EPCOS

Application Note

Sensors for Air-conditioning in Automobiles

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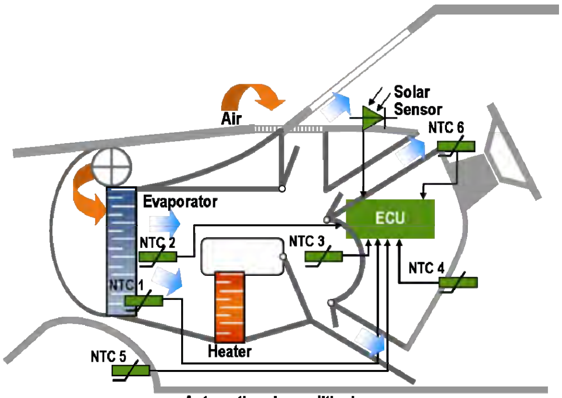
Contents

AUTOMOTIVE

Sensors for air-conditioning in automobiles

Increasing requirements are being made on an automatic and well regulated air-conditioning in automobiles of all classes. Sensor systems are becoming more complex and the demand for high-quality cost-effective sensors is growing.

Because motor vehicles have windows on all sides with various angles of slope, their interior compartment has an irregular temperature distribution and consequently represents a major challenge to creating pleasant ambient conditions.



Automotive air-conditioning

The control of the air-conditioning ought to require only the slightest attention from the driver. Effective air-conditioning helps the driver keep a cool head in the most tricky situations and also minimizes the stress on the passengers. Longer trips tend to be hard on both drivers and passengers, but a well functioning air-conditioning system relieves some of the discomfort.

1. Evaporator sensors

Controlling the temperature of the evaporator is one of the most important functions of temperature sensors in air-conditioning systems. The cooler the evaporator, the faster and more efficiently can the passenger compartment be cooled. However, the evaporator temperature should not come too near the freezing point. Because the evaporator is the coolest point encountered by the stream of air coming from the passenger compartment, this is where most of the condensation is formed due to the low absorption of moisture by the air. It would freeze at temperatures around 0 °C and thus obstruct the air stream. The evaporator sensor would then measure a higher temperature than the real temperature of the air coming from the evaporator. The air-conditioning unit would then continue to cool the air despite the fact that the evaporator was already iced up.

If a high degree of cooling is not required, the evaporator in modern air-conditioning systems does not cool down so much to prevent the air in the passenger compartment becoming too dry. After all, excessively dry air is felt to be unpleasant.

For these reasons, the key factor for an air-conditioning system that functions well is precise measurement of the evaporator temperature by a sensor with a fast response time and high resistance to moisture.

The fins of the evaporator are one possible location for the temperature sensors to monitor the temperature. Another method is to measure the air temperature directly in front of the evaporator. The latter solution has established itself in modern climate controls. This enables the use of faster and more cost effective sensors.

A reliable evaporator sensor from EPCOS is indispensable for a proper functioning of the air-conditioning system because of the ever higher requirements in terms of response time and long operating life.

In 2006 EPCOS has presented a new generation of evaporator sensors:

A newly developed NTC coating combined with well adjusted overmolding processes for the housing results in a sensor solution that features

- increased reliability *

- reduced response time from eight seconds to four seconds.

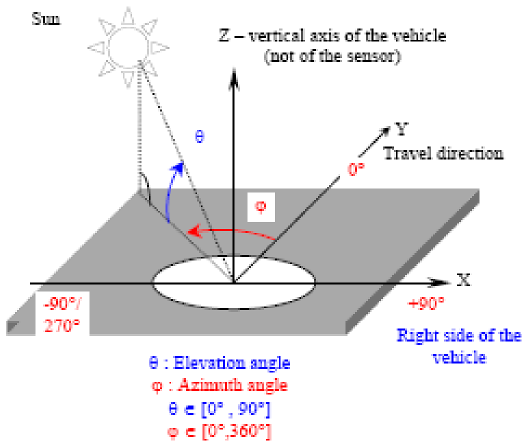
The new evaporator sensor is thus also suitable for the latest CO_2 air-conditioning units.

2. Integral sensors

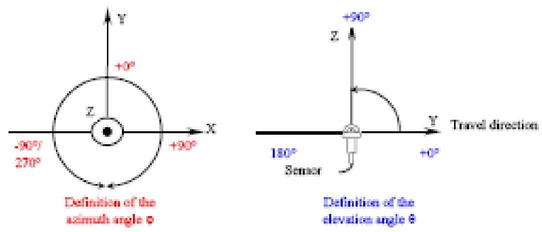
However, an evaporator sensor and an interior temperature sensor alone are not sufficient to set the temperature exactly as required for the passenger compartment. Precise regulation requires temperature sensors that record the temperature of the air stream as far as possible in every air outlet designed to carry air to the feet or body of the driver and passengers in order to enable an automatic regulation process. The temperature sensors should ideally measure the average temperature of the air current. An integral sensor measures the temperature over the entire length of its metal plate, thus recording a good reference value and giving it a critical advantage over point sensors that measure the temperature only at specific spots. Because of the difficulty of predicting the air currents due to the various temperatures it is almost impossible to define a corresponding reference point for a point sensor.

3. Solar sensors

One effect that no temperature sensor can detect is the temperature felt by the passengers caused by direct sunshine on the skin. However, solar sensors are already used in almost every European car starting from the compact class. They can evaluate the solar intensity and in many cases also the direction of the incoming solar rays. This helps dual-zone air-conditioning systems, for instance, to cool the irradiated side of the vehicle more than the side in the shade, irrespective of the temperature actually selected by the control unit.



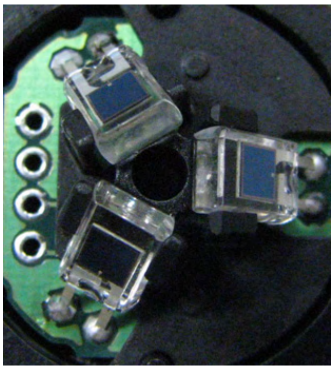
The direction of the solar radiation is defined by a hemisphere described by the azimuth and elevation angles. Both parameters are specified in angular degrees – the azimuth from 0° to 360° and the elevation from 0° to 180°. The degrees of azimuth define the incoming solar radiation in the horizontal plane, where 0° designates the direction of travel. The degrees of elevation describe the incoming solar radiation in the vertical plane, where 90°C corresponds to solar rays coming directly from overhead.



The special features of the passenger compartment, the size of the car's windows, their translucence to solar rays, their slope, and the design aspects of the interior all have a major impact on the effect of the incoming solar rays. Therefore, a solar sensor must as far as possible be exactly adapted to these features as well as to the specific model of vehicle.

Even though the external appearance and the size of the sensor's translucent surface are frequently dependent on the requirements defined by interior designers, the sensor's operation must in no way be limited by these factors.

To ensure that the sensor is as independent as possible of the external design of its housing, it requires a direct optical guidance system of the kind that EPCOS has patented for its sensors.



Using a mathematical algorithm the new 3-zone solar sensor with 3 photodiodes allows the exact determination of the position of the sun and the intensity of the radiation. . The sensor delivers 3 analog signals to the electronic control unit. Alternatively, an active sensor solution can perform the evaluation by itself.

4. Icing protection switches

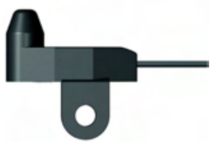
Icing protection switches represent a low-cost alternative to complex control electronics for the air-conditioning system. They are used principally in manual air-conditioning systems.

An electronic circuit connected downstream of the sensor signal evaluates the measured temperature on the basis of reference values and supplies a signal that merely switches the compressor of the coolant circuit on or off. This circuit is integrated into the sensor casing or in the case of a cabled sensor placed just behind the actual sensor.

5. External temperature sensors

Not only must external temperature sensors inform the passengers about the outside temperature, they must also pass on the necessary information to the air-conditioning system or the engine control system.

External temperature sensors mounted behind the front bumper, on the mirror or another part of the bodywork are completely exposed to the elements. They must be able to withstand moisture, heat, frost, road salt and high-pressure washing. Moisture could slowly creep from critical parts such as material junctions up to the sensor head and cause it to fail. The NTC can be protected only if it is part of a completely sealed system.



For this reason, cabled sensors are recommended, so that the connector is not located near any moisture. If the connector is molded directly onto the external temperature sensor, the connector must be absolutely watertight. No moisture must get to the sensor prior to the mounting of the connector. The junction of the plastic to the metal contacts can never be absolutely moisture-tight. The NTC should be completely encapsulated and bonded to the cable. This is the only way to obtain a really watertight design.

6. Design flexibility

Sensors are available with a cable outlet or with a connector outlet molded directly to the sensor in a plastic injection molding process.

To seal the mounting position of the sensors into the air channels tightly against outgoing air, sealing rings may be used in conjunction with bayonet sockets or special catching hooks that are also injection molded to the sensor.

The right selection between the various available mounting types must be made in accordance with the mechanical requirements and the specified mounting forces.