Sensor / Detectors / Transducers are electrical, opto-electrical, or electronic devices composed of specialty electronics or otherwise sensitive materials, for determining if there is a presence of a particular entity or function. Many types of sensors, detectors, and transducers are available including those for detecting a physical presence such as flame, metals, leaks, levels, or gas and chemicals, among others. Some are designed to sense physical properties such as temperature, pressure or radiation, while others can detect motion or proximity. They operate in a variety of manners depending on the application and may include electromagnetic fields, or optics, among others. Many applications over a wide range of industries use sensors, detectors, and transducers of many kinds to test, measure, and control various processes and machine functions.

Types of Sensors/Detectors/Transducers

**Vision and Imaging**
Vision and Imaging Sensors/Detectors are electronic devices that detect the presence of objects or colors within their fields of view and convert this information into a visual image for display. Key specifications include sensor type and intended application, along with any particular transducer features.

**Temperature**
Temperature Sensors/Detectors/Transducers are electronic devices that detect thermal parameters and provide signals to the inputs of control and display devices. A temperature sensor typically relies on an RTD or thermistor to measure temperature and convert it to an output voltage. Key specifications include sensor/detector type, maximum and minimum measurable temperatures, as well as the dimensions of diameter and length. Temperature sensors are used to measure the thermal characteristics of gases, liquids, and solids in many process industries and are configured for both general- and special-purpose uses.
Radiation
Radiation Sensors/Detectors are electronic devices that sense the presence of alpha, beta, or gamma particles and provide signals to counters and display devices. Key specifications include sensor type and minimum and maximum detectable energies. Radiation detectors are used for surveys and sample counting.

Proximity
Proximity Sensors are electronic devices used to detect the presence of nearby objects through non-contacting means. A proximity sensor can detect the presence of objects usually within a range of up to several millimeters, and, doing so, produce a usually dc output signal to a controller. Proximity sensors are used in countless manufacturing operations to detect the presence of parts and machine components. Key specifications include sensor type, maximum sensing distance, minimum and maximum operating temperatures, along with dimensions of diameter and length. Proximity sensors are generally short range devices but are available too in designs that can detect objects up to several inches away.

Pressure
Pressure Sensors/Detectors/Transducers are electro-mechanical devices which detect forces per unit area in gases or liquids and provide signals to the inputs of control and display devices. A pressure sensor/transducer typically uses a diaphragm and strain gage bridge to detect and measure the force exerted against a unit area. Key specifications include sensor function, minimum and maximum working pressures, full scale accuracy, along with any features particular to the device. Pressure sensors are used wherever information about the pressure of a gas or liquid is needed for control or measurement.

Position
Position Sensors/Detectors/Transducers are electronic devices used to sense the positions of valves, doors, throttles, etc. and supply signals to the inputs of control or display devices. Key specifications include sensor type, sensor function, measurement range, and features which are specific to the sensor type. Position sensors are used wherever positional information is needed in a myriad of control applications. A common position transducer is a so-called string-pot, or string potentiometer. See also proximity sensors.

Particle
Particle Sensors/Detectors are electronic devices used to sense dust and other airborne particulates and supply signals to the inputs of control or display
devices. Particle sensors are common in bin and baghouse monitoring. Key specifications include transducer type, minimum detectable particle size, operating temperature range, sample volume, and response time. Particle detectors used in nuclear engineering are referred to as radiation detectors (see above).

**Motion**

Motion Sensors/Detectors/Transducers are electronic devices that can sense the movement or stoppage of parts, people, etc. and supply signals to the inputs of control or display devices. Typical applications of motion detection are detecting the stalling of conveyors or the seizing of bearings. Key specifications include intended application, sensor type, sensor function, and minimum and maximum speeds.

**Metal**

Metal Detectors are electronic or electro-mechanical devices used to sense the presence of metal in a variety of situations ranging from packages to people. Metal detectors can be permanent or portable and rely on a number of sensor technologies with electromagnetics being popular. Key specifications include intended application, maximum sensing distance, and certain feature choices like handheld and fixed systems. Metal detectors can be tailored to explicitly detect metal in specific manufacturing operations such as sawmilling or injection molding.

**Level**

Level Sensors/Detectors are electronic or electro-mechanical devices used for determining the height of gases, liquids, or solids in tanks or bins and providing signals to the inputs of control or display devices. Typical level sensors use ultrasonic, capacitance, vibratory, or mechanical means to determine product height. Key specifications include sensor type, sensor function, and maximum sensing distance. Level sensors/detectors can be of the contacting or non-contacting type.

**Leak**

Leak Sensors/Detectors are electronic devices used for identifying or monitoring the unwanted discharge of liquids or gases. Some leak detectors rely on ultrasonic means to detect air leaks, for example. Other
leak detectors rely on simple foaming agents to measure the soundness of pipe joints. Still other leak detectors are used to measure the effectiveness of the seals in vacuum packages.

**Humidity**

Humidity Sensors/Detectors/Transducers are electronic devices which measure the amount of water in the air and convert these measurements into signals that can be used as inputs to control or display devices. Key specifications include maximum response time and minimum and maximum operating temperatures.

**Gas and Chemical**

Gas and Chemical Sensors/Detectors are fixed or portable electronic devices used to sense the presence and properties of various gases or chemicals and relay signals to the inputs of controllers or visual displays. Key specifications include intended application, sensor/detector type, measurement range, and features. Gas and chemical sensors/detectors are used for confined space monitoring, leak detection, analytical instrumentation, etc. and are often designed with the capability of detecting multiple gases and chemicals.

**Force**

Force Sensors/Transducers are electronic devices that measure various parameters related to forces such as weight, torque, load, etc. and provide signals to the inputs of control or display devices. A force sensor typically relies on a load cell, a piezoelectric device whose resistance changes under deforming loads. Other methods exist for measuring torque and strain. Key specifications include sensor function, number of axes, minimum and maximum loads (or torques), minimum and maximum operating temperature, as well as the dimensions of the sensor itself. Force sensors are used in load measuring applications of all kinds, from truck scales to bolt tensioning devices.

**Flow**

Flow Sensors/Detectors are electronic or electro-mechanical devices use to sense the movement of gases, liquids, or solids and provide signals to the inputs of control or display devices. A flow sensor can be all electronic—using ultrasonic detection from outside a pipeline, say—or partially mechanical—a paddlewheel, for instance, that sits
and spins directly in the flowstream itself. Key specifications include sensor/detector type, sensor function, maximum flowrate, maximum working pressure, and minimum and maximum operating temperatures. Flow sensors are used extensively in the processing industries. Some designs for panel mounting allow quick indication of flow conditions to process operators.

**Flaw**

Flaw Sensors/Detectors are electronic devices used in a variety of manufacturing processes to uncover inconsistencies on surfaces or in underlying materials such as welds. Flaw detectors use ultrasonic, acoustic, or other means to identify defects in materials and can be portable or fixed installations. Key specifications include sensor type, detectable defect or thickness range, and intended application.

**Flame**

Flame Detectors are opto-electronic devices used to sense the presence and quality of fire and provide signals to the inputs of control devices. A flame detector typically relies on ultraviolet or infrared detection of the presence of flame and finds use in many combustion control applications such as burners. A key specification is detector type. Flame detectors find applications in safety settings too, such as in under-the-hood fire suppression systems.

**Electrical**

Electrical Sensors/Detectors/Transducers are electronic devices that sense current, voltage, etc. and provide signals to the inputs of control devices or visual displays. Electrical sensors often rely on hall effect detection but other methods are used as well. Key specifications include sensor type, sensor function, minimum and maximum measurement ranges, and operating temperature range. Electrical sensors are used wherever information on the state of an electrical system is needed and are employed in everything from railway systems to fan, pump, and heater monitoring.

**Applications and Industries**

A sensor is generally intended to produce a variable signal over some measurement range as opposed to a switch which generally acts in a binary fashion, as in on or off. While this is not always true it helps when it comes to deciding between sensors or switches. For example, a level switch can detect when a certain specified level in a tank has been reached and signal a pump to stop running. A level sensor, on
the other hand, can sense changing tank depth and provide signals that can be proportionally displayed on a readout, etc. Thus, where a sump pump could use a level switch to signal a pump to start running at a certain level, a fuel tank level sensor would determine the tank status between empty and full and provide signals to a fuel gage, etc. Some manufacturers refer to this distinction as “point” versus “continuous” sensing.

Sensors are arranged by what is being sensed: pressure, temperature, proximity, etc. Intended application makes a good place to search for specific situations where a specifier might not know the sensor/transducer type. For example, if a gear tooth sensor is needed for building a zero-speed detector, selecting this will produce several products for gear tooth detection, some of which rely on hall effect and others which use magnetics to sense a passing tooth. Picking the value “zero-speed” will produce similar results. Likewise, selecting values from sensor/detector/transducer function will search across the many sub-categories to produce matches from the range of transducer types. Picking the value “speed” here will produce sensors of the optical and hall effect varieties. Speed sensors can also be magnetic or infrared based.

Transducer type is another way to search for particular sensors. Selecting “infrared,” for example, will produce leak detectors, flame detectors, speed sensors, etc. all of which use infrared as their sensing means.

There is some overlap among the sub-categories. For instance, while geartooth sensors detect metal, metal detectors are also available as complete units designed to detect metal on food processing conveyor lines, injection molding lines, etc. Selecting the sub-category Metal Detectors will not show any geartooth sensors because these are found under Motion sensors.

**Considerations**

Infrared sensors use infrared light in various forms. Some detect the infrared radiation emitted by all objects. Others cast infrared beams that are reflected back to sensors which look for interruptions of the beams.

Temperature sensors generally rely on RTDs or thermistors to sense changes in temperature through the change in electrical resistance that occurs in materials.

Non-contacting proximity sensors often use hall effect phenomena, eddy currents, or capacitive effects to detect the nearness of conductive metals. Other methods are used as well, including optical and laser. Where proximity sensors can be used to detect small changes in the positions of targets, simple on/off proximity switches use the same methods to detect, for instance, an open door.

Ultrasonic sensors measure the time between the emission and reception of ultrasonic waves to determine the distance to a tank’s contents, for example. In another form, ultrasonic sensors detect the ultrasonic energy emitted by leaking air, etc.
Force and pressure sensors typically use strain gages or piezoelectric devices which change their resistance characteristics under applied loads. These changes can be calibrated over the linear ranges of the transducers to produce measures of weight (force) or pressure (force per unit area).

Vision sensors typically rely on CCD, infrared, or ultraviolet cameras to produce images that can be interpreted by software systems to detect flaws, sense barcodes, etc.

**Important Attributes**

**Sensor/Detector/Transducer Type**
Sensor types are common among many of the various subcategories. For example, Hall effect sensors are found in proximity sensors, level sensors, motion sensors, and so on. Infrared sensors are used for level sensing, flame detection, etc. Sensing a fuel level in a tank, say, can be achieved through a number of sensor types.

**Intended Application**
Picking an intended application can help narrow choices for specific instances. Proximity sensors for pneumatic cylinders, for example, are designed to attach directly to a cylinder's tie rods, and thus have specific mounting arrangements, as shown at right.

**Output Types**
Many control sensors use 4-20 mA current loops, where 4 mA represents the low side of the analog signal and 20 mA represents the high side. Digital switches are used as well, among them NPN/PNP, USB, etc.

**Response Time**
Many sensors have response times measured in milliseconds, while sensors for gases, leaks, etc. may have their response times measured in seconds or even minutes.

**Features**
Sensors designed to function in extreme environments, hazardous locations, etc. can be selected here.

**Related Product Categories**

- **Encoders** are electromechanical devices which are used to convert linear or rotary motions to analog or digital output signals.
- **Load Cells** are mechanical or electronic devices designed to convert forces, either compressive, tensile, torsional, or shear, into electrical signals.
- **Monitors** are typically electronic devices used to remotely or conveniently view information as required.
- **Data Acquisition Systems** (abbreviated DAQ or DAS) collect analog signals from sensors measuring real-world samples and transduce them into digital formats that are processed by computers.
- **Data Loggers** are electronic data storage devices used to gather and record various data-over-time measurements.
- **Switches** are electro-mechanical devices that are used in electrical circuits.
- **Thermocouples** are mechanical devices formed of dissimilar metal wires welded together and used for the measurement of temperature.
- **Controls and Controllers** see our Controls and Controllers Buyer’s Guide.

**General**

A brief glossary of sensor terms
http://www.mfg.mtu.edu/cyberman/machtool/machtool/sensors/fundamental.html

The ISA maintains a collection of automation articles, with some addressing sensors

General discussion of sensor outputs

An industry text about sensors

Trade groups
https://www.isa.org

**Manufacturers and Suppliers**

http://ecatalog.beisensors.com/category/rotary-hall-effect-sensor
http://catalog.carelusa.com/category/air-conditioning-refrigeration-sensors-accessories&bc=100
http://catalog.compressedairsystems.com/viewitems/all-categories/compressed-air-leak-detectors?
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