

Chapter 32

Instrumentation and Automation Grounding

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ABSTRACT

In any electrical or electronic systems, unwanted signals known as noise signals are encountered which interact with the true signal and thus affecting signal quality. Noise may enter into a device or system in many forms and have a different order of impacts. Prevention and elimination of noise had attained paramount importance to ensure signal fidelity. This chapter presents a comprehensive analysis on elimination of noise by electronic grounding of instrumentation and automation systems as well as various engineering considerations for the same.

INTRODUCTION

Noise can be defined as an unwanted random signal which interferes with the desired signal to distort its quality. Our subject of interest in this paper is electrical noise. As is evident that noise need to be prevented to enter into the system and if already present need to be eliminated. For this we need to analyse the various sources of noise, the types of noise, the impact it creates on the main signal and the mechanism by which we can eliminate the noise and maintain signal fidelity. Noise may be internally generated within the system i.e., within the circuit when we call it internal noise or the source may be external when we call it an external noise (Attri, R. K., 1998). The sources of internal noise may be Thermal noise, Shot noise, etc. which may be defined as below.

1. Thermal Noise is generated as a statistical random kinetic motion of electron due to thermal energy. This sets up a noise voltage whose time integral over a long period is however zero. This random voltage depicts as a random noise.

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2. Shot noise is characterised by random arrival of electron across junctions like P-N junctions in a semiconductor circuit.
3. Transit Time Noise is due to the different time taken by the charge carriers to travel from input to output terminals. This is particularly significant at high frequency signal.
4. Flicker noise also known as (1/f) noise is a type of low frequency noise, which is generated mainly in DC electronic circuits due to variation in either base current or junction temperature in BJTs or MOSFETs resulting in variation of resistance and hence voltage or current fluctuations in the circuit.

Principle external noise is classified as Atmospheric, Solar/Cosmic Noise and machine made noise which may be described as below.

1. Atmospheric noise arises due to lightning discharge in the atmosphere while the solar and cosmic noises are emitted as electrical energy due to very high temperature of the Sun or stars.
2. Machine made noise is generated by electrical machines, high voltage lines, fluorescent lights, etc.

Next it is important to study the impact of noise on the basic signal. The impact of noise is analysed by Signal to Noise ratio (S/N). The noise appears in a current carrying conductor in common mode or differential mode. The nature of noise pickup is different and so is the methodology of elimination. Based on the nature of noise pick up, noise in a circuit is classified as Common Mode Noise and Differential Mode Noise.

1. In Differential mode noise for a dual input system, noise voltage is picked by the two inputs having voltage at same magnitude but with 180° out of phase. As a result the differential mode signal flows through the load. In a twisted pair cable the direction of current at the adjacent wires are opposite and they cancel out the magnetic field (Pfeiffer, C. John).
2. Common mode noise for a two-input system is classified by that noise which generates same voltage at the two terminals resulting in zero differential voltage across the terminal. However, the common mode current flows to the ground coupled with the stray capacitance between the current carrying conductors and ground. This results in generation of electromagnetic radiation. In a twisted pair cable the current in the adjacent twisted pair flows in the same direction adding positively the magnetic field. This results in generation of electromagnetic noise.

While there are many techniques, which eliminate noise pick up in Electronic devices and current carrying conductors, this paper will address the methodology adopted in grounding procedure abiding various codes and standards and various industrial procedures which have been successfully adopted leading to successful elimination of noise in an integrated Instrumentation and Automation system which are geographically distributed in a Plant (Klipec, E. B.) and (Shah, J. S).

ELECTRONIC GROUND

Electrical/electronic ground is a conceptual medium, which at any point of time may act as an infinite source or sink for electrical charges without any rise or fall of its own potential. Earth's surface is con-

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