A Multi-Channel Hardware Prototype for IEMI Diagnosis

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***Abstract*—In this paper we present the design of cost-efficient multi-channel hardware for the detection, location, and analysis of intentional electromagnetic interference (IEMI) signals. The system is designed to identify the type of IEMI signal and locate the IEMI source. Preliminary measurements on a single-channel prototype are performed and confirm the suitability of the design.**

Keywords- hardware; intentional EMI; pulse-width modulation;

I. Introduction

Protecting important electronic systems against IEMI is of high importance. One way of protecting is IEMI event (attack) detection. However, this is not always sufficient. Sometimes, it is useful to perform IEMI diagnosis, i.e., to be able to determine the type of the signal or find the location of the IEMI source.

Unlike IEMI detection systems, which can be relatively inexpensive, systems for performing IEMI diagnosis are significantly more complex and thus costly. The reason lies in the nature of IEMI signals: they are typically very short and exhibit very fast rise/fall times. To capture, visualize, and analyze them, one needs a high-speed digitizing channel per EM-field sensor. The price of such a system increases quickly with the number of sensors in use. In this paper we show a cost-efficient hardware-implementation of a modular system for (i) visualization of IEMI signals, (ii) their classification according to the waveshape (continuous wave, damped sinusoid, double exponential) and (iii) the estimation of the location of the IEMI source, based on the time difference of arrival algorithm.

II. System Architecture

Fig. 1 shows a simplified block diagram of a two-channel system. Since the design is modular, additional channels are added simply by replicating the first channel. The IEMI signal is received using a field sensor. Its output is connected to the electronic system by a coaxial cable. At the cable output, a variable attenuation is introduced. This is necessary as IEMI signals have a very high dynamic range. After being attenuated, the signal is fed to the amplitude-measurement circuit and to a 1-bit digitalization module. To decrease the overall system cost, only one of the input signals is relayed for displaying on a high-frequency oscilloscope. Based on the measured signal amplitudes, the FPGA generates selection signals for the switch block, choosing the signal with the higher amplitude for external monitoring. The output of the 1-bit digitalization block is a pulse-width modulated sequence of unit-amplitude impulses, where the duration of the impulses is proportional to the duration of IEMI impulses. The time durations are measured by an FPGA and used to determine the approximate waveshape of the IEMI signal.

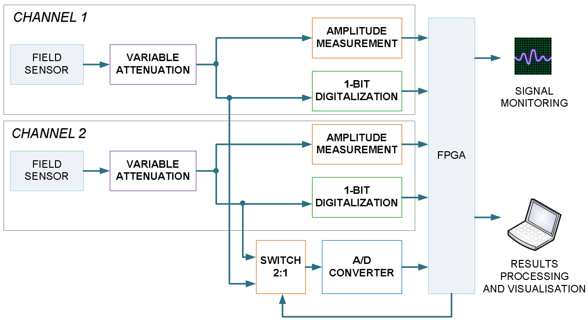

Figure 1. Block architecture of a two-channel system for IEMI diagnosis.

III. Experimental Verification

To verify the correctness of the system design, we used a one-channel prototype. Fig. 2 shows the signal measured at the output of the 1-bit digitalization module when a damped sinusoid excitation is used. The results confirm that the pulse-modulated impulses contain the information on the half-pulse width, needed to identify the signal type. Estimating the location of the IEMI source requires at least four channels and is left for future work.

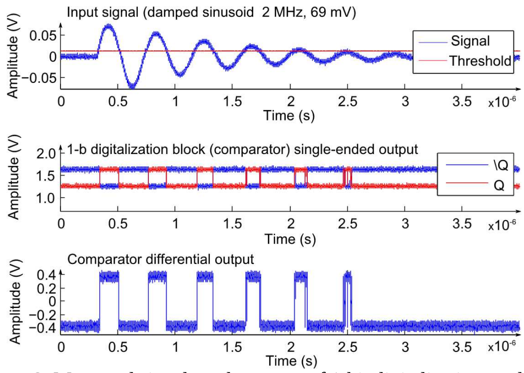

Figure 2. Measured signals at the output of 1-bit digitalization module.

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