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SYSTEM FOR MEASURING CONTROL AND MONITORING OF POWER CONSUMPTION AT THE DRESSING PLANT OF THE "ELATSITE-MED" Co

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ABSTRACT

A microprocessor system for measuring all the values, characterizing the power consumption of the whole enterprise is commissioned. The active and reactive power of at all the inlets and outlets of the GPP 110/20/6 kV are visualized. Daily and monthly record of consumed power and the power factor for different rate zones for each outlet and for the whole enterprise is printed automatically. Power consumption is evaluated for different outlets of the enterprise and for the enterprise, as a whole, according to relevant regulations. A load schedule is printed for specific workshops and for the enterprise as a whole.

With the commissioning of the automated system an opportunity is established for optimum regulation of loads in the specific rate zones, which is a precondition for reduction of power consumption. Control of electric power consumption in the specific departments of the enterprise is improved. The needed technical preconditions for observation of the requirements of the power producing company and avoiding penalties is absolutely possible.

STRUCTURE OF THE SYSTEM

The linear scheme of the main sub-station (fig. 1) shows the zones, which control power and power consumption. At both ends of the ORU 110 kV there are three thri-phase transformers for active power, for reactive (inductive) power, for ,reactive (capacity) power. Two thri-phase transformers for active and for reactive power are mounted at all the outlets of the KRU 20 kV and 6 kV. Outgoing direct current unified signals 0 – 5 mA from all transformers (totally 32 transformers) are brought to the microprocessor system by multiple screened cables. They enter a converter, where current signals are transformed into voltage: from 0 – 5 mA into 0 – 10 V. Signals are scanned and identified from the controller and then they are supplied consecutively to the computer, which process them in real time.

Consumed power of voltage 110 кV, of voltage 20 кV and voltage 6 кV are visualized selectively on the background of linear schemes shown in the monitor (fig. 2, fig. 3, fig. 4).

Information about consumed power, calculated by the data of all transformers, is printed in an appropriate layout at certain given intervals of time. Data for each day, for each month and for the whole year are printed automatically.
The system is incorporated to a circuit of 220 V by an uninterrupted power supply (UPS), which guarantees work without supplied voltage for 15 min.

APPARATUS

The microprocessor system is constituted of modern elements.

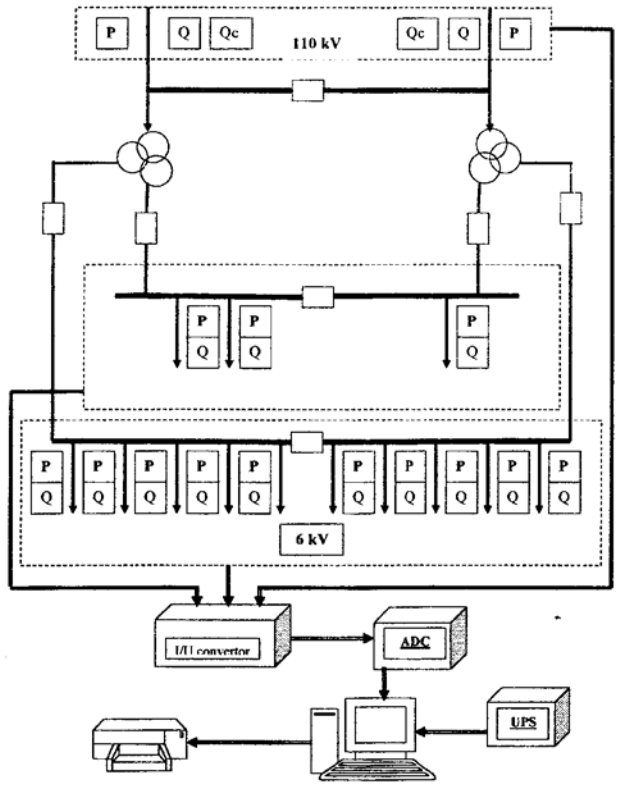

Figure 1.

Preliminary transformers for power:
- for active power – type E 829/1
- for reactive power– type E 830/1

with parameters at the inlet: voltage: 100 V; current 2,5/5 A; outgoing current: direct current 0 - 5 mA;
Maximum resistance of charges Rт 3 кΩ;
Class of precision 1,0;

Converter current-voltage I/U

Type: PCLD 880; Voltage at the outlet for inlet 5 mA - 10V; Resistance of load - 2 kΩ; Precision of resistors - 0,1%; Number of active inlets 32

Controller microprocessor

Type: PCL 813B; Number of channels 32; A/D convertor 12 bits; Inlet voltage: Bipole ± 5V; ± 2,5V; single pole 0-10V; 0 - 5V; 0 - 2,5V; 0 - 1,25V; Time for converting 25 μs; Resistance at inlet > 10 MΩ; Ambient temperature: - 20 + 65°C; Precision ± 0,01%

Computer configuration

There is a computer configuration of standard elements: *processor, monitor, printer and uninterrupted power supply* - "APC" Back UPS 300 MI

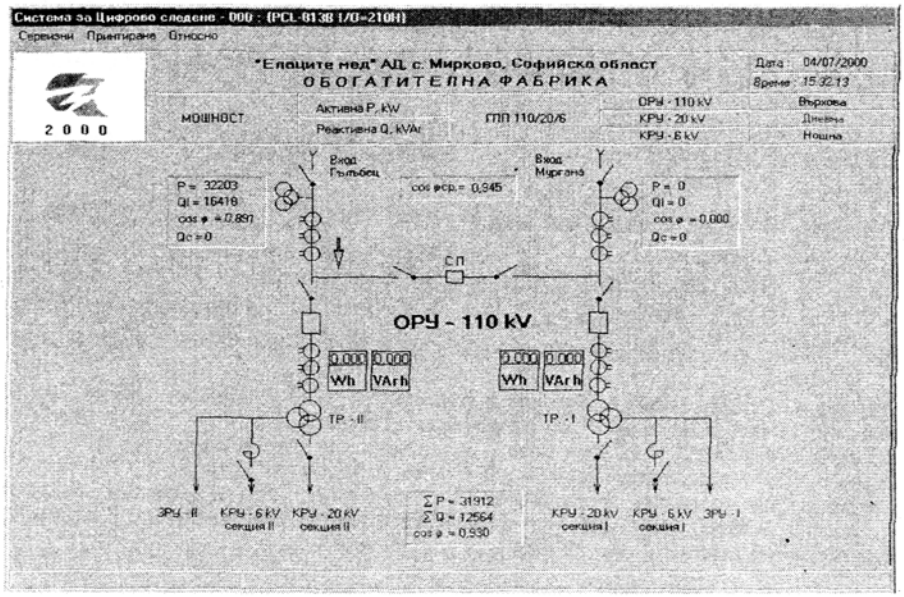

Figure 2.

Software

General characteristic

The software of the system is constituted hierarchically. The operational media is WINDOWS`98

At the first level of selective scanning of data from the 32 preliminary transformers of power (15 for active power and 17 for reactive power) and their addressing into the PC apply the software products Activ DAQ and Visi DAQ and Ver 11 – installation.

A specialized software program "ELATZITE" is developed for the second level of processing of information and calculation.

All the installed software products are authorized.

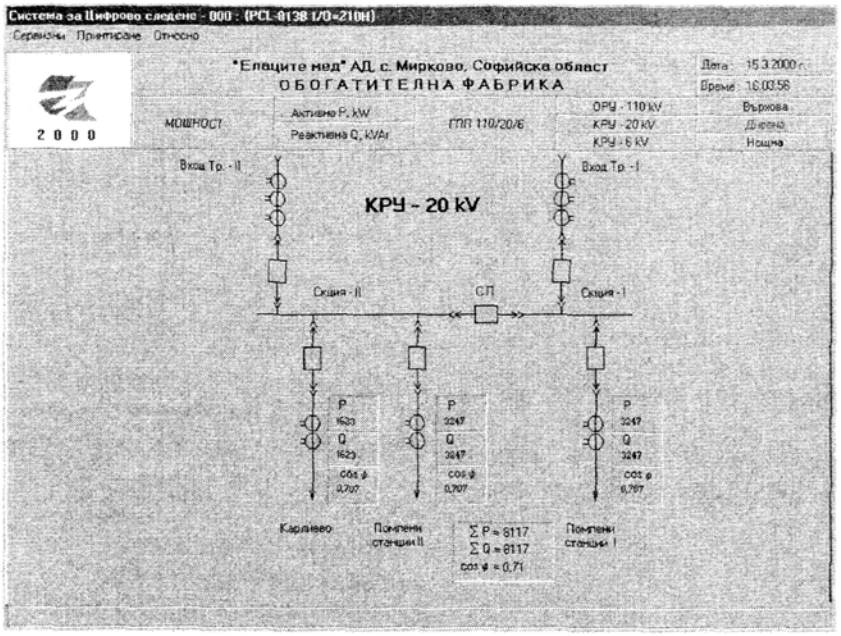

Figure. 3

The basic requirements towards the software uniting both levels in WINDOWS media correspond to the relevant principles.

They are as follows:

The system acquires, processes and stores information in real time.

Scope of the system

- Inlets for measuring at 110 kV:

"Murgana" and "Galabets"
- Outlets for 20 kV:
Pumping plant "Benkovski I", pumping plant "Benkovski II", pumping plant "Karlievo"
-Outlets of workshops for 6 kV:
Workshop medium and fine crushing 1 (CCT 1)
Workshop medium and fine crushing 2 (CCT 2)
Workshop medium and fine crushing 3 (CCT 3)
Crushing-flotation department (Main building 1)
Crushing-flotation department (Main building 2)
Mechanical-repairing workshop (РМЦ 1)
Mechanical-repairing workshop (РМЦ 2)
Boiler heating department
Electrical repairing department (ЕРЦ)
Administration

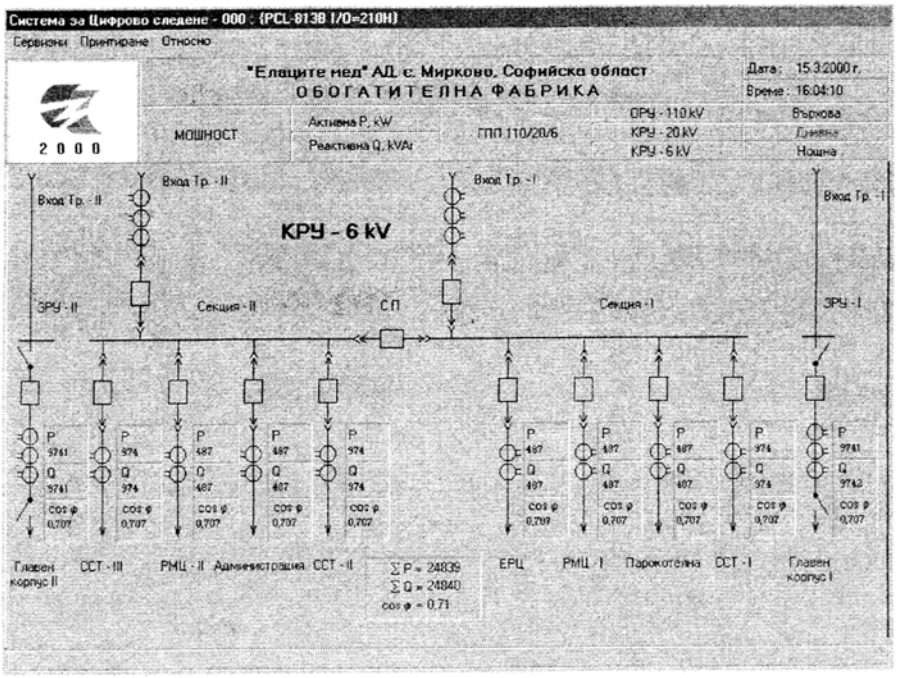

Figure 4

Directly measured and calculated values:
-Active power P – for all inlets and outlets, values are obtained as:

$$P = k_I . k_U . k_P . m ,$$

where: k_I is a factor of transformation of the current transformer

k_U - factor of transformation of voltage transformer

k_P - factors of transformation of power transformation

m - digit, read by АЦП

-Reactive power Q – calculated according to the same way, including:
with inductive character Q_L – for all the inlets and outlets;
with capacity character Q_C - only for two inlets (110 kV).

Calculated values:
- power: average values are calculated for intervals of time 5s and 30min
- Average values for cosφ - for 5 s and for 30 min

Remark: The average power for 5 s is considered and visualized as a momentum value:
- Power:
active $W_a = \Sigma P_i . t_i$;
reactive $W_L = \Sigma Q_{Li} . t_i$ и $W_C = \Sigma Q_C . t_i$
- Cost of electric power is determined according to acting regulations for evaluation and rates of electric power. Daily, monthly and annual cost of electric power for the peek, daily and night rate zones and the backward reactive capacity power in the system.
- Normed limits. When certain limits are introduced for specific values $L_{(x)}$ the percentage of consumed portion is calculated $N_{(x)}$:

$$L_{\%} = \frac{N_{(x)}}{L_{(x)}} . 100 , \%$$

Measurements and calculations of all the parameters is done according to zones of different rates:
- power, energy and currency expenses:
peek – subdivided for two parts of the day
daily – subdivided into three parts in the day (from the peek zones)
nightly
- average values of cosφ for the day and the month:
daily (calculated by the total power consumed in the peek and the daily zones):

2000	"Елаците мед" АД с. Мирково, Софийска област ОБОГАТИТЕЛНА ФАБРИКА	Дата : 10/07/2002
	КОНСУМИРАНА ЕЛЕКТРИЧЕСКА ЕНЕРГИЯ	Време : 06.00.37

Период от 10/06/2002 до 10/07/2002

ВХОД / ИЗХОД	Консумирана енергия по зони						$\cos\varphi_{ср}$		Върната енергия, kVArh
	Върхова		Дневна		Нощна		дневен	нощен	
	W_a kWh	W_r kVArh	W_a kWh	W_r kVArh	W_a kWh	W_r kVArh			
110 kV	194040	85116	320291	141450	260657	116113	0,915	0,913	4
Гълъбец	0	0	0	0	0	0	0,000	0,000	4
Мургана	194040	85116	320291	141450	260657	116113	0,915	0,913	0
20 kV	11339	7177	16913	12313	19508	12504	0,841	0,842	0
Помпени станции I	11259	7177	18778	12312	19401	12503	0,839	0,841	0
Помпени станции II	11	0	20	1	13	0	1,000	1,000	0
Общо Помпени станции	11269	7177	18798	12313	19414	12504	0,839	0,841	0
Карлиево	70	0	116	1	95	1	1,000	1,000	0
6 kV	167172	58650	276408	97531	221507	77934	0,943	0,943	0
Гл. корпус I	75596	8754	125892	14924	100809	12510	0,993	0,992	0
Гл. корпус II	80480	18172	133902	32355	108256	26557	0,973	0,971	0
Общо Гл. корпус	156075	26926	259793	47279	209065	39067	0,984	0,983	0
ССТ I	693	17530	1115	29050	881	23100	0,039	0,038	0
ССТ II	9735	13897	14348	20635	10727	15266	0,572	0,575	0
ССТ III	0	0	0	0	0	0	1,000	0,000	0
Общо ССТ	10427	31428	15464	49685	11607	38366	0,304	0,290	0
РМЦ I	0	0	0	0	0	0	1,000	1,000	0
РМЦ II	154	93	291	211	210	168	0,825	0,782	0
Общо РМЦ	154	93	291	211	211	168	0,826	0,782	0
ЕРЦ	24	14	40	26	34	18	0,853	0,888	0
Парокотелна	48	90	119	176	131	162	0,533	0,629	0
Администрация	443	100	700	154	460	154	0,976	0,948	0

Figure. 5

Storage of information

Momentum values of the active, reactive power and cosφ (average for 5s) are saved for 30 min.

All the average data for 30 min are saved for a period of time not less than 5 years.

Constants, that should be introduced by the operative staff (in case of relevant protection).

- factors of transformation of measuring transformers, current transformers k_I=x/5 A and voltage transformers k_U=x/100V;
- factors of transformation of power transformers k_P and k_Q
- rate zones in astronomic time (hours) for the power: peek, daily, nightly rate zones;
- rate zones in astronomic time (hours) for cosφ: peek plus daily and nightly rate zones;
- given limits (if there are any)
- data for correction of the factor for payment of reactive energy depending on the average monthly values of $\cos\varphi_{мес.}$
- data for cost of electric power: peek, daily, nightly;
- corrections for dates and astronomic time;
- corrections for time for reading and processing of data (scanning, average, visualization, record etc.).

Visualization

A linear scheme of ОРУ 110 кV, КРУ 20 кV and КРУ 6 кV is shown in a main and two additional menus. The screen has a window for visualizing the rate zone in the moment of measuring.

For all the inlets and outlets there is a visualization of the momentary values of the active power P, reactive power Q and cosφ.

In the main menu the backward reactive power Q_c in the system is also visualized, combined with a sound signal.

The main menu indicates also the $\cos\varphi_{ср}$, calculated from the beginning of the month till the moment of observation..

The window "ADMINISTRATOR" organizes and visualizes all the service programs and records for printing at the printer.

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2000	"Елаците мед" АД с. Мирково, Софийска област ОБОГАТИТЕЛНА ФАБРИКА	Дата: 10/05/2002
	МЕСЕЧНИ РАЗХОДИ ЗА ЕЛЕКТРИЧЕСКА ЕНЕРГИЯ	Време: 16.49.24

Период 2002 година

ВХОД / ИЗХОД	За консумирана енергия по зони общо, лв				Санкция, лв.		Премия, при cosφ<0,7, лв.	Всичко, лв.
	Върхова	Дневна	Нощна	ОБЩО	При cosφ< 0,9	От върната капац. енергия		
Януари	734377	777274	403147	1914798	0	15	0	1914813
Февруари	669074	723850	371630	1764555	0	19	0	1764574
Март	718980	781786	400163	1900929	0	20	0	1900948
Април	700472	749488	377619	1827580	0	42	0	1827622
Май	711389	764388	391459	1867235	0	19	0	1867254
Юни	685076	723937	377465	1786478	0	15	0	1786493
Юли	585322	634251	324249	1543822	0	16	0	1543838
Август	683159	729256	362380	1774795	0	13	0	1774808
Септември	675936	711624	366049	1753610	0	19	0	1753629
Октомври	101442	114861	59917	276221	0	3	0	276224
Ноември	0	0	0	0	0	0	0	0
Декември	0	0	0	0	0	0	0	0

Figure 6

Documentation

-the following records are printed each day at 6.00 h:

- "Consumed electric power", which includes all the inlets and outlets, energy for different rates, average values for: cos φ_{cp} - daily (peek + daily zones) and nightly and returned capacity power – fig..5
- "Cost of electric power" – expenses in leva, including all inlets and outlets for zones and a total
- "Daily loading schedule", which includes data for hour active and reactive power, totally for the enterprise and for all the outlets of КРУ 20 and КРУ 6 for the substation.

-each month is printed the following:

- "Monthly consumption of electric power" for different rate zones, with calculated cos φ_{cp} – daily and nightly rates and returned capacity power.
- "Annual expenses for electric power" for the zones with a calculation of different rates according to relevant regulations for cost and rates – fig. 6.

Assembly

The complete system is positioned at one of the fields of the central panel of the sub-plant.

The micro-processing system is commissioned in March 2000 and has been working since.

Records for consumed electric power, expenses in leva and daily schedule are presented to the professionals from the power supply department of the enterprise. Analysis of information provides an option for in-time activities and effective power management. Having in mind that the dressing plant of "Elatsite med" Co is a power consuming enterprise (the average power consumption is nearly 30 MW) the skillful management of power consumption brings to significant savings of currency.

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