**International Journal of Engineering Research and Development**
*e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com*
*Volume 10, Issue 4 (April 2014), PP.72-85*

# Types of Sensors and Their Applications

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**Abstract:-** As we all know that the sensors are the most important part of the embedded system and the robotics world. By using different types of sensors we can minimize the logic circuits and also make the system more efficient to get output by taking less input. Therefore, here is detailed view of different types of sensors and their applications in the different fields.

**Keywords**:- sensors, temperature sensors, IR sensors, UV sensors, Touch sensors, Proximity sensors, advanced sensor technology.

## I. INTRODUCTION

**Sensors** are sophisticated devices that are frequently used to detect and respond to electrical or optical signals. A **Sensor** converts the physical parameter (for example: temperature, blood pressure, humidity, speed, etc.) into a signal which can be measured electrically. Let's explain the example of temperature. The mercury in the glass thermometer expands and contracts the liquid to convert the measured temperature which can be read by a viewer on the calibrated glass tube.

### A. CRETERIA TO CHOOSE THE SENSORS

There are certain features which have to be considered when we choose a sensor. They are as given below:

1. **Accuracy**
2. **Environmental condition - usually has limits for temperature/ humidity**
3. **Range - Measurement limit of sensor**
4. **Calibration - Essential for most of the measuring devices as the readings changes with time**
5. **Resolution - Smallest increment detected by the sensor**
6. **Cost**
7. **Repeatability - The reading that varies is repeatedly measured under the same environment.**

### B. CLASSIFICATION OF SENSORS

The sensors are classified into the following criteria:

1. Primary Input quantity (Measured)
2. Transduction principles (Using physical and chemical effects)
3. Material and Technology
4. Property
5. Application

## II. CLASSIFICATION BASED ON PROPERTY:

- Temperature - Thermistors, thermocouples, RTD's, IC and many more.
- Image Sensors - These are based on the CMOS technology. They are used in consumer

Motion Detectors - These are based on the Infra-Red, Ultrasonic, and Microwave / radar technology. They are used in videogames and simulations, light activation and security detection.

- Pressure - Fibre optic, vacuum, elastic liquid based manometers, LVDT, electronic.
- Flow - Electromagnetic, differential pressure, positional displacement, thermal mass, etc.
- Level Sensors - Differential pressure, ultrasonic radio frequency, radar, thermal displacement, etc.
- Proximity and displacement - LVDT, photoelectric, capacitive, magnetic, ultrasonic.

- Biosensors - Resonant mirror, electrochemical, surface Plasmon resonance, Light addressable potentio-metric.
- Image - Charge coupled devices, CMOS
- Gas and chemical - Semiconductor, Infrared, Conductance, Electrochemical.
- Acceleration - Gyroscopes, Accelerometers.
- Others - Moisture, humidity sensor, Speed sensor, mass, Tilt sensor, force, viscosity.

Surface Plasmon resonance and Light addressable potentio-metric from the Bio-sensors group are the new optical technology based sensors. CMOS Image sensors have low resolution as compared to charge coupled devices. CMOS has the advantages of small size, cheap, less power consumption and hence are better substitutes for Charge coupled devices. Accelerometers are independently grouped because of their vital role in future applications like aircraft, automobiles, etc. and in fields of videogames, toys, etc. Magnetometers are those sensors which measure magnetic flux intensity B (in units of Tesla or As/m2).

**Classification based on Application:**

- Industrial process control, measurement and automation
- Non-industrial use – Aircraft, Medical products, Automobiles, Consumer electronics, other type of sensors.

**Sensors can be classified based on power or energy supply requirement of the sensors:**

- Active Sensor - Sensors that require power supply are called as Active Sensors. Example: LIDAR (Light detection and ranging), photoconductive cell.
- Passive Sensor - Sensors that do not require power supply are called as Passive Sensors. Example: Radiometers, film photography.

**In the current and future applications, sensors can be classified into groups as follows:**

- Accelerometers - These are based on the Micro Electro Mechanical sensor technology. They are used for patient monitoring which includes pace makers and vehicle dynamic systems.
- Biosensors - These are based on the electrochemical technology. They are used for food testing, medical care device, water testing, and biological warfare agent detection.

## III. TYPES OF SENSORS

### 1. Temperature Sensors

This device collects information about temperature from a source and converts into a form that is understandable by other device or person. The best illustration of a temperature sensor is mercury in glass thermometer. The mercury in the glass expands and contracts depending on the alterations in temperature. The outside temperature is the source element for the temperature measurement. The position of the mercury is observed by the viewer to measure the temperature. There are two basic types of temperature sensors:

- Contact Sensors – This type of sensor requires direct physical contact with the object or media that is being sensed. They supervise the temperature of solids, liquids and gases over a wide range of temperatures.

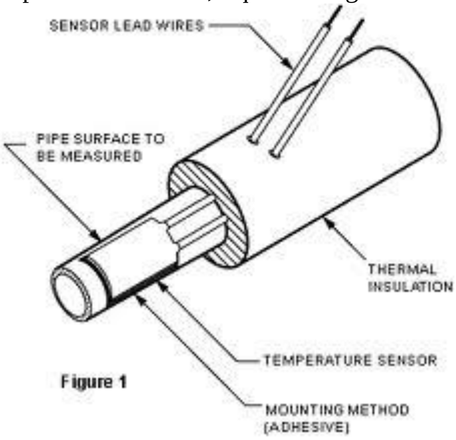


Figure 1

- Non contact Sensors – This type of sensor does not require any physical contact with the object or media that is being sensed. They supervise non-reflective solids and liquids but are not useful for gases due to natural transparency. These sensors use Plank's Law to measure temperature. This law deals with the heat radiated from the source of heat to measure the temperature.

**Working of different types of Temperature Sensors along with examples**

**(i) Thermocouple** – They are made of two wires (each of different homogeneous alloy or metal) which form a measuring junction by joining at one end. This measuring junction is open to the elements being measured. The other end of the wire is terminated to a measuring device where a reference junction is formed. The current flows through the circuit since the temperature of the two junctions are different. The resulted milli-voltage is measured to determine the temperature at the junction. The diagram of thermocouple is shown below.

**(ii) Resistance Temperature Detectors (RTD)** – These are types of thermal resistors that are fabricated to alter the electrical resistance with the alteration in temperature. They are very expensive than any other temperature detection devices. The diagram of Resistance Temperature Detectors is shown below.

**(iii) Thermistors** – They are another kind of thermal resistor where a large change in resistance is proportional to small change in temperature.

**2. IR Sensor**

This device emits and/or detects infrared radiation to sense a particular phase in the environment. Generally, thermal radiation is emitted by all the objects in the infrared spectrum. The infrared sensor detects this type of radiation which is not visible to human eye.

**Advantages**

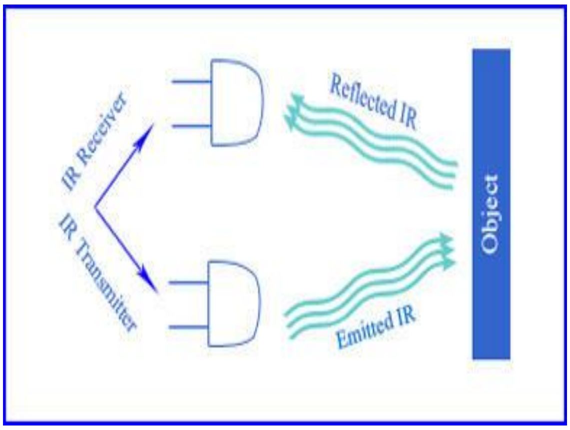
- Easy for interfacing
- Readily available in market

**Disadvantages**

- Disturbed by noises in the surrounding such as radiations, ambient light etc.

**Working**

The basic idea is to make use of IR LEDs to send the infrared waves to the object. Another IR diode of the same type is to be used to detect the reflected wave from the object. The diagram is shown below.




When IR receiver is subjected to infrared light, a voltage difference is produced across the leads. Less voltage which is produced can be hardly detected and hence operational amplifiers (Op-amps) are used to detect the low voltages accurately.

Measuring the distance of the object from the receiver sensor: The electrical property of IR sensor components can be used to measure the distance of an object. The fact when IR receiver is subjected to light, a potential difference is produced across the leads.

**3. UV Sensor**

These sensors measure the intensity or power of the incident ultraviolet radiation. This form of electromagnetic radiation has wavelengths longer than x-rays but is still shorter than visible radiation. An active material known as polycrystalline diamond is being used for reliable ultraviolet sensing. UV sensors can discover the exposure of environment to ultraviolet radiation.

**Criteria to select a UV Sensor**

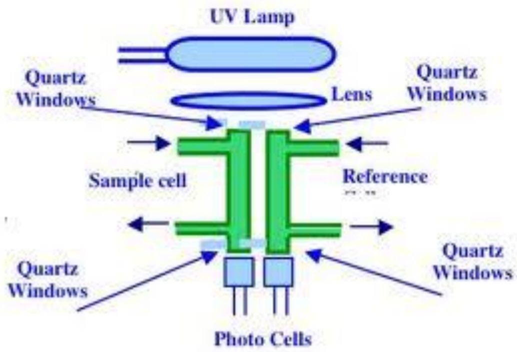
- Wavelength ranges in nanometres (nm) that can be detected by the UV sensors.
- Operating temperature
- Accuracy
- Weight
- Power range

**Working**

The UV sensor accepts one type of energy signal and transmits different type of energy signals.
To observe and record these output signals they are directed to an electrical meter. To create graphs and reports, the output signals are transmitted to an analog-to-digital converter (ADC), and then to a computer with software.

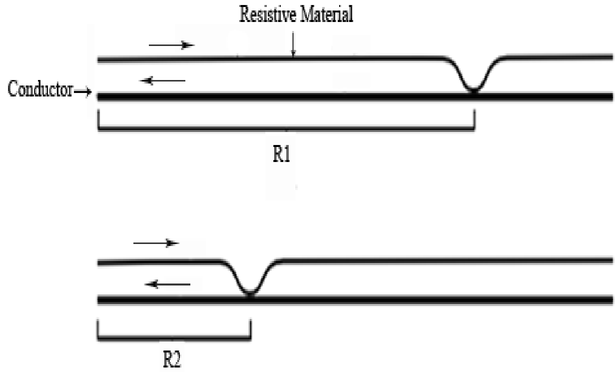
**Examples include:**

- UV phototubes are radiation-sensitive sensors supervise UV air treatments, UV water treatments, and solar irradiance.
- Light sensors measure the intensity of incident light.
- UV spectrum sensors are charged coupled devices (CCD) utilized in scientific photography.
- Ultraviolet light detectors.
- Germicidal UV detectors.
- Photo stability sensors.




## IV. TOUCH SENSOR

A touch sensor acts as a variable resistor as per the location where it is touched. The figure is as shown below.

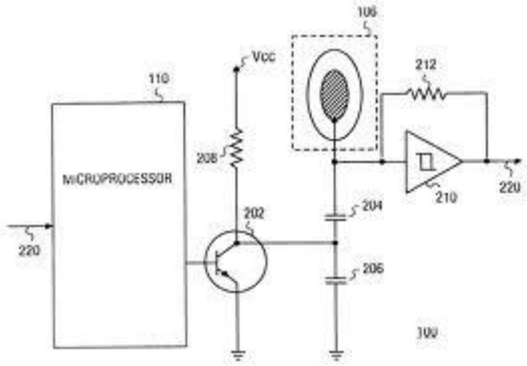



A touch sensor is made of: Fully conductive substance such as copper Insulated spacing material such as foam or plastic partially conductive material

**Principle and Working**

The partially conductive material opposes the flow of current. The main principle of the linear position sensor is that the current flow is more opposed when the length of this material that must be travelled by the current is more. As a result, the resistance of the material is varied by changing the position at which it makes contact with the fully conductive material.

Generally, softwares are interfaced to the touch sensors. In such a case, a memory is being offered by the software. They can memorize the 'last touched position' when the sensor is deactivated. They can memorize the 'first touched position' once the sensor gets activated and understand all the values related to it. This act is similar to how one moves the mouse and locates it at the other end of mouse pad in order to move the cursor to the far side of the screen.




## V. PROXIMITY SENSOR

A proximity sensor detects the presence of objects that are nearly placed without any point of contact. Since there is no contact between the sensors and sensed object and lack of mechanical parts, these sensors have long functional life and high reliability. The different types of proximity sensors are Inductive Proximity sensors, Capacitive Proximity sensors, Ultrasonic proximity sensors, photoelectric sensors, Hall-effect sensors, etc.

**Working**

A proximity sensor emits an electromagnetic or electrostatic field or a beam of electromagnetic radiation (such as infrared), and waits for the return signal or changes in the field. The object which is being sensed is known as the proximity sensor's target.

Inductive Proximity sensors – They have an oscillator as input to change the loss resistance by the proximity of an electrically conductive medium. These sensors are preferred for metal targets.

Capacitive Proximity sensors – They convert the electrostatic capacitance variation flanked by the detecting electrode and the ground electrode. This occurs by approaching the nearby object with a variation in an oscillation frequency. To detect the nearby object, the oscillation frequency is transformed into a direct current voltage which is compared with a predetermined threshold value. These sensors are preferred for plastic targets.

The movement of ultrasonic waves differs due to shape and type of media. For example, ultrasonic waves move straight in a uniform medium, and are reflected and transmitted back at the boundary between differing media. A human body in air causes considerable reflection and can be easily detected.

The travelling of ultrasonic waves can be best explained by understanding the following:

**1. Multi-reflection**

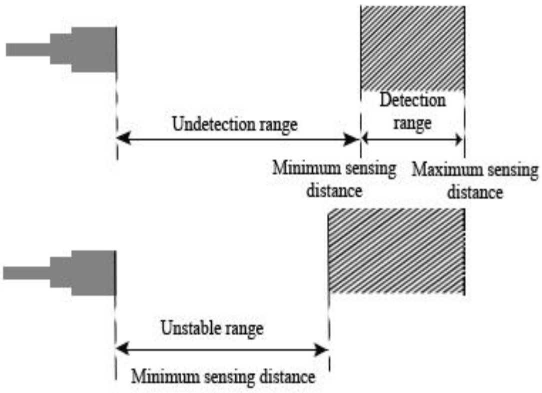
Multi-reflection takes place when waves are reflected more than once between the sensor and the detection object.

**2. Limit zone**

The minimum sensing distance and maximum sensing distance can be adjusted. This is called the limit zone.

**3. Undetection zone**

The undetected zone is the interval between the surface of the sensor head and the minimum detection distance resulting from detection distance adjustment.




The Undetection zone is the area close to the sensor where detection is not possible due to the sensor head configuration and reverberations. Detection may occur in the uncertainty zone due to multi-reflection between the sensor and the object.

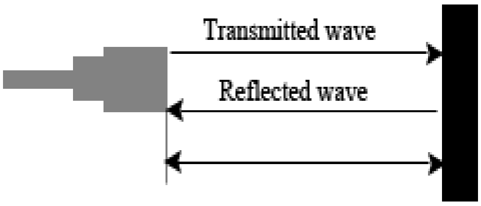
**Principle**:

Different definitions are approved to distinguish sensors and transducers. Sensors can be defined as an element that senses in one form of energy to produce a variant in same or another form of energy. Transducer converts the measured into the desired output using the transduction principle.

Based on the signals that are obtained and created, the principle can be categorized into following groups namely, Electrical, Mechanical, Thermal, Chemical, Radiant, and Magnetic.

Let's take the example of an ultrasonic sensor.

An ultrasonic sensor is used to detect the presence of an object. It achieves this by emitting ultrasonic waves from the device head and then receiving the reflected ultrasonic signal from the concerned object. This helps in detecting the position, presence and movement of objects.




Since ultrasonic sensors rely on sound rather than light for detection, it is widely used to measure water-levels, medical scanning procedures and in the automobile industry. Ultrasonic waves can detect transparent objects such as transparent films, glass bottles, plastic bottles, and plate glass, using its Reflective Sensors.

**6. Advanced Sensor Technology**

Sensor technology is used in wide range in the field of Manufacturing. The advanced technologies are as follows:

1. **Bar-code Identification** - The products sold in the markets has a Universal Product Code (UPC) which is a 12 digit code. Five of the numbers signify the manufacturer and other five signify the product. The first six digits are represented by code as light and dark bars. The first digit signifies the type of number system and the second digit which is parity signifies the accuracy of the reading. The remaining six digits are represented by code as dark and light bars reversing the order of the first six digits. Bar code is shown in the figure given below.

09062001 02920

The bar code reader can manage different bar code standards even without having the knowledge of the standard code. The disadvantage with bar coding is that the bar scanner is unable to read if the bar code is concealed with grease or dirt.

2. **Transponders** - In the automobile section, Radio frequency device is used in many cases. The transponders are hidden inside the plastic head of the key which is not visible to anyone. The key is inserted in the ignition lock cylinder. As you turn the key, the computer transmits a radio signal to the transponder. The computer will not let the engine to ignite until the transponder responds to the signal. These transponders are energized by the radio signals. The figure of a transponder is as shown below:


3. **Electromagnetic Identification of Manufactured Components** - This is similar to the bar code technology where the data can be coded on magnetic stripe. With magnetic striping, the data can be read even if the code is concealed with grease or dirt.
4. **Surface Acoustic Waves** - This process is similar to the RF identification. Here, the part identification gets triggered by the radar type signals and is transmitted over long distances as compared to the RF systems.
5. **Optical Character Recognition** - This is a type of automatic identification technique which uses alphanumeric characters as the source of information. In United States, Optical character recognition is used in mail processing Centre's. They are also used in vision systems and voice recognition systems.

Applications of these sensors:

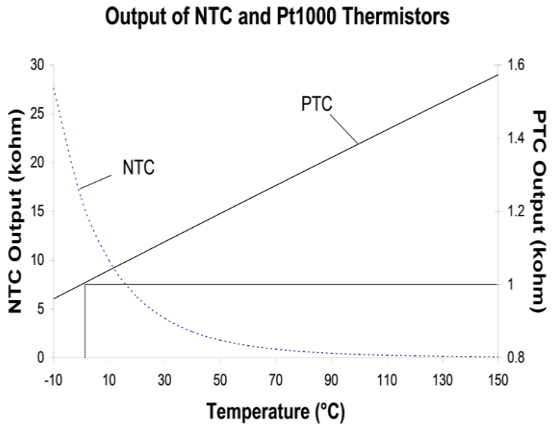
1. Temperature sensors:

[1] Thermistors

Thermistors (thermally sensitive resistors) are available in two types:

- NTC (Negative Temperature Coefficient) resistance decreases with rising temperature
- PTC (Positive Temperature Coefficient) resistance increases with rising temperature

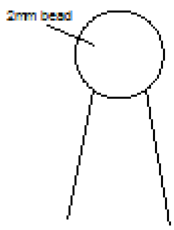
In both types, the electrical resistance changes with temperature according to a defined curve.




| **Temp (°C)** | **Resistance (ohm)** | | **Temp (°C)** | **Resistance (ohm)** | |
|---|---|---|---|---|---|
| | **NTC** | **Pt1000** | | **NTC** | **Pt1000** |
| **-10** | **27665** | **960.9** | **80** | **629** | **1308.9** |
| **0** | **16325** | **1000.0** | **90** | **458.8** | **1347.0** |
| **10** | **9950** | **1039.0** | **100** | **340.0** | **1385.0** |
| **20** | **6245** | **1077.9** | **110** | **255.6** | **1422.9** |
| **30** | **4029** | **1116.7** | **120** | **194.7** | **1460.6** |
| **40** | **2663** | **1155.4** | **130** | **150.4** | **1498.2** |
| **50** | **1802** | **1194.0** | **140** | **117.4** | **1535.8** |
| **60** | **1244** | **1232.4** | **150** | **92.65** | **1573.1** |
| **70** | **876** | **1270.7** | | | |

**[2] NTC**

The NTCs used by McLaren Electronics are polycrystalline metal oxide ceramic. These precision NTC elements have a very tight measuring tolerance in a small package, which results in a fast and accurate response.




Near room temperature, these devices offer the greatest sensitivity to temperature differences – an order of magnitude greater than PTCs or thermocouples. The nominal resistance of the NTC thermistors used in McLaren Electronics sensors is 5kohm at 25°C. However, the resistance decreases very rapidly with temperature, making them less suitable for accurate high temperature measurements. Furthermore, the low resistance at higher temperatures makes the sensors sensitive to the resistance of the harness and connector contacts.

Because of their high output, NTCs can interface with simple electronic interface circuits as used in mass market control systems. Our systems have high sensitivity inputs which do not need the high output of an NTC sensor. However, our systems can interface to NTC sensors, if required.

The Temperature-Resistance function for NTC thermistors is defined as follows:

Temperature (K) = 1 / (A + B*ln[R] + C*[lnR] 3)

R = Resistance of sensor (ohm)

A = 1.28735 x 10-3

B = 0.2357532 x 10-3

C = 94.95448 x 10-9

**[3] PTC**

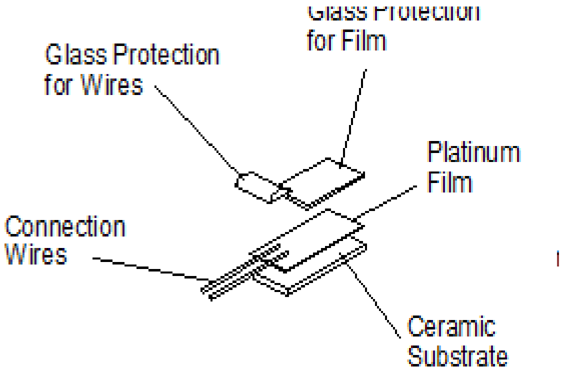
Platinum (Pt.) thermistors are the most stable temperature sensors in common use today. They are constructed from a platinum film deposited onto a ceramic substrate. Platinum has been used to measure temperature for over 100 years. It offers high reliability, long term stability, and rapid response. It is also insensitive to vibration and thermal shock.

The resistance varies with temperature in a precise fashion. Between 0 and 600°C, this response can be expressed as an exact mathematical function. Pt. elements are normally supplied with a base resistance of either 100 ohm (Pt100) or 1000 ohm (Pt1000), measured at 0°C.

The Resistance-Temperature transfer function for Pt1000 sensors is defined as follows:

Sensor Resistance (ohm) = 1000 * (1 + ((3.90802x10-3 * T) – (0.5802x10-6 * T2)))

T = Temperature (°C)




**[4] Application of NTCs and PTCs**

To measure resistance, an electric current has to flow through the element. This generates heat, resulting in errors. To minimize such errors, the measuring current needs to be kept low (typically less than 1mA). The wires joining the sensing element to the measuring device have their own resistance, which may vary in unpredictable ways, and so cause further errors. By selecting the sensor resistance to be as large as possible, both self-heating and lead wire resistance errors can be minimized.

Pt100s exhibit such a small resistance change with temperature that they tend to be overly sensitive to cable length and connector contact resistance changes. McLaren Electronics offers temperature sensors of all three types, i.e. NTC, Pt100 and Pt1000. We recommend the use of Pt1000 devices for highest accuracy and stability. All of our ECUs support Pt1000s as standard, but can be modified to support NTCs and Pt100s.

**[5] Sensor Design**

In automotive applications, the temperature of a gas (typically air) or a liquid (typically oil, water, fuel, etc.) needs to be measured. Gases and liquids have very different thermal characteristics, so each medium requires a different sensor design in order to make accurate temperature measurements.

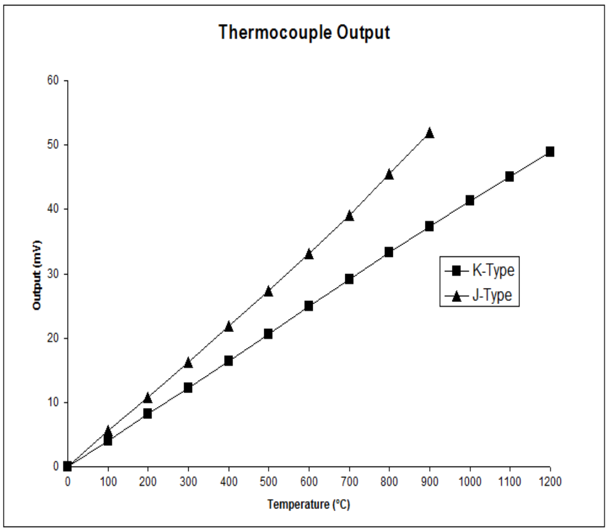
Heat conducted into the sensor from the surrounding medium alters the temperature of the sensing tip. Because gases are poor heat conductors and have a very low thermal mass, air temperature sensors must also have a very low thermal mass. This minimizes errors in measurement and allows a rapid response to changes in air temperature.

McLaren Electronics air temperature sensors achieve this by exposing the sensor element tip directly to the air flow, without compromising ruggedness or reliability. Both screw-in and flange mount body styles are available. Sensors with a flange mount body can be aligned in the air stream to exploit the planar symmetry of the Pt. elements. This is most important for low velocity air flows, for example if the sensor is located at the end of a manifold pipe.

With screw-in devices, the point at which the screw thread will tighten cannot be defined exactly. Any error due to misalignment of the element in the air flow is minimized by careful attention to the design of the sensor housing.

The fluids used in automotive applications are often aggressive and turbulent. The sensing element must be isolated from the medium, so the sensor element is encapsulated at the tip of a thermally conductive housing. This tip is made as small as possible to ensure minimal thermal mass – reducing error and response time. This package offers a very rugged and accurate method of measuring fluid temperature.

**[6] Thermocouple**




A thermocouple consists of a pair of metals, with different thermo potentials, which are welded together to form a junction. This junction can be very small, so a thermocouple is easily manufactured into a small package. When the junction is heated, a voltage is generated which increases with increasing temperature. Thermocouples are usually used to measure very high temperatures, such as exhaust gas, but may also be used for lower temperatures. MESL offer both K-type (Chromel/Alumel) and J-type (Iron/Constantan) thermocouples. The output voltages from these two types of thermocouple are shown below.

| **Temperature (°C)** | **Output (mV)** | |
|---|---|---|
| | **J-Type** | **K-Type** |
| **0** | **0** | **0** |
| **100** | **4.095** | **5.629** |
| **200** | **8.137** | **10.779** |
| **300** | **12.207** | **16.327** |
| **400** | **16.395** | **21.848** |
| **500** | **20.640** | **27.393** |
| **600** | **24.902** | **33.102** |
| **700** | **29.128** | **39.132** |
| **800** | **33.270** | **45.494** |
| **900** | **37.325** | **51.877** |
| **1000** | **41.269** | |
| **1100** | **45.108** | |
| **1200** | **48.828** | |

For optimum performance the Chromel/Alumel thermocouple wires should be terminated to Alumel and Chromel contacts within a connector. Thermocouple compensating cable must be used in the harness to connect to the interface electronics. If copper or copper alloy contacts are used in intermediate connectors, errors may be introduced which will depend on the temperature difference across the connector pair. These errors will be negligible if the connector is kept isothermal.

**[7] Interface Electronics**

The junction is the point of temperature measurement. The other end of each sensor wire needs to be connected to specialized electronics for reference cold junction compensation. Because the output voltage changes by just a few microvolts per degree, well designed and well filtered electronics are required, particularly if used close to an ignition system.

**[8] Sensor Design**

McLaren Electronics thermocouple sensors are mainly for the measurement of high temperature (up to approx. 1250°C). The element is surrounded by a stainless steel tube. The diameter of the steel tube has been selected as a compromise between mechanical robustness (particularly important when measuring exhaust gas temperature) and short response time. The steel tube is electrically isolated from the thermocouple as required by most cold junction compensation circuits.

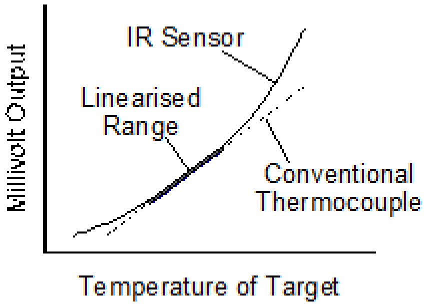
**[9] Infra-Red**

Infra-red sensors measure temperature by detecting the heat radiated from a target which may be some distance away. Such a non-contact measurement can be used in applications where direct contact with the medium is difficult, e.g. when measuring the temperature of rotating parts such as a tyre or a brake disc.

**[10] Principles of Operation**

The Infra-red sensor is a thermoelectric device which converts radiated heat energy into an electrical potential. The output is non-linear (although it is continuous and repeatable).

0-5V Output: Over the specified target temperature, the sensor gives an output in the 0-5V range.

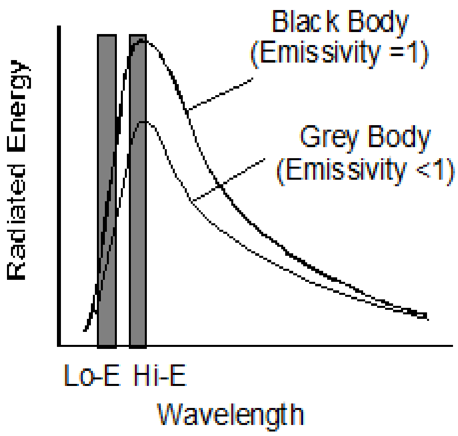



MES Infra-red sensors obtain all their power from the energy radiated from the target so, in order to minimize errors, the leakage current drawn by the attached measuring device must not exceed 10nA.

**[11] Emissivity**

Different materials have a different emissivity, i.e. they radiate different amounts of energy even when held at the same temperature. Emissivity values are in the range 0 to 1. A perfectly reflecting surface has an emissivity of 0. Such a surface acts like a mirror in that it reflects an image of its surrounds rather than emitting its own radiation.

A perfect black body has an emissivity of 1. This kind of surface does not reflect at all, it emits energy in a characteristic way which depends entirely on its temperature.




All real objects have a lower emissivity than an ideal black body and therefore radiate less energy. Shiny metal surfaces have a low emissivity, in the region of 0.05 to 0.2, whilst non-metals, organic materials and coated metals typically have high emissivity, in the range of 0.8 to 0.95. McLaren Electronics offers Infra-red sensors suitable for the high emissivity range of 0.8 to 0.98.

Emissivity is difficult to measure accurately and it can change with the temperature of the target surface. This affects the relationship between the temperature of the surface and the amount of energy it radiates. Unless the sensor reading is interpreted to take the emissivity into account, this appears as a measurement error. The sensors are sensitive to wavelengths which are much longer than those of visible light, so the color of the target has little effect.

Please contact McLaren Electronics for assistance in determining the emissivity of your target medium.

**[12] Failure Modes**

The sensor reading will change if the sensitive face becomes dirty or scratched, and care should be taken to clean the sensors with a suitable, non-aggressive substance. An air purge system can be supplied which may be used to force air through the linearized output sensor to prevent the accumulation of debris in dirty environments. For both types of IR temperature sensor the narrow field of view also allows the sensor to be positioned some distance from the target.

Failure of the sensor may be induced by over temperature of either the sensor or the target, or by static discharge (if not properly grounded). The mounting arrangement should minimize vibration and prevent the impact of debris on the sensor.

If an Infra-red sensor is pointed at a very high temperature target, the internal circuits may be overloaded, causing permanent damage. Please contact McLaren Electronics if you intend to use an Infra-red sensor in a situation where the target temperature may exceed the temperature stated in the Product Summary.

**[13] Applications**

Due to its small size and ruggedness, this sensor is ideal for tyre and brake disk temperature measurement.

2. IR sensors

**Common applications using InfraTec Pyroelectric infrared detectors include:**

- NDIR gas analysis
- IR flame detection
- A variety of analytical instruments for detection of radiation from deep UV to FIR (THz)
- Single and Multi-channel pyrometers

There are also a growing number of diverse applications (some surprising) that use InfraTec thermal detectors. Please let us know if your application might benefit from our highly stable, high performance, and highest quality pyroelectric infrared detectors.

GAS DETECTORS / GAS LEAK DETECTION – By mounting a NBP (Narrow Band Pass) filter in front of our infrared detectors; our device will produce a signal when a pulsed or "chopped" source is used to illuminate it. The absorption region of $CO_2$ gas is 4.26μm so placing a NBP filter at this spectral region in front of our device allows it to see only that region. When $CO_2$ gas leaks into the detector's Field of View the user would see a drop in the device signal when the gas absorbs light energy. In some cases a second "Reference" detector with a 3.95μm filter is used so that the comparison between the two channels gives further evidence of a leak.

**FLAME DETECTION** – Hydrocarbon flames emit radiation between 4-4.6μm and the natural 10 Hertz flickering of any flame is a natural source for our detectors mounted with an "HC" filter. Many clients use this solution to protect lives at chemical and petroleum plants as well as general building safety.

**ALCOHOL TESTING** – Another application in the gas detection market is the testing for an illegal level of alcohol in the breath of a driver. Very accurate readings can be obtained as legal evidence for DWI cases. This concept is being taken a step further with the discovery that certain illnesses cause gases to form in the lungs that are not normal, specifically in the case of cancer. By being able to detect certain gases, a quick and inexpensive method of diagnosis may be possible.

**ANESTHESIOLOGY TESTING** – Another gas detection application is the use of our detectors to test for the correct level and mixture of gases used in hospital operating rooms for anesthesiology. Too much, or too little of one component could be fatal.

**PETROLEUM EXPLORATION** – A number of companies are using our detectors for high-temperature down-hole operations as well as topside. Production testing for gas levels below and on the surface is important to determine if drilling operations are proceeding as planned.

**PLANT HEALTH** – Imagine having a device that can test the level of $CO_2$ absorption to analyze the health of plants and check the effect of global warming…it is being done today.

**RAIL SAFETY** – Testing is underway for a device that will "look" at rail cars to test brake and wheel bearing temperatures on the move. This is critical, especially for high speed rail in Europe to detect potential failures before they happen.

**SPACE OPERATIONS** – InfraTec is qualified by the European Space Agency for use on platforms for Earth limb detection for satellite orientation and will potentially see applications in LIDAR applications in the future.

**UNDERGROUND SOLUTION** – The detection of Methane and other gases in mining operations is very critical to the safety of operations around the world. Many customers use our highly reliable devices to protect the lives of those that work long hours beneath our feet.

**WATER and STEEL ANALYSIS** – Clients use our devices to test gases emitted from water as it is boiled down to test for and identify impurities. In the production of steel, the same process can be used to test for correct mixture of elements by super-heating steel pellet samples and observing the level of known gases for quality and content. This gives controllers an opportunity to make corrections before molding or processing the molten metal.

**3. UV sensors:**

The total photon flux of UV radiation from sunlight is close to 8.5 percent of the PPF in full sunlight. The photosynthetic photon flux at noon in full sunlight is about 2000 µmol $m^{-2}$ $s^{-1}$, thus the photon flux of UV radiation is about 170 µmol $m^{-2}$ $s^{-1}$.

The SU ultraviolet sensor comes with a standard length of 5 meters of cable. The sensor is weather resistant. The ultraviolet meter comes in two versions, the MU-100 with a built-in sensor and the MU-200 with a remote sensor attached to the meter with 2 meters of cable.


**4. TOUCH SENSORS:**

- Gaming controllers
- Home entertainment
- Home appliances
- Cellular handsets
- Portable media devices.

**5. Proximity sensors:**

- Parktronic, car bumpers that sense distance to nearby cars for parking
- Ground proximity warning system for aviation safety
- Vibration measurements of rotating shafts in machinery.
- Top dead Centre (TDC)/camshaft sensor in reciprocating engines.
- Sheet breaks sensing in paper machine.
- Anti-aircraft warfare
- Roller coasters
- Conveyor systems
- Mobile devices
- Touch screens that come in close proximity to the face
- Attenuating radio power in close proximity to the body, in order to reduce radiation exposure.

## VI. CONCLUSION

By knowing these types of sensors and their application we can be able to use them in a much specified manner. And also we can them in the various fields according to their principles and applications. The flexibility, fault tolerance, high sensing fidelity, low-cost and rapid deployment characteristics of sensor networks create many new and exciting application areas for remote sensing. In the future, this wide range of application areas will make sensor networks an integral part of our lives. However, realization of sensor networks needs to satisfy the constraints introduced by factors such as fault tolerance, scalability, cost, hardware, topology change, environment and power consumption. Since these constraints are highly stringent and specific for sensor networks, new wireless ad hoc networking techniques are required. we encourage more insight into the problems and more development in solutions to the open research issues as described in this paper.

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