scanner, the **LT120481** fiber optic light guide and the **AL000078** attachment optics.
This system, which is insensitive to ambient light, is able to detect even the smallest differences in brightness during print mark detection in real time and with an extremely short response time thanks to a maximum switching frequency of 200,000Hz. The **OK630180** contrast scanner with free parameterization software integrates two digital inputs and two digital outputs. The **LT120481** fiber optic light guide is equipped with a compact probe head with attachment optics (**AL000078**), which has a zoom lens.



The system solution, e.g. consisting of the parameterizable **OK630180** contrast reader and an **LT120481** fibre optic light guide with top optics (**AL000078**), detects even the slightest differences in brightness during print mark detection in real time and with a maximum switching frequency of 200,000Hz.

7.1.2 KEY ADVANTAGES OF CONTRAST READERS FOR PRINT MARK DETECTION

There is a large selection of light guides and optics for the contrast scanners from ipf electronic. This means that customized solutions for ambient light-insensitive print mark

detection can be implemented for the respective specific applications, including by using the free parameterization software for optimum adjustment of the switching threshold. The systems, consisting of robust components in industrial design, have very high switching frequencies of up to 200,000Hz and are therefore ideal for high-speed applications such as color and print mark detection. In this context, the solutions also enable long operating ranges of 100mm to 200mm. Another decisive advantage in practice: the compact light guides plus optics mean that the high-precision systems can even be installed in confined spaces.

8 SUMMARY AND CONCLUSION

The special properties of thin films and similar materials make them difficult to detect during production and further processing, e.g. transparent, opaque, high-gloss, dark, light, extremely thin or embossed with fine or rough surface structures, to name just a few examples. The challenges, e.g. for the realization of reliable presence control, thickness measurement, length measurement, web edge control, etc., are therefore extremely diverse. In addition, the sensors used for these and similar tasks often have to react particularly quickly due to high-speed processes and must also be highly precise.

Whatever a specific task may look like against this background, ipf electronic's extensive portfolio of very different sensor technologies has a solution for almost every application. Here are just a few examples: optical sensors especially for detecting transparent materials or ultrasonic sensors with long ranges for non-contact, surface-independent presence monitoring, high-precision laser line sensors for exact web edge control of very thin materials even with height fluctuations in the web, magnetic or flexibly parameterizable optical displacement measurement systems as particularly simple, solutions for displacement measurement without slippage or very robust and flexibly parameterizable encoders for length measurement, laser fork light barriers for high-precision thickness measurement of very thin strip materials with high resolution, laser triangulation sensors for almost colour-independent, non-contact detection of strip materials with different surfaces for determining the diameter of coils etc.

The range of these and many other technologies is flanked by the decades of application experience of the experts at ipf electronic, who repeatedly demonstrate their wide-ranging know-how and not least their ingenuity and innovative spirit in the development of special sensor solutions, among other things.

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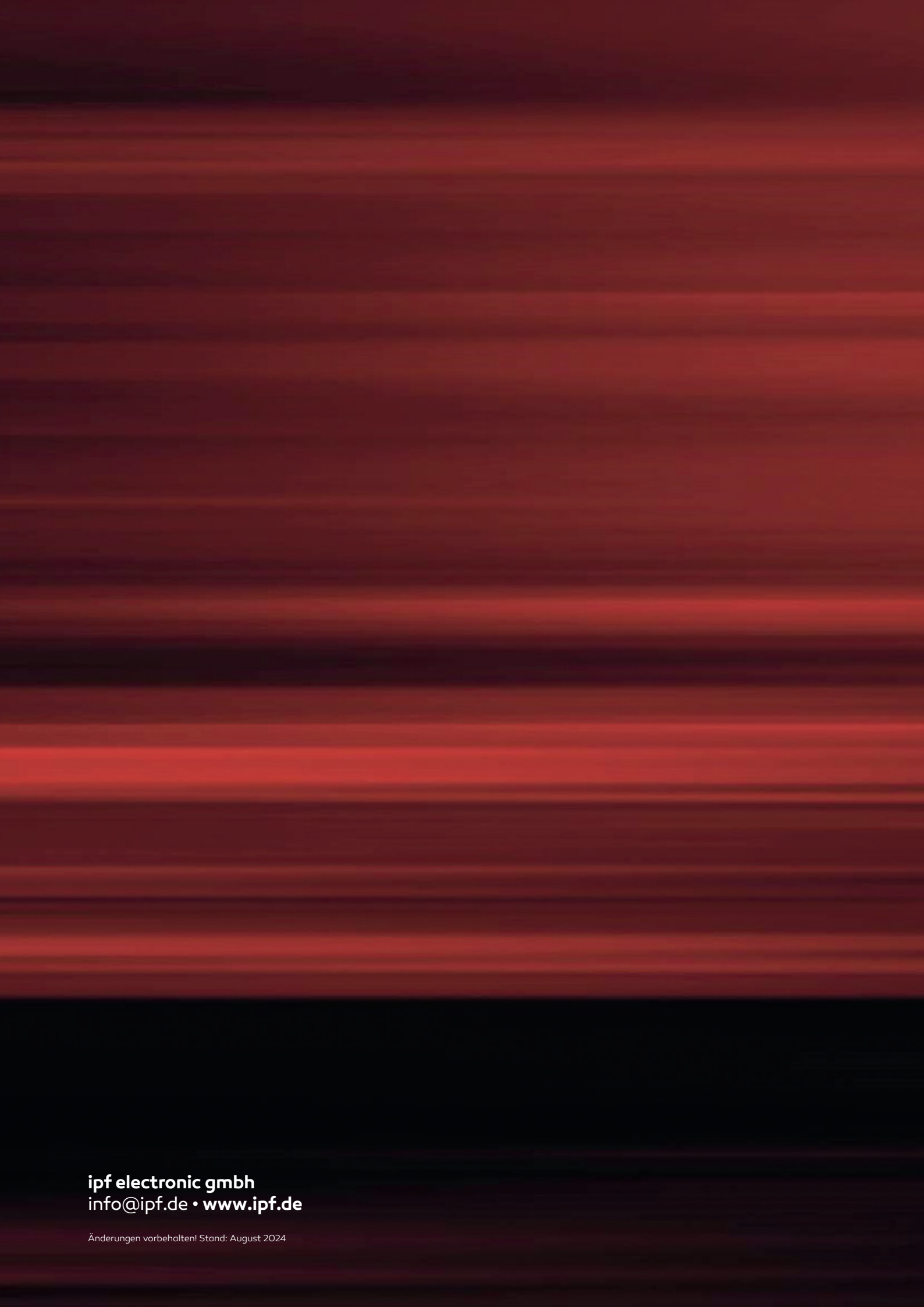

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Änderungen vorbehalten! Stand: August 2024