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Monitoring and evaluation of the quality of electricity in a building

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Abstract

The term, "Quality of Electricity" has been applied to a wide variety of many power system phenomena. The increasing application of electronic devices as well as the production and distribution of electricity has increased the interest in energy quality. Today, non-linear loads have increased, mainly with the addition of computer equipment, printers, photocopiers, fans, heaters, air-conditioning systems, refrigerators, elevators, etc. Therefore, it is good to take some measures to reduce the levels of general disturbances, as well as to immunize the sensitive equipment in such a way as to ensure the stability of the electrical installations. To achieve these objectives, it is important to measure and analyze harmonic distortion. For this, the origins and possible consequences of harmonic disturbances in computer equipment and distribution networks of the building or university campus are studied, which is the focus of this study. The paper argues the main precision strategies in an electrical installation applied in a building, in which the biggest loads are computer and laboratory equipment. For this and many other reasons that affect the Quality of Electricity will be argued.

Introduction

In the preparation of our research, we set as a separate task and analysis, the monitoring of electricity in a part of the building of a consumer environment with computers and information technology equipment. Since usually schools, universities, etc., are users of many computer and ICT devices, there is a need to do a study in these facilities where these devices are installed. In the following, we will get to know the quality of electricity in the devices that are included in this study. In order to make it possible to monitor electricity, we will also look at the electrical installation with computer equipment, which serves as a starting point and basis for laying out the foundation issues in solving problems that may occur during the measurement period or other phenomena. Further along this road, we will see the progress of changing the electrical load with the addition of equipment. Rather, we will focus on problems related to the quality of electricity, how this quality changes depending on the electrical load, etc. [1-3].

Material and Method

In terms of the quality of electricity supply, I was initially introduced to some generalizations regarding the quality of the electricity supply system to users, the quality of production, and the quality of the system. It is reasonable to know the quality of the above elements, since they provide us with a good quality of electricity, with acceptable parameters [4,5]. Interruption of the user's electricity supply, as well as any deviation from the nominal values of voltage and frequency, reduce the efficiency of devices that operate on electricity. In a more analytical way, the "Quality of Electricity supply" of users is mainly characterized by the following factors: [6-8]

a. Continuous supply of electricity (or degree of security of supply); b. Stability of supply voltage; c. Frequency stability; d. Purity of the shape of the supply voltage curve; e. Tendency to have the three-phase system of symmetrically clean voltages.

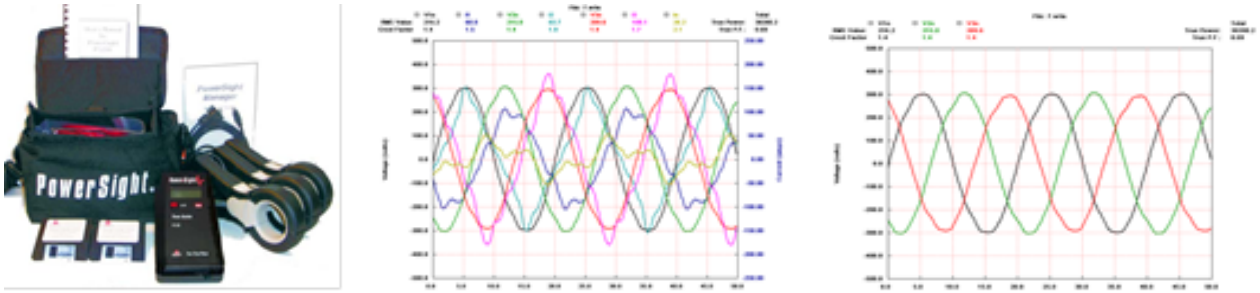
Absolute provision of uninterrupted electricity supply to all users, without any interruptions of any kind, is practically impossible. Aiming for such a thing leads to large unwarranted capital and operating expenses. The level of guarantee of uninterrupted supply is evaluated by the "security degree" of this supply. More clearly, the degree of supply is expressed by the possibility of uninterrupted supply [9-13].

Quality of production, quality of electrical system and electricity. In today's language, the word quality is very usable and is related to different concepts and colors, it has a high degree of subjectivity, which often takes on personal colors, electricity has its own quality [14]. The quality of electricity is ideal when the dependence of current or voltage on time is a pure sinusoid, that is, when the dependence graph has no deformations, deviations. But this thing is purely theoretical, enough to be familiar with the terms of the quality of electricity. The quality of electricity varies at different times for different electrical loads. In reality, electricity does not have a 100 percent quality. The change in the quality of electricity is directly proportional to the change in electrical loads. In order to use good quality electricity, the three-phase system, which serves as a source of electrical power for consumers, should generally be symmetrical. So, in order to preserve this symmetrical system, it is necessary that the three phases of the same electrical system have the same amplitude, the same voltage magnitude, the same frequency for the three phases, and their phasing in time must necessarily be 1200. However, this is not really possible for many reasons. It is worth mentioning that the increase in linear electrical loads has always affected and is still affecting the quality of electricity [15-18].

Results and Discussion

In the paper, the monitoring of electricity in a part of the building of a university environment, namely the central building of the Department of Engineering at the Albanian University, was considered and analyzed separately. Initially, the Power Network Analyzer "Power Sight 250" (Figure 1a) was installed, which serves to measure/monitor and analyze the quality parameters of the power network.

Results of Monitoring and Their Analysis. Figure 1a and 1b shows the viewing window of the form of currents and voltage for the monitored three-phase system. Here, two complete cycles of sinusoids with a time of 50 mS are triggered by the process. From the visual inspection, we noticed that the shape of the sinusoids deviates from their ideal shape. This deviation is visually more noticeable for the curves that present the law of current change, and especially with the naked eye it is clear that the curve of the neutral conductor current is much more deformed than those of the phase currents, (Figure 1b) while those of voltages appear in a much more regular form compared to current curves (Figure 1c).

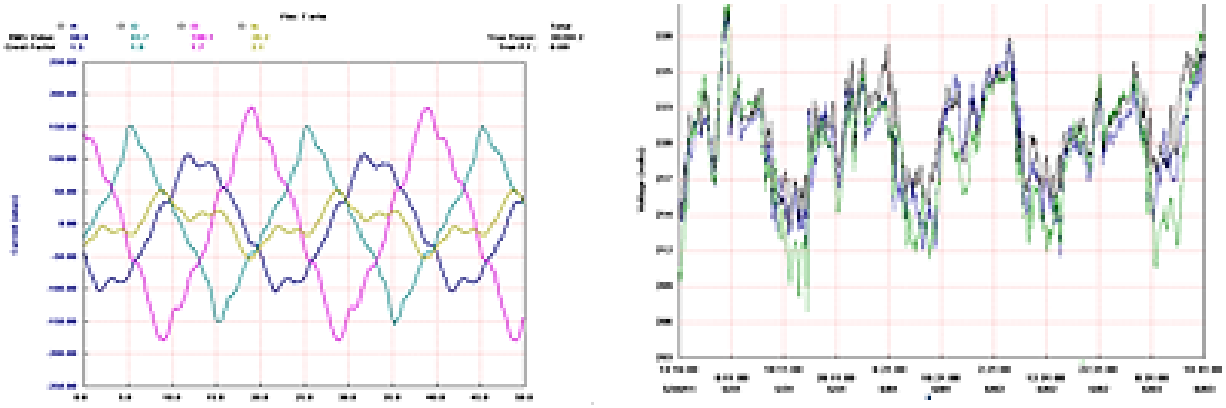


(a) (b) (c)

Figure 1a. Power Sight apparatus and other measuring devices. **Figure 1b.** Graphic representation of analog voltage / current quantities for the three-phase system. **Figure 1c.** Graphical representation of analog values of the three-phase voltage system at the 0.4 kV level.

The monitoring process started on 26.04.2021 at 10:15 until 03.05.2021 at 15:30. The monitoring was carried out for a period of 5 days, where records with data of average values were taken from the process. The graph below shows the legality of the current change for the monitored period. From the Figure 2a and Figure 2b, it can be seen that this legality changes periodically during the day and night according to the load change, giving us information on its profile.

Monitoring for Voltage Fluctuation based on the standard refers to the difference of the effective value in the magnitude (198 - 242) V with periodic fluctuations in magnitude. From the control of the database, there are no major voltage fluctuations. The variation of the change of the power coefficient results within the allowed norm. During the monitoring process, the change in legality resulted on average for all three phases in the range of 0.91-0.93, i.e., within the standard. The variation of the frequency change results within the standard and allowed norm (49.80 – 50.20) Hz.



(a) (b)

Figure 2a. Graphic representation of analog quantities, system of three-phase currents and zero current. **Figure 2b.** The profile of the voltage changes for the monitored period

Conclusion

Disturbances such as Voltage Reduction, Under-Voltage, Over-Voltage are present only in 3% of the monitoring window and do not constitute concerns for computer and ICT equipment in the building under observation.

In the case of the monitoring carried out by us, the data analysis process was carried out exclusively by the "Power Sight 250" measuring/monitoring instrument.

The sinusoidal waveform of the observed voltage does not consist only of the fundamental harmonics. The data collected during the monitoring period were analyzed and provide the necessary information regarding the performance of the quality of the electricity supply to the building of the Engineering Department.

For minimum load the symmetry is preserved, while for the peak load the symmetry is broken. The voltage profile is affected by the load change. The effective value of voltage and frequency for the minimum load period is within the permissible limits.

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