MEASUREMENT AND ANALYSIS OF TRANSIENT PHENOMENA OF SYNCHRONOUS GENERATORS

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ABSTRACT

The work mode changes of synchronous generators are associated with transient phenomena, that proceed inside of synchronous generators and influence their stability. Typical transient phenomena are connection of generators to power supply and disconnection from power supply and then a three-phase short circuit on output clips of synchronous generators. It is necessary to measure electrical magnitudes that describe transient phenomena during tests of synchronous generators and make a graphic analysis of electrical magnitudes on base of these measurements. Measuring of electrical magnitudes is realized by a hardware by a firm National Instruments that is fully designed by its technical parameters for measuring of transient phenomena. A user software that is designed by its software conception for an analysis of transient phenomena in synchronous generators was developed in a developing interface LabVIEW 8.6.

1. INTRODUCTION

Transient phenomena in synchronous generators appear during changes of work modes, rather during transit from one work mode to another work mode. Work modes of synchronous generators are connection of generators to power supply and disconnection from power supply, fast loading change and a three-phase short circuit on output clips of synchronous generators.

Transient phenomena can influence a stability of synchronous generator that's why it's necessary to analyse transient phenomena. Transient phenomena can be analysed by measuring of electrical magnitudes that describe immediate process of transient phenomena by their dependence on time. It is necessary to analyse measured signals by software and according to the analysis to make an action intervention for increasing the stability of synchronous generator.

In following sections we deal with a description of designed measuring system that enable exact and fast measuring of electrical magnitudes that describe transient phenomena. The measuring system for measuring of transient phenomena in synchronous generators is developed at request and according technical demands of a firm that is concerned with a development of synchronous generators.

2. CONNECTION OF A MEASURING SYSTEM NI PXI-1050

Currents running throught phases of the generator are measured by sensors AmpFLEX that are suitable for measuring of transient phenomena. Thanks their construction it is very practical for installation and removal from measured primary conductor throught that the measuring current is running. The sensor AmpFLEX is accessorised by a electronical integrator that allows to change sensibility of the sensor by change of measuring range. The integrator has two switchable ranges 0,1mV/A and 1mV/A. Output signal of the integrator is voltage that is directly brought into a module for modification of voltage level of measured signal NI SCXI-1327.

Line voltages between phases of generator are measured by instrumentation voltage transformers. The instrumentation voltage transformer has three switchable measuring ranges 7500V, 12000V and 15000V. Output voltage of instrumentation voltage transformer is 100V that is brought into the module for modification of voltage level of measured signal NI SCXI-1327.

Exciting current running in exciting winding of synchronous generator's rotor is measured by a current sensor DK20C5. The sensor DK20C5 has three switchable measuring ranges 5A, 10A and 20A. Output signal of the sensor is voltage in range 0V-5V that is directly brought into the module for modification of voltage level of measured signal NI SCXI-1327.

Exciting voltage is directly measured by the module NI SCXI-1327 because voltage level of the exciting voltage doesn't exceed the maximal voltage level that is used by physical analogue channel of the module NI SCXI-1327 and the module NI SCXI-1125.

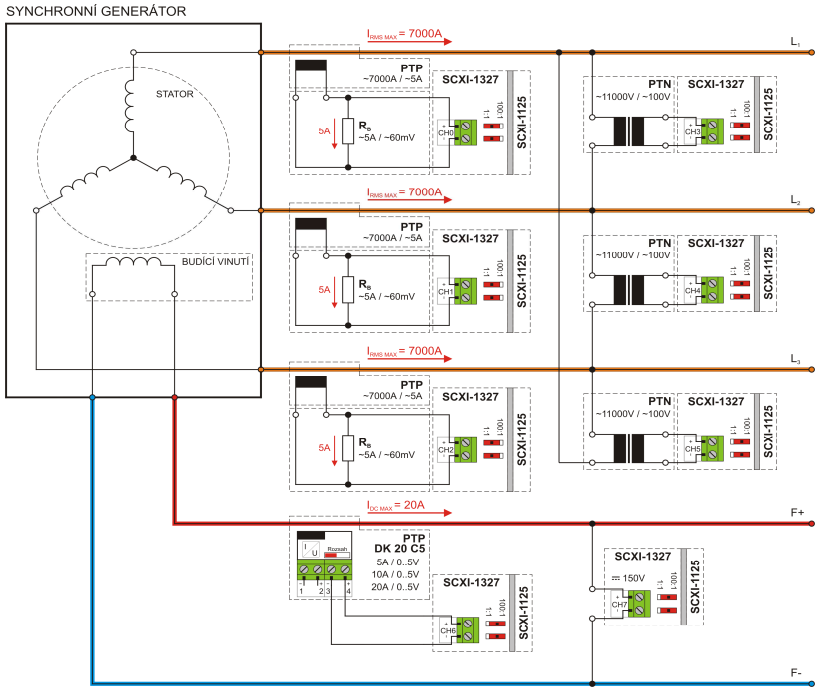

Figure 1: The block electrotechnical diagram of linkage with of transient phenomena in synchronous generators.

3. MEASURING OF TRANSIENT PHENOMENA

A measuring system of a platform PXI/SCXI for measuring of transient phenomena in synchronous generators is designed by a firm National Instruments. The platform PXI/SCXI is implemented into a control data unit with a type designation NI PXI-1050 that allows to use mutual communication of measuring hardware between the platform PXI and SCXI.

Figure 2: The control data unit NI PXI-1050 of the platform PXI/SCXI.

Figure 3: The measuring module PXI-6123 of the platform PXI.

Figure 4: The measuring module NI SCXI-1125 of the platform SCXI.

Figure 5: The module NI SCXI-1327 of the platform SCXI.

3.1. THE MEASURING MODULE NI PXI-6123 OF THE PLATFORM PXI

Sampling of measured signals is realized by a module NI PXI-6123 that is designed for measuring of transient phenomena. The measuring module has eight voltage analogue channels of differential type that enable to work in mode of simultaneously sampling with the maximal sampling frequence 500 kS/s/channel in a 16-bit resolution of A/D transducer. Every physical analogue channel has this transducer. The measuring module enable to set four measuring ranges of voltage levels ±10V, ±5V, ±2.5V, ±1.25V.

3.2. THE MEASURING MODULE NI SCXI-1125 OF THE PLATFORM SCXI

The measuring module NI SCXI-1125 has eight analogue channels of differential type. Every physical analogue channel has an amplifier and an electric wave filter that serves the purpose of modification of measured signal. Frequence of the electric wave filter can be set by software. The measuring module has twelve software regulable measuring ranges that can be set for every physical analogue channel. The measuring range of input analogue channels can be defined in range of voltage level from ±2.5mV to ±5V.

The maximal measuring range of the measuring module NI SCXI-1125 is ±5V. That's why it is necessary to complete the measuring module by a module NI SCXI-1327.

3.3. THE MODULE NI SCXI-1327 OH THE PLATFORM SCXI

The module NI SCXI-1327 is designated for modification of measured signal voltage level in rate 1:100. The module for modification of analogue signal has eight channels as well as the measuring module NI SCXI-1125. Every channel has a connector bus for connection of conductor with measured signal and DIP switch that serves switching the transfer rate of input voltage level on output voltage level of measured analogue signal. The module for modification of signal NI SCXI-1327 allows to set the transfer rate for every channel.

4. THE SOFTWARE TransientVIEW FOR ANALYSIS OF TRANSIENT PHENOMENA IN SYNCHRONOUS GENERATORS

The software environment *The setting guide of the system PXI/SCXI*

The user of software configures parameters of physical analogue channels of the module NI SCXI-1327, NI SCXI-1125 and NI PXI-6123 in a user environment *The setting guide of the system PXI/SCXI*. The user environment *The setting guide of the system PXI/SCXI* is developed for an exact configuration of analogue channels' parameters. Software conception demands exact configuration because of exact measuring in light of utilisation of bit resolution of A/D transducers of the module NI PXI-6123 during measuring ranges of the module NI SCXI-1125. In light of a high-quality sampling of measured signals it is important to set parameters of sampling. If parameters of sampling aren't set exactly it can cause an incomplete reconstruction of measured signals. All these aspects are respected and insert into conception of user environment *The setting guide of the system PXI/SCXI*.

The software environment *The analysis of transient phenomena*

The user environment *The analysis of transient phenomena* is divided into partial user environments that fully support the user of software during analysis of transient phenomena. These user environments provide information that are important for evaluation of results of transient phenomena as well.

The user environment *The analysis of transient phenomena* is a conception of user environment that allows to display all the analyzed signals into one user graphic display. This conception of user environment is a very effective conception, especially for user of the software that put the accent on possibility of displaying graphic courses into one timescale. The conception of displaying the graphic courses into one timescale means an advantage for the user of the software because of a well arranged analysis of transient phenomena.

Analysis of transient phenomena in synchronous generators is made by means of mathematical functions and dynamic cursors. Dynamic cursors are intended for graphic analysis and they are closely joined with the user graphic display. Based on movement of dynamic cursors in the graphic display, immediate positions of these dynamic cursors are marked. The graphical analysis of transient phenomena in synchronous generators is made on base of information about actual position of dynamic cursors in the graphic display.

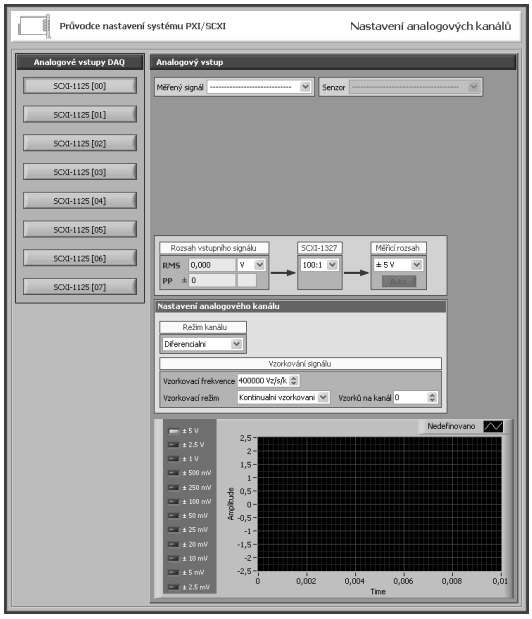

Figure 6: The software conception of user environment *The setting guide of the system PXI/SCXI* intended for setting of physical analogue channel of measuring system NI PXI-1050.

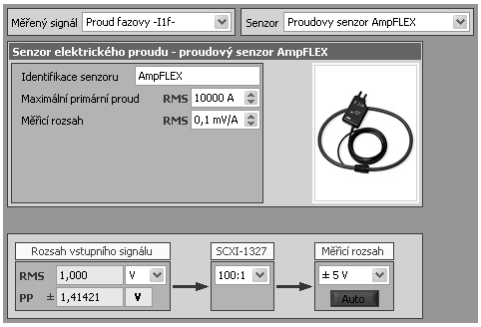

Figure 7: The software conception of user environment of sensor AmpFLEX for measuring of alternate current with example of this sensor type technical parameters.

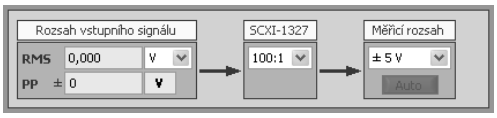

Figure 8: The software conception of user environment of measuring chain configuration of the module NI SCXI-1327.

5. CONCLUSION

On the beginning of development of the software TransientVIEW was deliberated the software conception of user environments that were consequently created. High demands were posed especially on development of user environment in which the user of software makes configuration of measuring system NI PXI-1050. Based on these demands an exactly deliberated user environment signed *The setting guide of the system PXI/SCXI* was created. This user environment thanks its user functions fully ensures exact setting of measuring system NI PXI-1050. The user environment *The setting guide of the system PXI/SCXI* is characterized especially by its robustness against incorrect intervention of users that could damage the measuring system.

Then an user environment *Analysis of transient phenomena* was created. This is used for analysis of transient phenomena in synchronous generators. There were created appropriate partial user environments in the user environment *Analysis of transient phenomena*. These environments thanks their implemented user functions enables in fast and exact way to analyse transient phenomena in synchronous generators.

ACKNOWLEDGMENTS

The article was created under FEKT-S-10-10 „Motors for specific application“ and GAČR 102/09/1875.

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