HIGH VOLT

Partial Discharge Detector,
Type ICM*compact*

6.21/3

Application

Partial discharge (PD) measurement is the most important, non-destructing method for the detection of insulation defects (weak points) in electrical power equipment. It is used for quality testing in factory as well as for diagnostic on-site testing of cables, GIS, power and instrument transformers, rotating machines and their components.
The general requirements for PD measurement are described in the “horizontal” **IEC Standard 60270:2000** considering the PD circuit, the measuring instrument, the calibration and the measuring procedures. The most important PD quantity is the **apparent charge** of a PD pulse. It is that charge which, if injected within a very short time between the terminals of the test object, would give the same reading on the PD detector as the PD current pulse itself (The calibration of the measuring circuit is exactly performed according to that definition). For AC voltage tests the **specified magnitude of the apparent charge** (usually expressed in pC) is the **largest repeatedly occurring PD magnitude**. A limiting value of that specified in the relevant apparatus standard is the usual criterion for passing or failing a PD test.
For identification of PD failures inside an insulation additional PD quantities – as e.g. the pulse repetition rate (ratio of number of PD pulses in a time interval and the duration of interval) or the phase angle of the occurrence of a PD pulse- are helpful tools. The analog combination of both is the **PD pattern** for one period (Fig. 3) or for a longer measuring time (Fig. 4). Important derived quantities are the **PD inception voltage** (lowest applied voltage at which the PD magnitude exceeds a specified value) and the **PD extinction voltage** (corresponding value at decreasing voltage). ICM*compact* is designed for the measurement of these PD quantities in measuring circuits according to IEC 60270.
The procedures and requirements for PD measurement at the different apparatus and components are described in the relevant “vertical” standards, but always based on the definitions and principles of the IEC Standard 60270.
ICMcompact therefore additionally considers the optimum adaptation to all the different practical test objects in case of standard PD measurement. Its easy portability, simple operation and ready flexibility make it an excellent choice for routine PD testing in a variety of utility and industrial applications. Furthermore it can be connected to HIGHVOLT control and measuring systems (types CMS22, CMS23) for computer-aided and automatic PD testing, well adapted to modern production processes but also for students’ training.

For PD measurement according to IEC 60270 the test object is connected to the HVAC source ((1): AC circuit with test transformer or AC resonant circuit) via a filter and decoupling unit (Fig. 1). The Pi-filter consists of the voltage divider ((2): type WMC, see Data Sheet 1.31/1), the blocking impedance ((3): type LS, see Data Sheet 1.35/1) and the coupling capacitor ((4): type WMC, see Data Sheet 1.31/1). It blocks HF noise signals arriving via the HV connection and offers a circuit of low impedance for PD signals from the test object. The capacitance of the coupling capacitor (4) should not be smaller than 1/10 of that of the test object. The voltage divider (2) can be realized by the bushing of the test transformer or reactor, in case of low external noise it can fall away, and the coupling capacitor (4) can be used for voltage measurement, too.

Measuring Circuit

The PD measuring impedance ((5): types CIL and CIT, see Data Sheet 6.31) can be arranged in the earth connection of the coupling capacitor (4) (Fig. 1) or the test object. For optimum adaptation, the measuring impedance shall be selected according to the capacitance of the coupling capacitor and the current through the impedance. The measuring impedance shall be directly coupled to a pre-amplifier ((6): type RPA, see Data Sheet 6.32), which is connected by a coaxial cable to the PD detector (7). The remote-controlled pre-amplifier conditions the PD signal according to the proper-selected frequency range of the measurement and amplifies it before transmission for an improvement of the signal-noise ratio. Furthermore it provides enhanced over-voltage protection.
The PD circuit is calibrated for measurements of the apparent charge by an external calibrator ((10): type CAL, see Data Sheet 6.33) which injects a charge pulse into the termination of the test object.
The conditioned PD signal is processed by the PD detector (7) according to different operation modes, described in the following. By its connection to the computer control system ((9): CMS, see Data Sheet 1.52/1) extended applications of the PD detector *ICMcompact* can be realized.

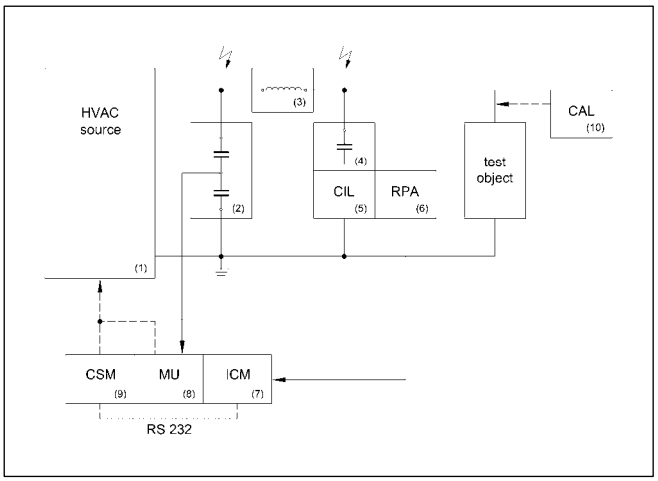

Fig. 1: PD measuring circuit according to IEC 60270 (explanations in the text)

Operation Modes

ICMcompact provides a simple push-button interface for the operator and on-screen menus in an embedded LCD panel. The following operation modes can be selected:

PD charge meter (METER mode) of adjustable sensitivity delivers both, the digital and a quasi-analog display of the apparent charge according to IEC 60270. The gain can be set manually or automatically. The apparent charge is available for recording at an BNC socket on the backside of the detector.

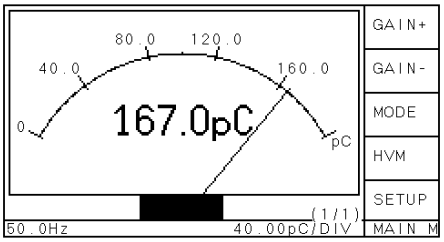

Fig. 2:
METER MODE

Scope-like display (SINE or NORM mode) of adjustable sensitivity shows the pulses of the apparent charge superimposed on the applied voltage (SINE mode) or on the internal zero line (NORM mode) for direct analysis. For the latter case a separate sine wave synchronous to the test voltage is provided. The phase shift is adjustable. Any separate scope is not necessary.

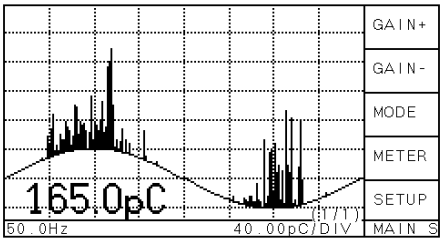

Fig. 3:
NORM MODE

Phase-resolved PD pattern (HOLD mode) deliver the PD pulse amplitudes over their phase position for an adjustable measuring time. This monochrome pattern is a helpful tool for the identification of PD failures.

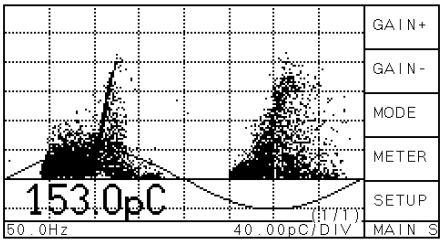

Fig. 4:
HOLD MODE

Additional modes with hardware and/or software extensions are available for

- **PD fault location** in cables, for details see Data Sheet 6.22,
- **TTL gating of steep switching pulses of IGBT driven** equipment, for instance of frequency-tuned resonant test systems, types WRV… and

ICM*compact* Design

- **ultra-high frequency PD measurement** on GIS/GIL, for details see Data Sheet 6.23 and
- **ultrasonic PD measurement** on GIS, see Data Sheet 6.24

Mechanical design: *ICMcompact* is supplied as a stand-alone (desk-top) device (see front page) or as plug-in for a rack or desk. All connections are on the back side, whereas the measurement is displayed on an integrated LCD screen (240 x 180 dots) on the front. Settings, calibrations and display selection are made by pushbuttons.

Electrical design: Electrically the complete PD measuring system consisting of *ICMcompact*, measuring impedance CIL/CIT and preamplifier RPA forms a wide-band system according to IEC 60270 with limiting frequencies of 40 kHz respectively 800 kHz (For special applications different preamplifiers RPA of different frequency bands are available, see Data Sheet 6.32).

Within the *ICMcompact* the current pulse is amplified and integrated into the apparent charge by one unit. The analog charge pulses are converted to digital values and processed according to the selected operation mode. Calibration and selection of gain ranges is supported, the adjustment of the scale is automatically performed by an auto-scale algorithm. The *ICMcompact* can be synchronized to the test voltage (Fig. 3, Fig. 4). The results are displayed on the LCD screen or available at an RS 232 interface for displaying on a separate industrial computer (e.g. of the HIGHVOLT control and measuring systems CMS 22 or CMS 23). Additional software allows a more comfortable operation. Also an analog output for recording the apparent charge is available.

Interference reduction: The sensitivity of the PD measurement is determined by periodic and/or stochastic noise signals which can be reduced by the following features:

- **adjustable lower discriminator** level for the suppression of low periodic signals (raising PD detection threshold above background noise),
- **pair of phase windows** of adjustable width and phase position for the suppression of phase stable noise pulses (Fig. 5),

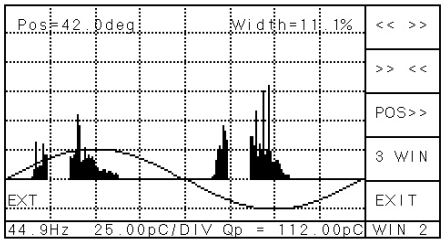

Fig. 5:
Phase window

- **automatic analog gating** for elimination of stochastic noise signals picked up by an antenna or a clamp-on current transformer (type CT, see Data Sheet 6.35),
- application of the **active bridge adapter** (type AB, see Data Sheet 6.35), the **differential coupling impedance** (type CIT, see Data Sheet 6.31) or the **optic transmission system** (type RPA 4, see Data Sheet 6.32)

Specification

ICMcompact for measurement of the apparent charge according to IEC 60270 is characterized by the following specification

min. detectable app. charge	0.1 pC
max. detectable app. charge (extension by differently selected components CIL and RPA)	1000 pC
auto-range function, also logarithmic scale	
frequency band (6 dB) (smaller ranges available)	40 … 800 kHz
pulse repetition rate (superposition error <10%)	≤ 125 kHz
input impedance (without RPA)	50 Ohm
BNC input for test voltage reference	
of test voltage frequency	20 … 300 Hz
of reference level / at input	≤ 100 V rms
with impedance	5 MΩ / 200 pF
BNC input for automatic gating	
BNC input for TTL gating	
power supply (mains)	
voltage	85…264 V_{AC}
frequency	47-440 Hz
power	~20 W
dimensions (W x D x H)	236 x 295 x 133 mm
weight	approx. 3 kg
temperature range	10 … 40 ºC

Options:

- version with multiplexer of 4 or 12 channels (e.g. for transformer testing) on request (MUX 4 or MUX 12)
- version with up to 8 auxiliary input channels to record extra signals like power, temperature, pressure etc.,
- battery powered version.
- set-up firmware STP 12 for the preselection of up to 12 individual set-ups with different calibration factors for routine and/or automatic PD testing.
- the gatings mentioned above are optinal.

Accessories, Extensions

Basic accessories: For a complete PD measuring system for general application ICM*compact* has to be completed by

- one measuring impedance (see Data Sheet 6.31), preferably type CIL4L (for coupling capacitors 0.6 to 2.5 nF)
- one pre-amplifier (see Data Sheet 6.32), preferably type RPA1 (frequency range 40 to 800 kHz)
- one PD calibrator (see Data Sheet 6.33), preferably type CAL1A (1 to 100 pC) or CAL1D (10 to 1000 pC)
- one coaxial signal cable, type RG58, standard lengths 10 m or 25 m

Other types of these accessories enable an optimum adaptation to special test objects and test conditions. For details see Data Sheets mentioned above.

Optional accessories include hardware and/or software for special applications:

- **interference reduction by**
  automatic analog gating for elimination of stochastic noise signals, triggered from an external signal, gating threshold to be set manually or automatically, includes the built-in logarithmic pre-amplifier RPA6 (Data Sheet 6.32) and software;
  TTL gating for steep switching impulses (e.g. of WRV test systems) with automatic gating according to the TTL signal;
  active bridge adapter; type AB (see Data Sheet 6.34)
- **Connection to industrial PC or laptop**.
- **PD fault location in cables** by
  Optional built-in DSO board or with additional PC and software ICM*compact* PRD (see Data Sheet 6.22) also for PD mapping.
- **PD decoupling by current transformer**
  galvanic isolated PD decoupling or sensor for noise signals (see Data Sheet 6.34)

Extensions of ICM*compact* for non-conventional PD measurement are available for

- **UHF/VHF PD measurement** of GIS (see Data Sheet 6.23),
- **Ultrasonic PD measurement** (see Data sheet 6.24).

For further information please contact:

HIGHVOLT Prüftechnik Dresden GmbH
Marie-Curie-Strasse 10
D-01139 Dresden / Germany

Telephone: ++49 351 84 25-700
Fax: ++49 351 84 25-679
E-mail: sales@highvolt.de
Website: www.highvolt.de

or our local representative: