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Information
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Comments on Partial Discharge Calibrators

1. Introduction

Calibrators for industrial applications are manufactured since 1950 marketed. The first company who manufactured PD calibrators was ERA-Robinson/UK. Some time later PD calibrators were standardised (IEC, ANSI) considering more or less Robinson's solutions.

A PD Calibrator is a current generator, as shown in the publication of Prof. Pfeiffer :

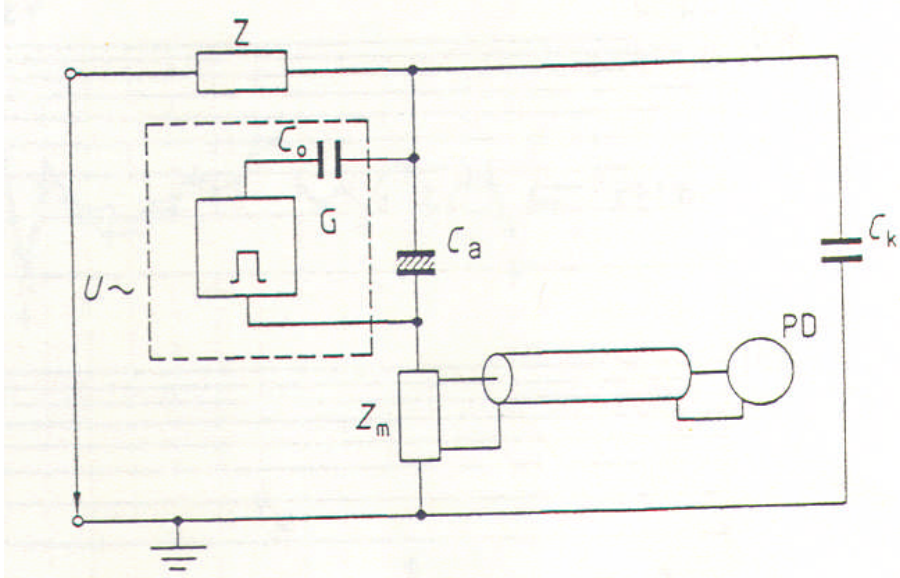


Figure 3.

Calibration in the test circuit. U: Test voltage source, Z: filter, C_o: calibration generator capacitance, C_a: test specimen, C_k: coupling capacitor, Z_m: measuring impedance, PD: partial discharge measuring instrument.

(W. Pfeiffer: Partial-discharge Testing of Components for Low-voltage Equipment, IEEE Transaction on Electrical Insulation, Vol. 26. No. 2, April 1991, pp 247...257)

2. Standardisation

Later the concept as per 1. above was standardised. In the standard IEC270 "Partial Discharge Measurements", 1981, it is described in detail :

"5.2.1 Calibration of instruments measuring apparent charge q

Calibration to determine the scale factor k_j of an instrument for the measurement of the apparent charge q of single partial discharges is carried out by passing short current pulses of any convenient but known charge magnitude, qo, through the measuring impedance Zm. Such pulses may be produced by means of a generator giving rectangular step voltages of amplitude U_o in series with a small known capacitance Co' Under these conditions, the calibration pulse is equivalent to a discharge of magnitude:

$$q_o = U_o C_o$$

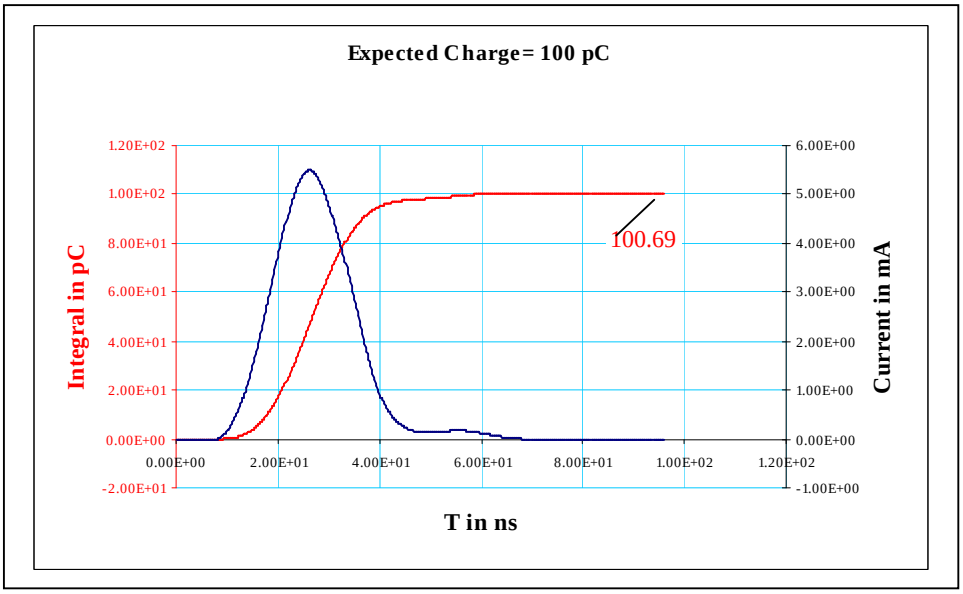
In practice, it may not be possible to produce ideal step voltage pulses and, even though other waveforms having slower rise times and finite decay times may inject essentially the same amount of charge, the detection circuit responses will be different due to the different durations of the corresponding current pulses.

The calibration pulse should have a, rise time such that the duration of the current pulse through C0 is short compared with 1/f2 and this rise time shall be not more than 0.1 μs. A decay time in the range of 100 μs to some 1'000 μs will usually be suitable."

And later the concept was the base for the German DIN/VDE standard DIN 57 434, VDE 0434/05.83: Hochspannungs-Prüftechnik, Teilentladungsmessungen, Mai 1983.

3. Comments:

According to standards a step generator with a voltage amplitude U_0 and a series capacitor C_0 generates a current impulse :



The above graph shows the rise of the Step generator (red) and the current impulse (blue) – the derivation of the voltage - of the Presco calibrator type PD-CLSB-CD00.

According to the latest standard IEC60270 –2000, the allowed maximum length of the current impulse is 60 ns (according the old IEC270 a length of 100 ns was allowed).

A Presco calibrator generates impulses with an average length of 30 ns.

For the measurement of the current impulse IEC 600270 allows digital measuring systems and also a numerical integration. The digital oscilloscope with which the current impulse is measured, has to have a bandwidth of at least 60 MHz and this is justified by the following considerations :

The current impulse has a shape of approx. a "Gauss Bell"; its width at 10% of the peak value is 30 ns. The respective frequency spectrum has – at -6dB – a width of 55 MHz. Hence with a digitising system with an analogue bandwidth of 60 MHz such a current impulse is recorded with sufficient accuracy.

If the current impulse is recorded e.g. with an oscilloscope with a 20 MHz bandwidth, the measured signal will be "destroyed" because the two spectra (digitiser and impulse) overlap.

To prove the performance of a calibrator is very simple by using a PD detector which does the quasi integration the classical way with a band pass filter with a bandwidth of e.g. 20 kHz … 200 kHz.

PD calibrators which are calibrated with a correct digital system will generate correct impulses which are independent of any test object.

Behind the above statements there is, of course, a lot of theory from the field "Random Signal Analysis". As this theory is not very simple, we strongly recommend to consider the basics of this theory. Otherwise – as per our experience – the calibration will be wrong, the PD measurements will be wrong and/or the situation regarding back ground noise level and the real PD level is extenuated !