Partial Discharges Calibrator

Martin Kříž

Czech Technical University, Faculty of Electrical Engineering,
Department of Measurement,
Technická 2, Praha 6, E-mail: krizm1@fel.cvut.cz

Abstract- Partial Discharges calibrator principles and microprocessor controlled calibrator design are discussed. The calibrator charge generation technique is classic electrical with storing capacitor. The microprocessor control of the calibrator is perspective because of easy calibrator parameters modification and remote control.

I. Partial Discharges

Normally cavities or voids included in electrical insulation are filled with gases, which have lower breakdown strength than the surrounding insulation. Furthermore the permittivity of the filling gas is often lower than permittivity of solid or liquid insulation. Stronger electric field in the cavity than in the surrounding insulation is result of that. Consequently, under the normal working conditions of the insulation system, the voltage across the cavity may exceed the breakdown value of the filling gas and cause a breakdown in the cavity. This phenomenon is called Partial Discharge (PD). PD can also develop on surfaces and in the vicinity of sharp electrodes. Due to PDs insulation degradation processes, PDs activities are monitored and measured.

II. Partial Discharge pulses generation

The pulses for calibration of PD measuring systems can be generated in the known volume cavity ofPD free capacitor. These pulses charge can be easy computed (physical principle). Unfortunately the physical calibrators are not suitable for practical use because of their complexity and necessity of high voltage source. In the European standard [1] the PD pulses are generated in square pulse generator with voltage amplitude U_0 and serially connected capacitor C_0. The calibrating pulses have charge q_0 (1).

$$q_0 = U_0 C_0 \qquad (1)$$

These ideal pulses cannot be generated, because in real world there are rising and falling time constants of voltage pulses (due non-ideal switching characteristic, parasitic capacitance, etc.). In the standard [1] the rising time t_r of PD pulse (from 10% to 90% peak value of pulse) must be shorter than 60 ns, falling time t_f is not defined. The total charge q_0 discharged in load R_L (figure 1), when switch SW changes from a) to b) can be computed as integral (2) of voltage pulse $u(t)$ (figure 2).

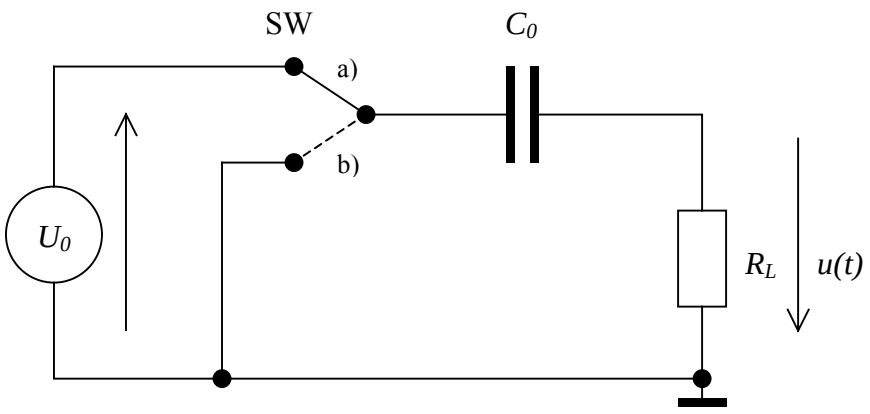

Figure 1. Generation of artificial PD pulse

$$q_0 = \frac{1}{R_L}\int u(t)dt = U_0 C_0 \qquad (2)$$

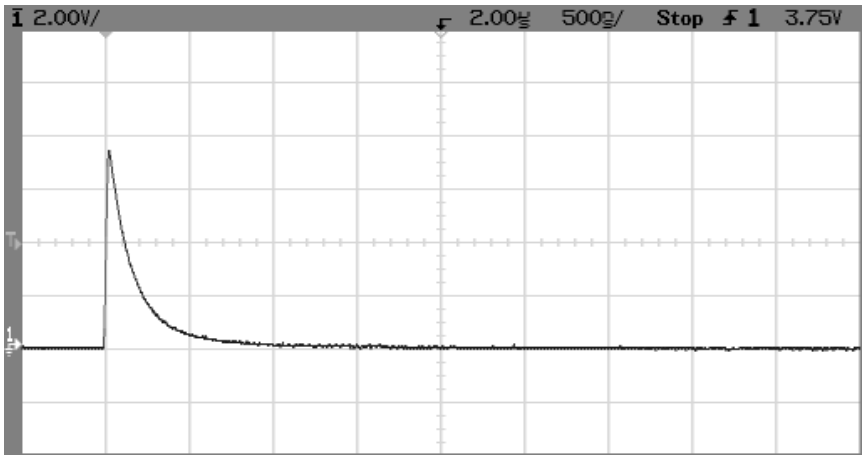

Figure 2. Example of PD pulse from calibrator
q_0 = *10 000 pC*, R_L=*220 Ω*, X: 500 ns/div, Y: 2 V/div

III. Partial Discharge calibrator design

In presented calibrator a microprocessor is used for stable time base generation, synchronization circuit, for phase shift between time base and output pulse and for user interface. The calibrator block diagram is on figure 3.

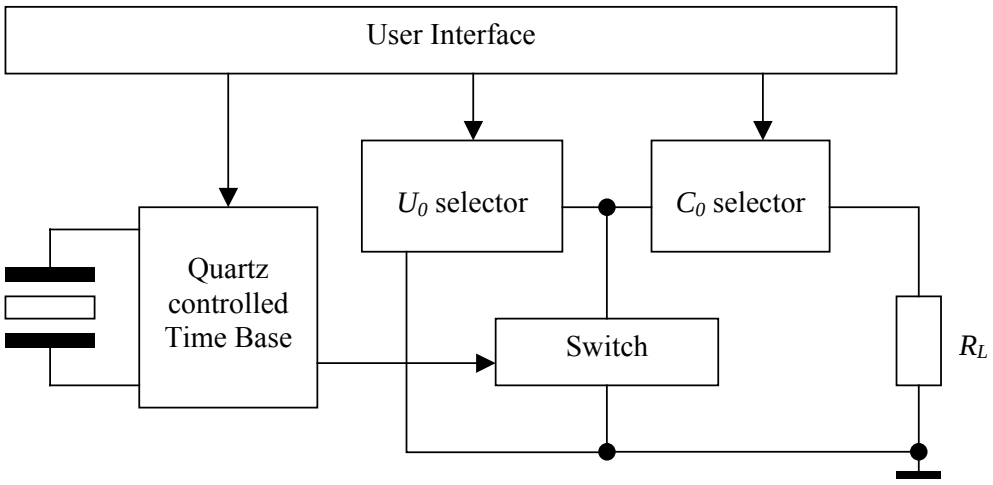

Figure 3. PD calibrator block diagram

VI. Conclusions

The usage of microprocessor in PD calibrator design is perspective and suitable because such calibrator conception enables easy modification of parameters and instrument interfacing. Time base is quartz controlled and generates 50 Hz, 100 Hz, 500 Hz, 1 000 Hz and 5 000 Hz pulses with variable phase shift from 0 to 20 ms with 10 µs resolution. Pulses can be synchronized by external electric signal or by flashing light. Generated charges are 10 pC, 100 pC, 1000 pC, 2 500 pC, 10 000 pC and 25 000 pC (Table 1).

Table 1. PD calibrator generated charges

Generated Charge q_0 [pC]	Capacity C_0 [pF]	Voltage U_0 [V]
25 000	1200	20,8
10 000	1200	8,33
2 500	120	20,8
1 000	120	8,33
100	12	8,33
10	12	0,83

The calibrator mains parameters have been measured and also compared with commercial partial discharges calibrators. Realized sample of calibrator is on figure 4.

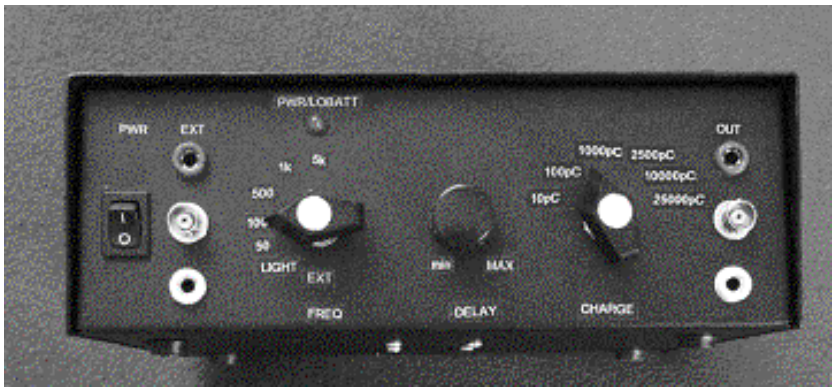

Figure 4. Realized PD calibrator sample

Measured results of important parameter – capacitive load ability for charges 1 000 pC and 10 000 pC are presented on the following figures (figure 5, 6).

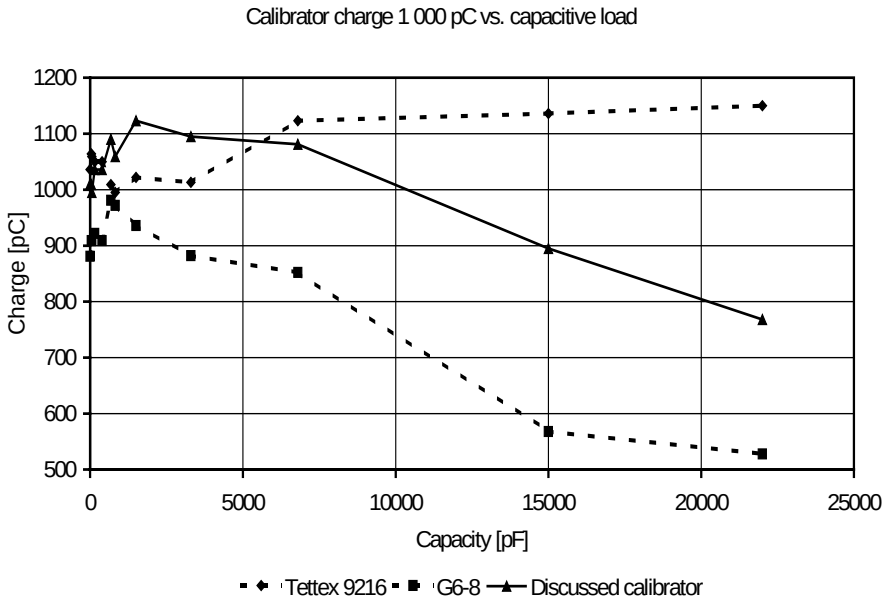

Figure 5. Calibrator charge 10 000 pC vs. capacitive load

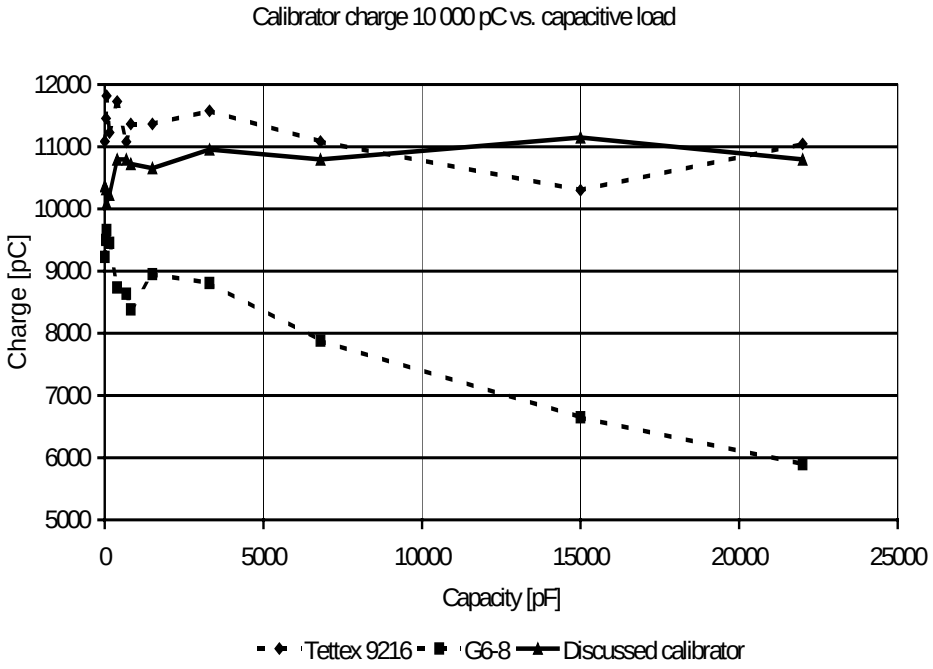

Figure 6. Calibrator charge 1 000 pC vs. capacitive load

Discussed calibrator is a part of partial discharge measurement system, whose principle and parameters are presented in papers [2], [3].

V. Acknowledgement

This research work has been partially supported by the research program No. MSM210000015 "Research of New Methods for Physical Quantities Measurement and Their Application in Instrumentation" of the Czech Technical University in Prague.

References

[1] European Standard EN 60270

[2] Kříž M.: Quantification of Partial Discharges Charge, Measurement 2003, 4th International Conference on Measurement, Slovak Academy of Sciences, 2003, pp. 407-410.

[3] Kříž M.: Preprocessing Circuits for Partial Discharges Measurement, IWADC 2003 8th International Workshop on ADC Modelling and Testing, Universita degli Studi di Perugia, 2003, pp. 201-203.