

## Smart sensor system stops dangerous motion

The protection of people in their daily work has the highest priority. This requires the use of smart sensors which stop the dangerous motion of a machine in the event of danger. Nevertheless, it still must be possible to suppress the sensors for certain purposes although this also still requires a satisfactory level of safety.

### Personnel protection

Every science fiction fan knows the three Robot Laws of the best seller "I, Robot" by Isaac Asimov:

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Whilst teaching a machine to protect itself still sounds like fiction, the first two laws have already been implemented in applications for a long time, even if we might not have been aware of it. They have been implemented in accordance with harmonised European standards, the so-called Machinery Directive EN 945-1, and in national legislation such as the German Equipment and Product Safety Act (GPGS) in order to simplify the free transfer of goods within the EU on the basis of a prescribed minimum level of safety.

This law applies both to the private use of products as well as to industrial applications. A typical example of this is the protection of automated processes in industry, in which non-contact safety devices are capable of distinguishing between the movements of persons from those of transported production goods in order to prevent accidents.

Special sensors, combined with diverse and redundant safety engineering provide the solution here. In no application is reliability and safe operation of such critical importance as in the field of personnel protection. This includes self-monitoring for example. This requires the architecture of the system to be redundant, in which the system is made safe by the multiple implementation of components.

A safety light curtain that initiates the shutdown of a dangerous machine when persons are detected too close to the hazardous area is an example that illustrates the operating requirements involved. The hardware and the firmware of the control unit are tested thoroughly by means of stringent FMEA (failure mode and effects analysis) procedures in order to ensure that no individual system component causes a failure that may result in a hazardous situation.

This is only possible by using two differently designed processors with different firmware that test each other cyclically. In this way, any random failure of similar components due to the same fault is excluded. These kinds of systems also offer exceptional diagnostics options due to their self-testing capabilities. These can consist of the output of an error code which is described at a suitable location such as in the operating instructions or on the device, or by means of a visual indication using a connected PC.

The controlled suspension of the safety function may seem to work against this stringent concept; however, it is especially useful for particular tasks such as the transport of production parts in a manufacturing cell. In this case, it must be ensured that the objects transported through the light curtain can be distinguished from persons, and that entry to the hazardous area is still prevented.

### Muting

The muting function provides this particular manipulation exactly, the controlled suspension of the safety switch output during the passing of production parts or general material flow into the dangerous and protected area of a machine. For this, the switch output of the safety device is combined to operate with other input variables that are exclusively interlinked in a unique way so that the stopping of the machine is prevented, even if a stop command was initiated. For this, the European Machinery Directive stipulates the use of additional sensor pairs that supply a signal within a maximum time window of three seconds, and operate in such a way that accidental activation by a person is not possible.

Only the material flow is able to carry out the actuation, whether at a location that is **inaccessible** to persons or by simultaneous triggering, which must be designed to suit the dimensions involved. The aim is to prevent the accidental activation of a muting cycle in which a person can enter the hazardous area without the safety system stopping the machine in the time in which the point of danger is accessible.



Diversity is also important in the selection of the muting sensors. However, these devices do not require any special safety approvals so that proven technology can be used satisfactorily. Diversity can consist of identical operating modes with different switch outputs, such as a PNP and an NPN transistor output. The key advantage of muting initiators is that the material flow is not time-dependent.

A safety light barrier with fixed blanking has a section of the protected area continuously intercepted by the material or object and thus has to be blanked in order not to activate the safety switch output. With muting, however, the safety device does not require the material flow to be constant. The muting function is the ideal solution when the time of pauses or gaps changes, such as is the case with bodyshell construction in the automotive industry.

If the space conditions allow horizontal as well as vertical monitoring, safe operation is possible because the safety system can detect and evaluate between the intercepted areas constant gaps which also, due to their dimensions, cannot be caused by a person but only, for example, by the transport system used.

This is called the entry-exit application and does not require any separate muting sensors. The muting status must be visible to the persons present, and this is implemented with a light indicator that is clearly visible when muting is active. This function is also achieved using a test function or the monitoring of the electrical energy required. A timer is used to define a maximum time range in which the muting is permissible.

This function prevents the intentional manipulation of the muting devices in order to initiate improper muting. It is also useful for the detection of a synchronisation fault that would impair the operation of all muting devices in the application. If material jams occur in the area of the safety light barrier, the Override function allows a brief intervention without the light barrier having to shut down the system. This is implemented by connecting a switch which lengthens the muting time when pressed.

## Applications

One-way or two-way muting is used depending on the application. With one-way muting, the direction of the material is only in one direction. This is used for example where one end of a machine or robot cell is fed with material and is discharged at the opposite end after the operation is completed. For this, one pair of muting sensors in front and behind the safety light barrier is normally enough, and is activated within a time window under certain conditions which may include the geometry of the material. The setting on the muting module allows the activation sequence to be defined so that the reverse motion is also permissible. This is called two-way muting. The crossing of two light barriers in the hazardous area is also a possibility. The future has already begun!!!

## Final comment

One more important note must be made about all the options described here, and this concerns the responsibility of the operator of a machine requiring protection. The supplier or manufacturer of safety components can never exactly know the entire scope of a machine as precisely as the machine manufacturer or operator. Consequently the safe operation of the machine and the drawing up of the so-called risk analysis is also the sole responsibility of the manufacturer/operator. However, the current state of the art also allows the operator himself to carry out cyclical checks on the safety components used. For this, the authorised person must have the appropriate qualifications and training.

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