Sensing distance

The sensing distance quoted in datasheets refers to a position at which the proximity switch operates when a standard detectable object is moved towards the sensing face, as shown in the below diagram (this is measured against a reference position).

Differential travel and resetting distance

The resetting distance for a proximity switch refers to the distance at which the proximity switch releases (i.e. turns off) when the detectable object is moved away from the proximity switch after it operates.

Differential travel is the term referring to the absolute value of a difference between the operating and resetting distances (shown in the diagram as distance differential. A typical value of 10% maximum is normally provided to prevent the proximity switch output from chattering due mechanical fluctuations.
Operating range (Sensing curves)

The operating range refers to the area in which the target object can be sensed by the proximity switch. The area is measured by moving the standard object (target) towards the centre of the proximity switch whilst keeping it parallel to sensing face, as shown in the below diagram.

When the target object reaches a position where it operates the proximity switch (shown as P) this is noted. This process is repeated at different distances from the face of the proximity switch to form the operating curve. Also shown above is the release curve when the object is moved away from the sensor.

As the magnetic field is symmetrical to the centre axis, if an object was to approach the sensor from the right then a mirror image of the operating curve would be found. In Omron datasheets both these curves are show, a typical example is shown below.
**Detecting range**

When the target object passes from left to right across the proximity switch face the sensor operates at position A and releases at position B. Note that this is not symmetrical as the differential travel allows a different release point.

![Diagram of detecting range](image)

**Standard object**

The standard object refers to the detectable target object of specified shape, size and material which is used as the standard to examine the performance of the proximity switch (because the performance of the switch will vary according to the shape, size or material of the detectable object).

In general the standard object is defined as a square mild steel plate with a thickness of 1mm and with a length of sides equal to the proximity switch diameter, or with sides three times the sensing distance.

Normally the sensing distance for a target object that is larger than the standard object is about the same as the quoted sensing distance.
Effects of different types of metal on sensing distance

All sensing distances in datasheets are quoted against a standard mild steel target (this will be detailed in the datasheet). If however a different type of metal is used then the sensing distance may be reduced. Below is a typical indication of the reduction in sensing range versus different types of metal. Non-ferrous metals have the greatest reduction in range.

In the datasheets more detailed information is given in the form of a table, an example of which is shown below. These detail the actual sensing performance of each type/size of sensor in relation to the target size and material.
Response Frequency

The response frequency refers to the frequency of outputs by the proximity switch per second, in response to the movement of the detectable object when brought closer to the switch.

The method of measurement of response frequency is shown in the below diagram, using a rotating body with standard target object (as defined by CENELEC standards).
AC/DC two wire proximity sensors – series and parallel connection

DC two wire – series (AND)

The sensors connected together must satisfy the following conditions.

\[ V_s - N \times V_r \propto \text{Load operating voltage} \]

(\(N = \) number of sensors, \(V_r = \) residual voltage of sensor, \(V_s = \) supply voltage)

DC two wire – parallel (OR)

The sensors connected together must satisfy the following conditions.

\[ N \times I \propto \text{Load operating voltage} \]

(\(N = \) number of sensors, \(I = \) leakage current of each sensor)
AC two wire – series (AND)

If 110 or 240VAC is used as a supply to the sensors, \( V_L \) (i.e. the voltage imposed on the load) will be obtained from the following.

\[
V_L = V_S - (\text{residual voltage} \times \text{no. of proximity sensors})
\]

Therefore, if \( V_L \) is lower than the load operating voltage then the load will not operate.

AC two wire – Parallel (OR)

In principle two AC proximity sensors can be connected in parallel. Provided that proximity sensor A does not operate with proximity sensor B simultaneously and there is no need to keep the load operating continuously, then the sensors may be connected in parallel.

However, due to the leakage current associated with two wire AC devices there is the possibility that the load may not turn off. Also problems can occur if both sensors switch at the same time, it is possible for the load to turn off momentarily. To overcome this relays should be used to switch the load.
DC three wire – series (AND)

DC three wire – parallel (OR)