# SICK AG WHITEPAPER

## safeHDDM® – THE NEW SCANNING TECHNOLOGY FOR SAFETY LASER SCANNERS

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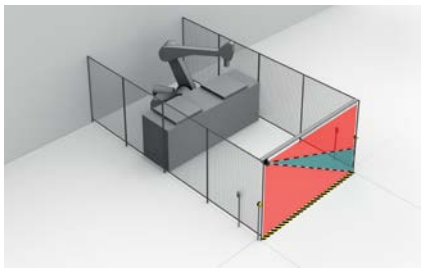
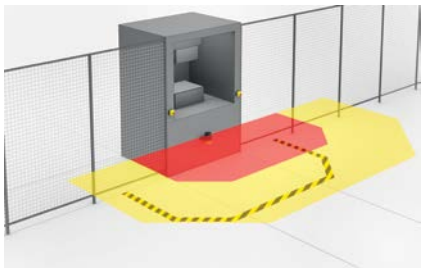
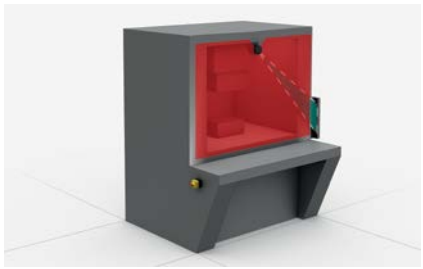
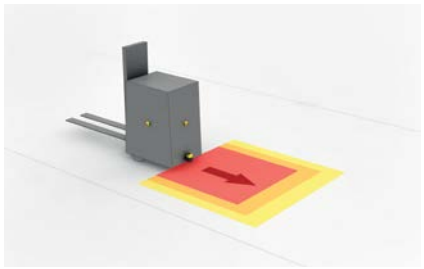
## Introduction: safety laser scanners in industrial automation

Safety laser scanners that meet performance level d according to EN ISO 13849 and SIL2 according to IEC 61508 are used in stationary and mobile applications for the non-contact, two-dimensional monitoring of hazardous points and areas, and access points. There is a range of variants in various sizes and with different protective field ranges, scanning angles, evaluation scenarios, and integration options. Safety laser scanners trigger a machine or vehicle to stop as soon as they detect a person, body part, or another obstacle inside the protective field. This prevents people from being put at risk as a result of dangerous machine movements.

We are currently seeing a change in technology in active scanning safety laser scanners: the previous principle of operation is based on the time-of-flight measurement with a limited number of individual pulses and analog distance evaluation. New safeHDDM® scanning technology (safe High Definition Distance Measurement) is a high-resolution, digital process for safety-related time and distance measurement. The future-proof measurement procedure provides a significantly improved optical ruggedness against influences such as ambient light and dust, and makes previously unattained availability possible in difficult application conditions.

Safety laser scanners are highly versatile and open up a diverse range of application possibilities. Mounted horizontally or vertically in a stationary position, they monitor hazardous points and areas, as well as access points to machines, and detect if persons reach or enter into these spaces. In mobile applications, they secure automated guided vehicle routes.

Safety laser scanners have proven to be reliable, electro-sensitive protective devices used in thousands of industrial applications for more than 20 years. However, previous time-of-flight measurement processes with analog signal evaluation reach their limitations in harsh ambient conditions. High-resolution, digital safeHDDM® technology provides the answer to this problem. The process developed and patented by SICK has been in use in the new generation of microScan3 safety laser scanners since the beginning of 2016.

## Scanning technology: previous standard of technology

**Time-of-flight measurement with analog signal evaluation**
Safety laser scanners are based on an active scanning principle of operation. A laser beam deflected by a rotating mirror is emitted and the remission of the light reflecting off the surface of an object is detected. In this type of measurement, scanners must also be able to reliably detect objects with a remission of just 1.8%, such as black material for pants. Even special scenarios, such as a leg in black pants in front of a reflector, must not impair the safety function.

The distance to the object is calculated using the time-of-flight measurement method. The time between the emission and reception of the laser pulse is proportional to the distance between the laser scanner and the object or person detected. In the previous time-of-flight measurement procedure, the signal is evaluated using analog electronics. The measuring frequency is around 500 pulses per scan at constant angle intervals, whereby each pulse generates a measured value.

**Fundamental advantages**
The safety laser scanners' active scanning principle, time-of-flight measurement, and evaluation procedure provide a multitude of fundamental advantages in practical applications compared to other protective devices: senders and receivers are located in the same housing; objects are detected directly; no need for reflectors. As a result, the safety laser scanner is simple to install and align. The scanners can monitor areas of varying sizes within a two-dimensional level. Inside a monitored area, warning and protective fields can generally be freely defined, toggled between during operation, and redesigned at any time if fundamental boundary conditions change. Depending on their design and connectivity, laser scanners can be integrated into stationary and mobile machines in a very space-saving and efficient manner.


**Application and availability restrictions**
The application of a safety laser scanner with simple time-of-flight measurement has a decisive impact on its availability. When operating these opto-electronic measurement systems, foreign and ambient light influences can cause dazzle. The remission of a person or obstacle detectable in such cases would disappear in the optical noise of the backlighting. In this case, the sensors generate an emergency stop signal. This brings the machine or vehicle to a stop even if no people or obstacles have been detected. To prevent dazzle – i.e., to achieve a greater signal-to-noise ratio – the laser output would need to be significantly increased. This is generally not easily possible in terms of both the availability of corresponding devices and compliance with laser protection provisions.

Dust particles in the air that build up over time on the front screen of the sensors can also impair the availability of the safety laser scanners. To reliably pick up black clothing material, for example, the measuring systems have to be very sensitive. At the same time, these systems should, however, ignore the remissions of dust particles. The higher the dust concentration in the air, the less capable the analog evaluation becomes to make such distinctions. This results in an emergency stop signal even if the safety laser scanner has not detected a person or obstacle.

Another scenario that can negatively impact availability is if multiple safety laser scanners are operating in the same space at the same time. In such applications, sensors are generally unable to discern whether a remission has been generated by its "own" send pulse or by the infrared laser light source of a different scanner nearby. This can lead to an unintended emergency stop signal.

Whether the issue was dazzle, dust, contamination of the front screen, or mutual interference, any stop that can be traced back to these factors impairs machine or vehicle productivity, causes troubleshooting work, and makes the user less confident in the reliability of safety technology. This is where the high-resolution, digital safeHDDM® scanning technology comes into play.

## safeHDDM®: the new, patented, and certified detection and evaluation technology

**Safety-related, high-resolution multi-pulse procedure**
safeHDDM® technology is the safety-related further development of the HDDM procedure that is tried and tested in the field of laser measurement technology. It is based on the time-of-flight measurement of laser pulses; however, in terms of technology, it is significantly different to the detection and evaluation technologies used in safety laser scanners up to now. The multi-pulse concept of safeHDDM® generates approx. 80,000 individual pulses in each scan – compared to the approx. 500 generated with conventional technology. Every single safeHDDM® measured value output therefore provides even more information because it is not just composed of a single time-of-flight measurement, but now includes evaluated information from lots of defined pulses. In this process, the digitized echoes are compiled into data packages and evaluated. This guarantees a significantly more stable time and distance measurement.

**Accumulating digitized measured values into a signal histogram**
A key aspect of the safeHDDM® safety technology is the bundling of small, digitized remission values for distance measurement. These are collected and accumulated in a histogram. Only signals above a significant threshold are considered during the accumulation of the histogram. Furthermore, digital filters in the histogram analyze the signal form and amplitude. As a result, safeHDDM® is able to reliably detect even predefined minimum remission values of 1.8% without them being masked by interference signals.

**Time-coded laser pulses**
In safeHDDM®, the pulse frequency is not only nearly 170 times greater in relation to previous measurement procedures, the laser pulses themselves are also coded by a time delay of a few nanoseconds. The sequence is not specific to every scanner; it is generated on a constant basis by an integrated random generator. The measurement technology only considers sequences in phase in the histogram. Although deviating individual pulses are detected, they disappear in the background noise during accumulation.

## Practical benefits of the new scanning technology

**More stable measured values for increased detection reliability**
As the number of laser pulses per scan is much greater in safeHDDM® than in conventional time-of-flight measurement, there is more scan data for calculating measured values. This and the evaluation of multiple digitized data packages result in extremely stable measured values that are based on multiple evaluated pulses in safeHDDM® rather than just one single pulse. As a basis for the safety-related detection of people and objects, this opens up whole new levels of detection quality and detection reliability – through a monitoring radius of 275°.

**Up to four times less sensitive to sunlight and ambient light**
The emission of laser pulses and the bundling of multiple digitized remission values for distance measurement have significantly increased ambient light immunity by a factor of 4 to 40,000 Lux. Safety laser scanners with safeHDDM® are therefore practically immune to dazzle – no matter whether it is from bright sunlight, high-frequency, artificial ambient lighting, or light sources or reflections shining directly into the optics.

**Increased resistance to dust and deposit formation**

The digital filtering of the remissions during histogram accumulation in safeHDDM® results in random individual remissions being blanked, while remissions from coded pulse sequences of the scanner are reliably detected and evaluated even when required signal strengths are low. As a result, dust particles or deposit formation on the optical interface have a much less negative impact on detection reliability and reliable protective function. Furthermore, the latest generation of safety laser scanners with safeHDDM® also feature parabolically curved front screens. These deflect reflections that arrive outside of the optical path of the laser pulses and their remissions into an optical trap – away from the receiver element in the device. This also increases the resistance to dust and deposit formation of safety laser scanners with safeHDDM®.

**Virtually no mutual interference**

The random pulse sequence time coding means that each safety laser scanner with safeHDDM® only evaluates its own pulses or pulse packages. As a result, the probability of two sensors detecting each other or using an identically encrypted sequence while detecting the same object at the same time is negligible. Other sensors and sensor systems that use laser LEDs as light sources do not impair the safety function and availability of this new scanner generation.

**Very high availability for machines and vehicles**

The new detection quality of safeHDDM® facilitates the protection of hazardous points and areas, and access points with significantly improved availability. The probability of the electro-sensitive protective device responding and triggering an emergency stop without there being a hazard to a person and based purely on critical operating conditions is reduced to a minimum with safeHDDM®. This increases machine or vehicle availability and productivity. safeHDDM® pays therefore for itself – the function of safety laser scanners with this technology is reliable and free of unintentional interruptions, and also reduces the risk of the muting and manipulation of the safety device.

**Important points for individual cases**

Safety laser scanners with safeHDDM® are active scanning systems with high-performance laser light sources and very high pulse frequencies. This may need to be considered if they are to be integrated into an environment that already has laser scanners with conventional technology or other laser sensors. To prevent the high pulse density of safeHDDM® from influencing other devices with time-of-flight measurement, we recommend mounting the devices at different mounting heights and with different scan planes to one another. The advantage of the high resistance to dust and deposits reaches its limits in places where dust loads are extremely high or particles are relatively large – such as in a sawmill. In such environments, we cannot recommend the use of safety laser scanners without further measures.

## Summary: safely into the future

safeHDDM® is a forward-thinking technology for safety-related time and distance measurement with certified safety laser scanners. The technology meets every requirement of the relevant standards and directives for safety and laser protection technology, and reaches a new level of reliability and therefore availability for machines and plants – even when used in difficult ambient conditions. Safety laser scanners with safeHDDM® also boast significant design features that increase their operational safety in industrial applications, such as in the automotive industry, mechanical engineering, or intralogistics.

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## REFERENCES

EN IEC 62061 “Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems”

EN ISO 13849-1 “Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design”

Directive 2006/42/EC of the European Parliament and of the Council of May 17, 2006, “Machinery Directive”