control design

# ESSENTIALS OF
# ROBUST SAFETY LASER SCANNERS

A Control Design Essentials Guide, by the editors of *Control Design*

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*—The Control Design Editorial Team*


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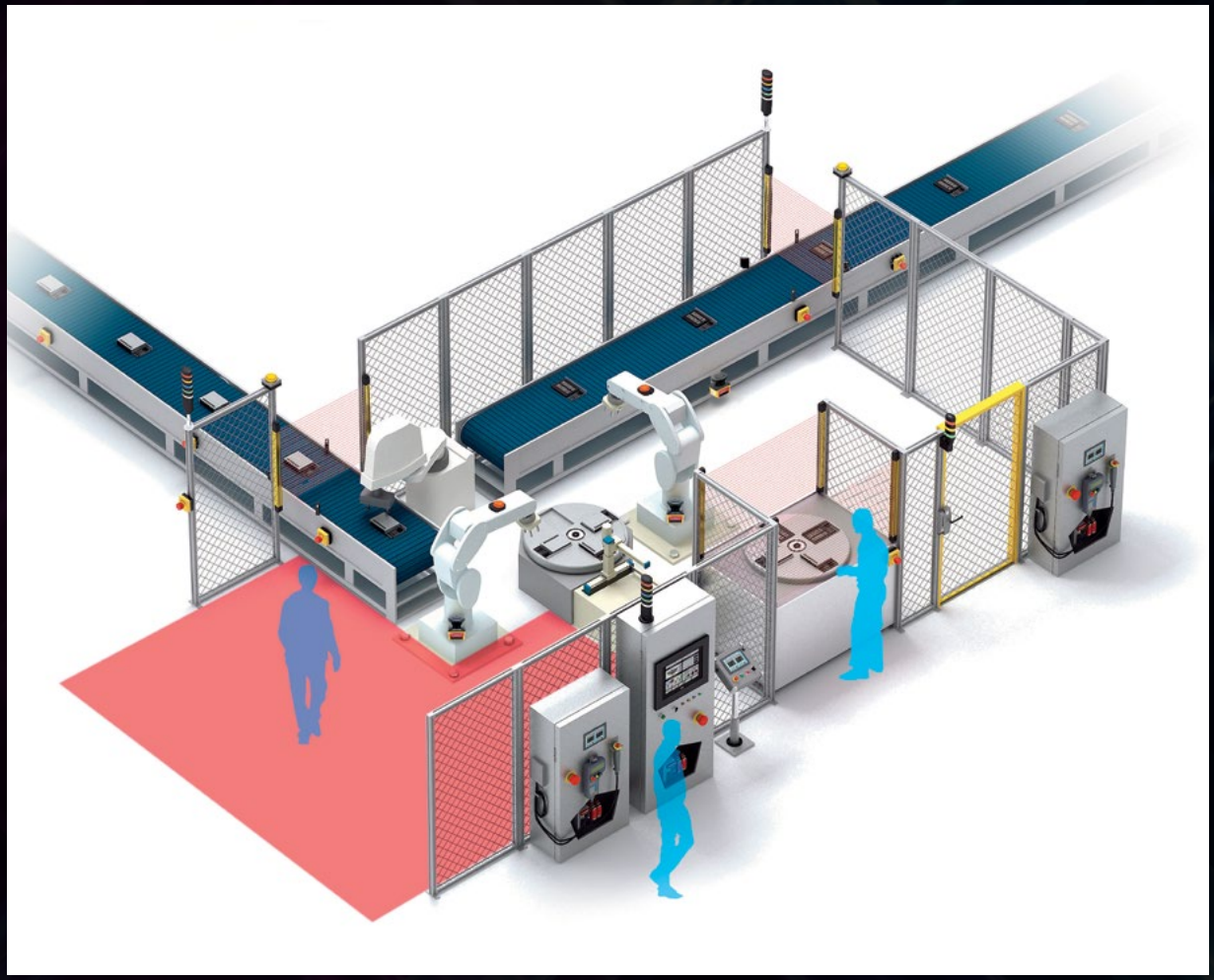
# STATE-OF-THE-ART SAFETY LASER TECHNOLOGY

There are many safety devices on the market designed to protect both personnel and machine. Fixed and removable mechanical guarding, safety guard switches, light curtains, and safety mats and edges are just some of the options. However, few are as configurable, robust and reliable as safety laser scanners. These scanners literally define area and zone safety where others lack the capability to reach the performance needed.

From safeguarding of industrial robots and machinery to intrusion detection and collision avoidance, an economical and compact safety laser scanner cannot be beaten in these and many other applications. The ability to teach complicated protection and warning zones, in many cases through automatic configuration by referring to obstacles such as walls and columns, is tough to beat when compared to other options such as light curtains and mechanical guarding.

Other safety devices such as a light curtain may be able to provide finger protection not offered by safety laser scanners, but the area they can protect is fixed by the height and distance of the sender and receiver. The shape is a window, so these light curtains cannot handle a complex perimeter. While mechanical guarding is often used in conjunction with light curtains and safety laser scanners, it can be costly to design and install and then difficult to reconfigure if the protection zone needs to change.



# SOLID PERFORMANCE OF SAFETY LASER SCANNERS

A safety laser scanner is a safety device that uses laser bean reflection to detect the presence of people or objects. Safety laser scanners are most commonly used with AGVs and forklifts. However, new laser scanners can provide protection and warning zones over longer distances, which makes them ideal for use with industrial robots and machinery.

These active optoelectronic protective devices responsive to diffuse reflections (AOPDDRs) detect diffused emitted light within the protection zone (safety) and warning zone (non-safety). The AOPDDR scans a 270º area with about 2000 laser beam pulses like spokes in a wheel. Body protection is possible out to 5 m with hand protection possible near the scanner.

Some safety laser scanners provide the ability to reduce false detection from debris and dust by continually monitoring the reflected signal. Reliable protection of Safety Category 3, Performance Level d (PLd), Safety Integrity Level 2 (SIL2) is possible

out to 5 m. An improvement to some scanners is a warning zone out to 20 m. These protection and warning distances and their configurability help to keep the machines moving through more thorough visual and audible warnings and physically slow down equipment when appropriate.

Expanding the performance even further, some safety laser scanners have one protection zone and two warning zones, with each zone's distance and shape configurable. Some scanners also provide dual protection zones with unique configurable shapes.

# TECHNOLOGY SEEN IN SAFETY LASER SCANNERS

Safety laser scanners in master-and-slave mode allow connection of a single safety controller to all four sides of an AGV. This master-slave function connects up to four safety laser scanners using RS-485 with one unit functioning as a master unit communicating with up to three slave units via a safety communication channel.

Configuration of the master unit sets an expected number of slave units allowing the master to report an error if the number of slave units is different than the configured settings. Area switching of the slave unit is linked to the master unit, so typically slave units transmit object detection information to the master, which switches the output-signal-switching-device (OSSD) safety output at the master unit. However, it is possible to use each slave unit's OSSD ensuring a reliable and configurable 360º object detection, in many cases with just one master unit and one slave unit.

With many safety laser scanners, the distance is measured by the time-of-flight (TOF) principle. The laser scanner sends out very short pulses of infrared light. A mirror rotated by a motor transmits the infrared light within a typical scanning range of 270º. The light is reflected back from an object within the range, and the distance is calculated using a simple equation where the distance to the object equals one-half the speed of light times the time difference.

A safety laser scanner's protection and warning area is very configurable; in addition to a protection zone and zero, one or two warning zones, some can be configured in a dual protection mode. This allows a single laser scanner, to protect two zones simultaneously.

The configuration software supplied with the safety laser scanner makes this possible. Protection and warning zones are easily created, and some allow 32 sets of scanning areas to be configured. Automatic zone configuration is also possible based on physical boundary detection.

# RELIABLE SAFETY LASER SCANNING IN THE TOUGHEST APPLICATIONS

With any identified machine hazard and related safety device, a risk assessment should be performed. Understanding that a safety laser scanner should not be used for finger protection is just one of the findings of a risk assessment. Ensuring the scanner is operating in a working environment within specifications is another one. The risk assessment will also ensure the safety distance, in accordance to ISO 13855 and IEC 61496-3, is suitable for the application.

There are several best-use applications for a safety laser scanner. The configuration and teaching function of these scanners is simple, and external device monitoring and muting functions benefit many applications. Ethernet communication and logging of distance measurement provides much usable information.

The large configurable protection and warning range works well safeguarding industrial robots and machinery. Scanning a horizontal plane, the safety laser scanner can be configured to protect a large irregularly shaped area. An even larger warning envelope works well in collaborative robot applications, slowing the robot down as an operator approaches it, for example. A warning light could illuminate, or an alarm horn could chirp, signifying the approach to a hazardous area.

Intrusion detection is another application for safety laser scanners. These scanners can be mounted to scan a vertical plane and replace light curtains. It would detect a body entering the area, but a muting function is available to allow a package to be conveyed through the detection area, or a robot to reach through it.

Probably the best use of a safety laser scanner is in for autonomous vehicle applications, especially where area and measurement data can be utilized. It is possible to adjust the protection detection area to many different patterns based on the vehicle speed and surrounding equipment using an encoder input function. Changing the detection range based on speed helps to prevent loads from falling. This can also help with collision avoidance when an AGV or forklift picks and places materials in several areas.

Add to any of these applications a master-slave function where multiple safety laser scanners can work together to guard multiple hazards, and all inclusive protection is realized. Utilizing the distance measurement data from these scanners, via an Ethernet connection, the AGV or robot can become smarter about the obstacles.

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