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Noise Susceptibility Measurements of Front-End Electronics Systems

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The conducted and radiated noise that is emitted by a power supply constrains the noise performance of the front-end electronics system that it powers. The characterization of the noise susceptibility of the front-end electronics allows setting proper requirements for the back-end power supply in order to achieve the expected system performance. A method to measure the common mode current susceptibility using current probes is presented. The compatibility between power supplies and various front-end systems is explored.

Summary

1. Introduction.

The front-end electronics of particle physics detectors aim to achieve high levels of performance in terms of resolution and accuracy. This performance is limited by the system intrinsic noise, but also by the noise properties of the power supplies. The compatibility between power supplies and front-end systems can be characterized, to obtain a manageable noise performance of the entire system. A method to evaluate the conducted noise susceptibility of a front-end system is proposed. Front-end power converters emit also near field radiated noise; a method to explore the front-end susceptibility to radiated noise is proposed. The methods are applied to the front-end electronics of the absolute luminosity monitor for ATLAS (ALFA) tand on the TOTEM front-end. On the basis of the susceptibility figures, the noise properties of the power supplies can be set for each system.

1. Bulk injection method.

The common mode current is known to be a back-end dominant source of noise that degrades the performance of a front-end system. The measurement of the front-end noise susceptibility is carried out with the injection of known common mode currents in the power supply lines over a given frequency range using bulk injection probes. The injected current is monitored with a calibrated probe and adjusted in an automated procedure. The voltage applied to the bulk probe allows to estimate the common mode input impedance and to identify the presence of filters and their effective frequency range.

1. Conducted susceptibility.

The conducted susceptibility measurement method was exercised on the ALFA front-end prototype. The power supplies feed a motherboard that interconnects with twenty five photomultiplier front-end modules (PMFs). Each PMF houses a MAROC front-end ASIC, that amplifies and discriminates the PMT signals. The signals are acquired and transmitted to the motherboard by FPGA logic. The motherboard packs and transmits the data through a GOL link. The system uses linear regulators, and the input power lines are fitted with common mode filters. The sensitivity of the PMF against noise is first determined by means of a threshold scan that delivers a noise S-curve. A threshold is then set and common mode currents are injected, with varying amplitudes up to 10mA and frequencies comprised between 150 kHz and 100 MHz. The measured common mode input impedance put in evidence the filters effectiveness between 35 MHz and 70 MHz. The injected current allows putting in evidence a susceptibility peak at 25 MHz, in agreement with the frequency response of the front-end preamplifiers. The relationship between the threshold and the current amplitude is explored.

1. Front-end power converters.

Power converters located in the vicinity of the front-end systems radiate electromagnetic fields that degrade the system performance. The compatibility between the TOTEM front-end electronics and switched power converters is explored. The susceptibility of the this system to near magnetic field is evaluated.

1. Conclusions.

The noise susceptibility of front-end systems is a key parameter that can be evaluated with accurate measurements. The obtained results bring valuable information on the noise coupling mechanisms between the power supplies and the front-end circuits, which can be used to set up appropriate filters and to specify a compatible power supply system.

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