

# IT and communication low power loads and harmonics

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**Abstract** - This paper presents the affect of information technologies (IT) and communication low power single phase loads such as personal and notebook computers, switch, modem/router, firewall etc on power quality problems. It is clearly shown nonlinear characteristics of appliances mentioned above individual and cumulative impact on generating harmonics. It is concluded that the larger group of these loads may have major influence on voltage distortions in electrical networks. Also, it is shown measurements and results of saved voltage and current waveforms in larger company headquarters in typical low voltage Bosnia and Herzegovina electrical network. It is concluded that measured results of current harmonics exceeding allowed IEEE standards while measured results of voltage harmonics stay within allowed IEEE standards.

**Key words:** Harmonic characteristics, Harmonic distortions, Voltage distortions, Power quality.

## I Introduction

Common and increasing usage of low power single phase loads such as personal computers, printers, communication equipment, scanners, TV sets (LCD, plasma...), home media devices, lightening systems etc, force us to think more and more about power quality problems. All devices mentioned above, generate nonsinusoidal currents results in harmonics levels increase and present serious power quality problems to utilities [1]-[2]. Current with harmonics generated by these electronic loads are too small to cause any major distortion in distribution feeders. Also, as the amount of these loads increases, the cumulative current harmonics may become very significant, causing voltage distortion levels on distribution feeders to increase enormously. These low power electronic loads are very sensitive to power quality problems and they require high qualitative power supply voltage and, at the same time, due to own nonlinear characteristics, these nonlinear loads inject harmonic currents into electrical network [3],[4],[5]. These and similar nonsinusoidal currents may have negative influence on power supply voltage distortions.

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## II Harmonic characteristics of individual IT and communication loads

This chapter presents the results of laboratory measurement of individual current waveforms and harmonic characteristics for typical low power loads such as personal and notebook computer, switch, modem/router and firewall. Joint operation of all these loads will be analyzed as well.

Figure 1. (a) & (b) shows typical personal computer (PC) later connected on Internet via modem/router, firewalled and measured current waveform and its harmonic content. Figures 2. to 5. show measured currents with it's total harmonic distortions (THD) for notebook computer, switch, modem/router and firewall.

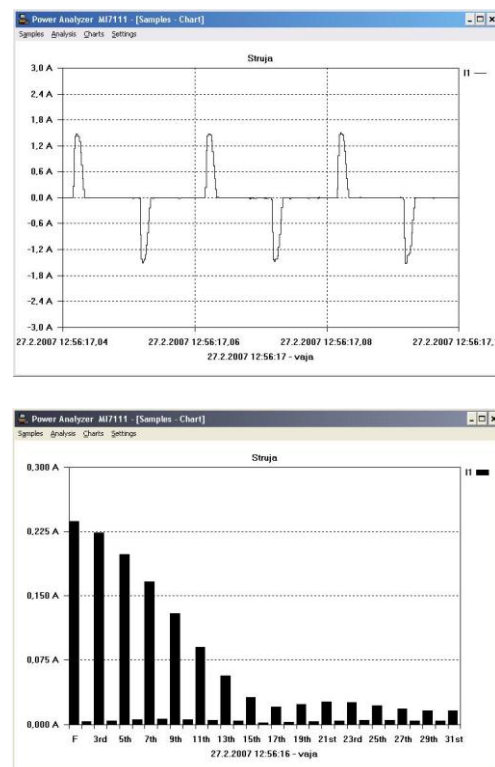


Figure 1. (a) & (b) PC current waveform and its harmonic content: THDI = 164 %

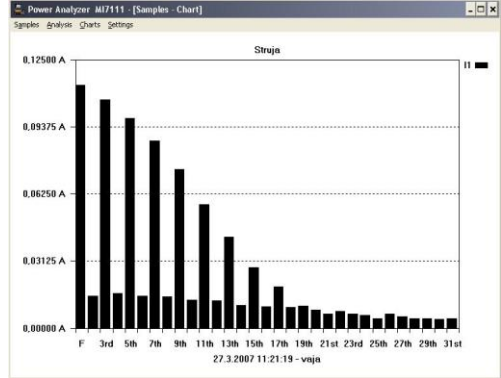
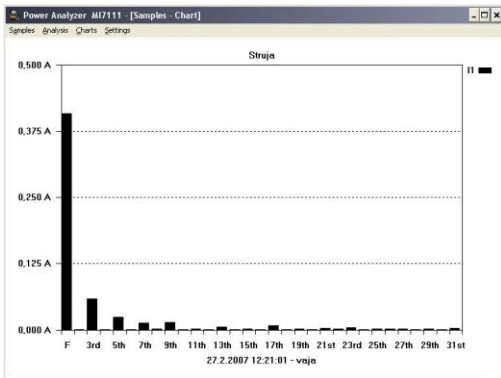
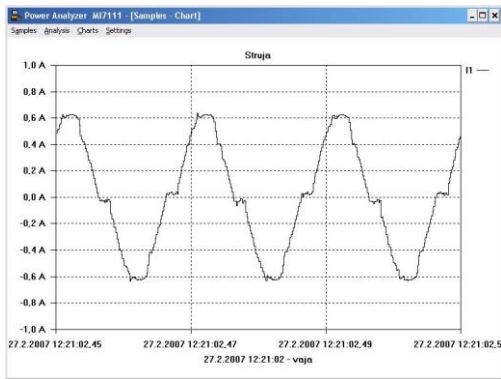


Figure 2. (a) & (b) Notebook current: THDI = 17 %

Figure 4. (a) & (b) Modem/router current: THDI = 182 %

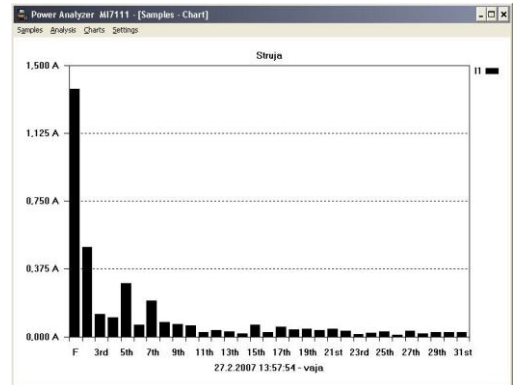
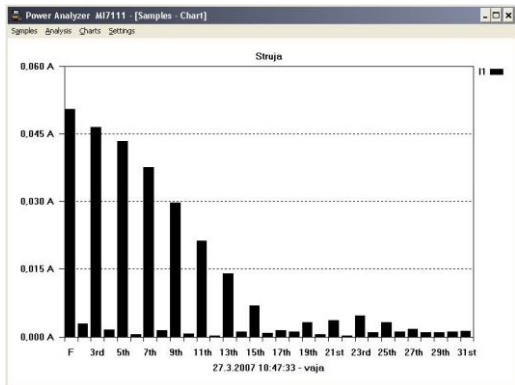
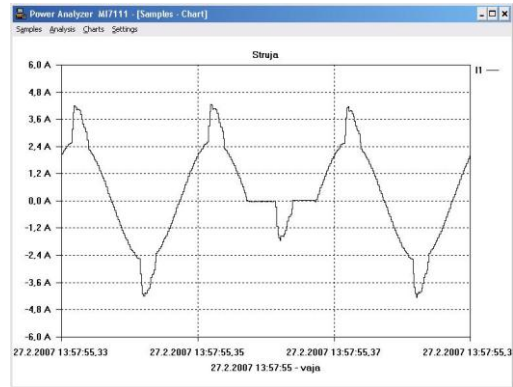
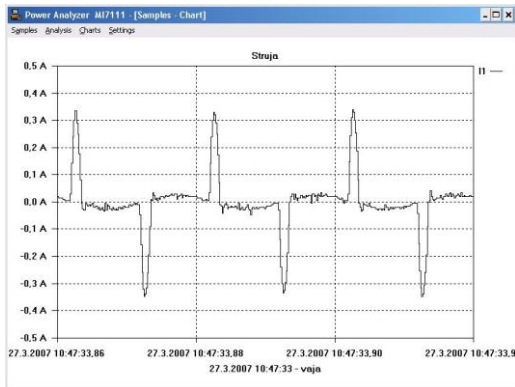


Figure 3. (a) & (b) Switch current: THDI = 168 %

Figure 5. (a) & (b) Firewall current: THDI = 49 %

### III Harmonic characteristics of collective IT and communication loads

This chapter presents collective affects of all the mentioned low power electronic loads (Small Local Area Network - *Figure 6*).

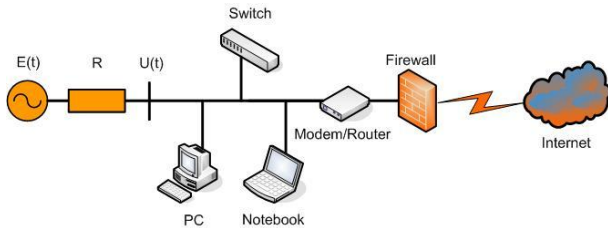


Figure 6. Collective affect of IT and communication loads – simplified model

*Figure 7.* (a) & (b) shows measured results of total current waveform with it's THDI value during the time in the case of  $R = 0$ .

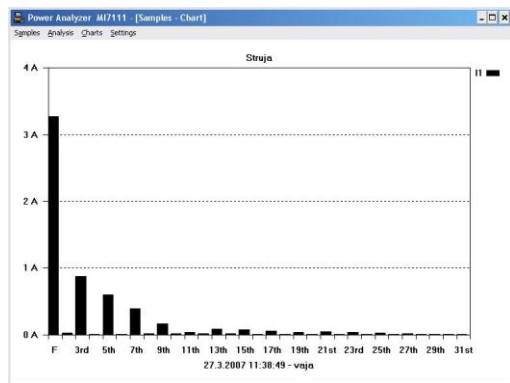
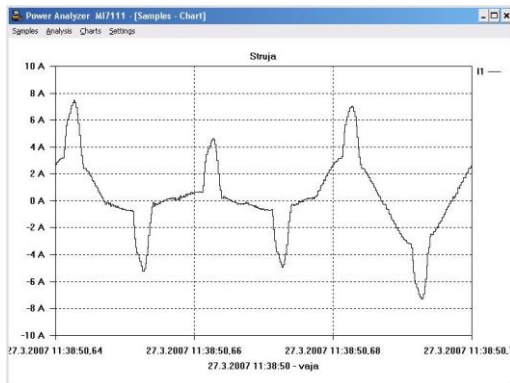


Figure 7. (a) & (b) Total current THDI = 35%

In this case total harmonic distortion of power supply voltage had value THDU = 2.78 %.

*Figure 8.* (a) & (b) shows measured results of total current and resistor voltage  $u(t)$  with THD values in the serial impedance  $R = 5 \Omega$  case.

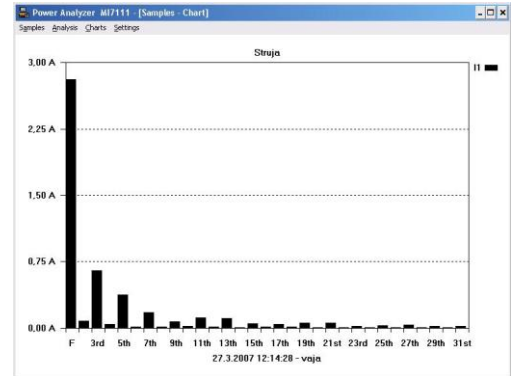
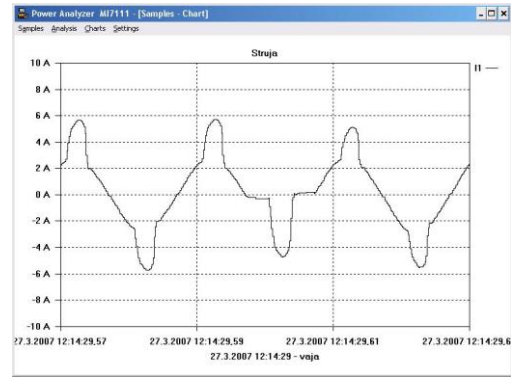


Figure 8. (a) & (b) Total current with serial impedance: THDI = 30%

Total harmonic distortion of resistor voltage had values THDU = 3.11 %

### IV Real commercial building – company headquarters, current and voltage measurement

In the final part of this paper, real commercial building (larger company headquarters) current and voltage measurements (0.4 kV electrical distribution network) with dominant consumer such as typical low power electronic loads analyzed above, will be shown. Commercial building mentioned above, consists of 160 low power electronic units (PC's, notebooks, printers, faxes, various communication devices such as telephones, modems, routers, switches etc) working simultaneously and measured during one week. *Figures 9.* and *10.* show the measured results of total harmonic distortion of currents and power supply voltage waveforms during one week. It can be shown that the levels of current harmonics are significant, exceeding IEEE Standard 519 limit levels [6]. At the same time the levels of voltage harmonics are within IEEE limit levels. It can be concluded that commercial or similar buildings are important harmonics source, and potentially, it could be the source of current and voltage waveforms distortion impacting other consumers. The similar situation can be expected in residential areas where dominant nonlinear loads are TV sets, CD/DVD players/recorders, and other modern low power home electronics appliances, where increase of current and voltage harmonics levels can be much higher.

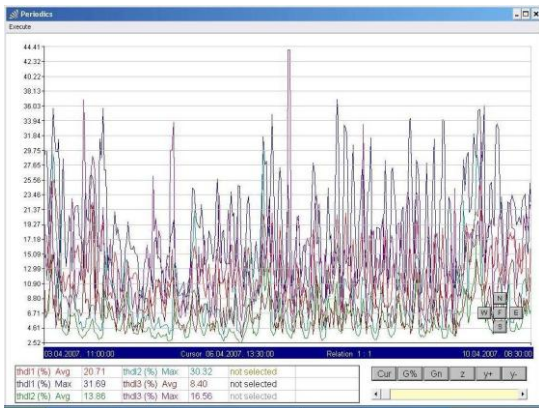


Figure 9. Current total harmonic distortions during one week

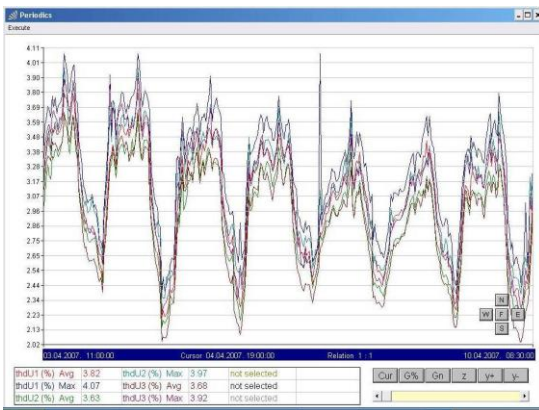


Figure 10. Voltage total harmonic distortions during one week

### V Conclusions

The great attention and respect should be given to low power electronic loads, as a dominant factor in power quality decrease. Individual and cumulative impact of low power single phase loads such as personal and

notebook computer, switch, modem/router, firewall etc., on power quality problems are described in this paper. Laboratory measurements showed that IT and communication loads have high content of current harmonics, in range from 17% to 182%, individually. Due to their low power, the voltage distortion is relatively low. Increasing amount of electronic loads voltage distortions are rapidly increasing. Finally, in this paper, results of current and voltage measurements in real commercial building (0.4 kV voltage level), are shown. It is concluded that measured results of current harmonics exceeds allowed IEEE 519 standards. At the same time, measured results of voltage harmonics stay within allowed IEEE 519 standards. It must be highlighted that, because of increasing number of these kinds of loads, in the future a great deal of attention should be given to the low power electronic loads, since they are causing power quality problems.

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