PD PROCESSING

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ABSTRACT

Partial Discharge (PD) investigation is very important in technology of high voltage devices such as transformers, rotary machines**,** electronic drives, etc. It helps us to predict an increased risk of breakdown. The monitoring of PD occurrence is necessary in semiconductor devices working at voltages above 600 V like VDMOS MOSFET, IGBT and special bipolar transistors, for example. Also in case of driving integrated circuits where the applied voltage is low, but conducting routes are not a long distance apart the distance between conducting routes is rather short, risk of occurrence of PD occurrence is relatively high. This work is focused on PC supported multi channel Partial Discharge measurement.

1. INTRODUCTION

Generally, it can be said the partial discharge threatens the systems working at more than 600V. Every fault in insulation (air bubble) between conducting routes can lead from a certain voltage level to Partial Discharge occurrence and subsequent degradation of insulation parameters, which finally can result to an electrical breakdown. Partial Discharges are often accompanied by sound, light and heat radiation or chemical reactions. The partial discharge is regarded as a parasitic effect occurring in insulating systems. Occurrences of partial discharge can be considered quite random effect. The Partial Discharge can be monitored in electronic circuits which work with high voltage and also with high frequency in the range of tents of kHz. Designed system can be used for monitoring of electronic circuits working at a high voltage or their parts as transformers (planar transformers) and printed circuits boards for it. In this designed system working at amplitude analyses of impulses principle it is possible to determine the amplitudes of peaks due to adjustable level detection and eliminate the rest of carrier wave and possible noise. All issues of measurements are processed by a PC or notebook via USB connection. Special control software for MS Windows is able to display four independent channels in two measuring modes, as you can see bellow.

2. PD MEASUREMENT

For partial discharge detection an electronic circuit has been designed working on the principle of amplitude analyses of impulses corresponding to individual partial discharge.

The block diagram of PD origin measurement in a sine wave on the planar transformer is displayed in Fig.1. Partial discharge occurs in different places over the specimen surface and volume. The peaks modulated on the supply wave are separated on high pass filter. Impulses corresponding to individual Partial discharges are compared with the reference voltage. For each channel, there are two high speed comparators, each for one polarity. The level of voltage reference is adjustable. Output signal from both comparators trigger a mono-stable multivibrator, and then it are processed by microcontroller.

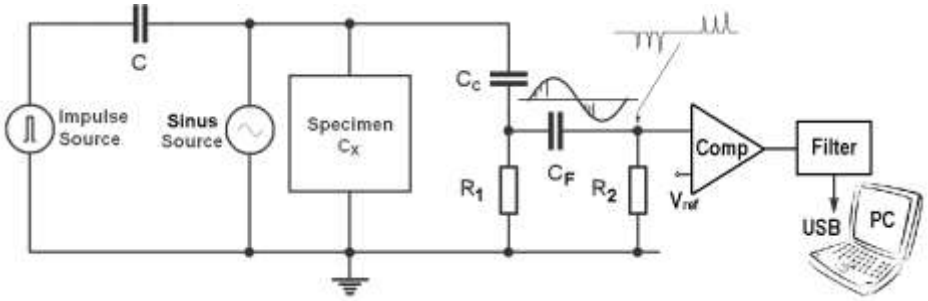

Figure 1.: Block diagram of PD origin measurement.

Because Partial Discharge occurrences of are absolutely random it is suitable to analyze the signal in more levels. Thereby we get a better idea of the number and size of monitored discharges. The system can be expanded by supplying one to eight comparators with a single-step multivibrator. Thus we receive a multi channel system with one to eight detection levels at the same time, see Fig. 2. It is clear that a half of those eight channels are used for positive peaks and the other half is used for negative peaks which are processed and then displayed in special partial discharge SW. For each couple of negative and positive peaks there are separate graphs.

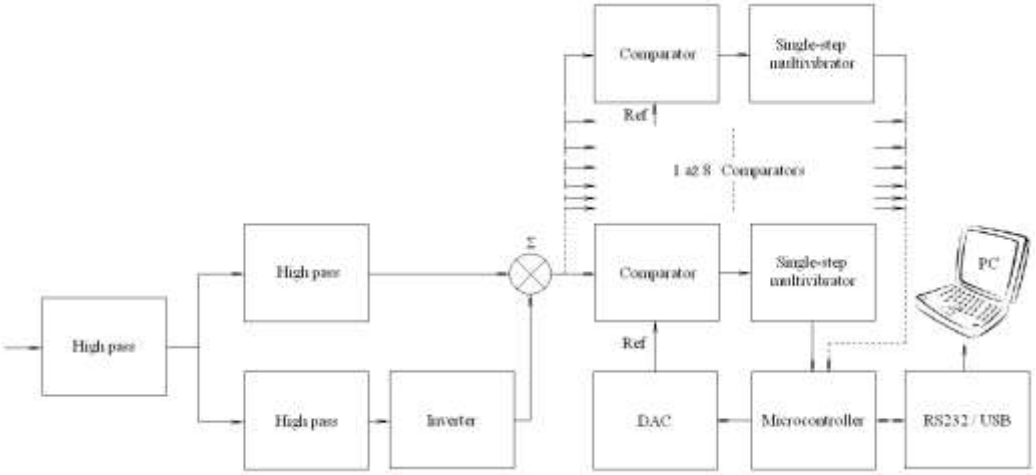

Figure 2.: Block diagram of multi channel measuring system.

2.1. DESCRIPTION OF HARDWARE

The core of hardware realization is the microcontroller ATmega88. This microcontroller communicates with PC via USB. Communication through USB is realized by USB I/O FTDI232. Setting detection levels for measured impulses is realized by 8 channels DAC, see Fig. 3.

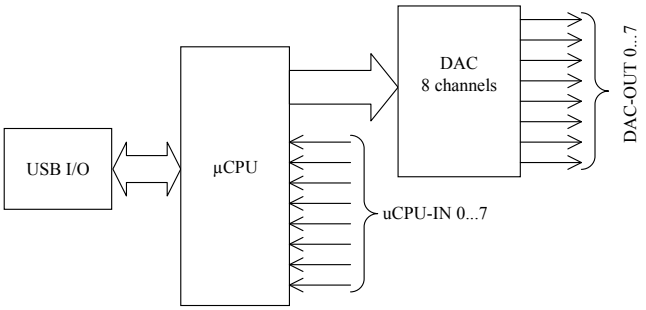

Figure 3.: Block diagram of digital part.

2.2. DESCRIPTION OF MEASURING INTERFACE

The measuring interface is segmented into three sections. In the first section, the user can select measuring device. In the second section, the user has to set the time measuring method. There are two methods: the first is suitable for short time measurements and the second method is suitable for long time PD investigation (if there are any occurrences). In the third section the measured signals and data are shown. The measuring interface is presented in Fig. 4.

The measuring interface provides two measuring methods:

Measurement with real time: in this case the system measures and sends to the PC impulses with real time.

Measurement with discrete time: in this case the system measures impulses with discrete time. The PD measuring system registers only the received impulses without a true time record. The PC only receives impulses and their incoming sequence. It is suitable for a long time measurement - for investigation if there are PD occurrences.

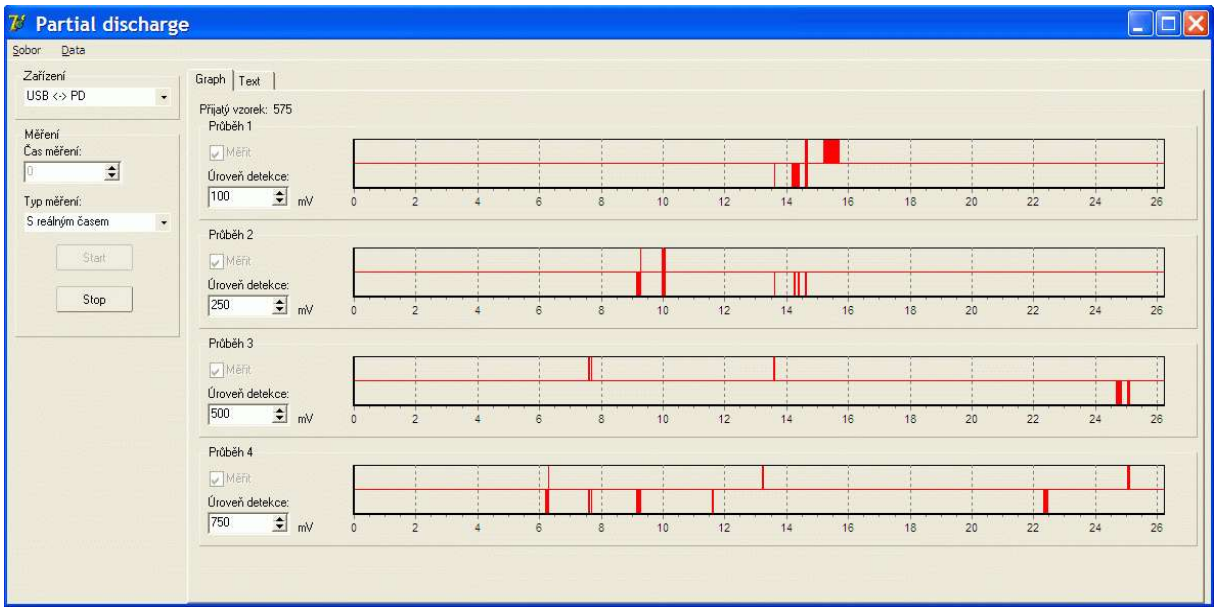

Figure 4.: Partial discharge measurement SW for MS Windows.

The measured data are shown in four graphs. The user can enable or disable the measurement for any graph and can set the detection level for both polarities measured of the impulses.

2.3. SOFTWARE CHARACTERISTICS

The software on PC is able to start and stop the measurement, send measuring configuration and receive the measured data from the microcontroller. The received data are in two formats.

The first format is for real time measurement and the second one for discrete time measurement. The microcontroller measures a real time if the real time measurement is selected and started. The measured time is sent to the PC with information which pin is activated.

The discrete time measurement is suitable when there is a need for PD occurrences investigation in long time. In this mode only a count of each polarity of impulses is sent to the PC without time information.

3. CONCLUSION

Introduced system is able to measure precisely the shape of impulses, and the user can set more detection levels for precise analysis. Due to multiple sensors, the measuring system can locate PD impulses. Real time measurement enables us to execute fast and precious measurements at the time interval of 18 hours. Discrete time measurement is limited by the size of the memory and the reliability of control PC. Due to precise analysis we can detect faults in device insulation and evaluate the quality of technological operations required for a reliable device function.

ACKNOWLEDGEMENT

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REFERENCES

[1] Boušek, J.: Planar transformer - a way to small dimensions and high power density in switched power supply, Brno 2004

[2] Boušek, J.: Variable Frequency/Amplitude Sine Wave Resonant Power Source for High Voltage and Electric Discharge Devices, In Proceedings of the Socrates Workshop 2003, Chania, Greece, Technological Institute of Crete, 2003, pp 186-191.

[3] Beljaevskij, O.A: Measurement of Partial Discharge in operational conditions, Russia, Sankt-Peterburg 2003.

[4] Stepenkov, V.V The theory and practice of measurement of partial discharge at the control of high-voltage insulation of the power equipment under operating conditions, Russia, Sankt-Peterburg 1999.

[5] IPEC Ltd., Partial Discharge, available from www: http://www.ipec.co.uk/partial_discharge.php