A Study on Mobile Communication Device Structure Design Resisting Dust Particles Ingress

Na Lu, L.J Xu, Huang Feng, and Y.S Li
Electric Contact Research Laboratory Beijing University of Posts and Telecommunications, Beijing, 100876, China
E-mail: nalu@bupt.edu.cn Tel: 86-10-62282300 Fax: 86-10-62282629

Abstract—**The reliability of mobile communication devices is affected by many factors, such as structure design, mechanical and electrical characteristic of devices, electromagnetic disturbance, electrical contact, dynamic environmental, temperature changes, , environmental pollution, etc. Studies show that 14% failure of the electronic products is caused by dust and salt mist. Dust particles ingress electronic device, and contaminate the internal components. This results in electric contact failure and reduced reliability of contact components. It is a very important consideration in electronic product design to protect internal components from operational impairment that due to ingress of dust particles and reduce the impact of dust on the communication device.**

This paper studies the ability of mobile communication device structure design to resist dust particles ingress and penetration the internal areas. It gives the dust distribution in the mobile phone by experiments and finite element analysis (FEA) using a mobile phone as the representation of the mobile communication device; it provides guidance for structure design and improves reliability of portable electronic products in the future.

***Index Terms*—mobile phone, dust distribution, FEA**

I. Introduction

The reliability of mobile communication devices is affected by many factors, such as structure design, mechanical and electrical characteristic of devices, electromagnetic disturbance, electrical contact, dynamic environmental, temperature changes, environmental pollution, etc. One of the main factors is environment. Studies show that 52% failure of the electronic products is caused by environment effects, among which 40% is by temperature, 27% by vibration, 19% by humidity and 14% by dust and salt mist [1]. Dust particle is a contact failure causative factor that cannot be ignored. Some theoretical and experimental studies on dust effects on electric contacts have been presented [2-5]. Dust particles can ingress into electronic devices, and contaminate the internal components. This results in electric contact failure and reduces the reliability of contact components. It is very important to consider in electronic product design to protect internal components from operational impairment due to ingress of dust particles and reduce the impact of dust on the communication device.

In this paper, for studying the ability of a mobile communication device structure design to resist dust particles ingress and penetration the internal areas, a mobile phone is used as the representation of the mobile communication device. The ingression simulating experiments are done in different kind of mobile phones. Environmental factors including wind speed, dust particle concentration and deposition time on the impact of dust particles ingress phone are analyzed, and the results of test and finite element analysis (FEA) are compared. It gives the dust distribution in the mobile phone by experiments; it provides guidance for structure design and improves reliability of portable electronic products in the future.

II. Analysis of Wind Speed, Dust Particle Concentration and Deposition Time on the Impact of Dust Particles Ingress Phone

A single dust particle in airflow is influenced by many forces - including dragging force by air flowing, added mass force, Basset force generated by accelerating or decelerating motion of particles in the fluid, Saffman force generated by velocity gradient in the flow field, Magnus force generated by the rotation of particles in the flow field, volume force generated by gravity, force generated by collisions between particles, and forces between particles and walls. Buoyancy and pressure gradient forces are much smaller and can be ignored compared with the particle's own inertial force in the gas-solid flow. This is due to gas density much less than the density of particles. Dragging force is important among the forces [6, 7].

Stationary dust particles can start moving only under certain wind conditions, the particles get enough momentum to moving from the air flow when the wind speed increases to a critical value. The critical value is called critical velocity (starting wind speed). Bagnold stated: the starting wind speed of homogeneous dust particle increases with particle size decreasing when particle size is less than 0.08 mm; it increases with particle size increasing when particle size is much than 0.08 mm. the starting wind speed firstly is small, then large with the diameter changing from small to big for inhomogeneous dust particle, the starting wind speed is expressed in [8, 9]: