FAQ

Safety Distance Calculation

What is a safety distance calculation?

Unlike hard guarding, which keeps an operator safe by preventing human access to a hazard, safety sensors such as light curtains or safety scanners keep an operator safe by stopping or slowing a hazard while maintaining access to it. The process of stopping a dangerous machine takes time – the safety sensor takes time to detect the operator, a relay or controller takes time to cut off power to the machine, and the machine itself takes time to stop or slow down enough to be safe. The safety distance calculation is a standard formula that determines how far away a safety sensor must be placed from the hazard so that it can successfully stop the machine in time before the operator comes into contact with the hazard. This FAQ is intended to give an overview of how to perform safety distance calculations, however, Omron recommends a full risk assessment be done before installing any safety devices on a machine. Learn more at: https://automation.omron.com/en/us/services/safety/

What do I need to perform a safety distance calculation?

The formulas for performing the safety distance calculations are relatively straightforward, however it is extremely important not only to collect accurate data to plug into the formula but select the formula that matches the type of guarding you intend to install. The formulas are part of exsiting safety standards, such as ISO 13855/EN ISO 13855 or ANSI B11.19 The following are the key pieces of info you will need before you begin.

Response Times:

The response time of a safety system is how long it will take for a safety sensor to detect an ingress and for the hazard to become safe. To calculate the response time of the whole system you have to include every device involved in taking the hazard from normal operation to a safe condition. This might include but is not limited to light curtains, safety scanners, controllers, PLCs, relays, and the moving parts of the machine itself. A longer response time will increase the safety distance calculation.

Detection Capabilities (Resolution):

The resolution of a safety sensor is the smallest diameter object that the light curtain is capable of detecting. Common resolutions for light curtains include 14mm, 25 mm, and 45 mm, which is frequently referred to as finger type, hand type, and limb type respectively. It is a common misconception that a finger type is safer or is more qualified to guard fingers than a limb type. This is not true; they are all equally safe as long as the safety distance calculations are performed correctly (see Figures 1 and 2). A larger resolution will allow the operator to get closer to the hazard before it detect an intrusion, so it must be mounted further away.

Type of Approach:

The actual formula used to perform a safety distance calculation will change depending on how the light curtains are mounted, how the operator is able to approach the machine, and what other types of safety and guarding are in the area (see Figures 3 and 4 below). There are many different approach possibilities, so we recommend a full risk assessment be done before installing and safety devices on your machine.
Learn more at: https://automation.omron.com/en/us/services/safety/

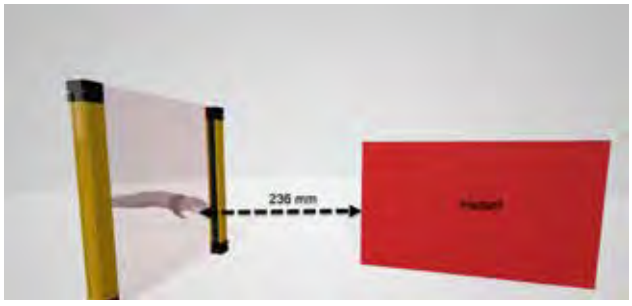


Figure 1

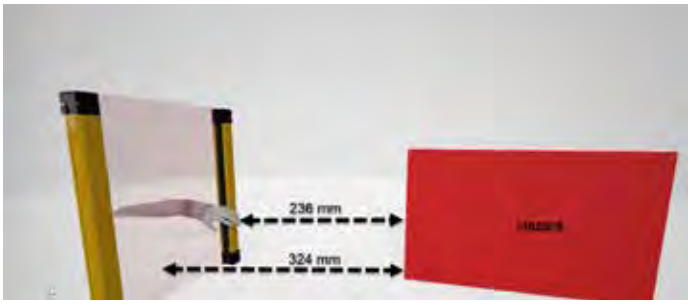


Figure 2

In both situations, the fingers of the operator remain the same distance away from the hazard. The light curtain is Figure 2 has a larger resolution than the light curtain in Figure 1, so it must be placed further away from the hazard.

Example: Safety Distance Calculation for a Vertical Approach with No Angle

In this example we will perform the safety distance calculation in two ways: by hand and by using SD Manager 3. This free software is used to configure advanced functions of the F3SG-SR light curtains, but can also assist in performing safety distance calculations.

A vertical approach with no angle is the most common way safety light curtains are used. In this situation, light curtains are mounted vertically and there is no possibility of an operator reaching around the light curtains to reach the hazard (figure 5).

We will use a F3SG-4SRA0160-14 light curtain and a G9SA-301 safety relay as a simple safety setup. The key pieces of information are:

- F3SG-4SRA0160-14 has 14 mm resolution
- F3SG-4SRA0160-14 has a maximum 18 ms
- G9SA-301 has a maximum 10 ms response time

The hazard take 90 ms to reach a safe condition (this is for our example, in practice each machine will have a different stop time).

The total machine response time is 100 ms total (the relay response time plus the hazard response time).

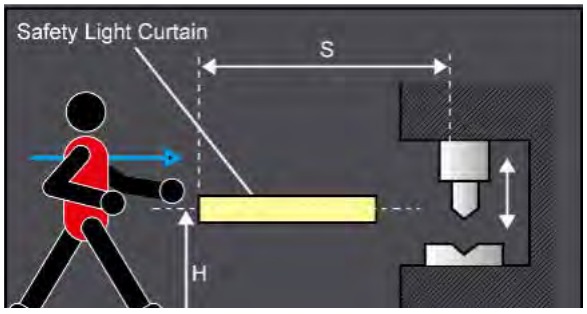


Figure 3

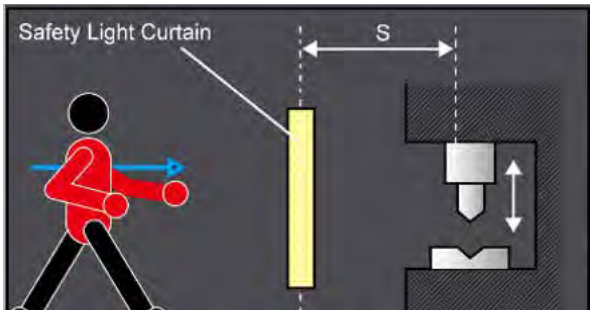


Figure 4

Method 1: Calculations by hand

In accordance with ISO 13855/EN ISO 13855, the formula for a vertical approach with no angle is:

$$S = (K \times T) + 8 \times (D - 14)$$

S = Safety Distance: How far the safety sensor must be away from the hazard.

K = Approach Speed Constant: ISO 13855/EN ISO 13855 sets this at 2000 mm/s. This speed represents how fast an operator could potentially move towards a hazard. While 2000 mm/s is the constant defined by the safety standard, a safety risk assessment may reveal that this value must be adjusted.

T = System Response Time: The total amount of time it takes for the light curtains to detect something and the machine to come to a safe condition. This value is produced by adding together the response times for ever device involved stopping or slowing the machine (including the machine itself)

D = Detection Capability: The resolution of the light curtain. This value cannot be less than 14 mm.

$$S = (2000 * .118) + 8 \times (14-14)$$
$$S = 236 \text{ mm}$$

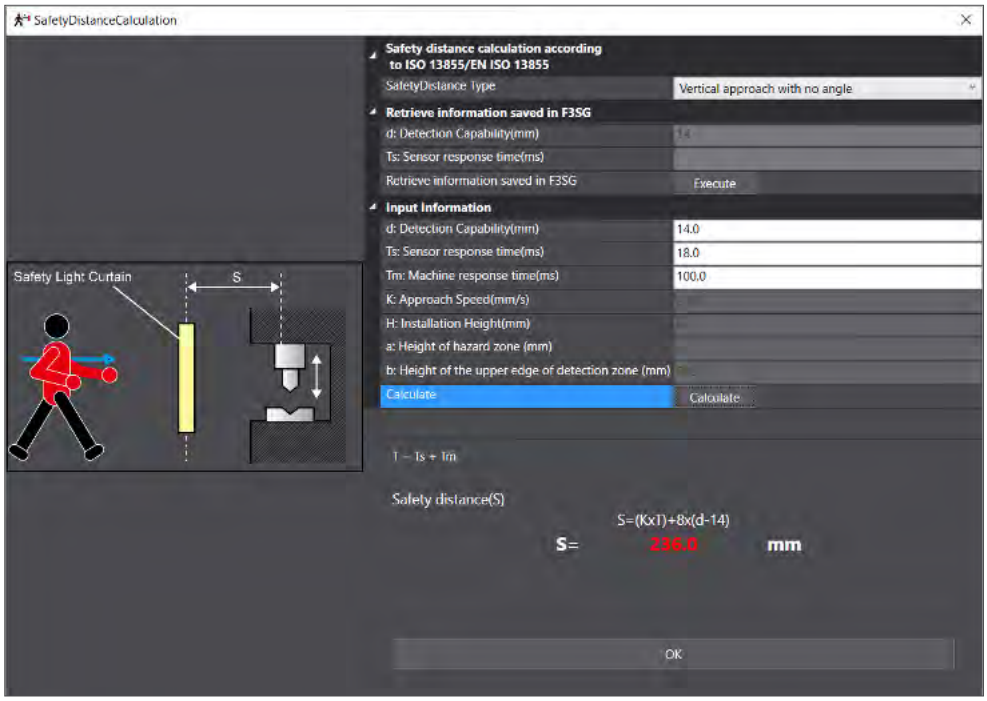
Plugging these values into the formula yields 236 mm, so the light curtains need to be mounted at least 236 mm away from the hazard.

NOTE: There are other standards, which use different formulas for the safety distance calculation. Generally speaking, the information you need to plug into the formulas will be similar and will yield similar results.

Method 2: SD Manager 3

SD Manager 3 allows you to simply input the information and let the software perform the calculations for you by following a few simple steps.

1. Select the appropriate approach type from the Safety Distance Type drop down.
2. If you have F3SG-SR light curtains currently connected to SD Manager 3, click the "Execute" button to read out the detection capability and response time from the curtains. If you do not, input those values in the Detection Capability and Sensor response time fields. This information can be found in the F3SG manual.
3. Input the total response time of all devices and machines (excluding the light curtains) into the Machine response time field.
4. Click the "Calculate" button to produce the safety distance value.



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