# Power quality in public lighting networks

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Public lighting is an extraordinary case with several specific aspects and parameters. On one hand the supply network influences public lighting grids, on the other hand, circuits with ballasts and control gears in public lighting luminaires with a certain structure and topology containing different types and wattages of lamps impacts backward to the supply network feeding there uncontrolled amount of harmonic frequencies, loading this way the neutral conductor and having many other disadvantageous consequences.

## Introduction

Power quality parameters at last time is still more and more important for scientist discussions. It is effect of payments for bad quality of giving energy. Aim of this paper is publish results of measurement different types of ballasts by site of power quality parameters. To show influence measure ballasts mainly using in public lighting networks. This results of measurement are base for next other analysis of lams faults.

## Measurement

Measurement was doing by network analyzer BK ELCOM 550 by diagram in the figure 1. Circuit was connected by source Chroma programmable AC source 61503. This source generated exact sinus voltage. Table 1 contents parameters of measurement lamps.
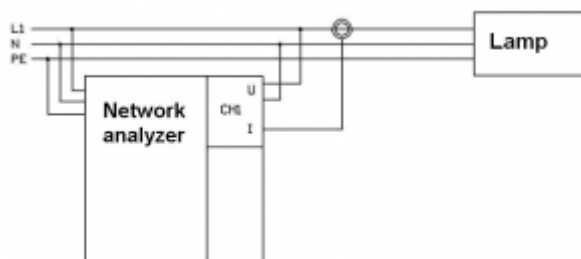


*Fig. 1 Connection diagram*

| Measurement number | Starter/electronic ballast | Lamp |
|---|---|---|

| | | |
|---|---|---|
| 1 | Starter:<br>BAG elektronics, NI 400 LE 4K<br>Capacitor:<br>Tesla, 20µF<br>Inductor:<br>ERC, HID 90, 150W, 1,5A, 230V, $\lambda$ 0,40, tw 130, Dt 75 | Osram, Vialox NAV-E 150 |
| 2 | Starter:<br>BAG elektronics, NI 400 LE 4K<br>Capacitor:<br>UNICOMP, 20µF<br>Inductor:<br>LAYRTON SM 150 21201, 150W, 1,8A, 230V, $\lambda$ 0,41, tw 130, Dt 65 | Osram, Vialox NAV-E 150 |
| 3 | Starter:<br>BAG elektronics, NI 70 S 4K<br>Capacitor:<br>DNA, 12µF<br>Inductor:<br>LAYRTON SM 70 13201, 70W, 1A, 230V, $\lambda$ 0,38,tw 130, Dt 65 | GE, LUCALOX LU70/90/T12/S7 |
| 4 | LUMITEC, ECOLUM EC3-150<br>150W, 0,66A, 230V, $\lambda \geq$ 0,98 | Osram, Vialox NAV-E 150 |

*Tab. 1 The parameters of lamp parts*

Induction ballasts in our measurement were more often because they are mainly using in public lighting network. Electronic ballasts are using less for their price and they are too modern. Different in price isn't so huge.
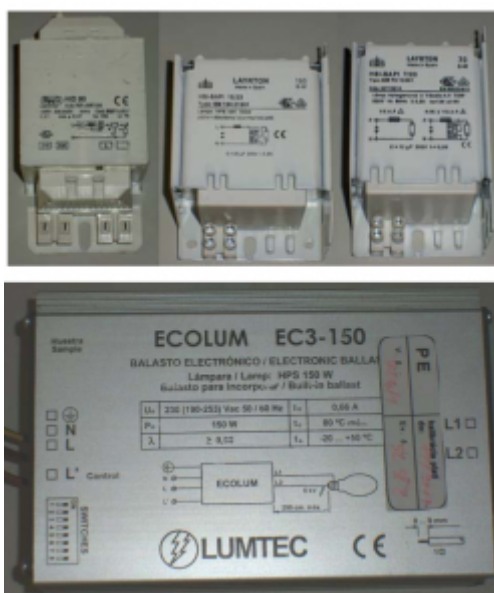


*Fig. 2 Used induction (ERC and Layrton) and electronic ballast ECOLUM*

For measurements was used components pictured up. Parameters of components are in the table. Best results had electronic ballast ECOLUM. It has good electric compensation. Lamps used for measurements were stabilized. Measurements are realized in laboratory of power quality.

## Results of measurement
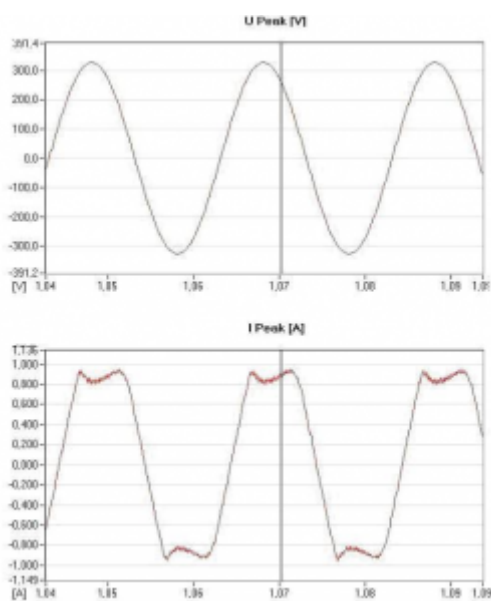
## Behaviour of voltage and current
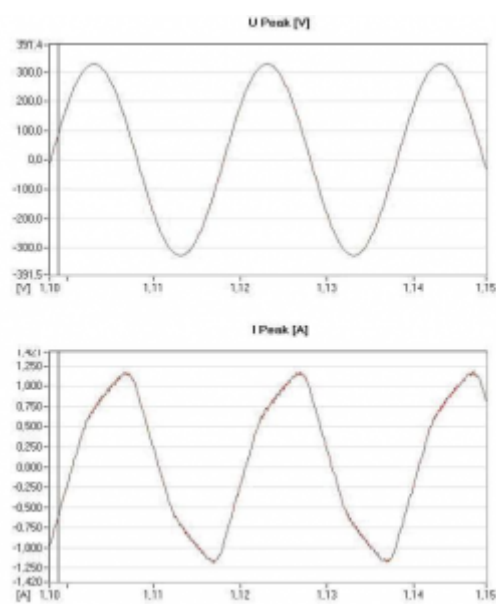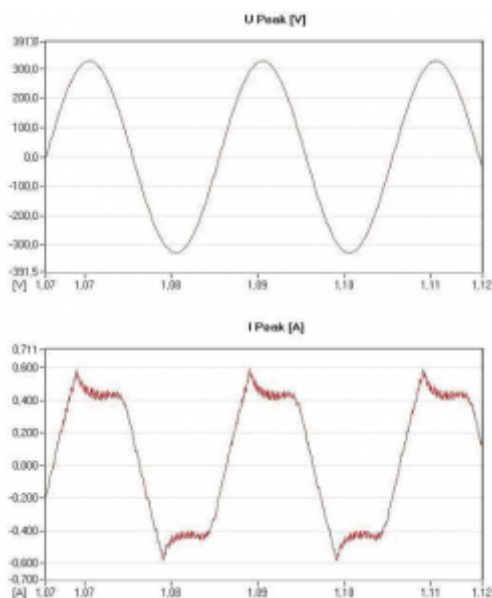


*Fig. 3 Measurement 1*
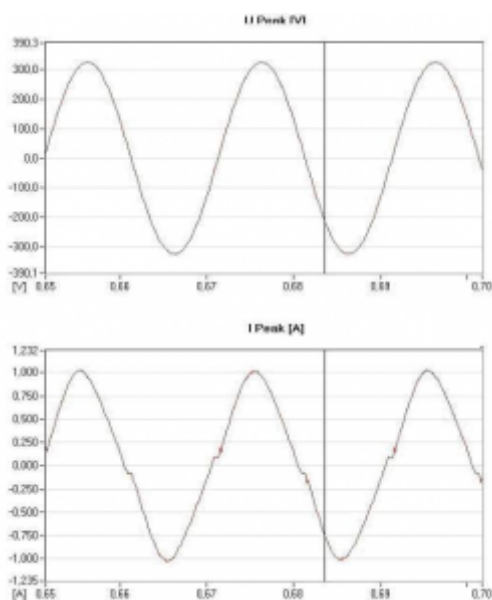


*Fig. 4 Measurement 2*

Fig. 5 Measurement 3



Fig. 6 Measurement 4

| Harmonic | Measurement 1 | Measurement 2 | Measurement 3 | Measurement 4 |
|---|---|---|---|---|
| | AVG [%] | | | |
| 1 | 0,800 | 0,790 | 0,400 | 0,666 |
| 2 | 0,009 | 0,001 | 0,008 | 0,002 |
| 3 | 0,130 | 0,123 | 0,086 | 0,057 |
| 4 | 0,004 | 0,001 | 0,003 | 0,002 |
| 5 | 0,034 | 0,029 | 0,029 | 0,011 |
| 6 | 0,002 | 0,001 | 0,002 | 0,000 |
| 7 | 0,021 | 0,023 | 0,014 | 0,009 |
| 8 | 0,000 | 0,000 | 0,000 | 0,000 |
| 9 | 0,006 | 0,009 | 0,005 | 0,007 |
| 10 | 0,000 | 0,000 | 0,001 | 0,000 |
| 11 | 0,006 | 0,007 | 0,005 | 0,005 |

| 12 | 0,000 | 0,000 | 0,001 | 0,000 |
|----|-------|-------|-------|-------|
| 13 | 0,003 | 0,004 | 0,003 | 0,004 |
| 14 | 0,000 | 0,000 | 0,001 | 0,000 |
| 15 | 0,002 | 0,003 | 0,002 | 0,003 |
| 16 | 0,000 | 0,000 | 0,000 | 0,000 |
| 17 | 0,002 | 0,002 | 0,002 | 0,002 |
| 18 | 0,000 | 0,000 | 0,000 | 0,000 |
| 19 | 0,001 | 0,001 | 0,002 | 0,002 |
| 20 | 0,000 | 0,000 | 0,000 | 0,000 |

*Tab. 2 Content of harmonics*
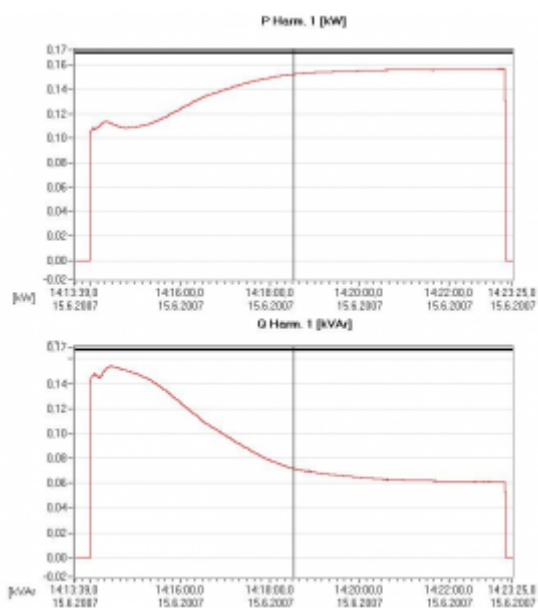
**Behaviour of power**
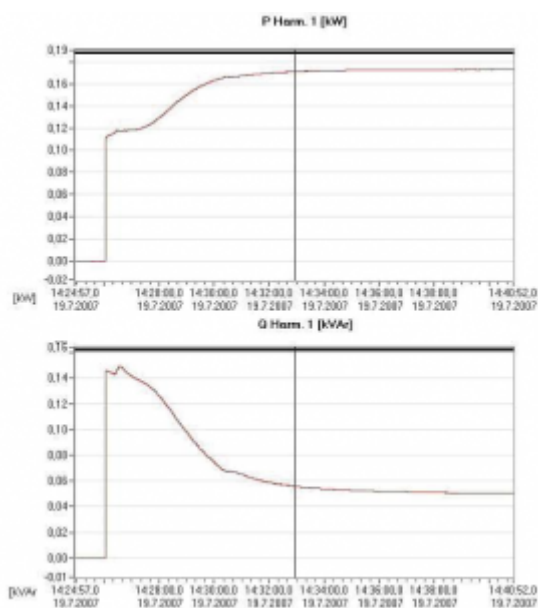


*Fig. 7 Measurement 1*
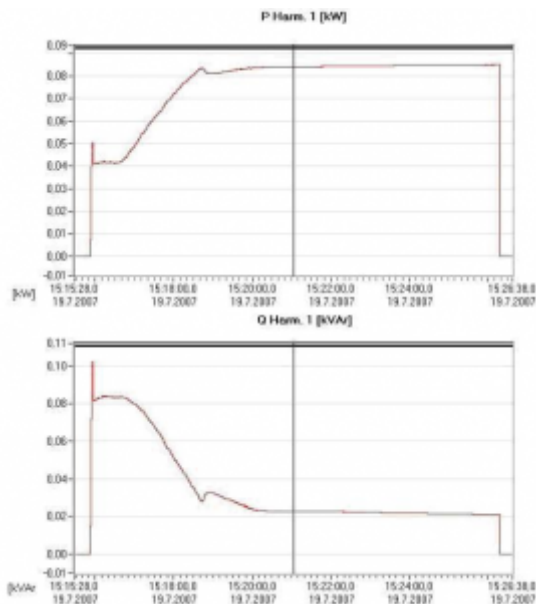


*Fig. 8 Measurement 2*
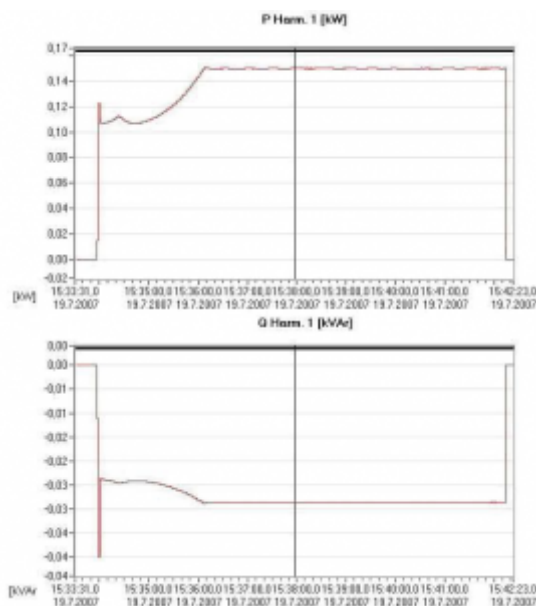
*Fig. 9 Measurement 3*



*Fig. 10 Measurement 4*

You can see form pictures quicker start of full power by using electronic ballast. When we use inductive ballast and 150W lamp start is almost same but not graph next part.

**Measure in exist public lighting networks**

I was doing the measure in Gabčíkovo with same lamps. Behaviour of current is strongly deformed but not so much than you tot up content of harmonics. On the graph you can see ballast of neutral line because it was common for other consumers either result was not objective than.
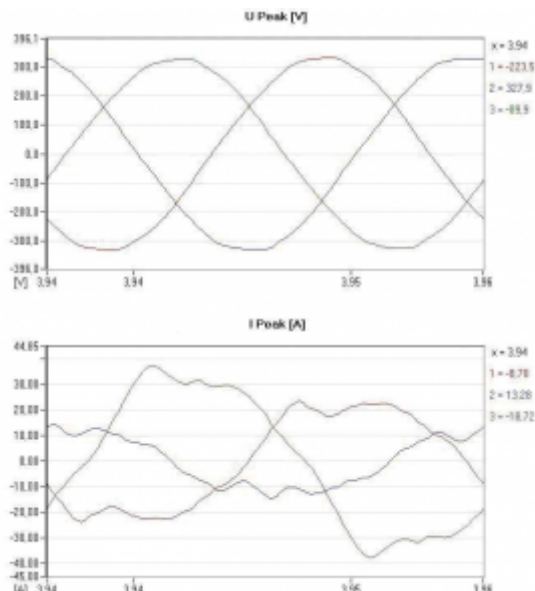
*Fig. 11 Behaviour of voltage and current*

## Conclusion

In measured values you can see signification content of harmonics mainly by inductive ballast. If you take, that middle size city has 2000 lamps with inductive ballast, we can get very important source of content of harmonics. For this reason is important to look for way how to particularly reducing them in public lightings networks. If you thing to use lamps with different ballasts may be possible to compensate content of harmonics. But if you use same lamps the contents are not tot up. Proportion of harmonics is decreasing by electronic ballast using. Lamps is easier to regulate and usage of electric energy decrease.

## References

1. Gašparovský, D., Krasňan, F., Pípa, M (2005). Analyses of Properties of Electronic Ballasts for High Pressure Sodium Lamps and Energy Saving Options by Applications of Electronics Ballasts to Streetlighting . In: Lux Junior 2005 Technische Universität Ilmenau.
2. Szathmáry, P (2003). Power Quality, ABB Elektro, s. r. o., Bratislava