



INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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A REVIEW ON CONDUCTIVE PLASTIC TYPE POTENTIOMETER (SENSOR)

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Accepted Date: 27/02/2014 ; Published Date: 01/05/2014

Abstract: Conductive plastic (CP) type potentiometer is based on a advanced technology in which conductive plastic resistance material is printed on a FR4/ Polyester substrate. This type of potentiometers is used in applications where the precise output and long operational life is required. This technology has made wide use of potentiometers in Automotive & Defence sector which is also called as sensors. CP potentiometers have better advantages over wire wound type of potentiometers in terms of Linearity, CRV (Noise) & Repeatability, thus its usage increasing continuously day by day. In India there are very few (1 or 2) companies which manufactures CP type potentiometers specially by using conductive plastic printing technology. But in other countries like USA, Germany, Japan, China there are number of manufacturers who manufactures CP type potentiometers. As per the current scenario, Indian market will take approx 5 to 10 years to acquire this technology fully.

Keywords: Conductive plastic (CP), Potentiometer (Sensor), Resistance element

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PAPER-QR CODE

Access Online On:

www.ijpret.com

How to Cite This Article:

Ankush Kadu, IJPRET, 2014; Volume 2 (9): 178-184

INTRODUCTION

Rapid developments in the fields of control engineering and in microprocessor and semiconductor technology have resulted in the widespread use of electronically controlled systems in every branch of industry today. This has created a need for sensors that are inexpensive but, at the same time, sufficiently robust, both electrically and mechanically, to withstand a wide range of temperatures (e.g. from -40 to +160 degrees centigrade), particularly in applications involving large quantities, such as the automobile industry. Considering the above needs, conductive plastic potentiometer has been developed that essentially comprises the following components:

1. Resistance element
2. Wiper
3. Shaft
4. Housing

LITERATURE REVIEW

1. Resistance Element

The resistance element comprises substrate & resistance track that gives output variation with respect to resistance value. Substrate is generally made up of FR4 material which is basically glass epoxy & that can sustain at high temperature. We can also use a polyester film as substrate which is a very flexible material.

Resistance track is made up of resistance ink which is formed by mixture of conductive plastic material, graphite powder, xylem & methyl in accurate proportion. This paste preparation is a very critical process which must be carried out in class 10,000 clean room. During paste preparation we have to control the environmental conditions like temperature & Humidity. Even excess contamination due to foreign particles may leads to change the electrical parameters. That's why number of particles in the vicinity to be maintained below the 10,000. After paste formation, paste is printed on the substrate with the help of high accuracy printing machines then it is passed through the various zones of tunnel oven & finally get the fully cured resistance element. The required value of resistance element is achieved by mainly percentage of graphite & accurate thickness of resistance ink.

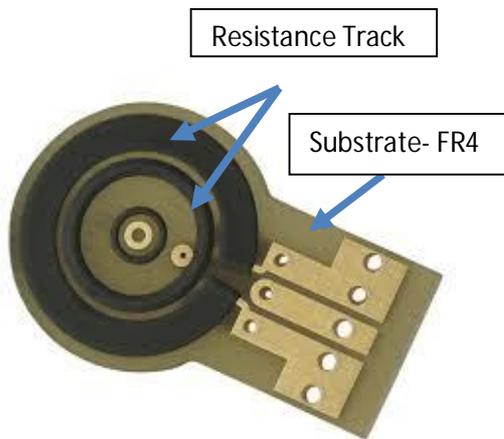


Figure 1. Resistance Element

2. Wiper

Wiper is a metal part which moves on the resistance track & gives output variation in terms of voltage. Wiper is made up of precious metal (PM) material which is chosen by considering the sensitivity, life & precise electrical measurement of potentiometer. PM wiper plays an important role in increasing performance & life of potentiometer, reducing the contact resistance & noise between resistance track & wiper.

In wire wound type potentiometer, generally the wiper material used is Beryllium Copper (BeCu) which reduces the performance & life of potentiometer. It also increases the contact resistance & noise between resistance track & wiper. Thus precious metal wiper having better advantages over Beryllium Copper wiper. These wipers are available in various types of design as per the requirement.

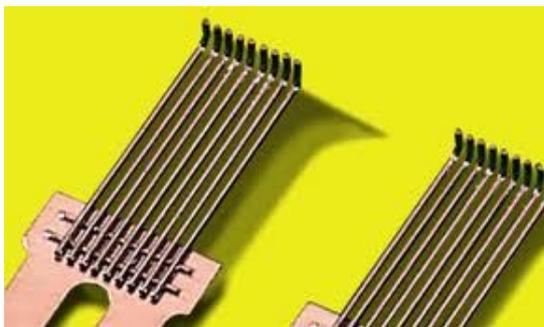


Figure 2. Precious Metal (PM) Wiper

3. Shaft

Shaft is a part that drives the wiper with the help of wiper carrier on resistance track. Generally the materials for shaft use like SS 303/304, Brass with plated & PBT with glass field. These type of shafts can be used for both conductive plastic type as well as Wire wound type potentiometers.

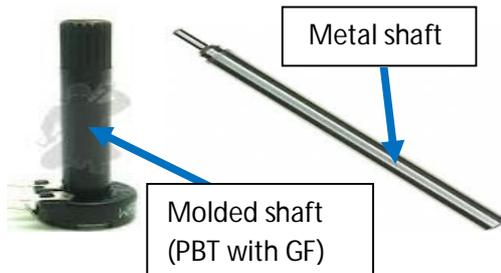


Figure 3. shaft

4. Housing

Housing is a protection cover in which all parts are assembled. Generally housing is made up of materials like Aluminum, Brass with plated & Engineering plastics.

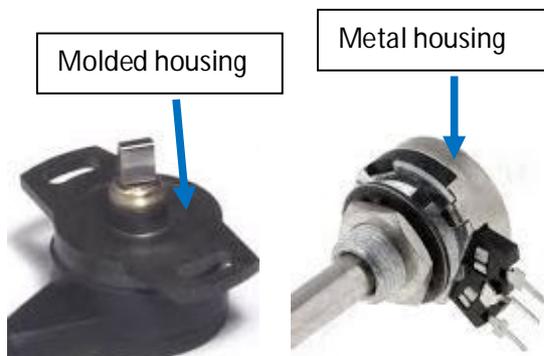


Figure 4. Housing

Performance Testing

Performance of CP potentiometer is checked by measuring mainly following electrical parameters:

1. Independent Linearity

The key specification of most potentiometer designs is linearity, which is defined as the proportional difference between the actual output voltage and a calculated voltage based on position (Figure 1). Linearity tolerance depends on the length or function angle, the total resistance, and the size of the tracks. The greater the angle and track size, the lower the resistance, and the better the accuracy that can be achieved. Linearity can be specified in one of two ways: either absolutely or independently.

Absolute linearity takes into account the actual electrical angle of the potentiometer. Potentiometers have a certain degree of angular variation; tolerances can vary from as little as 0.01° to as much as 2° depending on size, angle, and element material.

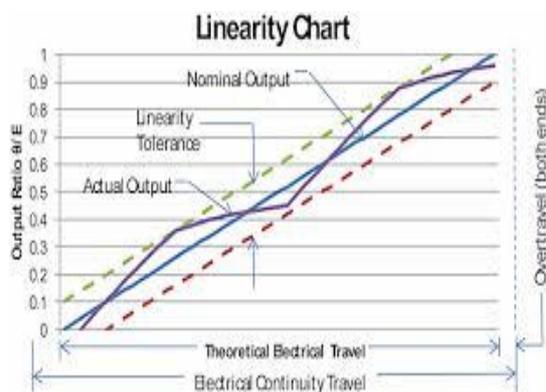


Figure 5. Linearity Graph

2. Contact resistance

Contact resistance is the resistance between the wiper terminal and the wiper's immediate point of contact on the potentiometer's resistive track. This contact resistance affects all the important quality features of a potentiometer.

3. Output Smoothness

Output smoothness is a measurement of any spurious variation any electrical output not present in input. It is expressed as a percentage of total applied voltage and measured for specified travel increments over the theoretical electrical travel. Output smoothness includes effect of contact resistance variation, resolution and other micro-nonlinearities in the output.

4. Hysteresis

Hysteresis is an error mainly produced by mechanical factors such as the bearings, the stiffness of the wiper system and the coefficient of friction between the conductive layer and the wiper. For this reason, attention must be paid to ensure a backlash-free, rigid mechanical coupling.

Applications

There are so many applications of conductive plastic type potentiometers but here we will see the application only in Automobile sector where it is widely used due to its high level electrical performance & longer life. Following photograph shows the location of various CP type potentiometers (Sensors) use in a vehicle.

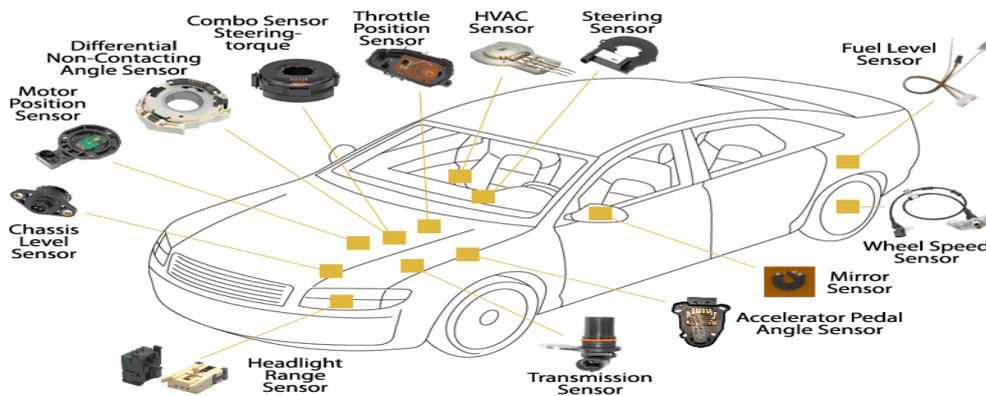


Figure 6. Location of various sensors in car

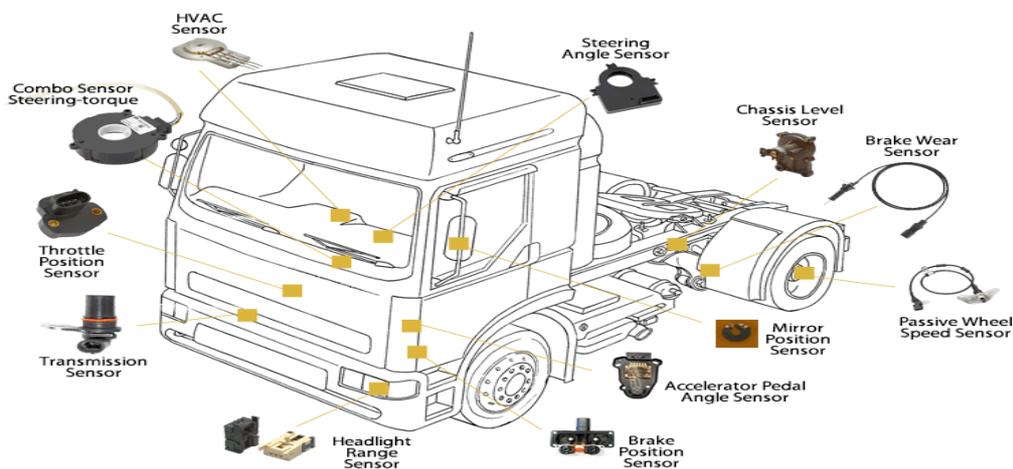


Figure 7. Location of various sensors in Truck

CONCLUSION

As we know that vehicle application has a direct impact on human life or safety. To achieve that safety, all Automobile industries are focusing on precision making devices, subassemblies or parts and implementing automation in a vehicle continuously. Conductive plastic type potentiometer is one of the precision making device that use as a feedback sensor in vehicle and drives the application very efficiently and precisely. Thus the innovation of CP type potentiometer is one of the kind of gift for Automobile sector.

In India, most of the potentiometer manufacturers are not aware about this type of technology especially conductive plastic printing. If they develop this technology, it will be a great success and can capture the market in India as well as in other countries also.

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