**A Study on Electrostatic sensor frond-end for particle measurement at the femtoampere level**

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| **Abstract**  Over nearly fifty years, electrostatic sensors (ES) have been employed for pneumatic-flow measuring particulate emissions, measuring fluidized beds and flame detection, online particle size, speed and radial vibration measurement of mechanical systems, and condition detection of power transmission belts, mechanical wear, especially for aero-motors, and some human activities. ES is constructed in main parts: the sensor electrode (The Flow Noise Antenna) and the signal condition circuit (SC). The electrode is a conductive metal that can detect the electrostatic flow noise from a moving charged particle. The charge induced to the electrode should be collected and amplified to an acceptable level using a suitable signal condition circuit. SC is related to a random and ultra-low level of electric charge fluctuations. Owing to the very high level of amplification, the sensor is very susceptible to sensing the noise which stems from external electromagnetic sources. The geometric structures of the probe considerably influence the output signal amplitude and its frequency [1-3]. In this study, SCs, developed at the level of femtoamperes (10-15), employed in the aforementioned fields have been investigated, simulated, and designed with some circuits suitable for relatively high frequency and noisy environments realized. Approximately ten topologies which consist of active and passive feedback, charge and instrumentation amplifiers, and its hybrid circuits have been evaluated in terms of noise, dynamic performance, and dc analysis using real components and realized active guarding techniques [4-7]. First, for low-noise circuit design, it is necessary to prevent noise and keep the signal-to-noise ratio at the highest level if noise cannot be avoided. The triaxial cable and connector from active guard have been used to protect noise. Especially particle measurement applications in turbine engines have importance due to the necessity of using a wider frequency band due to high speed. |
| Keywords: Electrostatic sensor, Electrostatic monitoring technology, particulate signal conditioning, Low noise amplifier, charge amplifier |

**References**

[1] Y. Yan, Hu, Yonghui, Wang, Lijuan, Qian, Xiangchen, Zhang, Wenbiao, Reda, Kamel, Wu, Jiali, Zheng, Ge (2021), “Electrostatic sensors – Their principles and applications,” *Measurement*, vol. 169, pp. 108506.

[2] Z. Wen, J. Hou, and J. Atkin (2017), “A review of electrostatic monitoring technology: The state of the art and future research directions,” *Progress in Aerospace Sciences*, vol. 94, pp. 1-11,

[3] M. F. a. R. Teimour Tajdari, Norhaliza Abdul Wahab and Iliya Tizhe Thuku (2013), “Low Noise Signal Conditioning Design for Electrostatic Sensors,” *Sensors & Transducers*.

[4] K. I. Inc, “Low Level Measurements Handbook (2016): Precision DC Current, Voltage, and Resistance Measurements, 7th ed.”

[5] A. Kay, Operational Amplifier Noise Techniques and Tips for Analyzing and Reducing Noise (2012.) Elsevier

[6] S. Franco (2015), “Design with operational amplifiers and analog integrated circuits,4th ed. McGraw-Hill Education”.

[7] Paul Horowitz, Winfield (2015), “The Art of Electronics (2015), 7th ed. Cambridge University Press”.