IMPLEMENTATION OF POWER QUALITY ANALYZER IN SIMULINK

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A general system diagram for industries is considered for analysis of power quality (Fig.1).

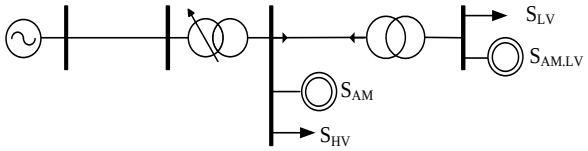

Fig.1. A general system diagram

The model of electricity system was developed in Simulink - a simulation application of MatLab software package (Fig. 2). The model consists of two main parts: power and data.

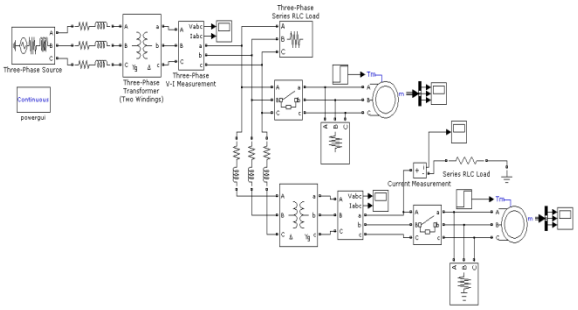

Fig. 2. The electricity system's model in Simulink

Power section consists of a three-phase voltage source, power line, step-down substations, cables, switches, one-and three-phase load and motor load (asynchronous machine). Information section consists of voltage and current measurements, scopes and data bus. The Unified Power Quality Index (UPQI) was calculated in the information section.

According to GOST 13109-97 "Standards of electric power quality within electric power supply systems of general-duty" the UPQI are: steady-state voltage deviation, voltage excursion, flicker indicator, voltage unbalance ratio by negative sequences, voltage unbalance ratio by zero sequences, voltage nonsinusoidality ratio, voltage harmonic component ratio, frequency deviation, voltage depression time, pulsing voltage and temporary overvoltage ratio [1].

Determination of UPQI and optimization of electricity system's model according to GOST 13109-97 are the main objectives of this work.

Manual calculation of UPQI is a difficult task. Therefore, in this work "Power Quality Analyzer" sub model has been developed; it consists of standard blocks from Simulink library (Fig.3).

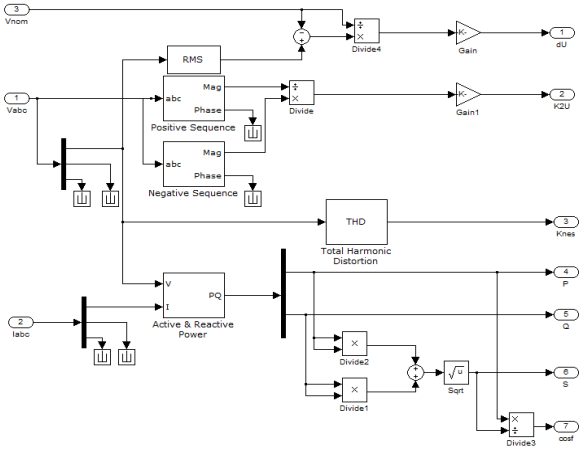

Fig. 3. Structure of "Power Quality Analyzer" sub model

Sub model calculates such UPQI as steady-state voltage deviation δU(%), voltage unbalance ratio by negative sequences K_{2U}(%), voltage nonsinusoidality ratio $K_{n(1)}$(%),active power ratio (cosφ), and also active, reactive and full powers.

A fragment of electrical system is given as an example. It consists of a voltage source, three-phase asymmetric active-inductive load connected to the source, capacitor bank and power quality analyzer (Fig.4).

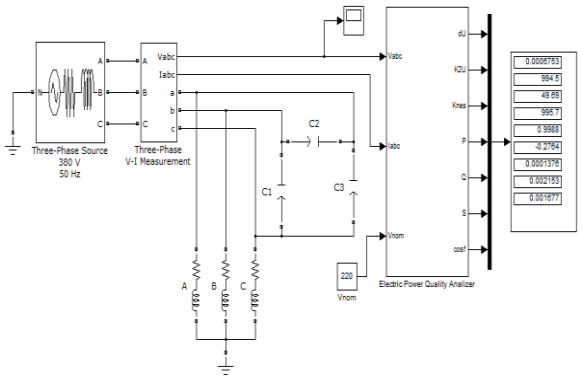

Fig. 4. A fragment of electrical system with a power quality analyzer

Simulation results without using capacity banks, proves that the main UPQI are in acceptable limits (Table 1).

Table 1. Simulation results

UPQI	ΔU, %	K_{2U}, %	$K_{n(1)}$, %	P, W	Q, VAr	S, VA	cosφ
	-0,29	0,345	1,505	999,4	795,5	1277	0,782

Parameters of electricity system's model were optimized by connection capacity banks in order to compare the main UPQI

Table 2 shows simulation results. The step of capacity change is 50 VAr.

Table 2. Simulation results after optimization

UPQI	Q_c=100 VAr	Q_c=150 VAr	Q_c=200 VAr	Q_c=200 VAr
δU, %	-0,28	-0,27	-0,27	-0,27
K_{2U}, %	0,002	0,001	0,001	0,001
$K_{n(1)}$, %	0,018	0,008	0,008	0,018
P, W	994,4	994,5	994,5	994,5
Q, VAr	646,4	497,2	348,1	198,9
S, VA	1186	1112	1054	1014
cosφ	0,838	0,894	0,944	0,981

Conclusion:

According to simulation results, it can be said, that power quality analyzer works correctly. Optimization solution by inclusion of capacity bank providespositive effect as well. According to table 2 inclusion of capacity bank decreases the steady-state voltage deviation, voltage unbalance ratio by negative sequences, and significantly increases the active power ratio.

Thus, this model of power quality analyzer can be used for rapid analysis of UPQI.

References:

1. GOST 13109-97 "Standards of electric power quality within electric power supply systems of general-duty", 1997. – 35 p.

2. V.P.Dyakonov. Simulink 5/6/7: Tutorial. - M.: DMK-Press, 2008. - 784 p.: Ill.