UNIVERSIDAD DE VALLADOLID

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Grado en Ingeniería de Organización Industrial

# CONCEPTUAL DESIGN OF AN AUTOMATIC DEVICE FOR CONTROLLING THE THICKNESS OF LAMELLAS IN AN AUTOMATED CUTTING LINE.

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TFG REALIZADO EN PROGRAMA DE INTERCAMBIO

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|---|---|
| TÍTULO: | Conceptual design of an automatic device for controlling the thickness of lamellas in an automated cutting line. |
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## RESUMEN

La introducción de la llamada cuarta revolución industrial en la industria de la madera es un salto cualitativo muy importante, considerando que la madera, en concreto la de roble, es un material caro y no uniforme.

En el presente documento se desarrolla una máquina que permite clasificar las láminas de madera según su calidad, que depende de los defectos en su ancho y espesor. Esta máquina consiste en una mesa con un dispositivo basado en la transmisión por correa dentada que permite empujar las láminas sobre ella, dos cintas transportadoras, una unidad de medida del espesor y una unidad de medida del ancho, cada parte conformada por distintos componentes de diversas empresas tecnológicas. El modelo se lleva a cabo en el software de diseño 3D Autodesk Inventor.

## PALABRAS CLAVE

Industria de madera 4.0, láminas de roble, sensores, automatización, medición

## ABSTRACT

The introduction of the so-called fourth industrial revolution in the wood industry is a very important qualitative leap, considering that wood, specifically oak, is an expensive and non-uniform material.

In the present document, a machine is developed that allows to classify the wood lamellas according to their quality, which depends on the defects in their width and thickness. This machine consists of a table with a device based on toothed belt transmission that allows the sheets to be pushed onto it, two belt conveyors, a thickness measurement unit and a width measurement unit, each part made up of different components of various technology companies. The model is carried out in Autodesk Inventor 3D design software.

## KEYWORDS

4.0 wood industry, oak lamellas, sensors, automatization, measurement

PAŃSTWOWA WYŻSZA SZKOŁA ZAWODOWA W NYSIE

UNIVERSITY OF APPLIED SCIENCES IN NYSA

DEGREE IN PRODUCTION MANAGEMENT AND ENGINEERING

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# CONCEPTUAL DESIGN OF AN AUTOMATIC DEVICE FOR CONTROLLING THE THICKNESS OF LAMELLAS IN AN AUTOMATED CUTTING LINE

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Nysa, june 2022

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# INDEX

# INTRODUCTION AND OBJECTIVES

The development of the present paper is based on the transition of a wood industry of oak lamellas towards the industry 4.0.

Industry 4.0 is a widely debated topic in recent literature and taking into account its strong technological advancements, it can be considered a disruptive phenomenon that will impact both industry and society (Molinaro & Orzes, 2022).

Industry 4.0 relies on the adoption of several technologies that allow to collect, share and analyze real-time data, to connect the cyber-space with the real environment and to enable new digital production systems (Culot, Nassimbeni, Orzes, & Sartor, 2020).

Along with the agri-food industry, one of the sectors where these technologies seem to have a significant potential is the wood one (Molinaro & Orzes, 2022).

The huge amount of data generated along the wood supply chain process can be used to extract relevant information and improve the management of the entire supply chain. Moreover, the new technologies can also create a cyber-physical environment for the design and manufacturing of wood products, optimizing the processes (Molinaro & Orzes, 2022).

Wood industry is key for sustainability and an important economic activity in many countries. In recent years, manufactured wood products for construction have had special relevance. These represent 38.1% of wood-based products worldwide (H. Ramage, et al., 2017).

Being a biological material, the physical and anatomical properties of the wood vary when it undergoes a mechanical or chemical transformation process. To achieve quality and productivity standards, the multiple process variables existing in industrial systems must be controlled. Although humans have been able to manage operating systems on their own for centuries, using sensors and computers so as to collect data and help in decision-making is more efficient and precise (Ramos-Maldonado & Aguilera-Carrasco, 2022).

Moreover, working with wood is even more complex, due to the nature of the material. Technically this is an anisotropic material, although it is treated as an orthotropic one, so the mechanical properties of the wood change on the longitudinal, radial and tangential axes. This fact affects the “cutting” behavior conforming to the direction of the stress of the cutting tool (Ramos-Maldonado & Aguilera-Carrasco, 2022), as well as other characteristics such as density, moisture content or singularities can have a big impact on the quality obtained.

The tool interaction in the cutting machine with the material produces cutting forces that release energy producing problems in the parts such as pressure waves and tool wear, so the surface quality increases its roughness (Ramos-Maldonado & Aguilera-Carrasco, 2022).

The purpose of the present document is to explain how the quality of the lamellas produced in the industry can be measured without stopping the production line, using a classifying machine based on sensors and other electromechanical and pneumatical devices.

# STATE OF THE ART

It is necessary to explain some details about the software which represents the main tool used in the development of this project, as well as to give information about the specific industries that provide us with a technical background related to devices and parts of the machine object of study in the current paper.

## AUTODESK INVENTOR

In this project we built the virtual design of the machine used for analyzing the quality in our production line of oak lamellas in Autodesk Inventor, Figure 1.

This program is an engineering design software developed by Autodesk. Inventor offers professional, dedicated tools for 3D mechanical design, product documentation and simulation, making the product design job easier.

In this way both designers and clients can create visual prototypes and make tests and drawings of 3D models.

As it is a specific program for product design, it has a large number of functions such as parametric design of parts and assemblies, simulation, visualization, automation, libraries of normalized elements and sketching, which are secondary in other CAD programs.

Inventor enables the integration of 2D and 3D data in a single environment by creating a virtual representation of the final product, so that product performance can be inspected and adjusted at any time during the design phase.

AUTODESK® INVENTOR®

FIGURE 1

## INDUSTRIES OF COMPONENTS

In this paper, we will refer to parts of the machine and we will give some advice of specific parts that can be used in a project of these characteristics and were used in the 3D model, Table 1.

| | |
|---|---|
| SICK Sensor Intelligence. | SICK offers with its intelligent sensors and application solutions a basis for process control, for the protection of people and for the prevention of accidents and environmental damage. |
| wenglor the innovative family | An innovative industry in intelligent sensor and image processing technologies, with patented product and system solutions used in automated industries. |
| METAL WORK PNEUMATIC | Metal Work is specialized in the production of pneumatic components for automation systems. This company currently market five different product ranges: actuators, valves, FRL units, fittings and handling components. |
| MÄDLER GEGRÜNDET 1882 | MÄDLER®, founded in 1882, is one of the leading suppliers and manufacturers of drive elements and standard parts. |
| NORD DRIVESYSTEMS | This industry develops, produces and distributes drive systems. In addition to standard drives, NORD supplies application-specific concepts and solutions for special requirements, for example with energy-saving drives or explosion-protected systems. |
| SEW EURODRIVE | Although the company is specialized in electric motors, they produce gearmotors, reducers, motors, components for decentralized installations, electronically controlled drives, drives with mechanical variators, and also drive solutions that contain a high engineering component. |
| BRECOflex | This business is the leader and industry pioneer in the polyurethane timing belt industry, as well as they act as source supplier of polyurethane timing belts, pulleys and related accessories. |

TABLE 1

## THE PROBLEM OBJECT OF STUDY

In the industry of this study, the machine built is used to solve the problem of detecting lamellas which do not achieve the quality standards of thickness or width.

The idea of the production line is obtaining lamellas of 3-5 mm of thickness from blocks of oak wood of 2000 mm of length, a variable width between 100 mm and 300 mm (from now on a hypothetical width of 200 mm will be considered in the document), and an original thickness of 33 mm.

From each wood block, five lamellas are obtained, but the thickness must be between 3 and 5 mm, depending on the batch. Besides, the cutting machine could damage the sides of the lamellas too, so additionally to the device in charge of controlling the thickness, we have included another part in the machine that monitors the width and accepts parts within tolerance limits.

Due to the fact that the width is only 200mm, we have studied that the only defects that can appear in the surface are going to be either on the middle of the lamella or in the sides, dismissing the possibility of waves being shown in the surface of the lamellas after the cutting process for the wide of the side.

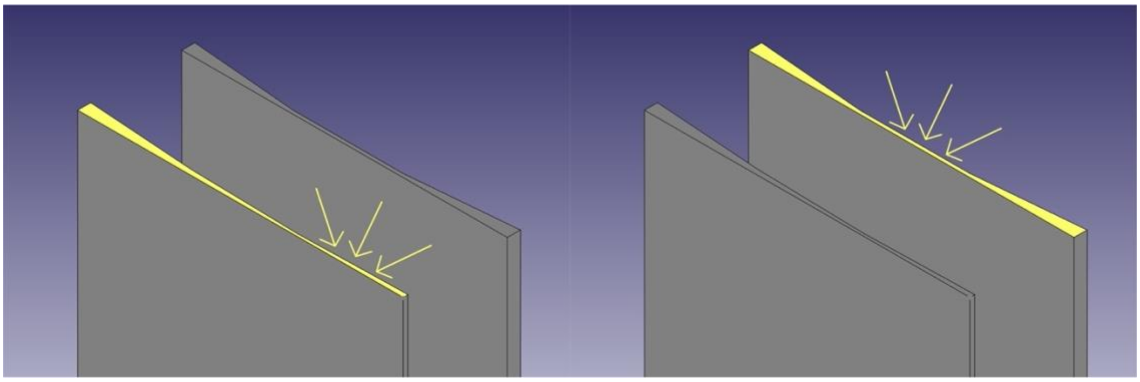

FIGURE 2

The defects likely to happen that were explained before are shown in the Figure 2, Figure 3 and Figure 4. The pictures have been developed using FreeCad, a free software for 3D design with the computer.

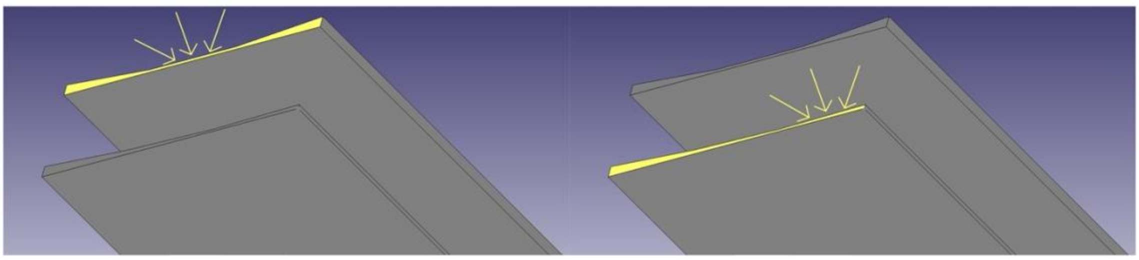

FIGURE 3

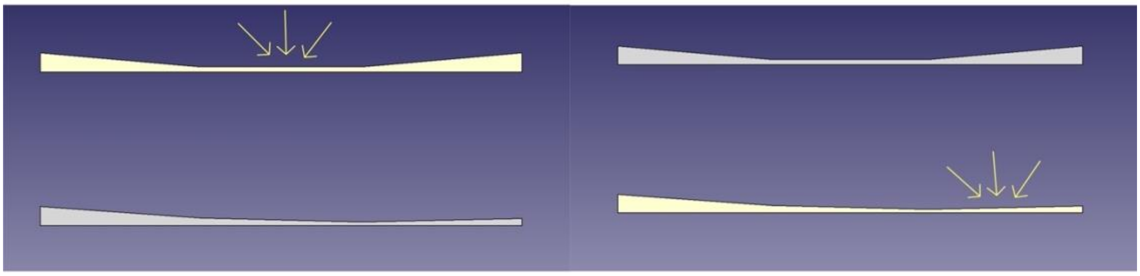

FIGURE 4

Although the mistakes can appear in the surface, during the process of cutting, the sides of the lamellas can be damaged too, as it is shown in Figure 5. For studying those cases of wrong parts, we have included a device which is in charge of measuring the width of the lamellas in order to make sure that the distant between the edges is constant or in the tolerance limits.

At first, we did not consider this as a problem because of the little width of the lamellas as we said before, but we reconsider the possibility of including this device to make sure that the sides of the pieces are not damaged, so as to achieve the best quality regarding to the client's specifications.

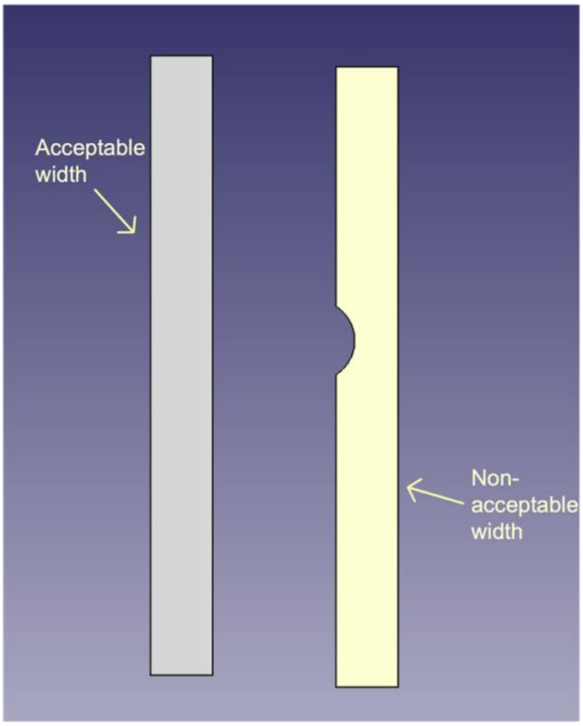


FIGURE 5

The final solution to these problems is the system exposed in Figure 6, a machine preceded and followed by belt conveyors to connect the measuring device with the rest of the parts of the production line. The virtual design of this solution has been done using another software specialized in 3D design, Autodesk Inventor, already explained in previous sections.

These kinds of problems do not happen every time, considering that in the process the quality required is achieved in more than 90% of the lamellas in the cutting machine.

The objective of this device of control is to clasify those wrong lamellas for the other machines of the line, due to the necessity of stablishing different processes regarding the quality and the characteristics of the resulting lamellas after the cutting machine.

In this way, before the machine object of study in this paper, in the production line we can find a milling machine, the cutting machine and other devices, but after this measuring table, the lamellas will be classified in different piles.

If the lamellas have flaws in their thickness, after the drying machine they will suffer more than one grinding process, so the final product will be thinner than expected. On the other side, if the thickness of the lamellas is correct, the grinding process will happen only once for those acceptable parts, resulting a final product thicker and with a higher quality.

Talking about the width, if the current machine detects lamellas with wrong size between sides in a part of its length, the piece of them that it is not acceptable will be cut, obtaining two smaller but with correct width lamellas.

The majority of the problems occur because of the non-uniform nature of the material, considering that oak wood has a lot of wood grains, so when the cutting machine goes over the block, it can cause some defects in the surface. Moreover, the hardness is different through all the block, so the tools have issues while working, going to the minimum effort part of the surface easily. This does not happen with wood chipboard, because it has the same hardness and density through the block.

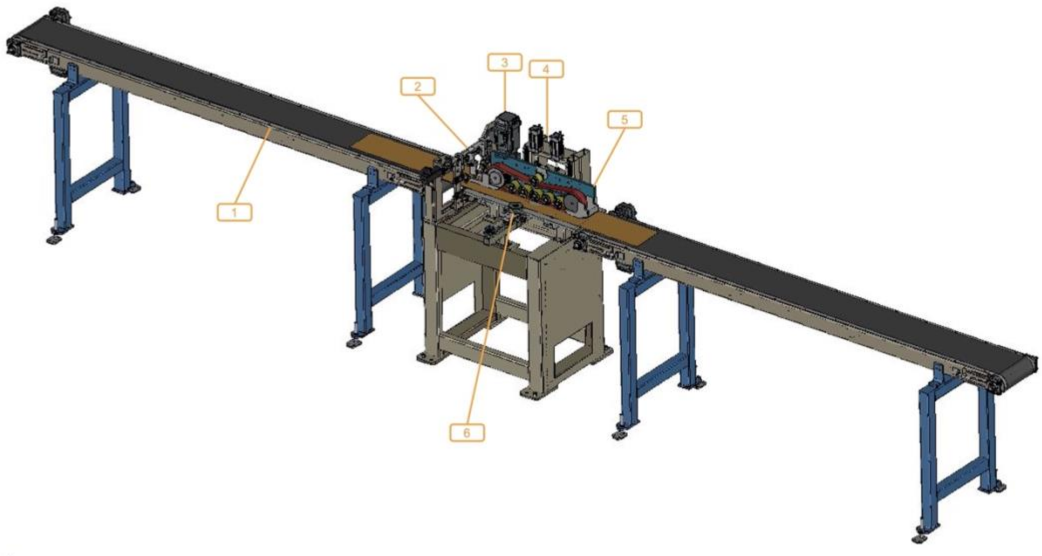


FIGURE 6

| Number in the picture | Element of the machine |
|---|---|
| 1 | Belt conveyor |
| 2 | Thickness measuring unit |
| 3 | Motor to move the toothed belt drive |
| 4 | Pneumatical system |
| 5 | Toothed belt drive |
| 6 | Width measuring unit |

TABLE 2

As it can be seen in the Table 2, there are seven main components of the machine, each of them will be described in a deeper level in next chapters.

## 1.- BELT CONVEYOR

To connect the machine in the production line, a conveyor is needed before and after the measuring table.

The lamellas are moved in the direction of their longer dimension and a high precision is required to avoid vibrations that could reduce the reliability of the measures taken in the machine.

Therefore, we decided to join the machine with other components of the production line using belt conveyors, which are used whenever it is necessary to move materials in a quick and precise way.

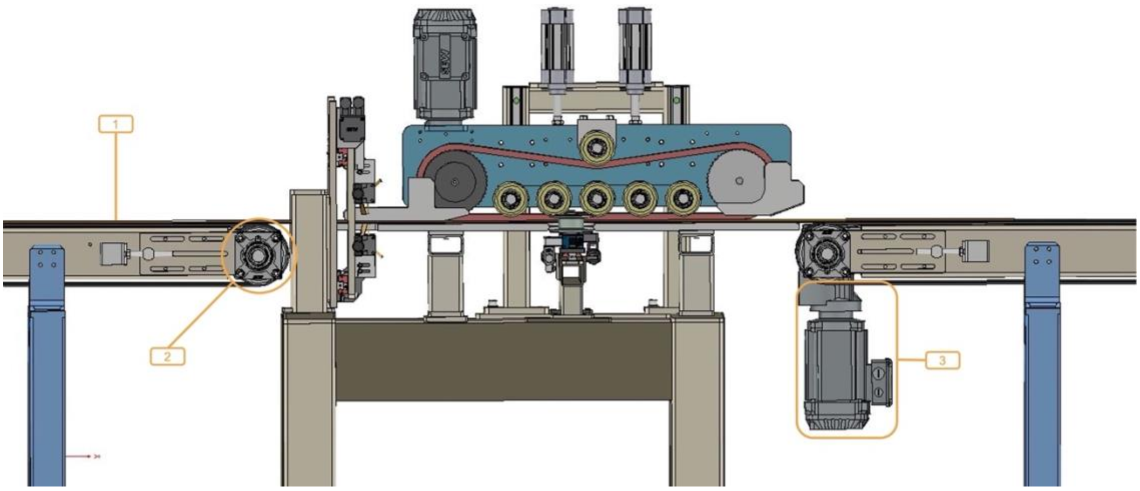


FIGURE 7

The best material to build these two conveyors shown in the part 1 of the Figure 7 is using a combined fabric and rubber core that can be called carcass and rubber covers. The covers usually consist of two to six spacers made of synthetic polyamidepolyester fabrics permeated with latex to avoid damaging the device and to protect the carcass from weather and chemicals (Barburski, 2016).

This device is moved by a standard asynchronous electrical motor (number 3 of the Figure 7), consisting of an electrical motor as it is shown in the 3.2. of the Figure 8 and a gear box, which correspond to the 3.1. in the Figure 8. We have chosen a model from SEW, which works with a rated motor speed of 1440 1/min that involves an output speed of 72 1/min. The last speed is the output speed of the hole of the gear box, so it is the same of the belt conveyor itself.

The speed of the conveyor was chosen based on the speed in the rest of the production line as well as the capacity of the measuring table.

We have decided not to use a servomotor because it turned out to be too expensive for this application: while a standard electrical motor with gear box costs around 500 euros, a servomotor and its electronic components with the same watts is priced between 1000 and 2000 euros.

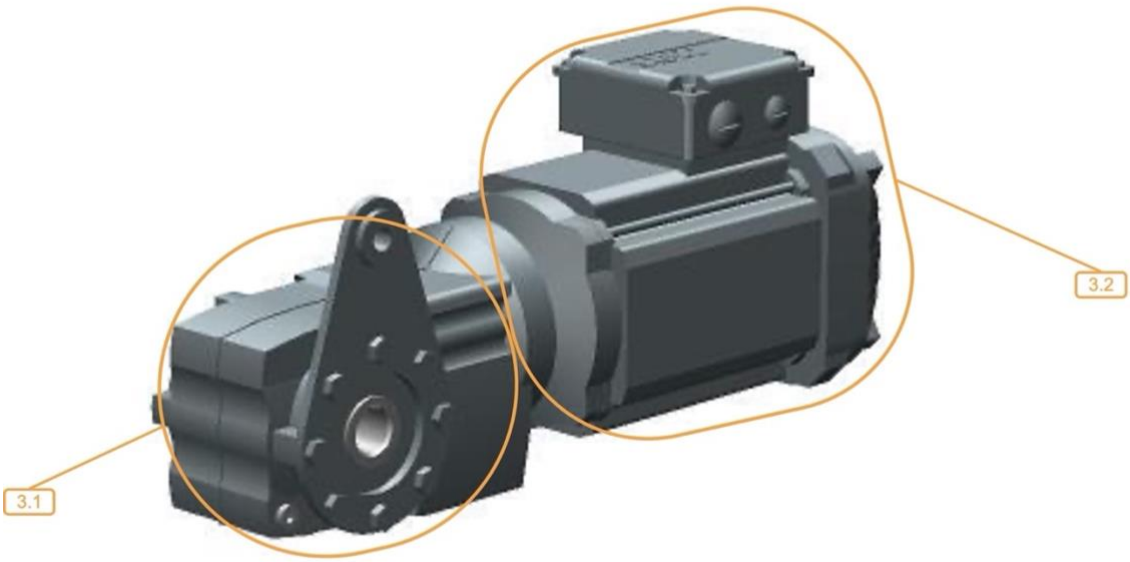


FIGURE 8

It is important to mention in this point that the role of the belt conveyor is a key to change the model of the industry towards a 4.0 industry. Monitoring belt conveyor systems used to be performed by means of inspectors and off-line, but in the new era the developments are focused on fully automated inspection systems. The Internet of Things enables to be provided with a huge amount of information obtained from sensor systems, which implies a 24/7 monitoring belt conveyor systems, so it requires the utilization of big data and eliminates the unexpected maintenance (Lodewijks, Li, Pang, & Jiang, 2016, September).

Finally, in the part marked as 2 in the Figure 7 we find a roll with a shaft. There is a hole in the gear box of the motor system instead of a shaft because in case of testing and prototypes, it would only be needed to change the shaft and not the whole motor for a specific application or in case of damages (since the damages occur mostly in the shaft).

## 2.- THICKNESS MEASURING UNIT

In this section of the paper, the device for controlling the thickness of the lamellas will be described in detail. It consists of a framework in which six sensors are housed, corresponding to the part number 2 of the Figure 9; in that same picture the number 1 corresponds to the servomotor that will enable the whole system to be flexible towards lamellas of different widths.

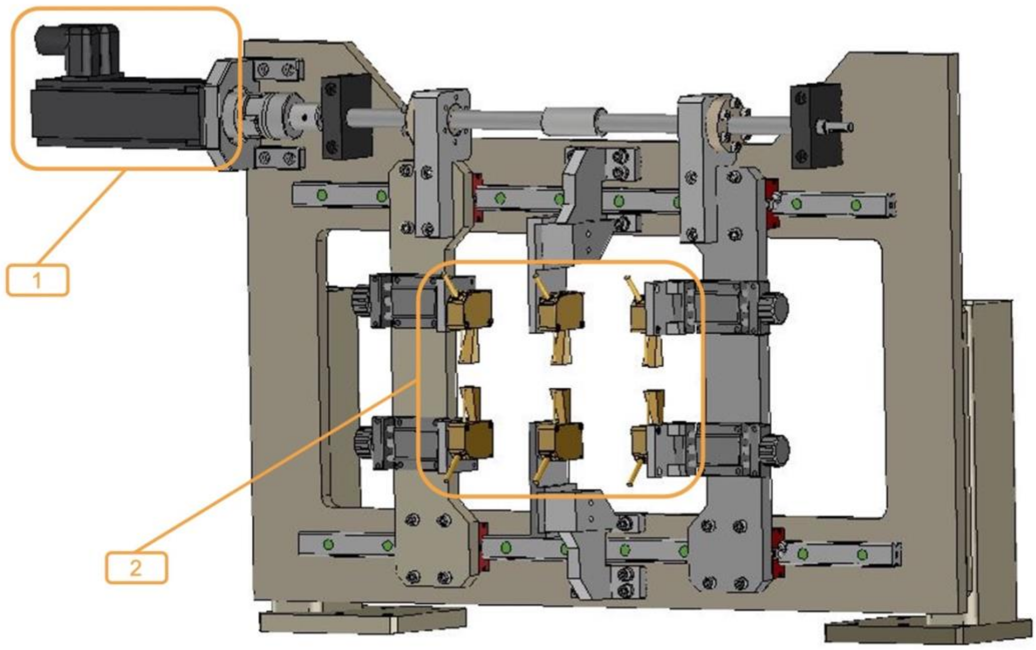


FIGURE 9

### 2.1.- SENSORS

In the framework the main important devices which make the machine work are the sensors.

As it was explained in the Figure 2, Figure 3 and Figure 4, the only possible mistakes that can occur during the cutting process involve damages in the four sides (above and below) or in the middle of both faces of the lamella. For this reason, only 3 pairs of sensors monitoring the thickness of the superior and inferior faces of the part are needed.

It was decided to place the side pairs of sensors at 20 mm from the edge, both because the wrong cutting characteristics can be noticed at that distance and due to the existence of a complementary device to measure defects on the edges: the width measuring unit.

Among all the possibilities considered, we chose a laser triangulation sensor due to its favorable characteristics regarding the function that these sensors are going to develop. In the next paragraphs, a description of the process of selecting the type of sensor will be discussed in detail.

First, considering that the sensors will be used in a sophisticated way of measuring presence, we thought that the best idea was selecting optical sensors. An optical sensor or photoelectrical sensor can detect the presence of an object from the distance, through the change in light intensity.

These devices operate with the intervention of a transmitter and a receiver.

Where the transmitter is in charge of sending the signal in the form of light and the receiver receives the information given by the sender, emitting a message, in the form of flashing lights, as the most common way.

In order to avoid mistakes due to the presence of other light sources in the working environment, the infrared LED, is used as an emitter and the phototransistor as a receiver, where both transmitter and receiver are synchronized to a specific frequency, so that the receiver is always sure that the signal it detects is the one produced by the transmitter or motion sensor.

Moreover, we needed a more precise sensor because our intention was to measure the thickness of the lamellas, so we chose the laser triangulation sensors. The method is called "triangulation" because the sensor housing, the emitted laser and the reflected laser form a triangle. In these sensors, a light spot is projected onto the measurement object. The reflected light is reproduced at a certain angle on a light-sensitive receiver. Based on the angle between the transmitting and receiving direction, with the help of mathematical triangle relations the position of the object is then calculated. The entire process described can be seen in detail in the Figure 10 (SICK Sensor Intelligence., 2018).

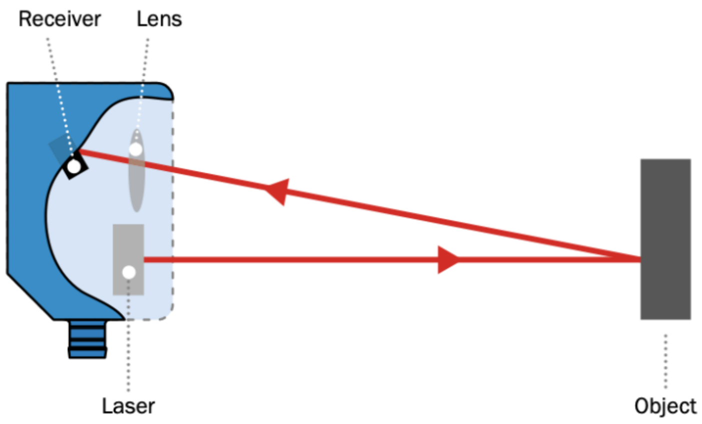


FIGURE 10

According to their sensors report (SICK Sensor Intelligence., 2018), with SICK's laser triangulation sensors, the thickness of transparent material can also be determined. With a single sensor head, it calculates this value with extraordinary accuracy: the sensor's laser beam is reflected by both optical boundary surfaces of the material, as in Figure 11. A differential calculation of the two signals reliably provides the desired measured value of the thickness of the transparent object (a)

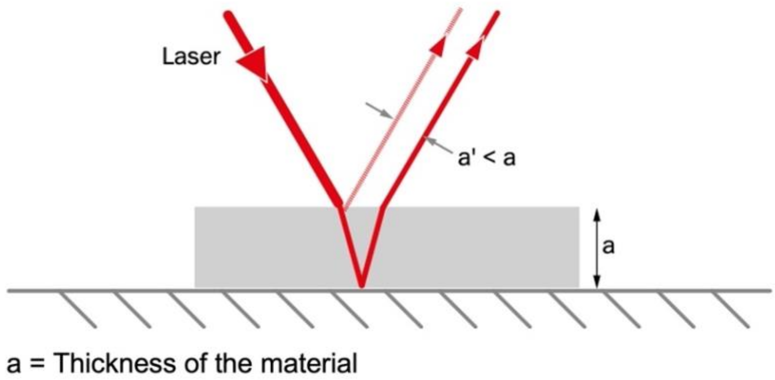


FIGURE 11

In specific, we decided to use in the 3D design the OD1-B100C50I14, a displacement measurement sensor belonging to the OD Mini family of sensors of SICK (Figure 12).

The OD Mini displacement measurement sensors from SICK use the triangulation principle to monitor series production in diverse processes. Due to their small design, the sensors are flexible and can be used in many applications, for example in the inspection of manufacturing tolerances in quality control and for classification and sorting (SICK Sensor Intelligence., 2022).

FIGURE 12

However, other possibilities must be considered, such as the CP24MHT80 Laser Distance Sensor High-Precision of Wenglor (Figure 13). This device works in high-resolution and determine distance using angular measurement, so it gives similar capabilities than the SICK sensors.

FIGURE 13

## 2.2.- SERVOMOTOR

We have decided to use a servomotor as the one represented in Figure 14 in order to enable the measuring table to adapt in facing the measuring of lamellas with diverse widths, because the flexibility towards different production batch is a must in the factory studied.

This mechanism is used specifically to automatically change the position of the sensors measuring the sides of the lamellas considering that no matter the width of the lamella, the distance between the edge and the sensor in the side must be 20mm. Therefore, with this motor it is possible to change these parameters online without any manual operation and avoiding the intervention of a worker in the environment of the machine.

FIGURE 14

The reasons of using a servomotor instead of the manual job are diverse.

First, in an inside line manual regulations are not recommended for safety reasons. This is the main reason of deciding to implement a servomotor in the measuring unit, in order to avoid human performance in the line so as to avoid accidents.

Additionally, there are other factors to consider if an automatization like this one should be implemented in the line, like for example an economical study.

Talking about price, it is a must to consider that in a factory, every stop is a huge problem, because having the machines unused due to a stop in the production line for using a manual system to adjust parameters involves a high cost per minute. Thus, changing the position of the sensors remotely is an improvement regarding the costs of production.

In other industries this problem of adjusting the machine might not be a real issue considering the lot size. However, in the wood industry, and particularly in the oak one, we work with both a natural and a very expensive material. The extraction of the oak wood comes from trees that have a circular base, from which rectangular blocks are obtained, which in turn will be transformed into the lamellas measured in the machine object of study. The diversity in the size of the width of those blocks is caused as a consequence of its price, trying to take advantage of as many parts of the oak trunk as possible.

Being aware of this situation, we have to consider that the percentage of each width in the line will probably be very variable, and the number of times that the production will have to stop to change the position of the sensors will be too frequent, so using a servomotor in this case is going to be profitable.

## 3.- MOTOR TO MOVE THE TOOTHED BELT DRIVE

In the Figure 15, a closer view of the devices that make the lamellas go through the table is presented. As it was specified in Table 2, the number 3 of this representation correspond to the motor that moves the toothed wheels of the drive mechanism.

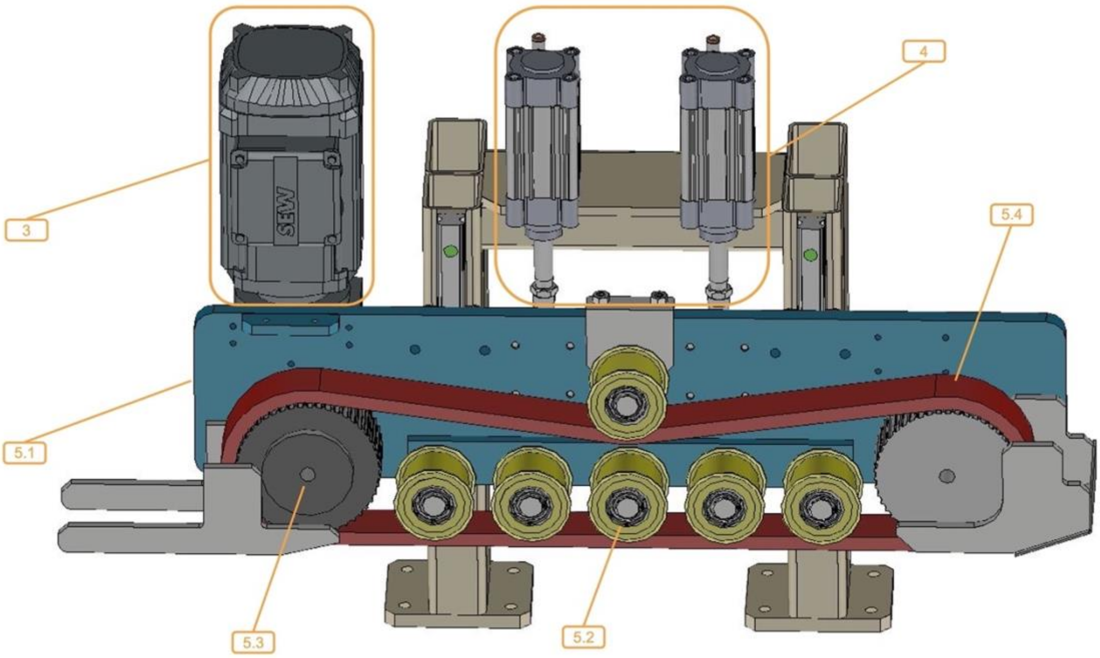


FIGURE 15

### 3.1.- FIRST OPTION CONSIDERED, CONVERSION ASYNCHRONOUS MOTOR:

For the movement of the lamellas in the measuring table we use a mechanical system formed by an electric motor and a gear box, hidden below a blue box used for safety reasons.

The combination of electric motor and gearbox in one device used to ensure the transmission of power from the motor to the output side. Within the compact device formed by electric motor and gearbox, the gearbox acts as a speed and torque converter.

The principle of operation of an electric motor with a gearbox is simple: the speed of the electric motor is slowed down by the gearbox, which then transmits the torque to its output side. The advantage of this solution is that the gearbox can take care of the transmission of much higher torque than the electric motor itself (Hrach, 2021).

The model used in this project is the UNICASE Helical Bever Gearmotor of NORD, model type: SK 92172.1A – 80LP/4 TF RD, Figure 16.

FIGURE 16

The motor power is 0,75kW, as we can see in the datasheet Annex F with the specifications of the mechanical system.

We want the lamellas to be moved in the table of the machine with a speed between 30m/min and 50m/min. For that reason, we calculate the spindle speed (min$^{-1}$) using the cutting speed formula, so as to know which the speed of the electric motor is or, in other words, the speed of the belt shaft assembly.

The cutting speed is a term used in manufacturing technology. It is the instantaneous relative speed with which a tool is facing the material to be removed, or in other words, the speed of the cutting movement. In this case, we use this term to refer to the speed with which the lamellas are supposed to be moved in the table, thanks to the friction provoke by the toothed belt against them.

$$v_c = \frac{\pi\, d\, n}{1000}$$

ECUATION 1

Where:

$$v_c = Cutting\ speed\ (m/min)$$

$$\pi = 3{,}14\ (the\ circular\ constant)$$

$$d = diameter\ (mm)$$

$$n = spindle\ speed\ (min^{-1})$$

Using that formula:

$$v_c = \frac{\pi\, d\, n}{1000} \rightarrow n = \frac{1000\, v_c}{\pi\, d}$$

For the diameter, we must consider that the motor moves the axis of a cogwheel with a radius of 75 mm. This wheel moves the red toothed belt we can see in the picture, the thickness of this belt is 15 mm. We do not consider friction losses because the belt and the wheel both have dents. In conclusion, the radius of the assembly is 80 mm, so 160 mm of diameter.

$$n = \frac{1000\ v_c}{\pi\ d} \rightarrow n = \frac{1000\ v_c}{\pi\ 160}$$

For the cutting speed, as we said before, we need the lamellas to be moved minimum at 30m/min, so if we consider that data as the cutting speed we have a spindle speed of 60 min-1.

$$n = \frac{1000\ 30}{\pi\ 160} \rightarrow n = 60min^{-1}$$

### 3.2.- SECOND OPTION CONSIDERED, SERVOMOTOR:

Another possibility to move the axis of the toothed wheel could be a servomotor. The electric motors with gearbox are used mostly when there is a need of stability in the model, while for frequent stops and starts a servomotor is better because it is very precise if a moving control is required.

We considered using a servomotor with the same power of the electric motor with gearbox presented in the 3D model of the machine, because although the characteristics of the asynchronous motor are enough for this application, the servomotor would perform in a better way. Finally, we discard this option due to the cost of the servomotor, too expensive to be profitable when we can use the electric motor and gearbox.

Nevertheless, in the measuring unit (Figure 9) we chose a non-very fast servomotor over the asynchronous motor, in order to achieve the precision that we need, because position cannot be controlled with an electrical motor and gearbox. In this case of the measuring unit, we have the option of using an electrical stepper motor, but it is less precise than a servomotor, so we did not finally choose it.

## 4.- PNEUMATICAL SYSTEM

Before introducing the part of the pneumatical system in the machine, it is important to clarify that an optical sensor is needed to detect if there is or is not a lamella entering the measuring table, between the machine and the belt conveyor before it. If the sensor detects the part in the right place, the pneumatical system begins to work.

### 4.1.- OPTICAL SENSOR

The complexity of the sensor required is not as high as the ones used in the measuring unit, we just need a simple sensor that must detect presence.

Between all the options available, we decided to choose one from SICK, the miniature photoelectric sensor WTB4FP-22161220A00, from the photoelectric sensor’s family

W4F (Figure 17). This product family offers a wide range of technologies to ensure reliable detection results in diverse applications (SICK Sensor Intelligence., 2022).

Besides, the small size of this sensor in particular enables us to place it between the belt conveyor and the table, and its precision in the detection of objects gives us the reliability to know if there is a lamella or not.


FIGURE 17

## 4.2.- PNEUMATICAL CYLINDER

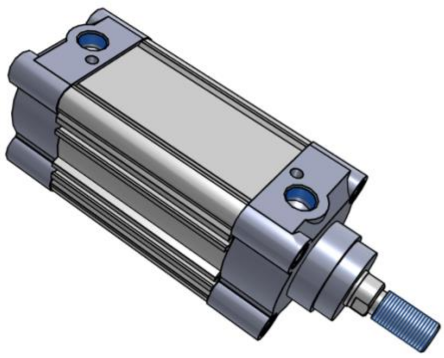

FIGURE 18

In case of detection of lamellas by the sensor explained in the 4.1., the pneumatical system starts working to push the whole toothed belt drive against the table.

The device used is a pneumatical actuator, that converts the energy of compressed air into mechanical energy, which can be in the form of rotary or linear motion, depending on the type of actuator.

In this model a pair of pneumatical cylinders have been used, a specific type of actuators that produce linear motion. They consist of a cylindrical container fitted with a plunger or piston. By introducing a certain flow of compressed air, it expands inside the chamber and causes a linear displacement. If a rigid stem is attached to the piston, this mechanism can push an element, as it happens with the current cylinder system that applies pressure on the toothed belt drive system.

Based on the maximum pressure that can be applied in this installation, 6 bar, and on other characteristics important for this system, we chose the Cyl ISO 15552 TypeA Double Acting Magnetic Cushioned 063 0050 CP of Metal Work Pneumatic, Figure 18.

## 5.- TOOTHED BELT DRIVE

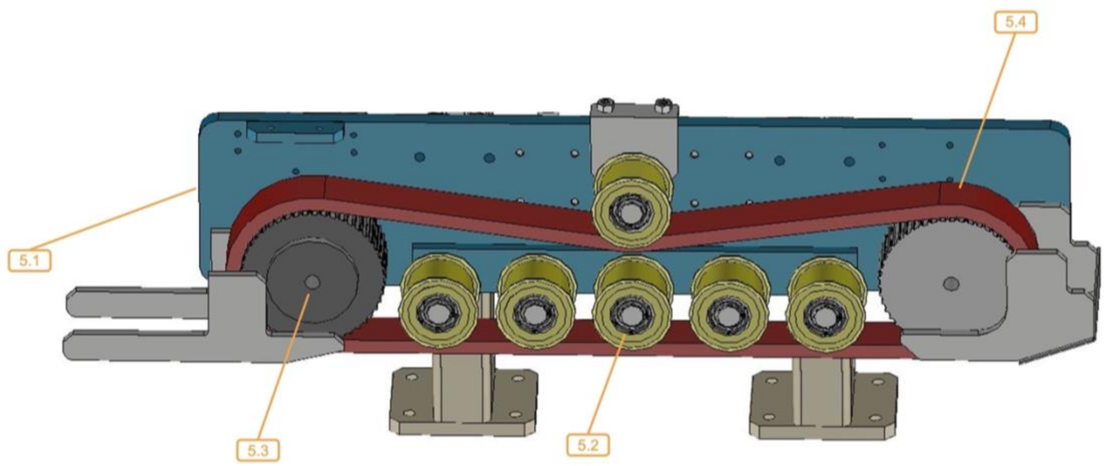


FIGURE 19

In this part of the paper, the system in charge of moving the lamellas, Figure 19, is explain in detail.

### 5.1.- SOLID FRAME

In order to hold the components together in the system and to connect the pneumatical cylinders with the toothed wheels, a solid frame is used.

The material of this component must be able to bear the pressure, so we thought about using iron or steel instead of aluminum.

### 5.2.- ROLLERS

The function of these devices is basically to push the lamellas down through all the belt because it would not be enough with the two toothed wheels due to the necessity of a constant pressure in the whole belt. Those steel rollers do not have any power or buffering.

The rollers are shown in the Figure 19, five of them are in charge of pushing the belt against the table, while the other one applies pressure from the top.

## 5.3.- TOOTHED WHEEL

The key for selecting this part of the mechanism is the material: whenever it exists high power and speed rotation, we use steel in the toothed wheel. However, as it has been explained in this paper, the toothed belt drive does not work with high parameters of power or speed rotation, so it is better and cheaper to use aluminum in this case.

The specific wheel used in the 3D model is shown in the Figure 20 and Figure 21. It is a Madler product, an AT10 aluminum 48 teeth wheel, for a belt width of 50 mm.

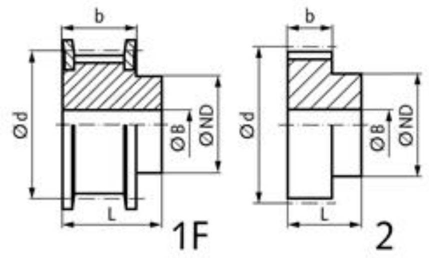


FIGURE 20

FIGURE 21

## 5.4.- TOOTHED BELT

The last part to explain of this system is the type of belt.

First, it is vital to use a toothed belt because we need to move the lamellas with high precision, so that is why toothed wheels are used too.

In the 3D model, we used the Madler product that can be seen in the Figure 22 and Figure 23: Polyurethane timing belt AT10 width 50mm Lw 1800mm 180 teeth 50 AT10/1800.

FIGURE 22

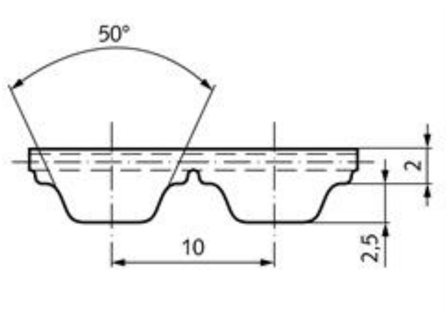


FIGURE 23

In addition to achieving the necessary specifications and carrying out the transmission correctly, an important point in the choice of the belt is the cover, that should be made of rubber or polyurethane so that the coefficient of friction is as high as possible and energy is not lost when catching the lamella, as it is explained in the timing belts catalog of the industry BRECOflex CO., in the Figure 24.

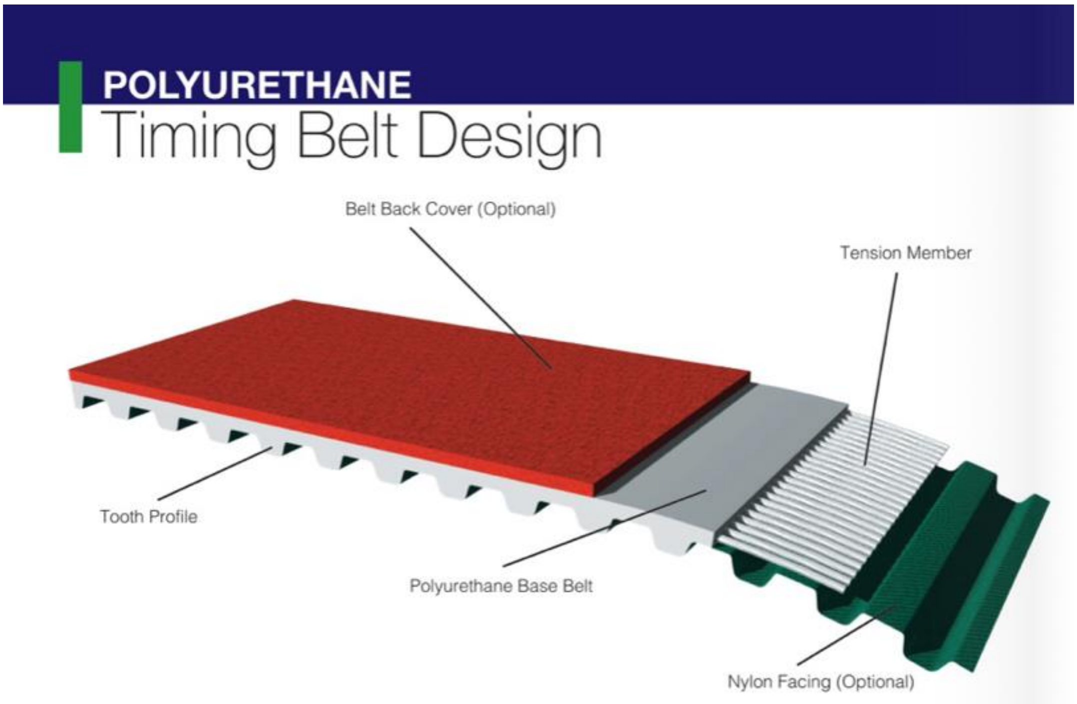


FIGURE 24

## 6.- WIDTH MEASURING UNIT

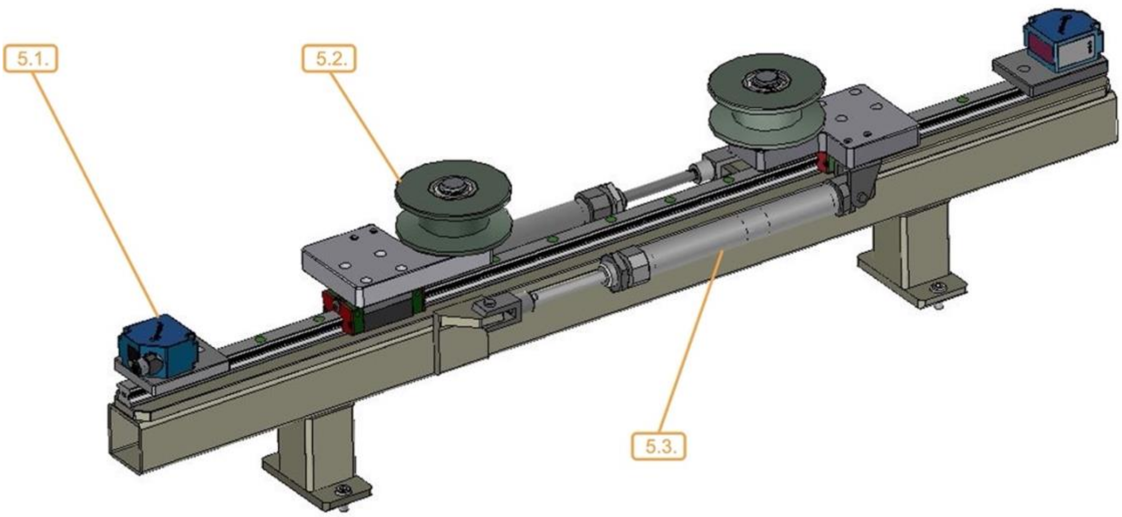


FIGURE 25

This is the last device we decided to add to the original machine, that can be seen in the Figure 25.

The 5.2. represents two rollers made of aluminum or steel. When the production line is not activated, the rollers are placed in the sides of the device. However, if the factory is working, the lamellas go between the rollers and the two sensors represented by 5.1. measure the distance to the roller, that should be constant.

Those sensors are specifically two displacement measurement sensors with the same characteristics as the six sensors used in the thickness measurement unit. If the distance between the sensor and the roller varies for a length superior to 10 or 15 mm, the lamella is considered wrong, talking about the width size.

Finally, the 5.3. is another important part of the device, the representation of the pneumatical system, consisting of two mini-pneumatical cylinders from the Metal Work Pneumatical industry.

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# CONCLUSIONS

This project pursued the objective of devising a machine to solve a concrete problem in the oak wood lamella production line analyzed: the management of wrong lamellas as well as its detection for not achieving the thickness or width tolerances.

From the beginning of the development of the machine we have faced lots of doubts regarding the devices to use and how to combine them until we came up with the idea of the measuring table with thickness and width measuring units.

In this paper, it has been a must to research about the characteristics of the oak wood, so as to choose the best materials and try not to damage the lamellas being measured.

As we said in previous chapters, the idea of this machine is to classify the lamellas based on the defects or the absence of them in different piles that will suffer different treatments and will produce diverse quality ranges lamellas according to the treatments used in them. This means that our design determines the subsequent layout of the entire industry or production line, so the planification for introducing this new machine must be done with a great level of detail.

Another point of this document that could be useful in future modifications or further investigations is the possibility of using the new technologies of 3D scanning of surfaces instead of 6 sensors and the width measuring unit. The advantages of those new methos are the extreme precision, although the price nowadays is almost unaffordable for an industry that requires these tolerances. Nevertheless, it could be implemented in more demanding applications regarding the final quality of the parts in the future, and the data could be managed to get closer to the 4.0 Industry achieving preventive maintenance or constant monitoring of the surface of the lamellas.

# ANNEXES

A. MOTOR AND GEARBOX IN BELT CONVEYOR – DATASHEET

B. SICK SENSORS IN THICKNESS MEASURING UNIT – DATASHEET

C. SICK FAMILY OF SENSORS IN THICKNESS MEASURING UNIT – DATASHEET

D. WENGLOR SENSORS IN THICKNESS MEASURING UNIT – DATASHEET

E. SERVOMOTOR IN THICKNESS MEASURING UNIT – DATASHEET

F. MOTOR WITH GEARBOX IN TOOTHED BELT DRIVE – DATASHEET

G. SICK SENSORS IN PNEUMATICAL SYSTEM – DATASHEET

H. SICK FAMILY OF SENSORS IN PNEUMATICAL SYSTEM – DATASHEET

## Catalog designation

KA29/TDRN80M4
Bevel-helical gearmotors K..DRN.. (IE3)

## Product data

| | | |
|---|---|---|
| Rated motor speed | [1/min] | : 1440 |
| Output speed | [1/min] | : 72 |
| Overall gear ratio | | : 19,99 |
| Output torque | [Nm] | : 99 |
| Service factor SEW-FB | | : 1,30 |
| Mounting position | | : M1,M2,M3,M5,M6A |
| Base / top coat | | : 7031 Blue gray (51370310) |
| Position of connector/terminal box | [°] | : 270 |
| Cable entry/connector position | | : X |
| Hollow shaft | [mm] | : 25 |
| Permitted output overhung load with n=1400 | [N] | : 3940 |
| Lubricant quantity 1st gear unit | [Liter] | : 0,7 |
| Motor power | [kW] | : 0,75 |
| Duration factor | | : S1-100% |
| Efficiency class | | : IE3 |
| Efficiency (50/75/100% Pn) | [%] | : 80,7 / 82,9 / 82,9 |
| CE mark | | : Yes |
| Motor voltage | [V] | : 230/400 |
| Wiring diagram | | : R13 |
| Frequency | [Hz] | : 50 |
| Rated current | [A] | : 3,05 / 1,75 |
| Cos Phi | | : 0,74 |
| Thermal class | | : 130(B) |
| Motor protection type | | : IP54 |
| Design requirement | | : Europe (CE) |
| Mass moments of inertia (referring to the input side) | [10 $^{4}$ kgm$^{2}$] | : 25,00 |
| Weight | [kg] | : 20.50 |

### Additional feature

T- Torque arm for shaft mounted feature
Lubricant: CLP PG 460 (-20 / +60 °C): 0,7 Liter

Product data sheet

# OD1-B100C50I14

## OD Mini

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**DISPLACEMENT MEASUREMENT SENSORS**

| Type | Part no. |
|---|---|
| [illegible] | [illegible] |

| | |
|---|---|
| Supply voltage $V_s$ | [illegible] |
| Power consumption | [illegible] |
| Warm-up time | [illegible] |
| Housing material | [illegible] |
| Window material | [illegible] |
| Connection type | [illegible] |
| Indication | [illegible] |
| Control elements | [illegible] |
| Weight | [illegible] |
| Dimensions (W x H x D) | [illegible] |
| Enclosure rating | [illegible] |
| Protection class | [illegible] |

| | |
|---|---|
| Measuring range | [illegible] |
| Target | [illegible] |
| Repeatability | [illegible] |
| Linearity | [illegible] |

44

| | |
|---|---|
| **Response time** | ≥ 2 ms [4] |
| **Measuring frequency** | ≤ 2 kHz |
| **Output time** | ≥ 0.5 ms |
| **Light source** | Laser, red<br>visible red light |
| **Laser class** | 1 (IEC 60825-1:2014, EN 60825-1:2014) [5] |
| **Typ. light spot size (distance)** | 700 µm x 600 µm (100 mm) |
| **Additional function** | Averaging 1 ... 512x, automatic or manual sensitivity adjustment, Analog outputs can be taught in, digital outputs can be taught in, invertable digital output, switching mode: window (Wnd), switching mode: distance to object (DtO), switching mode: object between sensor and background (ObSB), multifunctional input: laser-off / external teach-in / trigger |

1) Averaging function set to: 512.

2) Constant ambient conditions.

3) Measurement on 90 % remission (ceramic, white).

4) With fixed sensitivity adjustment and averaging setting = 1. With automatic sensitivity and measuring rate 500 µs: 2 ... 7.5 ms response time/measuring rate 1,000 µs: 4 ... 15 ms response time.

5) Wavelength: 655 nm, max. output: 390 µW (laser class 1) / < 1 mW (laser class 2).

## Interfaces

| | |
|---|---|
| **Analog output** | |
| Number | 1 |
| Type | Current output |
| Current | 4 mA ... 20 mA, ≤ 300 Ω |
| Resolution | 13.4 bit |
| **Multifunctional input (MF)** | 1 x [1] |

1) MF can be used as laser-off, trigger, external teach-in or deactivated.

## Ambient data

| | |
|---|---|
| **Ambient temperature, operation** | –10 °C ... +50 °C |
| **Ambient temperature, storage** | –20 °C ... +60 °C |
| **Min. rel. humidity (not condensing)** | 35 % |
| **Max. rel. humidity (not condensing)** | 95 % |
| **Temperature drift** | ± 0.08 % FS/K (FS = Full Scale = Measuring range of sensor) |
| **Typ. Ambient light immunity** | Artificial light: ≤ 3,000 lx<br>Sunlight: ≤ 10,000 lx |
| **Vibration resistance** | 10 Hz ... 55 Hz (amplitude 1.5 mm, x-, y-, z-axis 2 hours each) |
| **Shock resistance** | 50 G (x, y, z axis 3 times each) |

## General notes

| | |
|---|---|
| **Note** | Not free of paint wetting impairment substances. |

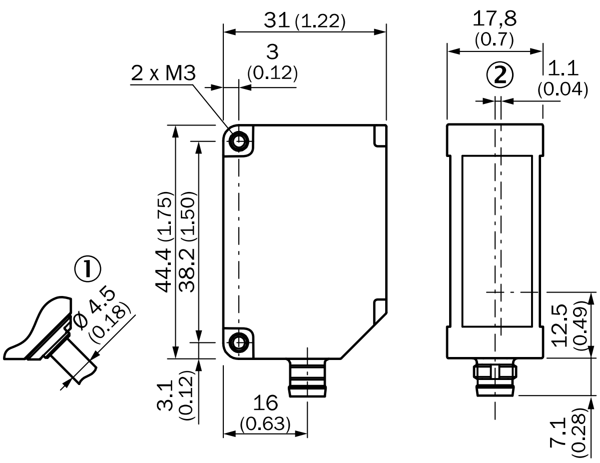
## Classifications

| | |
|---|---|
| **ECl@ss 5.0** | 27270801 |
| **ECl@ss 5.1.4** | 27270801 |
| **ECl@ss 6.0** | 27270801 |
| **ECl@ss 6.2** | 27270801 |
| **ECl@ss 7.0** | 27270801 |
| **ECl@ss 8.0** | 27270801 |

| | |
|---|---|
| **ECl@ss 8.1** | 27270801 |
| **ECl@ss 9.0** | 27270801 |
| **ECl@ss 10.0** | 27270801 |
| **ECl@ss 11.0** | 27270801 |
| **ETIM 5.0** | EC001825 |
| **ETIM 6.0** | EC001825 |
| **ETIM 7.0** | EC001825 |
| **ETIM 8.0** | EC001825 |
| **UNSPSC 16.0901** | 41111613 |

## Dimensional drawing (Dimensions in mm (inch))

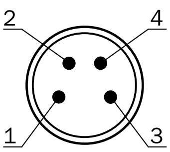
Aluminum housing




① Variant with 30 cm cable with M12, 5-pin connector
② Optical axis

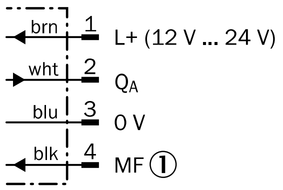
## Connection type

Connection type



## Connection diagram

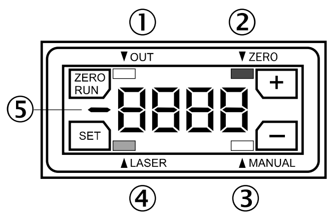
Connection diagram




① Multifunctional input (MF)

## Adjustment possible

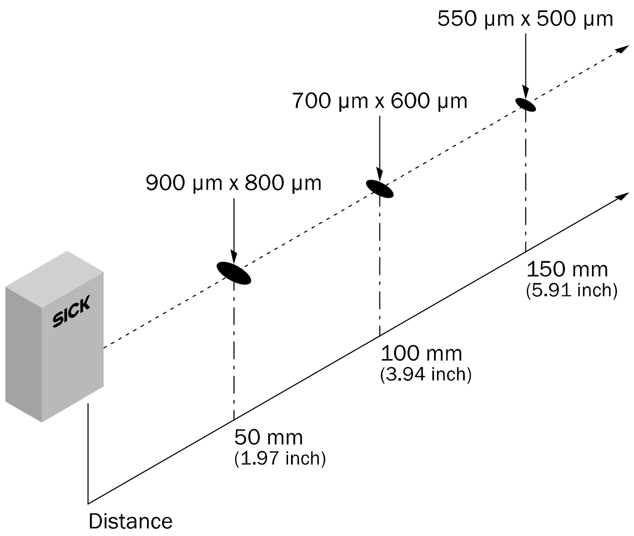
Adjustments




① Digital output status indicator
② Zero offset status indicator
③ Teach mode status indicator
④ Laser status indicator
⑤ Minus sign for measured value indicator

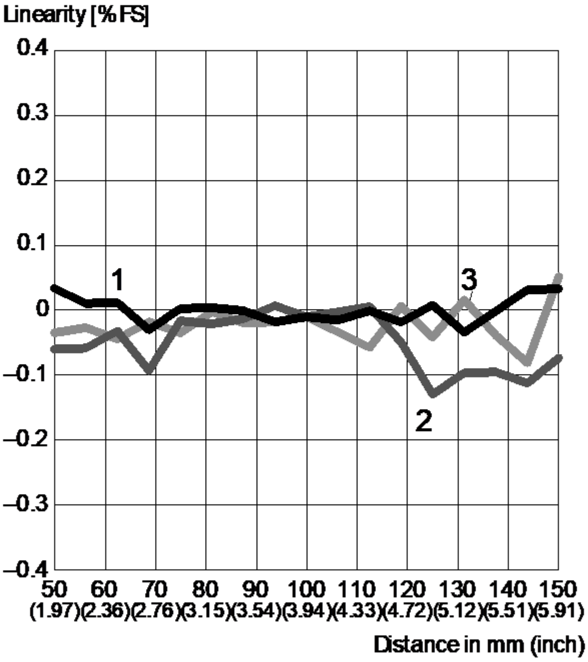
## Light spot size

OD Mini Prime 50 mm ... 150 mm



## Linearity

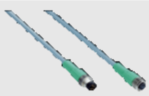
**Linearity**




① White ceramic
② Stainless steel
③ Black rubber

## Recommended accessories

**Other models and accessories** → www.sick.com/OD_Mini

| | Brief description | Type | Part no. |
|---|---|---|---|
| Mounting brackets and plates | | | |
|  | Mounting bracket, for wall installation, no alignment bracket, stainless steel | BEF-OD1-A | 5328343 |
|  | Mounting bracket, no alignment bracket, stainless steel | BEF-OD1-B | 5328344 |
| Plug connectors and cables | | | |
|  | Head A: female connector, M8, 4-pin, straight, A-coded<br>Head B: Flying leads<br>Cable: Sensor/actuator cable, PUR, halogen-free, unshielded, 2 m | YF8U14-020UA3XLEAX | 2094791 |
|  | Head A: female connector, M8, 4-pin, angled, A-coded<br>Head B: Flying leads<br>Cable: Sensor/actuator cable, PUR, halogen-free, unshielded, 2 m | YG8U14-020UA3XLEAX | 2095589 |
|  | Head A: female connector, M8, 4-pin, straight<br>Head B: male connector, M8, 4-pin, straight<br>Cable: PUR, 2 m | DSL-0804-G02MB | 6059742 |

| | Brief description | Type | Part no. |
|---|---|---|---|
|  | Head A: female connector, M8, 4-pin, straight, A-coded<br>Head B: male connector, M8, 4-pin, straight, A-coded<br>Cable: Sensor/ actuator cable, PUR, halogen-free, unshielded, 2 m | YF8U14-020UA3M8U14 | 2096347 |

## Recommended services

**Additional services** → www.sick.com/OD_Mini

| | Type | Part no. |
|---|---|---|
| Warranty extensions | | |
| • **Product area:** Identification solutions, machine vision, Distance sensors, Detection and ranging solutions<br>• **Range of services:** The services correspond to the scope of the statutory manufacturer warranty (SICK general terms and conditions of purchase)<br>• **Duration:** Five-year warranty from delivery date. | Extended warranty for a total of five years from delivery date | 1680671 |
| Commissioning | | |
| • **Product area:** Displacement measurement sensors<br>• **Range of services:** Inspection of connection and mounting, optimization of parameters of SICK product as well as tests, set-up of previously defined functions of the scaling of the analog measuring range, switching point position, hysteresis, measuring frequency, measured value filter, signal quality, evaluation function, or communication interface<br>• **Travel expenses:** The prices do not include travel costs such as hotel, flight, travel time and expenses.<br>• **Duration:** Additional work will be invoiced separately | DT20 Hi/ OD/ OL commissioning | 1612241 |

# SICK AT A GLANCE

SICK is one of the leading manufacturers of intelligent sensors and sensor solutions for industrial applications. A unique range of products and services creates the perfect basis for controlling processes securely and efficiently, protecting individuals from accidents and preventing damage to the environment.

We have extensive experience in a wide range of industries and understand their processes and requirements. With intelligent sensors, we can deliver exactly what our customers need. In application centers in Europe, Asia and North America, system solutions are tested and optimized in accordance with customer specifications. All this makes us a reliable supplier and development partner.

Comprehensive services complete our offering: SICK LifeTime Services provide support throughout the machine life cycle and ensure safety and productivity.

**For us, that is "Sensor Intelligence."**

# WORLDWIDE PRESENCE:

Contacts and other locations www.sick.com

Sensor Intelligence.

# OD Mini

Compact, lightweight sensor for precise measurement

SICK
Sensor Intelligence.

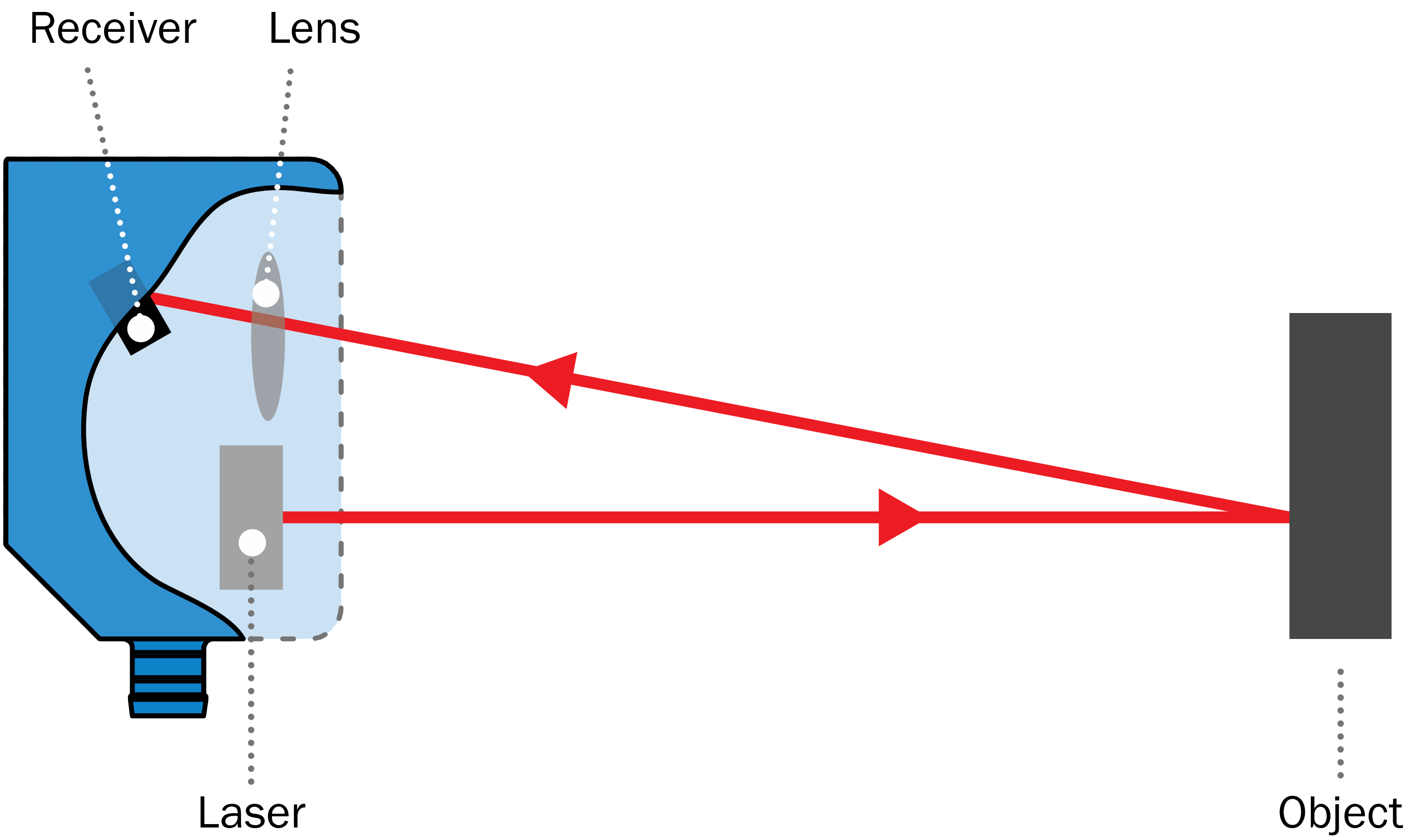
DISPLACEMENT MEASUREMENT SENSORS

Advantages

## Precision meets quality

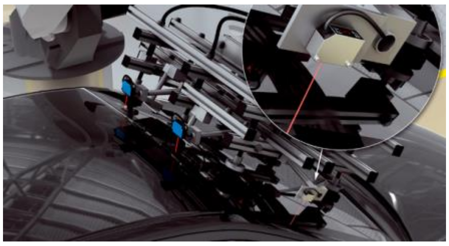
**With expert-developed intelligent measurement technology which proves its worth in industrial applications time and time again, SICK offers the solution to any challenge which demands maximum measurement accuracy and quality. A pioneering spirit founded on our years of experience and our own innovations in optical sensor technology. We ensure efficient processes while fulfilling the demands of even complex measuring tasks – regardless of surface, diameter, thickness, or width, and regardless of whether an object is to be positioned or measured. This is how we ensure that your products are every bit as perfect as you want them to be. Moreover, SICK's measurement technology supports quality assurance processes and delivers cost-saving benefits. Have a look on <a href=https://www.sick.com/measurement-sensors target="_blank">www.sick.com/measurement-sensors**

A point of light is projected onto the measuring object. The light reflected is captured by a light-sensitive receiver at a specific angle. Based on the angle between the send and receive direction, the position of the object is then triangulated (from the Latin "triangulum" = triangle).

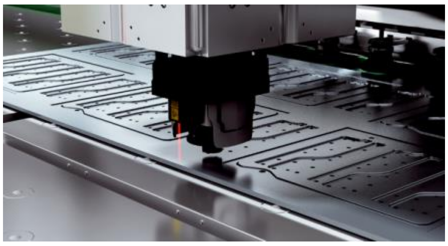


## OD Mini – The lightweight sensor in a compact housing

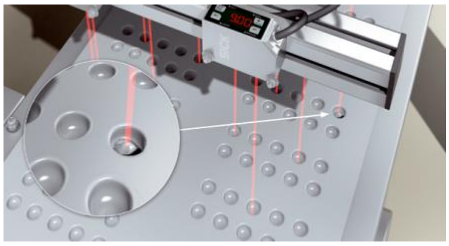
**The OD Mini displacement measurement sensors from SICK use the triangulation principle to very precisely monitor series production in assembly processes. Due to their small design, the sensors are extremely flexible and can be used in many applications, for example when measuring components, for precise positioning, in the inspection of manufacturing tolerances in quality control, for process controls by robot positioning and for classification and sorting (e.g. by length). Since manufacturing quality plays an important role in such applications, the OD Mini is perfect here due to its high measurement precision.**



**Precise positioning**
- Typical applications are robot guidance for the installation of front screens and high-precision positioning of carriages
- Typical industries are robotics, handling and assembly, automotive and parts suppliers



**Collision avoidance**
- Typical applications are height positioning and collision avoidance at the cutting head and positioning of grippers
- Typical industries are handling and assembly, machine tools



**Ensuring quality**
- Typical applications are quality control of components and checking the shape of blister packs
- Typical industries are consumer goods, handling and assembly, pharmaceutical and cosmetics manufacturers

### The OD Mini also impresses when used in highly dynamic applications due to its small size and low weight.

# OD Mini

DISPLACEMENT MEASUREMENT SENSORS

**OD Minis are among the world's smallest displacement measurement sensors with display and control elements in terms of their dimensions (44.4 mm x 31 mm x 17 mm). The product family impresses with its measurement accuracy in the µm range as well as the high-quality fittings, compact size and low weight. The OD Mini is available in two housing designs.**

**OD Mini in stainless-steel housing – the rugged version for use in harsh environments**

**OD Mini in aluminum housing – for highly dynamic applications, e. g. robotic arms and grippers**

**The OD Mini impresses with its measurement accuracy in the µm range and its rugged and compact housing.**

## SICK LifeTime Services

**SICK's services increase machine and plant productivity, enhance the safety of people all over the world, provide a solid foundation for a sustainable business operation, and protect investment goods. In addition to its usual consulting services, SICK provides direct on-site support during the conceptual design and commissioning phases as well as during operation.**

**The range of services not only covers aspects like maintenance and inspection, but also includes performance checks as well as upgrades and retrofits. Modular or customized service contracts extend the service life of plants and therefore increase their availability. If faults occur or limit values are exceeded, these are detected at all times by the corresponding sensors and systems.**

**Consulting and design**
Application-specific advice on the product, its integration and the application itself.


**commissioning and maintenance**
Application-optimized and sustainable — thanks to professional commissioning and maintenance by a trained SICK service technician.


**service contracts**
Extended warranty, SICK Remote Service, 24-hour helpdesk, maintenance, availability guarantees and other modular components can be individually combined on request.

[illegible]

| | |
|---|---|
| Measuring range | [illegible] |
| Linearity | [illegible] |
| Repeatability | [illegible] |
| Response time | [illegible] |
| Output time | [illegible] |
| Measuring frequency | [illegible] |
| Digital output | [illegible] |
| Light source | [illegible] |
| Type of light | [illegible] |
| Laser class | [illegible] |
| Serial | [illegible] |
| PROFIBUS DP | [illegible] |
| Analog output | [illegible] |
| Ambient temperature, operation | [illegible] |

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

## Fields of application

- Main field of applications in electronics and solar indsutries, the automotive industry and in machine tools
- Precise positioning
- Quality control of manufacturing tolerances in processed workpieces
- Classification and sorting
- Positioning of robots by grippers in closed control circuit
-

## Ordering information

- **Housing material:** metal

| Laser class | Measuring range | Type of analog output | Connection type | Typ. light spot size (distance) | Digital output | Type | Part no. |
|---|---|---|---|---|---|---|---|
| 1 | 10 mm ... 20 mm | Current output | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 500 µm (15 mm) | 1 x PNP/NPN, selectable | | |
| | | | Male connector, M8, 4-pin | 700 µm x 500 µm (15 mm) | – | | |
| | 20 mm ... 50 mm | – | Cable with male connector, M12, 5-pin, 30 cm | 1.6 mm x 1 mm (35 mm) | 1 x PNP/NPN, selectable | | |
| | | | Male connector, M8, 4-pin | 1.6 mm x 1 mm (35 mm) | 1 x PNP/NPN, selectable | | |
| | | Current output | Cable with male connector, M12, 5-pin, 30 cm | 800 µm x 450 µm (35 mm) | 1 x PNP/NPN, selectable | | |
| | | | Male connector, M8, 4-pin | 800 µm x 450 µm (35 mm) | – | | |
| | 50 mm ... 150 mm | Current output | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 600 µm (100 mm) | 1 x PNP/NPN, selectable | | |
| | | | Male connector, M8, 4-pin | 700 µm x 600 µm (100 mm) | – | | |
| 2 | 50 mm ... 250 mm | – | Cable with male connector, M12, 5-pin, 30 cm | 2 mm x 1.3 mm (150 mm) | 1 x PNP/NPN, selectable | | |
| | | | Male connector, M8, 4-pin | 2 mm x 1.3 mm (150 mm) | 1 x PNP/NPN, selectable | | |

- **Housing material:** stainless steel
- **Laser class:** 1

| Measuring range | Type of analog output | Connection type | Typ. light spot size (distance) | Digital output | Type | Part no. |
|---|---|---|---|---|---|---|
| 10 mm ... 20 mm | Current output | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 500 µm (15 mm) | 1 x PNP/NPN, selectable | | |
| | | Male connector, M8, 4-pin | 700 µm x 500 µm (15 mm) | – | | |
| | Voltage output | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 500 µm (15 mm) | 1 x PNP/NPN, selectable | | |
| | | Male connector, M8, 4-pin | 700 µm x 500 µm (15 mm) | – | | |
| 20 mm ... 50 mm | Current output | Cable with male connector, M12, 5-pin, 30 cm | 800 µm x 450 µm (35 mm) | 1 x PNP/NPN, selectable | | |
| | | Male connector, M8, 4-pin | 800 µm x 450 µm (35 mm) | – | | |
| | Voltage output | Cable with male connector, M12, 5-pin, 30 cm | 800 µm x 450 µm (35 mm) | 1 x PNP/NPN, selectable | | |
| | | Male connector, M8, 4-pin | 800 µm x 450 µm (35 mm) | – | | |
| 50 mm ... 150 mm | Current output | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 600 µm (100 mm) | 1 x PNP/NPN, selectable | | |
| | | Male connector, M8, 4-pin | 700 µm x 600 µm (100 mm) | – | | |
| | Voltage output | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 600 µm (100 mm) | 1 x PNP/NPN, selectable | | |
| | | Male connector, M8, 4-pin | 700 µm x 600 µm (100 mm) | – | | |

- **Communication interface:** Serial, PROFIBUS DP
- **Housing material:** stainless steel
- **Laser class:** 1
- **Type of analog output:** Current output
- **Digital output:** 1 ... 3 x PNP/NPN, selectable

| Measuring range | Connection type | Typ. light spot size (distance) | Type | Part no. |
|---|---|---|---|---|
| 10 mm ... 20 mm | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 500 µm (15 mm) | | |
| | Male connector, M8, 4-pin | 700 µm x 500 µm (15 mm) | | |
| 20 mm ... 50 mm | Cable with male connector, M12, 5-pin, 30 cm | 800 µm x 450 µm (35 mm) | | |
| | Male connector, M8, 4-pin | 800 µm x 450 µm (35 mm) | | |
| 50 mm ... 150 mm | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 600 µm (100 mm) | | |
| | Male connector, M8, 4-pin | 700 µm x 600 µm (100 mm) | | |

- **Communication interface:** Serial, PROFIBUS DP
- **Housing material:** metal
- **Laser class:** 1
- **Type of analog output:** Current output
- **Digital output:** 1 ... 3 x PNP/NPN, selectable

| Measuring range | Connection type | Typ. light spot size (distance) | Type | Part no. |
|---|---|---|---|---|
| 10 mm ... 20 mm | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 500 µm (15 mm) | | |
| | Male connector, M8, 4-pin | 700 µm x 500 µm (15 mm) | | |
| 20 mm ... 50 mm | Cable with male connector, M12, 5-pin, 30 cm | 800 µm x 450 µm (35 mm) | | |
| | Male connector, M8, 4-pin | 800 µm x 450 µm (35 mm) | | |
| 50 mm ... 150 mm | Cable with male connector, M12, 5-pin, 30 cm | 700 µm x 600 µm (100 mm) | | |
| | Male connector, M8, 4-pin | 700 µm x 600 µm (100 mm) | | |

## SICK AT A GLANCE

SICK is one of the leading manufacturers of intelligent sensors and sensor solutions for industrial applications. A unique range of products and services creates the perfect basis for controlling processes securely and efficiently, protecting individuals from accidents and preventing damage to the environment.

We have extensive experience in a wide range of industries and understand their processes and requirements. With intelligent sensors, we can deliver exactly what our customers need. In application centers in Europe, Asia and North America, system solutions are tested and optimized in accordance with customer specifications. All this makes us a reliable supplier and development partner.

Comprehensive services complete our offering: SICK LifeTime Services provide support throughout the machine life cycle and ensure safety and productivity.

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SICK AG | Waldkirch | Germany | www.sick.com

SICK
Sensor Intelligence.

# Laser Distance Sensor

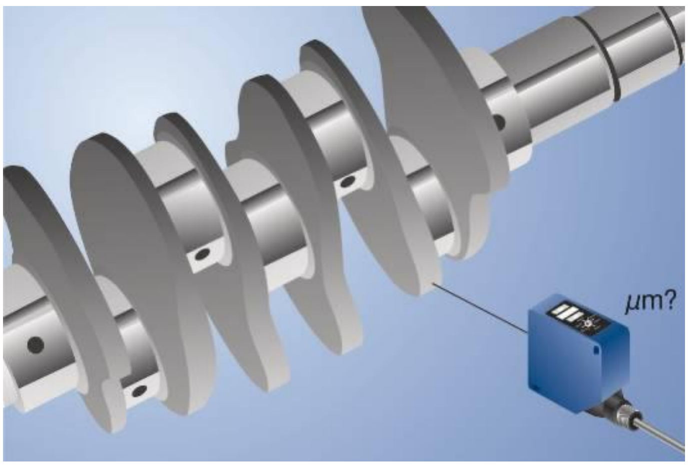
**High-Precision**

## CP24MHT80 LASER

Part Number

- **High resolution: 20 µm (resolution-mode)**
- **Linearity: 0,1 % (resolution-mode)**
- **Measured value independent of material, color and brightness**
- **Response time: < 660 µs (speed-mode)**
- **Zoom function**

These sensors work with a high-resolution CMOS line and DSP technology and determine distance using angular measurement. As a result, material, color and brightness related measurement differences are virtually eliminated.
Integrated analogue output can be configured for voltage 0...10 V (10...0 V) or current 4...20 mA (20...4 mA).




## Technical Data

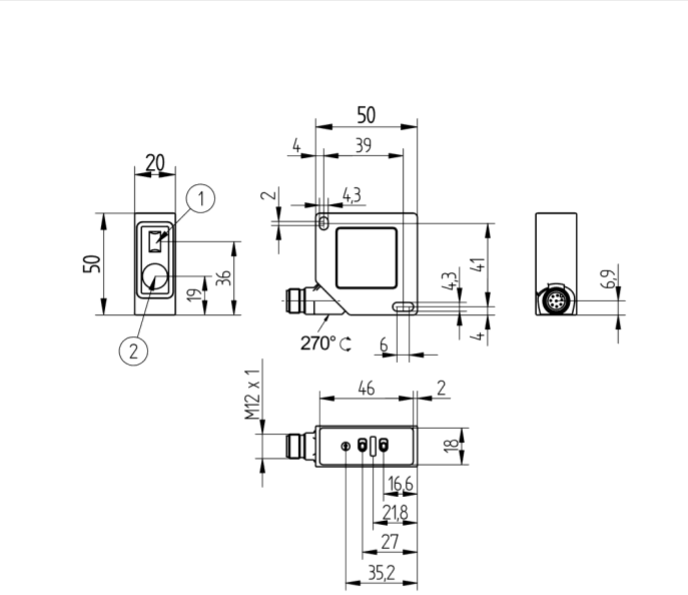
| | |
|---|---|
| **Optical Data** | |
| Working Range | 40...160 mm |
| Measuring Range | 120 mm |
| Resolution | 20 µm |
| Resolution (Speed-Mode) | 30 µm |
| Linearity | 0,1 % |
| Linearity (Speed-Mode) | 0,2 % |
| Linearity Deviation | 120 µm |
| Light Source | Laser (red) |
| Wavelength | 660 nm |
| Service Life (T = +25 °C) | 100000 h |
| Laser Class (EN 60825-1) | 2 |
| Max. Ambient Light | 10000 Lux |
| Light Spot Diameter | see Table 1 |
| **Electrical Data** | |
| Supply Voltage | 18...30 V DC |
| Current Consumption (Ub = 24 V) | < 80 mA |
| Measuring Rate | 1500 /s |
| Measuring Rate (Resolution-Mode) | 600 /s |
| Response Time | < 660 µs |
| Response Time (Resolution Mode) | < 1660 µs |
| Temperature Drift | < 10 µm/K |
| Temperature Range | -25...50 °C |
| Analog Output | 0...10 V |
| Load Current Voltage Output | < 1 mA |
| Current Output Load Resistance | < 500 Ohm |
| Interface | RS-232 |
| Baud Rate | 38400 Bd |
| Protection Class | III |
| FDA Accession Number | 0820589-000 |
| **Mechanical Data** | |
| Setting Method | Teach-In |
| Housing Material | Plastic |
| Degree of Protection | IP67 |
| Connection | M12 × 1; 8-pin |
| **Safety-relevant Data** | |
| MTTFd (EN ISO 13849-1) | 713,97 a |

| | |
|---|---|
| Error Output | ● |
| Analog Output | ● |
| RS-232 Interface | ● |

| | |
|---|---|
| Connection Diagram No. | 529 |
| Control Panel No. | P7 |
| Suitable Connection Equipment No. | 80 |
| Suitable Mounting Technology No. | 380 |

## Complementary Products

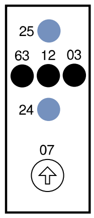
- Analog Evaluation Unit AW02
- Fieldbus Gateway ZAGxxxN01, EPGG001
- Interface Cable S232W3
- Protective Housing ZSV-0x-01
- Set Protective Housing ZSP-NN-02
- Software



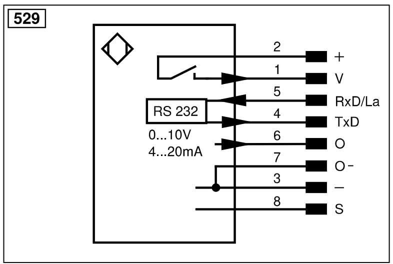

1 = Transmitter Diode
2 = Receiver Diode
Screw M4 = 0,5 Nm
All dimensions in mm (1 mm = 0.03937 Inch)

## Ctrl. Panel

P7




03 = Error Indicator
07 = Selector Switch
12 = Analog Output Indicator
24 = Plus Button
25 = Minus Button
63 = Analog Output Current Indicator

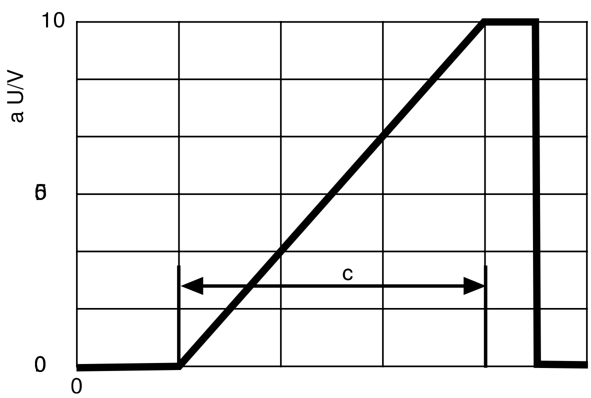



| Legend | | | | | |
|---|---|---|---|---|---|
| + | Supply Voltage + | nc | Not connected | ENB | Encoder B/B̄ (TTL) |
| – | Supply Voltage 0 V | U | Test Input | ENA | Encoder A |
| ~ | Supply Voltage (AC Voltage) | Ū | Test Input inverted | ENB | Encoder B |
| A | Switching Output (NO) | W | Trigger Input | AMIN | Digital output MIN |
| Ā | Switching Output (NC) | W– | Ground for the Trigger Input | AMAX | Digital output MAX |
| V | Contamination/Error Output (NO) | O | Analog Output | AOK | Digital output OK |
| V̄ | Contamination/Error Output (NC) | O– | Ground for the Analog Output | SY In | Synchronization In |
| E | Input (analog or digital) | BZ | Block Discharge | SY OUT | Synchronization OUT |
| T | Teach Input | AMV | Valve Output | OLT | Brightness output |
| Z | Time Delay (activation) | a | Valve Control Output + | M | Maintenance |
| S | Shielding | b | Valve Control Output 0 V | rsv | Reserved |
| RxD | Interface Receive Path | SY | Synchronization | Wire Colors according to DIN IEC 60757 | |
| TxD | Interface Send Path | SY– | Ground for the Synchronization | BK | Black |
| RDY | Ready | E+ | Receiver-Line | BN | Brown |
| GND | Ground | S+ | Emitter-Line | RD | Red |
| CL | Clock | ⏚ | Grounding | OG | Orange |
| E/A | Output/Input programmable | SnR | Switching Distance Reduction | YE | Yellow |
| IO-Link symbol | IO-Link | Rx+/– | Ethernet Receive Path | GN | Green |
| PoE | ower over Ethernet | Tx+/– | Ethernet Send Path | BU | Blue |
| IN | Safety Input | Bus | Interfaces-Bus A(+)/B(–) | VT | Violet |
| OSSD | Safety Output | La | Emitted Light disengageable | GY | Grey |
| Signal | Signal Output | Mag | Magnet activation | WH | White |
| BI_D+/– | Ethernet Gigabit bidirect. data line (A-D) | RES | Input confirmation | PK | Pink |
| EN0 RS422 | Encoder 0-pulse 0/0̄ (TTL) | EDM | Contactor Monitoring | GNYE | Green/Yellow |
| PT | Platinum measuring resistor | ENA | Encoder A/Ā (TTL) | | |

## Table 1

| Working Distance | 40 mm | 160 mm |
|---|---|---|
| Spot Size | 0,5 × 1,2 mm | 1 × 2,5 mm |

## Output Graph




c = Measuring Range
a = Analog Voltage Output

Specifications are subject to change without notice

## Catalog designation

CMP40S/BK/PK/AK0H/SB1
Synchronous servomotors CMP (High Dynamic)

## Product data

| | | |
|---|---|---|
| Rated speed nC | [1/min] : | 3000 |
| Mounting position | : | B5 |
| Base / top coat | : | 9005 Jet black (51390050) |
| Position of connector/terminal box | [°] : | 270 |
| Cable entry/connector position | : | Connector design: adjustable |
| Output shaft | [mm] : | 9x20 |
| Flange diameter | [mm] : | 55 (Square flange) |
| Standstill torque M0 | [Nm] : | 0,50 |
| Duration factor | : | S1-100% |
| Motor voltage | [V] : | 400 |
| Wiring diagram | : | DT11 |
| Static current I0 | [A] : | 1,20 |
| max. permitted current Imax | [A] : | 6,10 |
| Thermal class | : | F |
| Motor protection type | : | IP65 |
| Weight | [kg] : | 1.60 |
| Braking torque | [Nm] : | 1,90 |
| Brake voltage | [V] : | 24= |

### Additional feature

Output shaft: 9x20 mm
Material FKM
Temperature detection PT1000 temperature sensor
Electrical regulation IEC34-1
Degree of protection IP 65
SB1- adjustable right-angle connector (brakemotor) - M23 (1.5 - 4 mm²)
Brake BK permanent magnet brake
AK0H- Absolute angular encoder with Hiperface

## Catalog designation

KA19DRN80M4
Bevel-helical gearmotors K..DRN.. (IE3)

## Product data

| | | |
|---|---|---|
| Rated motor speed | [1/min] | : 1440 |
| Output speed | [1/min] | : 91 |
| Overall gear ratio | | : 15,84 |
| Output torque | [Nm] | : 78 |
| Service factor SEW-FB | | : 1,00 |
| Mounting position | | : M1,M2,M3,M5,M6A |
| Base / top coat | | : 7031 Blue gray (51370310) |
| Position of connector/terminal box | [°] | : 0 |
| Cable entry/connector position | | : X |
| Hollow shaft | [mm] | : 20 |
| Permitted output overhung load with n=1400 | [N] | : 3950 |
| Lubricant quantity 1st gear unit | [Liter] | : 0,4 |
| Motor power | [kW] | : 0,75 |
| Duration factor | | : S1-100% |
| Efficiency class | | : IE3 |
| Efficiency (50/75/100% Pn) | [%] | : 80,7 / 82,9 / 82,9 |
| CE mark | | : Yes |
| Motor voltage | [V] | : 230/400 |
| Wiring diagram | | : R13 |
| Frequency | [Hz] | : 50 |
| Rated current | [A] | : 3,05 / 1,75 |
| Cos Phi | | : 0,74 |
| Thermal class | | : 130(B) |
| Motor protection type | | : IP54 |
| Design requirement | | : Europe (CE) |
| Mass moments of inertia (referring to the input side) | [$10^{4}$ kgm$^2$] | : 25,00 |
| Weight | [kg] | : 18.00 |

### Additional feature

Lubricant: CLP PG 460 (-20 / +60 °C): 0,4 Liter

Product data sheet


# WTB4FP-22161220A00

W4F

MINIATURE PHOTOELECTRIC SENSORS

SICK

Sensor Intelligence.


Illustration may differ

## Ordering information

| Type | Part no. |
|---|---|
| WTB4FP-22161220A00 | 1113724 |

Other models and accessories → www.sick.com/W4F

## Detailed technical data

### Features

| | |
|---|---|
| **Functional principle** | Photoelectric proximity sensor |
| **Functional principle detail** | Background suppression, NarrowBeam |
| **Sensing range** | |
| Sensing range min. | 4 mm |
| Sensing range max. | 100 mm |
| Adjustable switching threshold for background suppression | 15 mm ... 100 mm |
| Reference object | Object with 90% remission (complies with standard white according to DIN 5033) |
| Minimum distance between set sensing range and background (black 6%/ white 90%) | 0.5 mm (at a distance of 40 mm) |
| Recommended sensing range for the best performance | 30 mm ... 60 mm |
| **Emitted beam** | |
| Light source | PinPoint LED |
| Type of light | Visible red light |
| Shape of light spot | Point-shaped |
| Light spot size (distance) | Ø2 mm (50 mm) |
| Maximum dispersion of the emitted beam around the standardized transmission axis (squint angle) | < +/- 1.5° (at Ta = +23 °C) |
| **Key LED figures** | |
| Normative reference | EN 62471:2008-09 \| IEC 62471:2006, modified |

| | |
|---|---|
| LED risk group marking | Free group |
| Wave length | 635 nm |
| Average service life | 100,000 h at $T_a$ = +25 °C |
| **Smallest detectable object (MDO) typ.** | 0.1 mm, At 50 mm distance (object with 90% remission (complies with standard white according to DIN 5033)) |
| **Adjustment** | |
| Teach-Turn adjustment | BluePilot: For setting the sensing range |
| IO-Link | For configuring the sensor parameters and Smart Task functions |
| **Indication** | |
| LED blue | BluePilot: sensing range indicator |
| LED green | Operating indicator<br>Static on: power on<br>Flashing: IO-Link mode |
| LED yellow | Status of received light beam<br>Static on: object present<br>Static off: object not present |
| **Special applications** | Detecting flat objects, Detecting small objects |

## Safety-related parameters

| | |
|---|---|
| **$MTTF_D$** | 642 years |
| **$DC_{avg}$** | 0 % |
| **$T_M$ (mission time)** | 20 years (EN ISO 13849)<br>Rate of use: 60 % |

## Communication interface

| | |
|---|---|
| **IO-Link** | ✓, IO-Link V1.1 |
| Data transmission rate | COM2 (38,4 kBaud) |
| Cycle time | 2.3 ms |
| Process data length | 16 Bit |
| Process data structure | Bit 0 = switching signal $Q_{L1}$<br>Bit 1 = switching signal $Q_{L2}$<br>Bit 2 ... 15 = Current receiver level (live) |
| VendorID | 26 |
| DeviceID HEX | 0x80024D |
| DeviceID DEC | 8389197 |
| Compatible master port type | A |
| SIO mode support | Yes |

## Electrical data

| | |
|---|---|
| **Supply voltage $U_B$** | 10 V DC ... 30 V DC [1] |
| **Ripple** | ≤ 5 $V_{pp}$ |
| **Use category (according to EN 60947-5-2)** | DC-12, DC-13 |
| **Current consumption** | ≤ 25 mA, without load. At $U_B$ = 24 V |
| **Protection class** | III |
| **Digital output** | |

[1] Limit values.
[2] Signal transit time with resistive load in switching mode.
[3] With light/dark ratio 1:1.

| | |
|---|---|
| Number | 2 (Complementary) |
| Type | Push-pull: PNP/NPN |
| Signal voltage PNP HIGH/LOW | Approx. $U_B$-2.5 V / 0 V |
| Signal voltage NPN HIGH/LOW | Approx. $U_B$ / < 2.5 V |
| Output current $I_{max.}$ | ≤ 100 mA |
| Circuit protection outputs | Reverse polarity protected<br>Overcurrent protected<br>Short-circuit protected |
| Response time | ≤ 500 µs [2] |
| Repeatability (response time) | 150 µs |
| Switching frequency | 1,000 Hz [3] |
| **Pin/Wire assignment** | |
| Function of pin 4/black (BK) | Digital output, light switching, object present → output $Q_{L1}$ HIGH; IO-Link communication C |
| Function of pin 4/black (BK) – detail | The pin 4 function of the sensor can be configured, Additional possible settings via IO-Link |
| Function of pin 2/white (WH) | Digital output, dark switching, object present → output $\bar{Q}_{L1}$ LOW |
| Function of pin 2/white (WH) – detail | The pin 2 function of the sensor can be configured, Additional possible settings via IO-Link |

[1] Limit values.
[2] Signal transit time with resistive load in switching mode.
[3] With light/dark ratio 1:1.

## Mechanical data

| | |
|---|---|
| **Housing** | Rectangular |
| **Dimensions (W x H x D)** | 16 mm x 40.1 mm x 12.1 mm |
| **Connection** | Male connector M8, 4-pin |
| **Material** | |
| Housing | Plastic, VISTAL® |
| Front screen | Plastic, PMMA |
| Male connector | Plastic, VISTAL® |
| **LABS-free** | Yes (VDMA 24364-A1-L) |
| **Weight** | Approx. 30 g |
| **Maximum tightening torque of the fixing screws** | 0.4 Nm |

## Ambient data

| | |
|---|---|
| **Enclosure rating** | IP66 (EN 60529)<br>IP67 (EN 60529) |
| **Ambient operating temperature** | –40 °C ... +60 °C |
| **Ambient temperature, storage** | –40 °C ... +75 °C |
| **Typ. Ambient light immunity** | Artificial light: ≤ 50,000 lx<br>Sunlight: ≤ 50,000 lx |
| **Shock resistance** | 30 g, 11 ms (3 positive and 3 negative shocks along X, Y, Z axes, 18 total shocks (EN60068-2-27)) |
| **Vibration resistance** | 10 Hz ... 1,000 Hz (Amplitude 1 mm, 3 x 30 min (EN60068-2-6)) |
| **Air humidity** | 35 % ... 95 %, relative humidity (no condensation) |
| **Electromagnetic compatibility (EMC)** | EN 60947-5-2 |
| **Resistance to cleaning agent** | ECOLAB |

| | |
|---|---|
| **UL File No.** | NRKH.E181493 & NRKH7.E181493 |

## Smart Task

| | |
|---|---|
| **Smart Task name** | Base logics |
| **Logic function** | Direct<br>AND<br>OR |
| **Timer function** | Deactivated<br>On delay<br>Off delay<br>ON and OFF delay<br>Impulse (one shot) |
| **Inverter** | Yes |
| **Switching frequency** | SIO Logic: 900 Hz [1)]<br>IOL: 800 Hz [2)] |
| **Response time** | SIO Logic: 550 µs [1)]<br>IOL: 600 µs [2)] |
| **Repeatability** | SIO Logic: 200 µs [1)]<br>IOL: 250 µs [2)] |
| **Switching signal** | |
| Switching signal $Q_{L1}$ | Switching output |
| Switching signal $\bar{Q}_{L1}$ | Switching output |

1) Use of Smart Task functions without IO-Link communication (SIO mode).
2) Use of Smart Task functions with IO-Link communication function.

## Diagnosis

| | |
|---|---|
| **Device temperature** | |
| Measuring range | Very cold, cold, moderate, warm, hot |
| **Device status** | Yes |
| **Detailed device status** | Yes |
| **Operating hour counter** | Yes |
| **Operating hours counter with reset function** | Yes |
| **Quality of teach** | Yes |

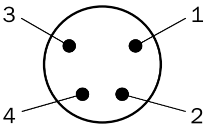
## Classifications

| | |
|---|---|
| **ECl@ss 5.0** | 27270904 |
| **ECl@ss 5.1.4** | 27270904 |
| **ECl@ss 6.0** | 27270904 |
| **ECl@ss 6.2** | 27270904 |
| **ECl@ss 7.0** | 27270904 |
| **ECl@ss 8.0** | 27270904 |
| **ECl@ss 8.1** | 27270904 |
| **ECl@ss 9.0** | 27270904 |
| **ECl@ss 10.0** | 27270904 |
| **ECl@ss 11.0** | 27270904 |
| **ETIM 5.0** | EC002719 |
| **ETIM 6.0** | EC002719 |

| | |
|---|---|
| **ETIM 7.0** | EC002719 |
| **ETIM 8.0** | EC002719 |
| **UNSPSC 16.0901** | 39121528 |

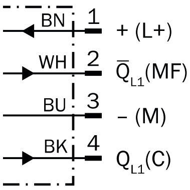
## Connection type

Male connector M8, 4-pin



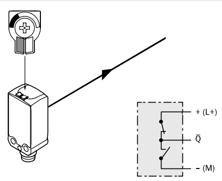
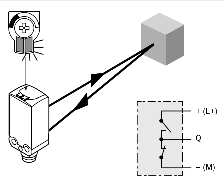

## Connection diagram

Cd-490



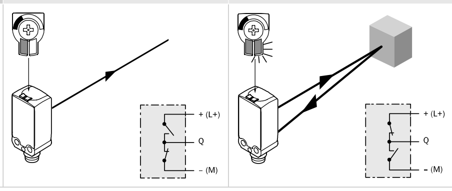

## Truth table

Push-pull: PNP/NPN – dark switching Q̄

| | Dark switching Q̄ (normally closed (upper switch), normally open (lower switch)) | |
|---|---|---|
| | Object not present → Output HIGH | Object present → Output LOW |
| Light receive | ✗ | ✓ |
| Light receive indicator | ✗ | ● |
| Load resistance to L+ | ✗ | ⚠ |
| Load resistance to M | ⚠ | ✗ |
| |  |  |

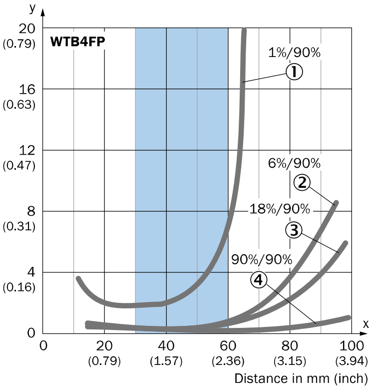
Push-pull: PNP/NPN - light switching Q

| | Light switching Q (normally open (upper switch), normally closed (lower switch)) | |
|---|---|---|
| | Object not present ➜ Output LOW | Object present ➜ Output HIGH |
| Light receive | ⊗ | ✓ |
| Light receive indicator | ⊗ | ☀ |
| Load resistance to L+ | ⚠ | ⊗ |
| Load resistance to M | ⊗ | ⚠ |

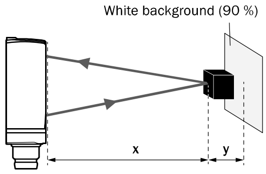



## Characteristic curve

Minimum distance in mm (y) between the set sensing range and white background (90 % remission)




Example:
Safe suppression of the background



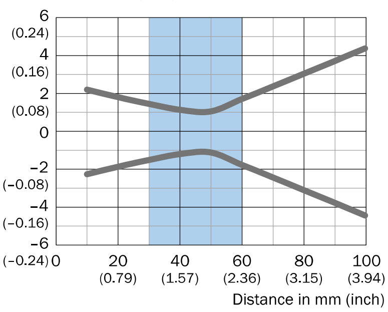

Black object (6 % remission)
Set sensing range x = 40 mm
Needed minimum distance to white background y = 0.5 mm

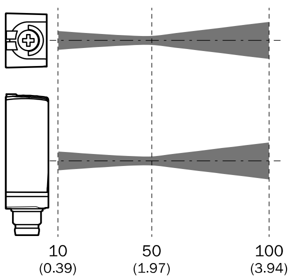
Recommended sensing range for the best performance

① Ultra black object, 1% remission
② Black object, 6% remission
③ Gray object, 18 % remission
④ White object, 90% remission

## Light spot size

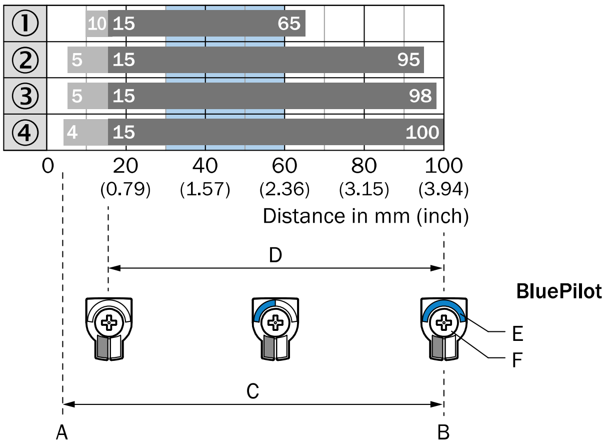
Dimensions in mm (inch)




Recommended sensing range for the best performance

## Sensing range diagram



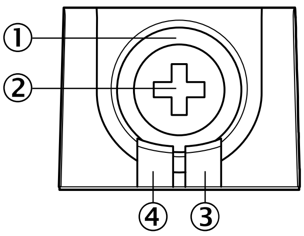

A = Sensing range min. in mm
B = Sensing range max. in mm
C = Viewing range
D = Adjustable switching threshold for background suppression
E = Sensing range indicator
F = Teach-Turn adjustment

Recommended sensing range for the best performance

① Ultra black object, 1% remission
② Black object, 6% remission
③ Gray object, 18 % remission
④ White object, 90% remission

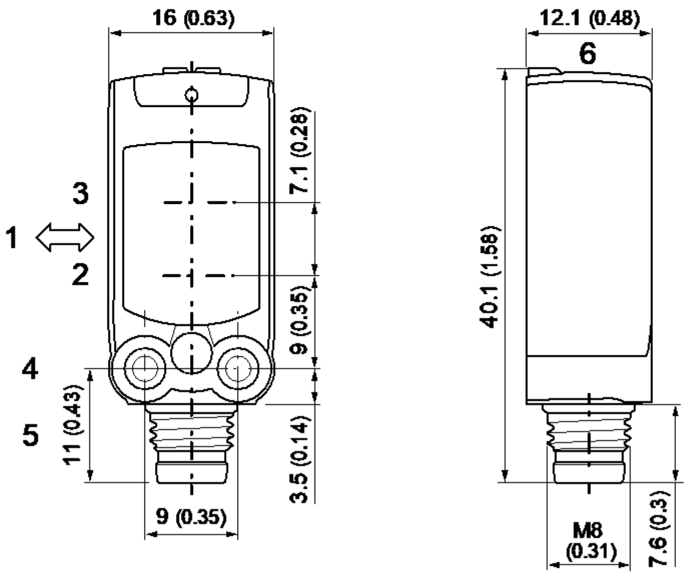
## Adjustments

Display and adjustment elements




① LED blue
② Teach-Turn adjustment
③ LED yellow
④ LED green

## Dimensional drawing (Dimensions in mm (inch))




① Standard direction of the material being detected
② Center of optical axis, sender
③ Center of optical axis, receiver
④ M3 mounting hole
⑤ Connection
⑥ Display and adjustment elements

## Recommended accessories

Other models and accessories → www.sick.com/W4F

| | Brief description | Type | Part no. |
|---|---|---|---|
| Mounting brackets and plates | | | |
|  | Mounting bracket for wall mounting, Stainless steel 1.4571, mounting hardware included | BEF-W4-A | 2051628 |
| Plug connectors and cables | | | |
|  | Head A: male connector, M8, 4-pin, straight<br>Cable: unshielded | STE-0804-G | 6037323 |

# SICK AT A GLANCE

SICK is one of the leading manufacturers of intelligent sensors and sensor solutions for industrial applications. A unique range of products and services creates the perfect basis for controlling processes securely and efficiently, protecting individuals from accidents and preventing damage to the environment.

We have extensive experience in a wide range of industries and understand their processes and requirements. With intelligent sensors, we can deliver exactly what our customers need. In application centers in Europe, Asia and North America, system solutions are tested and optimized in accordance with customer specifications. All this makes us a reliable supplier and development partner.

Comprehensive services complete our offering: SICK LifeTime Services provide support throughout the machine life cycle and ensure safety and productivity.

**For us, that is "Sensor Intelligence."**

# WORLDWIDE PRESENCE:

Contacts and other locations www.sick.com

SICK
Sensor Intelligence.


SICK AG | Waldkirch | Germany | www.sick.com


Product family overview
W4F
The high-flyers in intelligent automation
SICK
Sensor Intelligence.
PHOTOELECTRIC SENSORS

Advantages

## Reliable alignment in seconds with BluePilot

**With the intuitive "BluePilot" operating concept, sensors of the W4F product family can be aligned particularly conveniently and precisely. The blue LED display gives the user direct feedback for optimal alignment. The photoelectric sensors can be precisely adjusted in a very short time via a push-turn mechanism. In addition, BluePilot provides a visual indication if the detection quality should drop due to contamination or vibration, allowing faults to be corrected early on and preventing unplanned system downtime.**

With a combination of teach pushbutton and potentiometer, correct adjustment is easier than ever before.

The blue LED alignment aid accelerates optimal alignment of the sensor, and changes in operational safety are visible at a glance with BluePilot.

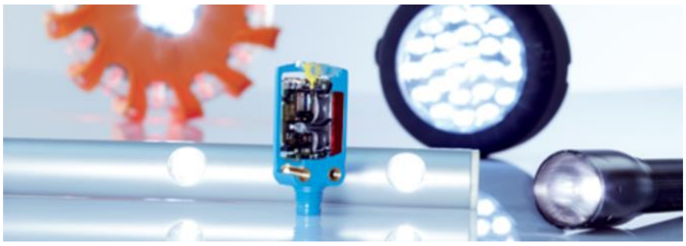
The mode setting can easily be read directly off the device via BluePilot.

**The "BluePilot" operating concept significantly speeds up calibration of the W4F while minimizing the risk of faults and failures during operation.**

## Outstanding detection results in almost any application

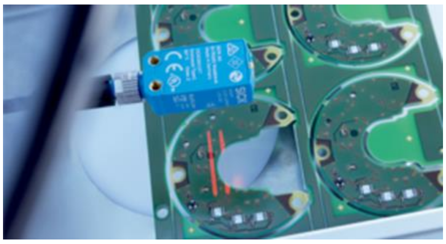
**Whether with particularly flat, highly reflective, perforated or transparent objects: The W4F offers a wide range of technologies to ensure reliable detection results in the most diverse applications. For example, with the coordinated optical concept of the V-optics, which reliably detects transparent objects such as glass panes or highly reflective objects such as displays. With highly reflective and at the same time very flat objects such as chocolate bars, cookies or assemblies, the photoelectric proximity sensor with ForegroundSuppression can really show off its capabilities. And last but not least, the DoubleLine technology can also reliably detect objects with uneven surfaces and recesses such as printed circuit boards. In addition, the new MultiSwitch photoelectric proximity sensor extends the range of possible applications. For example, the two switching points can be used to monitor assembly processes or to check levels and roll diameters using distance value output via IO-Link.**

In applications where reflectors used to be necessary, the W4F manages on its own thanks to the use of surface reflections from objects, thus taking up significantly less installation space.



The W4F always delivers precise detection results, even with various optical disturbances such as LED lamps and reflections from metal struts in the background.

Thanks to the two different switching points, the WTB4F MultiSwitch can distinguish between standing and lying objects.



The WTB4B photoelectric proximity sensor with DoubleLine technology can easily detect printed circuit boards with cut-outs without gaps.

Thanks to two LEDs and powerful foreground suppression, the WTV4F, like V-optics, is able to reliably detect very flat objects.

**With its Optical Experts, the W4F covers a wide range of challenging applications and, thanks to its compact design, it fits easily into most installation situations.**

## Rugged design for demanding ambient conditions

**Sturdy as steel, light as plastic: The smart interior of the W4F photoelectric sensors is protected by an ultra-rugged housing made of VISTAL®. This is made of fiberglass-reinforced plastic and thus easily withstands extreme thermal, chemical or mechanical loads. In combination with its small dimensions, the sensor is optimally suited for use in automation applications of all kinds.**

Thanks to the ultra-rugged VISTAL® housing, the sensor operates safely and reliably even under harsh ambient conditions.

**Whether dirt, heat or vibrations: The W4F is designed to deliver precise results even under tough conditions thanks to VISTAL® and rugged sensor technology.**


## Keeping full control

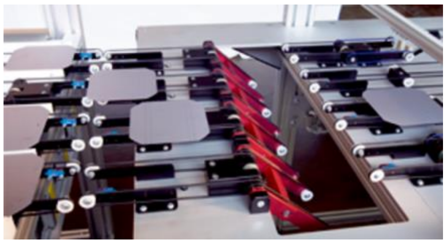
**Thanks to extensive diagnostic functions, the system knows at all times what state the W4F is in and can thus detect a critical drop in performance in advance. In addition, the sensor family features automatic self-monitoring and reports indepen-**

**dently as soon as process parameters such as temperature or degree of contamination deviate too much. Should a sensor still fail, the extensive diagnostic data enables rapid identification of the cause and elimination of the problem.**


At critical temperatures, the W4F can automatically initiate maintenance, thus preventing failures.

The possibility of foresighted and demand-oriented device and system maintenance minimizes failure risks.

Positioning tasks can be performed via the output of distance values.



The output of remission values of the objects to be detected form the basis for intelligent process control or quality monitoring.

**Thanks to extensive monitoring and diagnostic functions, the W4F enables predictive and demand-oriented maintenance, thus minimizing unplanned downtime and costs.**

## Technical data overview

| | |
|---|---|
| **Dimensions (W x H x D)** | 16 mm x 40.1 mm x 12.1 mm |
| **Light source** | PinPoint LED |
| **Type of light** | Visible red light / Infrared light (depending on type) |
| **Enclosure rating** | IP66 (EN 60529)<br>IP67 (EN 60529)<br>IP69 (EN 60529) |
| **Housing material** | Plastic VISTAL® |

## Product description

With the W4F, high performance and smart automation are now also available in a miniature size. The miniature sensor is the perfect complement to the product range of a new generation of opto-electronic sensors such as the W16 and W26 and, thanks to the new ASIC technology from SICK, consistently delivers extremely reliable detection results. This allows for versatile use in a wide range of challenging installation situations. Thanks to ForegroundSuppression, DoubleLine, V-optics and MultiSwitch, the W4F is a high-performance application specialist: Background suppression is improved, and flat, highly-reflective and transparent objects are detected even more precisely. In addition, the W4F as Smart Sensors make monitoring and diagnostics easier than ever before and enable future-proof use in I4.0 plants.

## At a glance

- Technologies: ForegroundSuppression, DoubleLine, V-optics and MultiSwitch
- Two switching points and distance value output in one device
- Diffuse sender LED for ambient light suppression
- BluePilot: Teach-Turn adjustment with optical sensing range and alignment aid
- Smart Sensor: Latest diagnostics and monitoring functions
- VISTAL® housing

## Your benefits

- Solution for particularly challenging detection tasks in tight installation spaces
- Very high reliability through powerful background suppression and excellent detection of flat, highly-reflective and transparent objects
- Two switching points as well as the output of distance values expand the application possibilities
- Flexible use thanks to high optical reliability
- The highly-visible light spot combined with the intuitive BluePilot operating interface enables set-up in mere seconds
- Maximum monitoring and process reliability thanks to intelligent monitoring and predictive maintenance
- As Smart Sensors, fit for Industry 4.0

## Ordering information

- **Sensing range min. / max.:** 4 mm / 220 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Detection principle | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|
| Background suppression | Cable with M12 male connector, 4-pin, 182 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | | |
| | Cable with M8 male connector, 4-pin, 110 mm | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| Detection principle | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|
| | Cable with connector M8, 3-pin, 110 mm | For setting the sensing range | | |
| | | | | |
| | Cable with connector M8, 3-pin, with knurled nuts, 340 mm | For setting the sensing range | | |
| | Cable, 3-wire, 2 m | For setting the sensing range | | |
| | | | | |
| | Cable, 3-wire, 5 m | For setting the sensing range | | |
| | Cable, 4-wire, 2 m | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | | |
| | | | | |
| | Cable, 4-wire, 5 m | | | |
| | | | | |
| | Connector M8, 3-pin | For setting the sensing range | | |
| | | | | |
| | Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Background suppression, MultiPulse | Cable with connector M8, 3-pin, with knurled nuts, 338 mm | For setting the sensing range | | |
| | Connector M8, 3-pin | For setting the sensing range | | |
| Background suppression, MultiSwitch | Cable with M8 male connector, 4-pin, 110 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | Cable, 4-wire, 2 m | | | |
| | Male connector M8, 4-pin | | | |
| | | | | |

- **Sensing range min. / max.:** 4 mm / 100 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Detection principle | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|
| Background suppression | Male connector M8, 4-pin | For configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | – | [redacted] | [redacted] |
| Background suppression, MultiSwitch, NarrowBeam | Cable with M8 male connector, 4-pin, 110 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | Cable, 4-wire, 2 m | | [redacted] | [redacted] |
| | Male connector M8, 4-pin | | [redacted] | [redacted] |
| | | | [redacted] | [redacted] |
| Background suppression, NarrowBeam | Cable with M8 male connector, 4-pin, 110 mm | | [redacted] | [redacted] |
| | Cable with connector M8, 3-pin, 110 mm | For setting the sensing range | [redacted] | [redacted] |
| | Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |

- **Sensing range min. / max.:** 4 mm / 200 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |

- **Sensing range min. / max.:** 4 mm / 48 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Cable with connector M8, 3-pin, 110 mm | – | [redacted] | [redacted] |

- **Sensing range min. / max.:** 4 mm / 47 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Cable with connector M8, 3-pin, 110 mm | – | [redacted] | [redacted] |

- **Sensing range min. / max.:** 6 mm / 250 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** Infrared light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M8 male connector, 4-pin, 110 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Cable with connector M8, 3-pin, 110 mm | For setting the sensing range | [redacted] | [redacted] |
| Cable with connector M8, 4-pin, with knurled nuts, 220 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| Cable, 3-wire, 2 m | For setting the sensing range | [redacted] | [redacted] |
| Cable, 4-wire, 2 m | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| Connector M8, 3-pin | For setting the sensing range | [redacted] | [redacted] |
| Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |

- **Sensing range min. / max.:** 7 mm / 150 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Detection principle | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|
| Background suppression, LineSpot technology | Cable with M8 male connector, 4-pin, 110 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | Male connector M8, 4-pin | | [redacted] | [redacted] |
| Background suppression, MultiPulse, LineSpot technology | Cable with connector M8, 3-pin, with knurled nuts, 338 mm | For setting the sensing range | [redacted] | [redacted] |

- **Sensing range min. / max.:** 7 mm / 120 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, DoubleLine
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M8 male connector, 4-pin, 110 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| Cable with connector M8, 3-pin, 110 mm | For setting the sensing range | | |
| | | | |
| Cable with connector M8, 4-pin, with knurled nuts, 115 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| Cable, 3-wire, 2 m | For setting the sensing range | | |
| | | | |
| Cable, 4-wire, 2 m | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | |
| Connector M8, 3-pin | For setting the sensing range | | |
| | | | |
| Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |

- **Sensing range min. / max.:** 4 mm / 56 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, NarrowBeam
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Connector M8, 3-pin | – | | |

- **Sensing range min. / max.:** 28 mm / 165 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, MultiPulse
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light
- **Setting Method:** –

| Connection type | Type | Part no. |
|---|---|---|
| Cable with connector M8, 3-pin, with knurled nuts, 318 mm | | |
| Connector M8, 3-pin | | |
| | | |

- **Sensing range min. / max.:** 3 mm / 25 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, MultiPulse
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Connector M8, 3-pin | – | | |

- **Sensing range min. / max.:** 2 mm / 50 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, V-optics
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M12 male connector, 4-pin, 182 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | |
| Cable with M8 male connector, 4-pin, 110 mm | | | |
| Cable with connector M8, 3-pin, 110 mm | For setting the sensing range | | |
| Cable with connector M8, 3-pin, with knurled nuts, 115 mm | For setting the sensing range | | |
| Cable with connector M8, 3-pin, with knurled nuts, 340 mm | For setting the sensing range | | |
| Cable, 3-wire, 2 m | For setting the sensing range | | |
| | | | |
| Cable, 4-wire, 2 m | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | |
| Connector M8, 3-pin | For setting the sensing range | | |
| | | | |
| Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | | |
| | | | |
| | For configuring the sensor parameters and Smart Task functions | | |

- **Sensing range min. / max.:** 4 mm / 22 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, V-optics
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Cable, 3-wire, 3 m | – | [redacted] | [redacted] |

- **Sensing range min. / max.:** 2 mm / 22 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Background suppression, V-optics
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Connector M8, 3-pin | – | [redacted] | [redacted] |

- **Sensing range min. / max.:** 0 mm / 100 mm
- **Sensor principle:** Photoelectric proximity sensor
- **Detection principle:** Foreground suppression
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M8 male connector, 4-pin, 110 mm | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Cable with connector M8, 3-pin, 110 mm | For setting the sensing range | [redacted] | [redacted] |
| Cable, 3-wire, 2 m | For setting the sensing range | [redacted] | [redacted] |
| Cable, 4-wire, 2 m | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Connector M8, 3-pin | For setting the sensing range | [redacted] | [redacted] |
| Male connector M8, 4-pin | For setting the sensing range, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | [redacted] | [redacted] |

- **Sensing range min. / max.:** 0 m / 4.5 m
- **Sensor principle:** Photoelectric retro-reflective sensor
- **Detection principle:** With minimum distance to reflector (dual lens system)
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M12 male connector, 4-pin, 182 mm | – | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Cable with M8 male connector, 4-pin, 110 mm | For sensitivity adjustment, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| Cable with connector M8, 3-pin, 110 mm | For sensitivity adjustment | [redacted] | [redacted] |
| | – | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Cable, 3-wire, 2 m | For sensitivity adjustment | [redacted] | [redacted] |
| | – | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Cable, 3-wire, 5 m | – | [redacted] | [redacted] |
| Cable, 4-wire, 2 m | For sensitivity adjustment, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Connector M8, 3-pin | – | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Male connector M8, 4-pin | For sensitivity adjustment, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | – | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Male connector M8, 4-pin, 110 mm | – | [redacted] | [redacted] |

- **Sensing range min. / max.:** 0 mm / 4.5 m
- **Sensor principle:** Photoelectric retro-reflective sensor
- **Detection principle:** With minimum distance to reflector (dual lens system)
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M12 male connector, 4-pin, 182 mm | For sensitivity adjustment, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| Connector M8, 3-pin | For sensitivity adjustment | [redacted] | [redacted] |
| Male connector M8, 4-pin | For sensitivity adjustment, for configuring the sensor parameters and Smart Task functions | [redacted] | [redacted] |
| | | | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |

- **Sensing range min. / max.:** 15 mm / 4.5 m
- **Sensor principle:** Photoelectric retro-reflective sensor
- **Detection principle:** With minimum distance to reflector (dual lens system)
- **Switching output:** push-pull: PNP/NPN

| Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|
| PinPoint LED | Visible red light | Connector M8, 3-pin | For sensitivi-ty adjustment | [redacted] | [redacted] |

- **Sensing range min. / max.:** 0 m / 10 m
- **Sensor principle:** Through-beam photoelectric sensor
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable with M12 male connector, 4-pin, 182 mm | For configuring the sensor parameters and Smart Task functions, For deactivation of the sender and execution of test logic | [redacted] | [redacted] |
| Cable with M8 male connector, 4-pin, 110 mm | | [redacted] | [redacted] |
| Cable with connector M8, 3-pin, 110 mm | For deactivation of the sender and execution of test logic | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| Cable, 3-wire, 2 m | | [redacted] | [redacted] |
| | | [redacted] | [redacted] |

| Connection type | Setting Method | Type | Part no. |
|---|---|---|---|
| Cable, 3-wire, 5 m | | | |
| Cable, 4-wire, 2 m | For configuring the sensor parameters and Smart Task functions, For deactivation of the sender and execution of test logic | | |
| Connector M8, 3-pin | For deactivation of the sender and execution of test logic | | |
| | | | |
| Male connector M8, 4-pin | For configuring the sensor parameters and Smart Task functions, For deactivation of the sender and execution of test logic | | |

- **Sensing range min. / max.:** 0 m / 1.5 m
- **Sensor principle:** Through-beam photoelectric sensor

| Switching output | Light source | Type of light | Connection type | Setting Method | Type | Part no. |
|---|---|---|---|---|---|---|
| Push-pull: PNP/NPN | PinPoint LED | Visible red light | Connector M8, 3-pin | For deactivation of the sender and execution of test logic | | |

- **Sensing range min. / max.:** 0 m / 2 m
- **Sensor principle:** Through-beam photoelectric sensor
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** visible red light
- **Setting Method:** For deactivation of the sender and execution of test logic

| Connection type | Type | Part no. |
|---|---|---|
| Cable with connector M8, 3-pin, 110 mm | | |
| | | |
| Connector M8, 3-pin | | |

- **Sensing range min. / max.:** 0 m / 10 m
- **Sensor principle:** Photoelectric retro-reflective sensor
- **Detection principle:** With minimum distance to reflector (dual lens system)
- **Switching output:** push-pull: PNP/NPN
- **Light source:** PinPoint LED
- **Type of light:** Infrared light
- **Setting Method:** –

| Connection type | Type | Part no. |
|---|---|---|
| Cable with connector M8, 3-pin, 338 m | | |
| Cable, 3-wire, 2 m | | |

# SICK AT A GLANCE

SICK is one of the leading manufacturers of intelligent sensors and sensor solutions for industrial applications. A unique range of products and services creates the perfect basis for controlling processes securely and efficiently, protecting individuals from accidents and preventing damage to the environment.

We have extensive experience in a wide range of industries and understand their processes and requirements. With intelligent sensors, we can deliver exactly what our customers need. In application centers in Europe, Asia and North America, system solutions are tested and optimized in accordance with customer specifications. All this makes us a reliable supplier and development partner.

Comprehensive services complete our offering: SICK LifeTime Services provide support throughout the machine life cycle and ensure safety and productivity.

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