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Design and Evaluation of Computer-based Electrical Power Quality Signal Generator

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***Abstract*—Electrical power quality signal generator, capable of reproducing the power quality disturbances in accordance with European standard EN50160, is presented in this paper. Signal generator is divided in two parts: LabVIEW based virtual instrumentation software for defining the disturbance parameters and hardware electronics for signal generation (data acquisition card and power amplifier). The paper focus is on the design of power amplifier for scaling the data acquisition card output voltage level to the nominal power line voltage (230 V). The signal generator can be used for generation of reference signals useful for testing the power quality measuring instruments and various algorithms for power quality disturbance detection. In such manner, this PC based signal generator can be used as suitable and cost effective alternative to the instruments for testing the power quality meters and analyzers. According to the relevant document - ISO Guide to the Expression of Uncertainty in Measurement, for detailed metrological assessment of developed signal generator, calculation and presentation of measurement uncertainty budget is performed.**

***Keywords*—electrical power quality, signal generator, power amplifier, virtual instrument, measurement uncertainty**

I. INTRODUCTION

DEGRADATION of the optimal power quality (PQ) can be caused by various problems and signal disturbances in electrical power distribution networks. Signal disturbances, present in form of voltage variations or high-order signal harmonics, directly worsen the energy efficiency in electrical power production, distribution and consumption. The increased concern for such problems in power quality, which is indicated in recent years, primarily is caused by limitations of natural energy resources necessary for power production. This is followed by widespread using of the renewable energy resources [1, 2]. Hence, power quality problems became very important and significant topic. In order to provide customer protection, optimal power quality level is defined according to relevant international standards and regulations [3]. European standard EN 50160 defines voltage characteristics of the public power distribution systems, for normal operating conditions. The required power quality level is determined by reference nominal values and acceptable limits of basic power quality parameters and typical network disturbances. Relevant information, necessary for power quality assessment, can be provided by measurement and processing of quality parameters at specific locations in power distribution network.

Various types of devices and equipment for measurement and software supported processing of standard PQ parameters are available on the market. These measurement instruments are developed to perform continuous monitoring of power supply quality inside power distribution networks. Instruments for PQ measurement can be used as single devices located at selected points in distribution network. Alternatively, several separated devices can be combined into distributed measurement system for monitoring of PQ, including measurement, recording and analysis of standard quality parameters and disturbances [4, 5].

Having in mind the challenges of the modern smart grids and great importance of PQ problems, special attention is paid to development of sophisticated and reliable microprocessor-based measurement systems for PQ monitoring. In the last decade especially attractive are so called ‘‘virtual instruments’’, which are well suited for development of flexible computer-based measurement systems. Generally, the virtual instruments can be successfully used for research and scientific purposes. A lot of scientific papers on virtual instrumentation for PQ analysis (both for measurement or signal generation) have being published [6-11]. However, usually less attention is paid to the signal amplification, which is very important for the practical implementation of virtual PQ signal generators.

In order to satisfy the specified level of the measurement accuracy and basic characteristics, devices for measurement of PQ parameters must be followed by appropriate metrological traceability chain. Reference instruments, such as voltage and current calibrators, are available in the various functional and constructive solutions. Such instruments are sources of the reference