WHITE PAPER

SAFETY LASER SCANNERS VS. SAFETY MATS

Which one should you choose?

AUTHOR

Tyler Glieden
Safety Market Product Manager at SICK, Inc.

SICK
Sensor Intelligence.

ABSTRACT

Since 1990, safety mats have faced increased competition from safety laser scanners. Because the price for safety laser scanners is continuously decreasing, manufacturers might face a decision of whether or not to replace a safety mat with a safety laser scanner. This paper aims to explain the functions and advantages of safety laser scanners over safety mats.

The main advantages are the highly reduced replacement costs through the non-contact functionality and the principle of the configuration memory in the system plug of the scanner. Moreover, the safety laser scanner can be easily adjusted to the machine design thanks to the configurable fields. Further advantages are the warning fields, which reduce the machine downtime significantly by warning an approaching person before the machine needs to be stopped for reasons of safety. Besides these advantages, the limitations of the scanner technology is also explained.

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Introduction: Safety Laser Scanners vs. Safety Mats — Which One Do I Choose?

For over half a century, safety mats have been used in virtually every industry as the standard form of area protection in the plant environment. For an old technology safety mats have proven quite resilient.

nanoScan3 safety laser scanner

Typically, safety mats operate using an open switch. When a specified minimum weight is brought to bear on the safety mat, the switch closes. This sends a signal to the mat controller that subsequently sends a safe stop signal to the machine being guarded by the mat, stopping its operation. The worker that accidentally came too close to the hazardous area and stepped on the mat is safe. However, safety mats are subject to physical wear, both environmental and operational. This is so, as to perform their designed function there must be a direct contact.

Since the introduction of safety mats in the 1950s, a host of new technologies have emerged for safety applications, including safety laser scanners in the 1990s. Initially, the argument for safety mats has been that scanners are much more expensive But now, the initial price point of safety laser scanners has fallen significantly; when total cost-of-ownership is considered, the overall ROI for safety laser scanners is significantly better than safety mats. If you have to replace a safety mat once or twice, you've exceeded the cost of a safety scanner; this doesn't even factor the higher productivity scanners enable. These latter factors are the principal reasons laser scanners have largely supplanted safety mats in the European Union.

microScan3 safety laser scanner

A Closer Look at Scanner Technology

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. With conventional scanning technology, the measuring frequency is around 500 pulses per scan at constant angle intervals, whereby each pulse generates a measured value.

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.

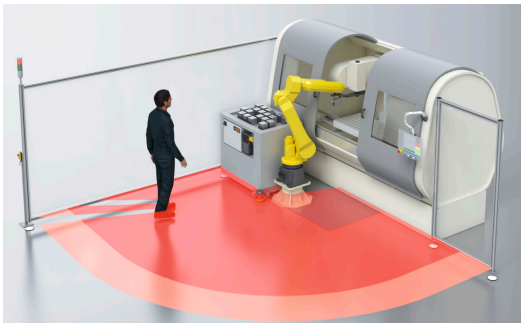
safeHDDM: The New, Patented, and Certified Detection and Evaluation Technology

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 approximately 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 140 pulses. In this process, the digitized echoes are compiled into data packages which overlap during evaluation. This guarantees a significantly more stable time and distance measurement.

A key aspect of thesafeHDDM® 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.

In safeHDDMTM, 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 overlapping evaluation of multiple digitized data packages result in extremely stable measured values that are based on 140 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°.

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.

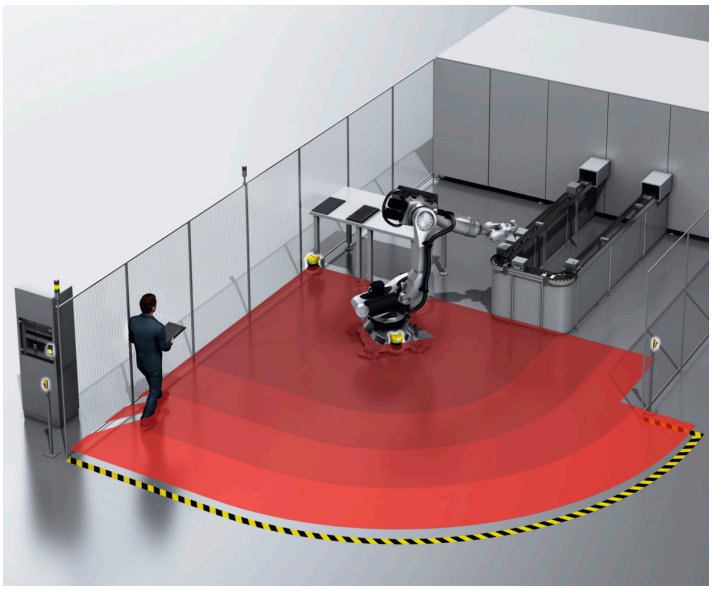
Very high availability for machines and vehicles
The new detection quality of safeHDDM® facilitates the protection of hazardous points and areas, and access points with significantly improved availability. The probability of the electro-sensitive protective device responding and triggering an emergency 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.

Powerful Advantages of Safety Laser Scanners

Safety laser scanners provide a number of key advantages over safety mats:

- Non-contact functionality
- Easy replacement
- Adjustability
- Warning field protection
- Simultaneous safety zones



NON-CONTACT FUNCTIONALITY

One of the biggest issues with safety mats is that they stop working, either because people repeatedly step on them (after all, that's what they're designed to do) or because tools, products, lubricants, vehicles e.g. fork trucks, or other environmental "hazards" come into contact with them. This causes downtime and increases the frequency of replacement.

In contrast, safety laser scanners function without needing physical object contact by providing protection through infrared lasers. If a mat fails because of physical contact, a machine will likely have to be shut down, depending on a company's internal processes and procedures regarding safeguarding. This shut down will remain in effect until the safety mat is replaced by one in stock or another is shipped and mounted. This process takes time and disrupts production, in addition to incurring capital costs. Laser safety scanners are not subject to this risk.

EASY REPLACEMENT

If a safety laser scanner is damaged, it is still quick and easy to replace. Most types consist of a scanner head and a system plug with an integrated memory plug — basically, a memory module, which contains the configuration of the scanner and all settings, including the field dimensions. If a safety laser scanner is damaged only the scanner head needs to be replaced. The system plug is permanently mounted on the machine. This is important, since this prevents the loading of an incorrect configuration into the device. The new scanner head will be attached to the system plug. This will immediately download the configuration from the system plug and assume the safety tasks of its predecessor. From a replacement perspective, there's no fudging or re-programming. It is a simple plug-and-play principle, which reduces machine downtimes to a minimum.

Also most types of safety mats have multiple parts: the mat and a control box. If a safety mat needs to be replaced, sometimes the control box will need to be changed, too. This is the case, when the machine operator buys new safety mats, and there has been a change in version, there may be an incompatibility problem with some control boxes.

Because safety mats are not "one-size fits all", mats also present stocking issues. For example, if a manufacturer has 20 machines, he might have to stock various sizes of mats for the different machines and floor plans.

ADJUSTABILITY

Safety mats are often limited in use by their initial application. In manufacturing facilities, safety mats are purchased to cover specific machines: for example, one machine setup may require 4x4m mats, while another uses 6x6m mats. In other cases, such as when new machines are bought, an existing operation is moved into new facilities, or floor plans are adjusted within existing facilities. An original safety mat designed for a 4x4m area may then no longer satisfy the requirement. A new safety mat must be purchased or a different one has to be secured from stock.

Another problem with safety mats is the standardized rectangular shape. If other shapes are needed because of the structural design e.g. a column is in the hazardous area, a special form is needed. The special form causes not only additional costs, but increasing lead times may also occur.

On the other hand, with the safety laser scanner and its warning and protective fields, everything is freely programmable. Using the original scanner, a user can easily configure the fields to whatever size and shape needed for operations, however the environmental conditions change.

WARNING FIELD PROTECTION

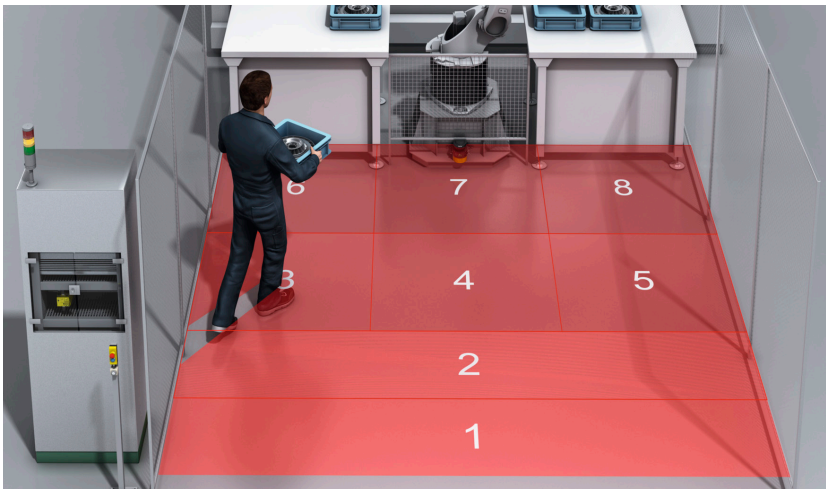
The importance of the warning field is that it provides an indication – a warning – to persons moving through the area that they are getting too close to the machine, before the operation has to be stopped due to safety reasons. Like the protective field, the warn- ing field is freely programmable. If the scanner senses somebody in the described warning field, it gives a discrete output, typically attached to a flashing light or some sort of horn.

Consider this alternative: a machine is running, producing parts. In a typical safety mat situation, you can see where the safety mat is if you are paying attention. If you are not paying attention—reading prints or watching the machine—and step on the mat, you will stop the machine.

From a company standpoint, production is lost for the time it takes to reset the machine. Depending on the machine, this can be a complicated process. This would not occur if a warning field has been activated, warning beforehand the unfortunate worker to not come any closer.

SIMULTANEOUS SAFETY ZONES

Depending on the application, the need to shut down different safety functions of the machine may be necessary or more efficient when running a process. When a safety mat is triggered, it produces a single safety output, which ultimately leads to a complete stop of the machine or a stop of one safety function. Safety laser scanners have more versatility with the quantity of zones that can be monitored simultaneously.



With some devices on the market, up to eight safety-rated zones can be monitored simultaneously and, with other hardwired options, two safety zones can be monitored to produce two independent hardwired outputs. This versatility can lead to new, innovative ways of using the laser scanner.

An application that has two separate safety functions on the left and the right side could be monitored by a safety laser scanner and control the two sides independently by how the zones of the scanner are set up. Additionally, safety zones can be ‘stacked‘ on top of each other; where the first safety zone brings the machine to a safe, but reduced, speed, and the second safety zone brings the machine to a complete stop, thus keeping the machine productive even when people are present.

Limitations of the Scanner Technology

Despite the powerful advantages of safety laser scanners, limitations of the scanner technology exist due to their non-contact functionality. Although the safety laser scanner is designed for reliable operation in optically challenging environments, especially polluted environment can lead to availability problems. Leaking oil, grease or dust can cause the laser scanner to trip although there is no danger. In order to counteract this problem, the parameters of the scanner can be adjusted so that the device ignores these types of issues. But this works only with the simultaneous increase of the response time of the scanner.

However, this applies only for specific conditions. Normal operating conditions are never a problem for laser scanners – and therefore the basis for their worldwide distribution in modern industry.

Contact Us

For more information about safety laser scanners, contact SICK Safety Market Product Manager, Tyler Glieden at info@sick.com or visit our website at www.sick.com.