ON-PCA SOLUTION FOR MONITORING POWDER CONTAMINATION ON ELECTRONICS

HP INC
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3D printers that use powder-based build materials may be internally exposed to powder dust contamination. Powder accumulation could eventually lead to electronics malfunction. The printer should be able to predict electronics failures associated with dust contamination and therefore prevent unwanted stops that will have a negative impact on productivity. Experience has shown that it is difficult to prevent powder dust from reaching certain areas of such a 3D printer. Some types of powder are slightly conductive. Metallic dust aggravates the issue. How could we monitor powder contamination on our electronics in an affordable way?

This article explains a method for monitoring powder contamination on electronics that would allow us to predict failures and act in consequence to solve those, avoiding unwanted stops of the printing process that would negatively impact on productivity. It is based on the fact that the capacitance between two parallel metallic plates changes when in contact with powder. The more powder accumulated, the bigger the change of capacitance.

With this method we check capacitance variations in order to sense powder accumulations. Rectangular apertures are provided on the PCB, defining 2 metallic areas on 2 opposite sides of the edge of the aperture (see figure below). This is built on the PCB itself. One of the two plated areas is connected to a capacitance-to-digital converter (or any other method to measure capacitance) and the other plated area is connected to ground. The output of the capacitance-to-digital converter is connected to a microcontroller that would read the variation of capacitance due to the accumulation of powder and act according to the value read.
As shown in the figure above, adding more rectangular apertures and connecting them in parallel will increase the sensitivity since the resulting capacitance will be the sum of all of them (note that all the nets named S1 will be connected since they have the same net name).

To guarantee that the powder is directed to the area of measurement, a fan could be added on top of the apertures, fitting a filter at the bottom of the aperture. This way, powder would be accumulated on top of the filter, leading to bigger accumulations of powder and therefore better sensing.

If it is desired to increase the capacitance further, vertical metallic plates could be soldered to the edge of the apertures to increase the surface area. The bigger the area the higher the capacitance.

Depending on the application a balance between number of plates and area of the plate will be achieved.

Another variation of this invention, which is more appropriate when the amount of powder deposited is smaller is the one depicted below:

A through aperture (L shaped) metallic extra component would be fitted on the PCB. That component would be placed in a way that it is on top (in parallel) to a rectangular metallic area of the PCB (same size of the rectangular than the component added on top – see Error! Reference source not found.). Having the metallic extra component in this position, on top of an uniform and solid area of the PCB will allow a better deposition of the powder in the area of measurement, not depending on adhesion of powder to the metallic plated apertures on the PCB like the first method exposed. That would also allow us to have a bigger area and therefore the capacitance would get increased.

This approach will have a lot of benefits when the PCA is mounted vertical in the system.

The printer would be able to send a warning message to the user telling him to clean the interior of the electronics after the capacitance increase above a threshold. If the capacitance changes even more (with respect to the initial one, that is the capacitance when no powder is deposited), then an error message could be displayed and the printer would not be able to launch another job without cleaning the interior of the printer (to avoid unwanted stops during a job).
If different materials are used, different thresholds will be defined.

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