UNIVERSITY OF MISKOLC

FACULTY OF MECHANIKAL ENGINEERING AND COMPUTER SCIENCE AND ENGINEERING

Investigation of Network Reactions Disturbing Information Tecnology Equipment

Summary of PhD Thesis

Written by

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Electrical engineer

JÓZSEF HATVANY DOCTORAL SCHOOL FOR COMPUTER SCIENCE AND ENGINEERING

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UNIVERSITY OF MISKOLC PhD THESISBOOK

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WHO IS AN APPLYING FOR A PhD TITLE

MISKOLC
2007

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1.Introduction

The trustiness of industrial output is highly influenced by the trustiness of electric networks. We can state that the quality and efficiency of supplied current is essential for productivity and competitiveness.
It is known that the current supplied by plant works regarding disturbances can be considered clear, and its transmission toward the consumer do not cause any damage in it and the source of disturbance is the consumer itself. As the individual consumers are not independent in energetic ways the disturbance caused can influence the quality of supplied energy by the other consumer. Several consumers who cause disturbances can be supposed at the same time on the wide networks so different disturbance picture evolves in a resultant, time and space.
The exploration and the confinement of disturbance sources is an important task in the smooth current supply.
The consumers like these can disfigure the ideal sinus shape of the waves of the currency on the network and together with this (upon the function of network tenseness) the wave shape of supply voltage.. The spasmodic load of other consumers like electric drives controlled by industrial electronics or heavy-duty welding machines, arc furnaces can “drag” the network with electronic swings causing rots, currency running-by and transients in currency. These so called network reactions can not only be dangerous for other unintended consumer but some interferences like ‘flashing’ generally known as flicker effect is harmful for humans and cause environmental pollution a risk for health.
The general quality of electricity supply are the following: frequency, slow change in voltage, voltage sign shape, fast change in voltage, rot in voltage, overrun, voltage failure, asymmetry.
Nowadays there is a significant change in the consistency of consumers. It can be seen both in industrial, communal and lightning techniques as well. This change is for the incredible level of IT technology and the spread of energy-save technical equipments. The changing in the sequence of consumers influences the quality of supplied currency and indicators which were not important in the past became significant e.g. short-time currency stripping.

The reference sensitivity of computing and measuring equipments called the electronical information equipments is competitively higher than other electronical equipments. That's why the different interferences in networks and the electromagnetic fields around the equipments especially for the IT equipment can be a contingency.

In the first part of my dissertation there is a review and criticism of literature on the pointers of quality of supplied energy, the quality of energy , the interaction between consumers, and the literature which is very important according to IT equipment. The literature is dealing with the quality and the general effects of supplied energy extensively. There is a wide scale on this topic in IEC standard but I realized that the definitions are not always precise the measuring results are ambiguous and as the result of it there are cases not defined in standard where the sensitivity of IT equipment can appear. If we take into consideration the widespread of IT equipment, software and the world-wide usage of them and the fact that without of them the world will not work properly it is highly essential to do some research work on the interferences in networks.

The second part of my dissertation is the important part of my work, I investigated the specific network disturbances, their spread and effects which can be a danger for the working of IT equipment., and extend on networks connecting with civil electricity supply.

The sensitivity of IT equipment were measured in the laboratory of University of Miskolc in the faculty of Electro technology and Electronics and on the other hand I checked the data measured in the laboratory on real networks in the area of North Hungary. This area is the most industrialized part of the Hungary according to electricity utilization. Heavy industry,
(metallurgical factories, chemical works) are significant and in the last few years several high power needed shopping malls were built which can influence the network. In the meanwhile the numbers of industrial consumers working with mechatronic, electronic and machine industrial technology are growing and they need qualified supply.

2. Reason of research

I determined the following aims:

2.1 Examination of the sensitivity of IT equipment with laboratory research

The aim of the examination is to definite the influence of the following disturbances to the IT equipment working in laboratories:

- short-time voltage outage
- voltage sag
- waveform distortion of welding and public lighting

2.2 Troubles caused by disturbances spreading on networks

I studied the sensitivity of IT equipment with measures done in laboratory of University of Miskolc in the faculty of Electronics and Electro technology.
I made industrial studies on the places shown figure 2.1. The results strengthened and certified the results of measures in laboratory. The dissertation deals with some results measured in the fields especially where the production direction and technology uses IT equipment in great numbers. These are the following:

- Investigation made in industrial factories in Eger and Jászberény
- Effects of automatics built in stations
- Lame working effects of 120 kV network

2.3 Flashing generated by electric arcfurnaces and summerizing of it on public networks

The health-demanding effects of the IT equipment, led and other other equipments producing light energy is caused by flicker effects.
The resultant disturbances of several consumers appears on 120 kV network and its studying the rearranging of components with a new mathematical method is the main topic of this dissertation.

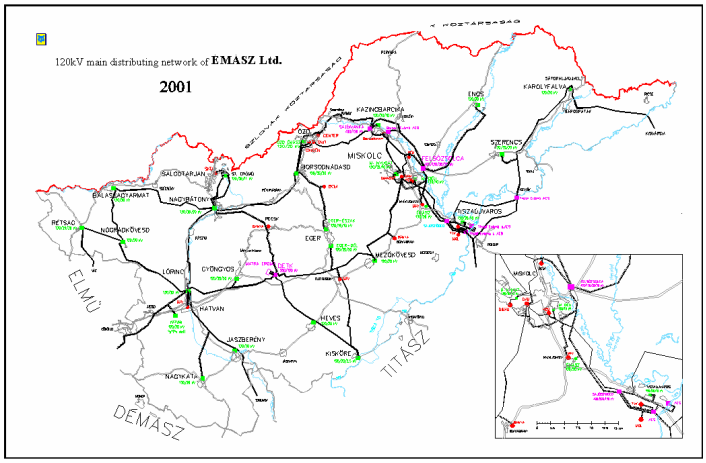

figure 2.1
120kV main distributing network of ÉMÁSZ Ltd.

3. The methods of research

3.1 Methods used during the research

A significant part of the research was done on computers obtainable in commerce. For the source of disturbances I used a welding machine and three different types of public lightning which are producing high strong upharmonics . In the process of measuring I used five computers at the same time and I made conclusion upon the results of the great number of measures.

The laboratory arranging represented the industrial arranging very well. I checked the reaction of computers for the slow changing of voltage with measures and for the the omission of voltage as well. It is shown in figure 3.1

An equipment at the faculty of Electronics and Electro technology in the University of Miskolc made the slow changing of voltage sure, and for the short time, min. 1 period voltage omission I invested a theoretically new electric circuit unit whose diagram is shown by figure 3.2.

In the case of measures done by computers I used 16 channels, high speed, 12 bits A/D transformers made by National Instrument and a drawing software for the collecting of data by computers.

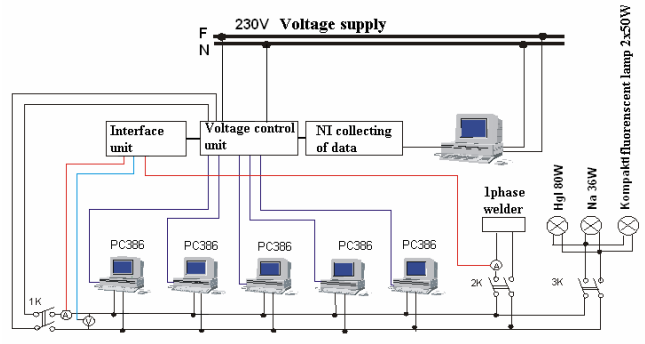

figure 3.1
Scheme of measure

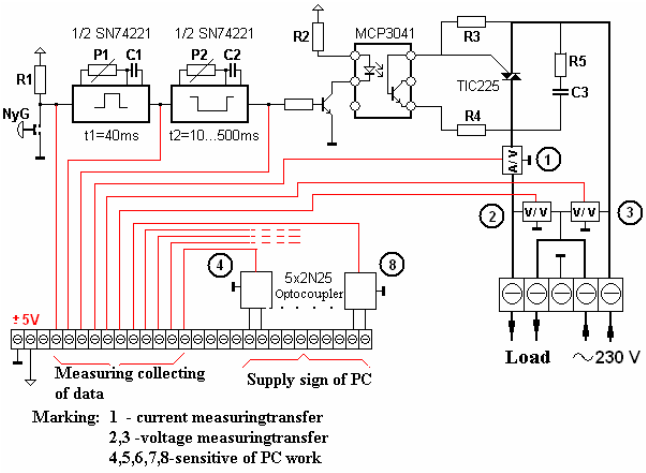

figure 3.2
Circiut providing short time voltage omission

3.2 Methods for the investigations of troubles caused by disturbances spreading on networks

I used methods providing synchronous data on electrical networks with high spread and stoic disturbances whose main point is the several investigation done at the same time on several points recorded for long time. (more than 30 days)
I made synchronous investigations in Eger –south station and 120 kV station in Jászberény and in purpose of tranzienses I generated artificial disturbances on 23rd May 2002. I made investigation on the inner network 0.4 kV of Electrolux Ltd in Jászberény.
On the 3.3 and 3.4 figure the measuring points are shown.

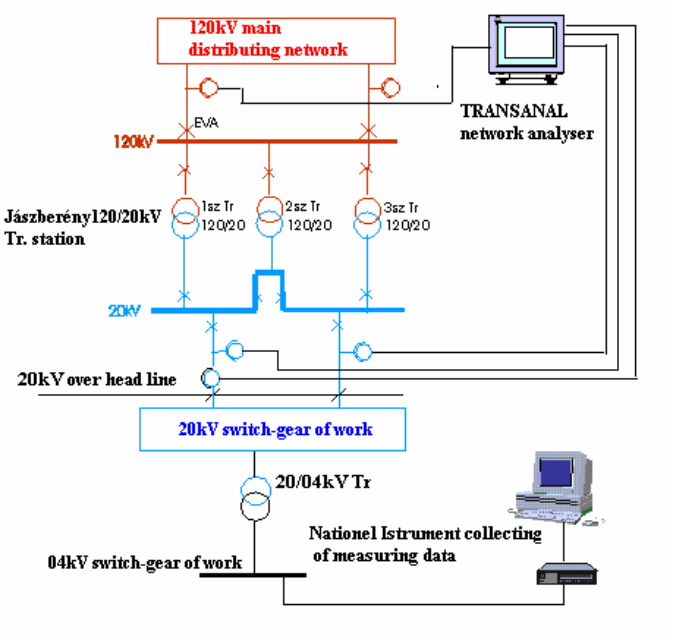

figure 3.3
Scheme of energy supply of Electrolux in Jászberény showing the measuring points

3.3 Methods used for the investigation of spreading and summarising of flashing generated by acfurnaces

The level of disturbances effects of flashing standardized by UIE-IEC is calculated with the following quantities:
short- time flicker effect with 10 minutes
changing of sliding time flicker effect from 120 data following each other in a minute calculated as:

$$P_{lt1}(k) = \sqrt[3]{\frac{1}{120}\sum_{i=0}^{119} P_{st1}^{3}(k-i)}$$

In the practice $P_{lt}(1)$ is used and that's why I followed the scheme above in the process of evaluation.

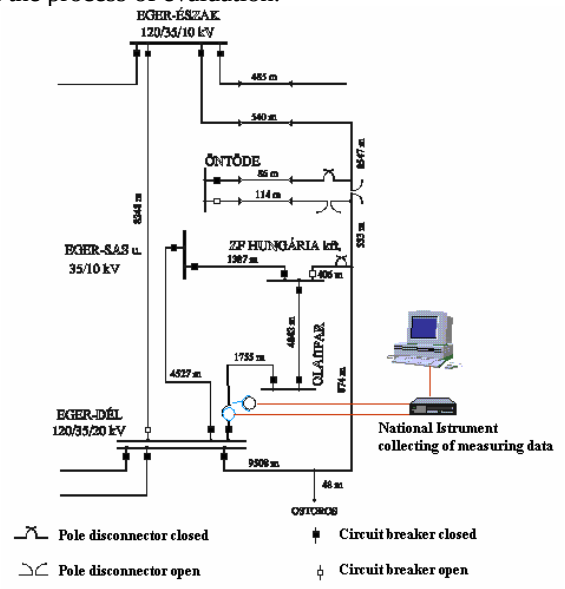

figure 3.4
35 kV network connections of energy supply of ZF Hungary Ltd showing the measuring places

Several different consumers can connect to the different part of high-voltage network that generates long-time flickers effects. The measuring done in case like this recorded a resulting so called summarized flicker level.

But this summarised value is not only the mathematical summarization of components. Both the short and long time flicker level and mathematical –statistical methods are used as well.

(calculus of probabilities) upon them a general summarizing rule has not been worked out yet.

The methods provided by measures which I carried out, for the determination of componenets are that we eliminate consumers generating flicker effects after each others. (exactly we measure time when they are not working)

The measures done and the determination of components separately proved the fact that the average value of the resulting flicker effect can be calculated by the rules of summarizing of dispersion with relatively high correctness considering the DAM- Felsőzsolca- Ózd 120 kV network impedantial relation.

4. The new scientific results –Theses

Measuring carried out in laboratory were totally proved by industrial data by Eger ZF Hungary and Electrolux, Jászberény. Based on my resarch on this field I came to the following scientific achievement drawn up in four thesis:

Thesis 1: *I developed a principle new computerized measuring process and a software for the examining of the effects of short –time voltage omission. (0-100 periodical time).*

On the results of my scientific research performed by new measuring process I carried out in practice and upon the diagrams I pointed out that the deficiancy of the machines statrted at T_1 sec. after the beginning of the omission. Growing the time of omission reaching the T_2 sec all the machines fell out. T_1 and T_2 are the value of the IT equipment.The new method can make the controlling of voltage sensitivity of any IT equipment possible.

Thesis 2: *I found out that if the upharmonius content of mains voltage is THDu>10% for more than 10 minutes, problems can appear in the working of IT equipment e.g data losses and freezing.*

According to the MSZ EN50160 standard the 95 % of THD value in any one week period can not be more than 8%. For the rest 5% which means 8 hours in a week there is no any regulation. Tha standard does not cover the fact that THD >10% should not occur. In the process of modernization of the standard I suggest taking it into consideration.

Thesis 3 *I stated that the value of omission time of IT equipments and the rest-voltage depends on the sloping of voltage reduction. If the decreasing of voltage mesured in V/sec is more than 1000 the time of omission is less than 0,3 sec and the restvoltage is under 25%. If the decreasing of voltage measured in V/sec is less than 300 the omissiion time grows up to about 0,6 sec and the restvoltage is about 50%. It is typical of transition and the whole process that in time of breaking the voltage down the sensitivity of IT equipments against the restvoltage is*

$$(0,9\text{-}U_{m(p.u)})xT_{omission}=constant$$

So IT equipments fall out in case of voltage break down if the missing voltage –time area reaches the characteristic value of certain IT equipment.

Thesis 4: *Upon the results of my scientific research and the diagrams I stated that the flickers generated by high-performance equipments working in pulsating mode (e.g electric arcfurnaces and electric railways) can appear and summerize. The value of source flicker at the measuring point is given by k power of the flicker by the individual users minus k root.*

$$P_E = \sqrt[k]{P_{1f}^k + P_{2f}^k + ... + P_{nf}^k}$$

(P_{1f}, P_{2f}, P_{nf} *are the flicker levels by users generating embarrasments*)

I checked the theoratical calculations in several power stations and the same results proved me right. With several calculatings on places far from each other I recorded the effects of two high performance flicker sources situated nearby, DAM arcfurnace and OAM arcfurnace as well and the common influance of the two furnaces and other sources. I compared the source value of average

P measured on several points and the caklculated values and I found out that the measured and calculated values are near the power of k=2 in every cases. I verified that the value of k in flicker summerizing is

k=2

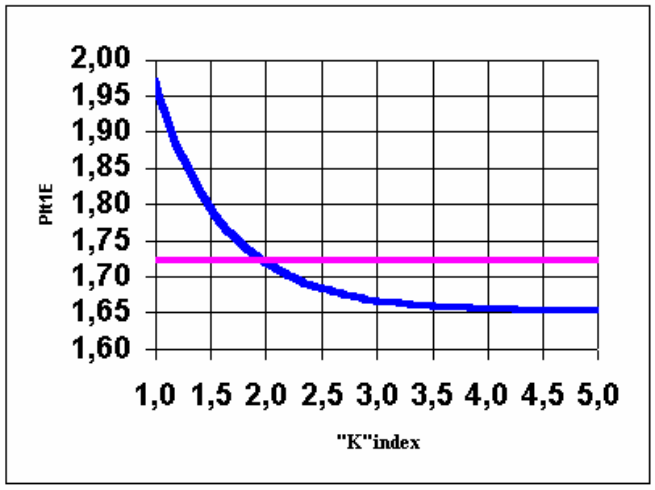

figure 4.6
On DAM 120/35 kV station 120 kV collecting rail calculated resultant upon 'k' power index $P_{lt,}$ (blue) and measured (purple) resultant $P_{lt}1$

5. Application of new scientific results

On the results of my scientific research any IT equipments can be checked properly. The reaction for short time voltage omission and other disturbances can be determinable.
The results obtained can be comparable with the working time of the automatics used by current supplies. According to this method the formation of new steps and standards can be done which built-in the networks can reduce the disturbance effect causing troubles in IT equipment. The composition of consumers and technology used is

changing during the time. Conclusion from one measuring can not be competent. The measures must be done in certain periods.
The investigation of flicker effect is essential. Human health, the health of people sitting in front of screen and the prevention of neurotically is well known. The disturbances generated by flickers and the endangering effects for the IT equipment are less known. That's why the continuous assessment of the quantity value of currency supplied on uninterrupted networks and the reveal of harmful effects is very important. (voltage cut-down, torsion of wave-shape, changing of amplitude, flicker effects etc.)
In the future more attention should be paid on the reveal of consumers causing harmful effects and investigation of protective new methods for supporting the safe and quality of production supported by electronics.

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