Electronic Products Laser Sensors Article

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Quantifying exact performance specifications for sensors used in factory automation by OEMs and users is a difficult task that crosses the bounds from science to art. Sensor performance specifications like sensing distance and target size, which are associated with inductive proximity sensors, photoelectric sensors and measurement sensors, are values based on a set of defined criteria. Standard target size, material, color, shape and orientation are just a few of these criteria. If you change any or all of these criteria to a variable as a result of your customer's application, predictable performance specifications don't seem so predictable anymore. It is at this point the input side of factory automation, the selection of sensing components, transitions from science to art.

Trial and error in seeing if a specific sensor solves the OEM's application almost seems as much a part of the solution selling environment as the quotation, purchase order and inventory management plan. While impossible to control your customer application parameters, selecting sensors that define critical performance values through actual performance data of your customer's actual applications are a strategic step critical to today's consultative selling professional. This is especially true in the application and sales of measurement sensors, which can be considered an extension of traditional sensor sales for more complex applications. But first let's examine some performance and application parameters involved with proximity and photoelectric sensors.

Performance specifications such as sensing distance for inductive proximity sensors are based on defined criteria including specific size, shape, material, orientation and presentation of the target to a specific sensor. For applications that deviate from these criteria, success in detecting the target repeatably depends on the ability to understand the cause and effect of these deviations on sensor performance. Change from the standard size target of a square of mild steel 1mm thick and the same diameter as senor face to stainless steel derates your maximum sensing distance. A brass, aluminum, copper or lead target of standard size uniquely alters the maximum sensing distance. Changing the shape or size of any of these target materials changes the performance of your sensor and probably alters your sensor selection. Designs of sensors which simplify applications, for example, all metal sensing proximity sensors, do not totally eliminate variable specification performance.

Photoelectric sensors are ultimately more complex because of the many sensing methods and light sources used in these products. Specifically, diffuse type sensors use similarly defined criteria to state performance specifications, including maximum sensing distance. Like proximity sensors, photoelectric sensors use a specific target, flat white paper with 90% reflectivity, of a specific size typically 10mm or 30mm square, to determine maximum sensing distance of a particular sensor. Once the target material changes from the standard color, size, texture, reflectance, translucence, shape or orientation, performance specifications are nothing more than a guideline to formulate a product selection to solve the application. Product design attributes including beam pattern that do not change based on target parameter changes also impact the ultimate performance specification of the sensor.

In those applications where proximity or photoelectric sensors are unable to solve the traditional target presence/absence condition or a process variable for quality purposes is required, a laser displacement or measurement sensor can be a suitable alternative. These sensors become the elements of a data acquisition system that converts changes in physical parameters, for example dimensional tolerances, into electrical signals, typically an analog 4-20mA output. Decisions made on product quality based on inaccurate data undermine the premise of quality control and ill define system quality capabilities and tolerances. Because laser displacement sensors have similarity of design with diffuse photoelectric sensor, they too are affected by target parameters that change performance specifications. Let's review three methods of using lasers for distance measurement.

The three primary methods each have their strengths depending on the application. The first method, pulse-type time of flight systems, uses a laser that emits a very intense pulse of light of a short duration directed at the subject target. By measuring the amount of time for the pulse to strike the target and returned the distance is measured. The accuracy of these sensors is typically limited by the accuracy with which the time interval can be measured and the rise time of the laser pulse. These types of sensors are best suited for long distances but impractical for factory automation applications.

The second method, modulated beam systems, also uses the time of flight method to measure distance, however, instead of measuring the total time of flight to and from the target, the laser is rapidly varied that produces a signal changes over time. The time delay, or distance measured, is indirectly calculated by comparing the outgoing signal with the returning delayed signal returning from the target. Effective applications for modulated beam systems involve measurement from a few inches to ten feet.

For measurement applications of a few inches with high accuracy requirements, laser triangulation sensors are the best fit. A semiconductor light emitting source with transmitting lens and a position sensitive detector (PSD) with receiving lens located in the sensor head use triangulation to determine target distance. Reflected light from the target is focused on the PSD through the receiving lens forming a beam spot. As the distance to the target changes the focused beam spot moves in a direct relation and a corresponding proportional analog signal, typically 4-20mA is output.

Key performance specifications of laser measurement sensors include measurement distance, both maximum and minimum, measurement range, analog output linearity and resolution. Resolution as defined as the smallest change in a unit of measure the sensor can detect, are based on a standard white ceramic target with 90% diffuse reflectivity. Change the target material and the effect on these key performance specifications is difficult to validate.

Let's focus on the performance specification of resolution. Typically expressed in microns where 1 micron is equal to .000039 inches or .001 mm, target characteristics including color, reflectivity, texture and surface structure can affect the maximum resolution performance of measurement sensors on a given target. The resolution performance specification of the application become non-deterministic in nature. This is hardly the arena to base critical quality decisions or acceptable tolerances of manufacturing processes.

However, recent advancements in laser measurement CPU's have created improvements in performance specification stability and allow for more user-friendly application of smart laser measurement sensors. Digital resolution indicators are now being included into the amplifier component of measurement sensors. The analog output from the PSD within the sensor head is input to the signal sampling for a selected time interval or measurement cycle. An internal clock function brackets the analog output with a start and stop reference time. Within the CPU the peak-to-peak analog value, or resolution, is calculated and displayed. Concurrently the analog output is processed through the displacement calculation for the selected sampling rate and then output in either a milliamp or volts dc analog signal. The result is the resolution to the particular target or application can be determined.

By validating the maximum resolution for your application, informed decisions can be made regarding acceptable high and low measurement values and provide key dimensional data needed to monitor critical manufacturing processes and operations.