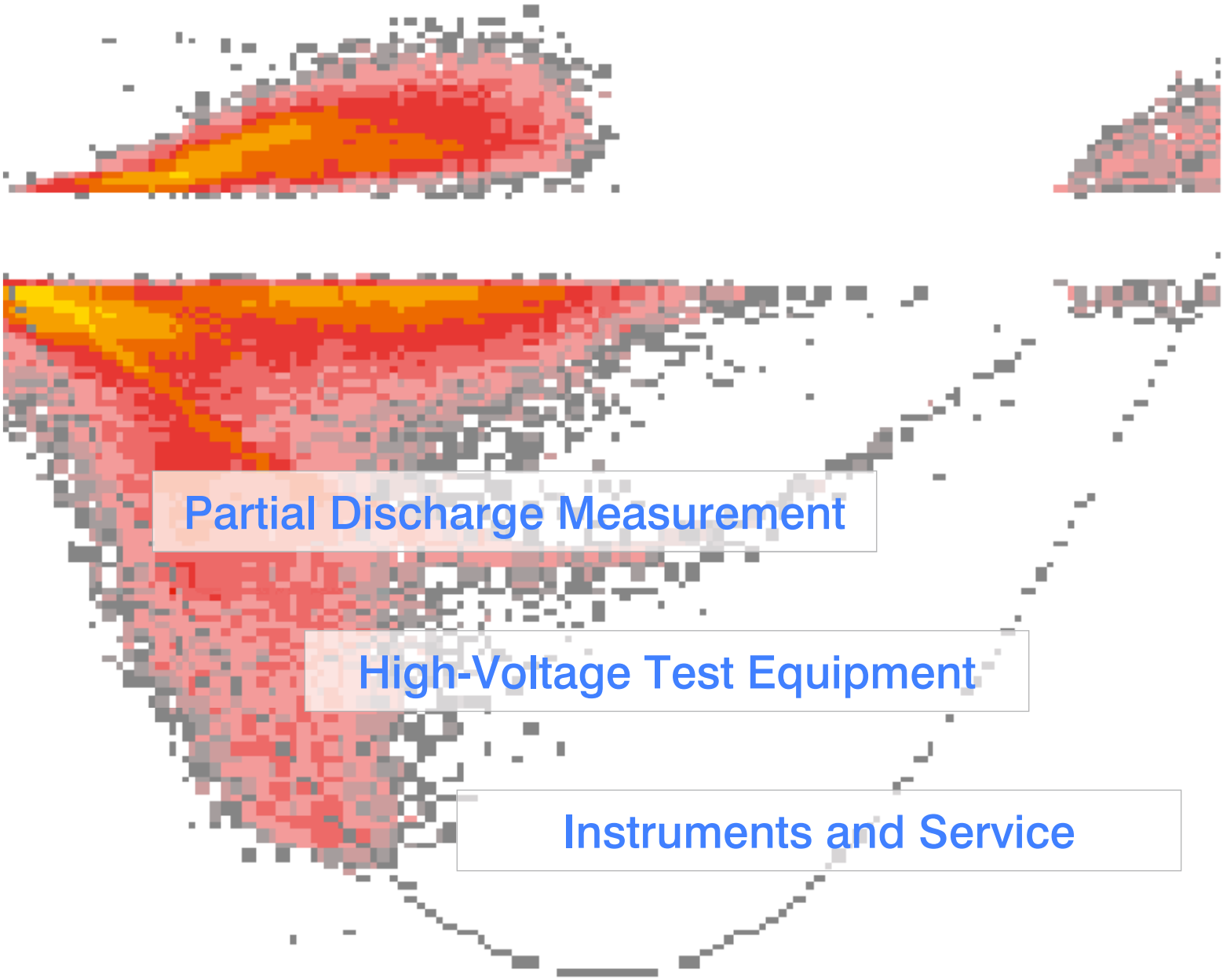
Diagnosis
Monitoring
Quality Control
Research and Development



Partial Discharge Measurement

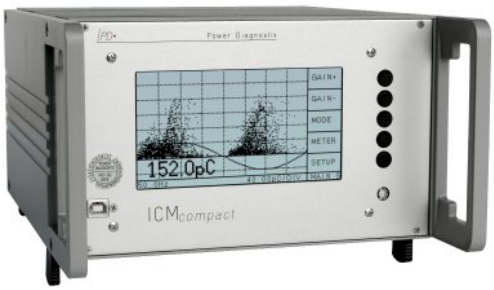
High-Voltage Test Equipment

Instruments and Service

Power Diagnostix · Vaalser Strasse 250 · 52074 Aachen · Tel +49 241 74927 · Fax +49 241 79521

Company Profile

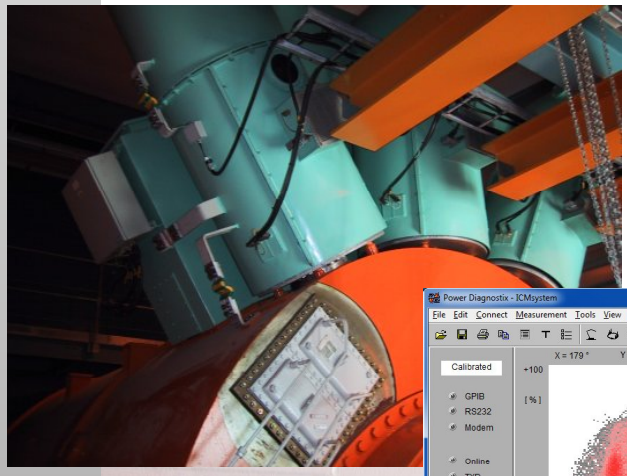
Power Diagnostix Systems GmbH provides quality instruments and engineering services for high-voltage diagnostic applications. Power Diagnostix has built a solid reputation since market introduction of our partial discharge detectors in early 1993. Our ICM*series* of digital partial discharge detectors is used for evaluation of electrical insulation by electric utilities, manufacturers, and research institutes worldwide.

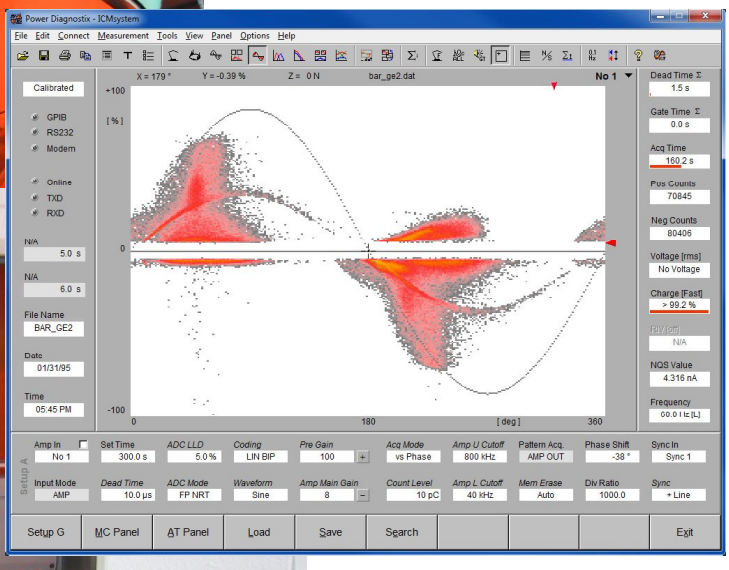


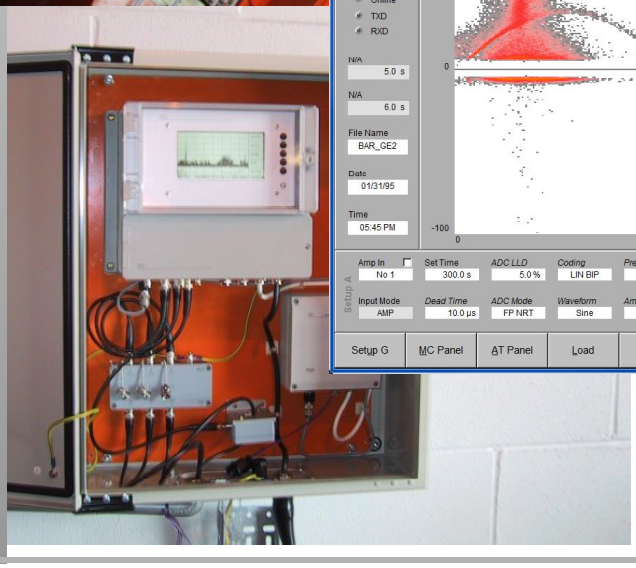
In addition to digital partial discharge detectors, Power Diagnostix produces instruments for commissioning tests of GIS systems, automated control of high-voltage tests, fiber optic connections for analog signal transmission between instruments and sensors, and for other applications in high voltage. All of our instruments and specialized software products are developed in Aachen, Germany.

The company's principal engineers are active in several scientific committees.

In June 2019, Power Diagnostix became part of the Megger Group.







Instruments

Power Diagnostix Systems GmbH produces versatile, top-quality instruments for high-voltage diagnostic applications. Power Diagnostix ICM*series* of partial discharge (PD) detectors is used worldwide for evaluation of electrical insulation used in electricity generation, transmission and distribution, in manufacturing, in research, and in industry. In addition to partial discharge detection equipment, Power Diagnostix produces instruments for fiber optic transmission, GIS fault localization, tanδ measurements, and high-voltage test control.

ICM*system* 7

The ICM***system*** is a digital partial discharge detection system. The instrument is completely controlled by software using a GPIB, USB, TCP/IP, GSM Modem, fiber optic or direct serial link.

ICM*compact* 11

The ICM***compact*** is a stand-alone partial discharge detector often used for quality assurance. Among other options, the ICM***compact*** can be equipped with circuits to perform partial discharge localization in power cables.

ICM*monitor* & ICM*monitor* CA 13

The ICM***monitor*** is an instrument for continuous on-line monitoring of partial discharge activity in high voltage equipment. The instrument tracks changes in key discharge quantities for storage in trending diagrams and for triggering user-settable alarms. TCP/IP, Modem, fiber optic or direct serial links enable remote access and full remote control.

AIA*compact* 19

The AIA***compact*** is a portable unit for acoustic and electric (UHF) partial discharge measurement on GIS, transformers, and cable accessories. Optionally, the unit can be equipped with circuits for UHF measurements.

ICM*flex* & ICM*flex* GRC 21

The ICM***flex*** instrument family, introduced in 2008, bases on the latest concept where the entire acquisition hardware is placed on high voltage potential. The instrumentsare fully remote controlled via high speed Bluetooth or fiber optic communication.

RIV*meter* 25

The RIV***meter*** is an instrument for the measurement of 'Radio Influence Voltage' according to NEMA 107-1987 and other relevant standards.

TDA*compact* 27

The TDA***compact*** is a loss factor meter. The capacitance C_x, the tanδ, and the voltage are derived by digitally processing the currents of the test capacitor and a reference capacitor.

HV*compact* 29

The HV***compact*** is a high voltage meter with an auto-ranging oscilloscope display of the voltage waveform. The unit displays $\hat{U}$, $\hat{U}/\sqrt{2}$, U_{rms}, frequency, and crest factor.

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The STEP*compact* allows running high voltage test sequences. The instrument controls via fiber optic cable the 'UP' and 'DOWN' contact of the motor driven voltage regulator (VARIAC). The instrument detects incipient breakdown.

The HV*control* offers all features that are required to manually control any high voltage test set. Current limits that trip the main circuit breaker can be set for I_{prim} and I_{sec}.

The FO*system* is a complete set of instruments for fiber optic transmission of analog signals from different sensors (e. g. temperature, pressure, acoustic, voltage, current). The signal bandwidth covers DC up to 10 MHz.

The ATT*analyzer* supports commissioning of gas-insulated switchgear yards. Signals of up to 16 acoustic sensors can be connected. Precise localization of breakdown within the GIS is provided by comparing the travel-time of the breakdown sound to the various sensors.

The GIS*monitor* offers parallel, real-time acquisition of UHF PD signals captured by any embedded or external sensors permanently installed on gas-insulated switch gear (GIS). The system builds on compact 8-channel sub-modules to allow flexible configuration.

GIS*monitor* Portable 43

This version of the GIS*monitor* is a portable unit for partial discharge measurements on gas-insulated switchgear (GIS). The instrument offers parallel real time PD acquisition on up to 40 channels.

HVTC & TCU 45

PD testing becomes increasingly important for insulation systems of a lower voltage level. Power Diagnostix offers test arrangement for such purposes.

DAkkS Deutsche Akkreditierungsstelle D-K-15068-01-00

Calibrators 47

We offer a variety of calibrators ranging from 1 pC to 50 nC. Due to their high bandwidth the calibrators are suitable for impulse reflectometry on cable systems and for GIS testing. New charge calibrators are shipped with the DAkkS calibration certificate to ensure the traceability to international standards.

Mobile HV AC Test System 49

On-site transformer testing is the main application of Power Diagnostix' mobile high voltage AC test system. However, it can be used as well for other on-site testing, such as of GIS, rotating machines, or high voltage cables.

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Preamplifiers & Quadrupoles 51

A quadrupole can be placed in series with either a coupling capacitor or in series with the test object in order to apply high voltage both to a test object and to the coupling capacitor. Preamplifiers serve to condition, filter, and amplify the PD signal to be measured.

Coupling Devices 55

Coupling capacitors with built-in quadrupoles are used to capture the PD signals and to synchronize the measurement to the test frequency. Additionally, rugged coupling capacitors are used for permanent installation for monitoring purpose.

Filters 57

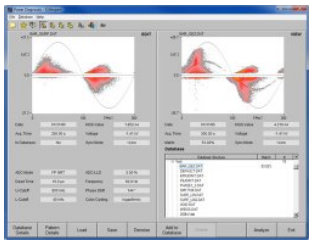
PD measurement requires a reasonably noise-free environment. Power Diagnstix filters are designed to reduce high frequent disturbance signals from sources such as the high voltage supply or ground potential of the power supply.

Sensors 59

We offer various sensors for temporary or permanent installation with gas-insulated switchgear (GIS), cable accessories, and power transformer. This includes several sensor models to capture UHF signals.

Miscellaneous 61

Miscellaneous accessories are available for the ICM*series* instruments such as bushing adapters, bushing coupling units, current transformers, and various antenna models. Each ICM*series* acquisition unit can be combined with these accessories to suit specific applications.



Special Software 65

Power Diagnostix offers specialized control and analysis software for personal computers and laptops with Windows operating system.

Applications 67

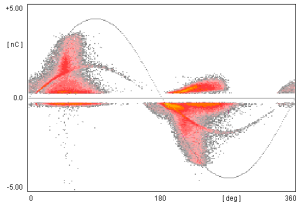
Using the range of instruments with the different applications, such as rotating machines, power transformers, cable systems, or GIS and GIL, requires considering the special conditions of each field.

Services 75

We offer on- and off-line PD analysis on rotating machines, transformers, cables, etc. Instruments can be provided temporarily on a rental base. Furthermore, an on-site DAkkS-calibration of HV_{AC} measurement systems up to 100 kV can be performed.

PDIX Web Site 77

Our web site informs about news, recent developments, and new instruments. Registered users of the restricted customer section MyPDIX benefit from free software updates, automatic provision of relevant documents, and notifications about updates and changes in their personal customer section.



Typical PD Patterns 79

With the PD pattern (φ-q-n pattern), each acquired impulse is sorted and counted with respect to its phase angle and acquired amplitude. The pattern contains information of various properties of the defect causing the discharge.

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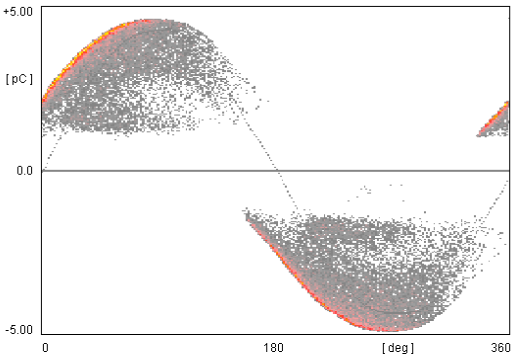
ICM*system*

The ICM*system* is part of the Power Diagnostix ICM series of digital partial discharge detectors. The ICM*system* is a powerful, versatile instrument for evaluating the condition of medium and high voltage insulation. The ICM*system* is usable over a range of frequencies of applied voltage, including power system frequency (50/60 Hz) and VLF (0.1 Hz).

Partial discharge (PD) measurements are a proven method for effective, non-destructive evaluation of electrical insulation. The Power Diagnostix ICM*system* provides high-resolution digital PD patterns for classification of defects in high voltage insulation systems.

Versatility

The key to the versatility of the ICM*system* is its modular design. The ICM*system* can be matched up with a variety of special accessories that adapt it to virtually any high-voltage testing environment. A wide range of external preamplifiers provides control of the frequency range in which PD activity is detected, from 40 kHz up to 2 GHz.



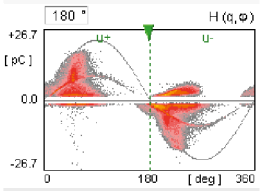
Phase-resolved PD pattern

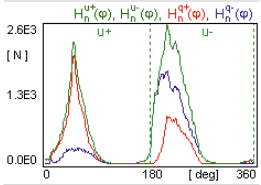
Assorted coupling devices, including quadrupoles, coupling capacitors, and current transformers, are available to sense the PD signal in the object under test. Like the other instruments in the ICM series, the ICM*system* provides effective noise gating that blocks phase-stable noise as well as noise independent of the applied voltage cycle, allowing the ICM*system* to be used in noisy environments without losing significant PD data. Appropriate selection of a preamplifier can assist further in achieving a high signal-to-noise ratio.

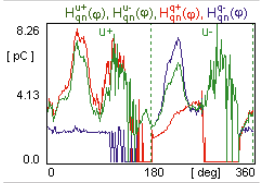
The key to the versatility of the ICM*system is its modular design.*

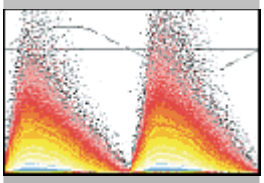
PC Software

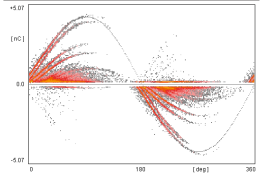
The operating parameters of the ICM*system* are fully computer controlled, making it simple to use with standard ICM*system* software. The PC application includes convenient options for in-depth analysis and printing of stored PD patterns.

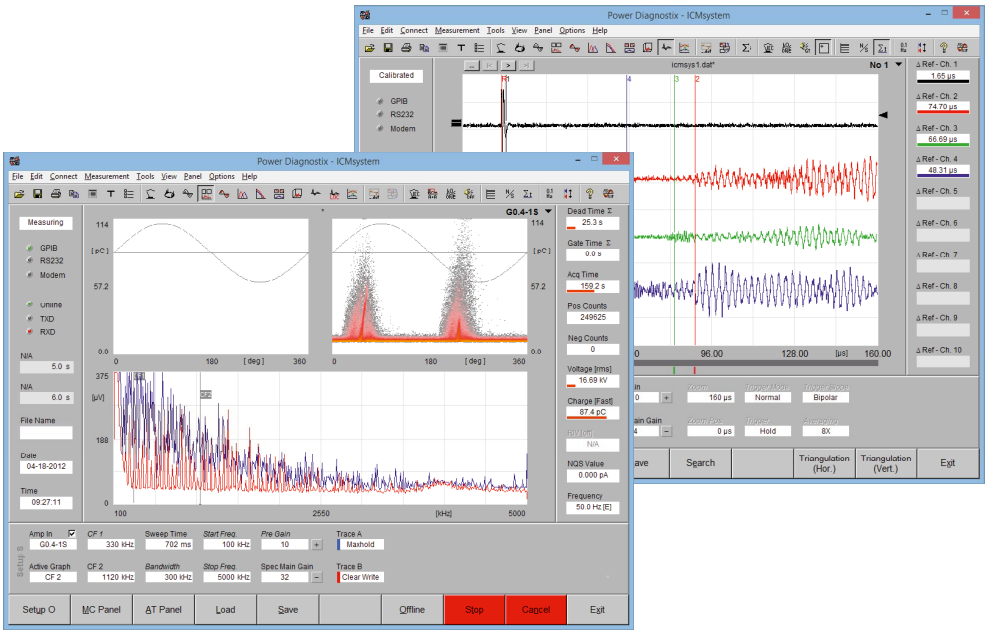












Optional software panels for spectrum analysis and for cable fault localization

Special Applications and Options

For applications such as DC testing or stepped high-voltage testing, the ICM*system* allows recording PD activity versus time (sequentially) instead of versus phase angle.

The optional spectrum function extends the functionality of the ICMsystem to provide a spectrum analyzer and a radio influence voltage meter for RIV measurements according to CISPR and NEMA standard.

A device with a software integrated option for cable fault localization (CFL) can perform PD fault localization measurements on medium voltage cables by processing partial discharge signals by means of the time domain reflectometry.

The ICM*system* software with φ-q trigger option allows marking up to ten different sub patterns (trigger masks) in a recorded PD pattern and assigning these masks to different trigger classes. Those trigger classes are then assigned to individual averaging baskets and allow seperation of different PD sources for acoustic measurements.

Hardware options such as a LAN interface or a built-in modem further extend the capabilities of the ICM*system*. The LAN and modem options permit remote access to data and control of the device.

Offering users complete access to detailed control parameters and the ability to download and analyze PD patterns on a PC makes the ICM*system* the ideal instrument for advanced analysis of phase-resolved partial discharge patterns, whether in research, utility, or industrial applications.

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The multi-channel version of the ICM*system* is specifically designed to meet the requirements of partial discharge acceptance tests on large power transformers. The instrument builds on the acquisition core of the standard ICM*system*.

*ICM*system *with ten channels*

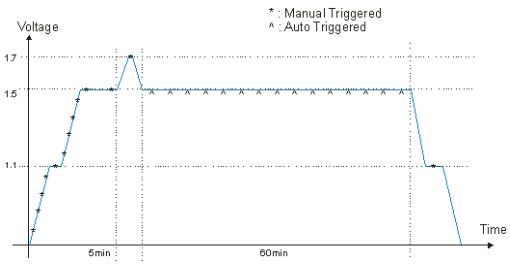
However, by introducing an individual amplifier plug-in board for each channel, true parallel acquisition of the discharge magnitude of up to ten channels is achieved. The instrument can be equipped with optional features like RIV or acoustic PD measurement.

Using the multi-channel ICM*system* greatly simplifies partial discharge acceptance tests on large power transformers. With the true parallel acquisition of the partial discharge activity on up to ten channels, the overall testing period is substantially shortened.

True multi-channel partial discharge acquisition

Independent Channels

For each of the partial discharge measurement channels an independent quadrupole, pre-amplifier, and amplifier plug-in board is required. Internally, the system controller processes the discharge readings acquired for each channel in a true bipolar peak amplitude acquisition. Optionally, the PD readings can be weighted according to IEC 60270-2000. Besides the partial discharge channels, the instrument offers the same number of independent channels for the measurement and sampling of the AC voltage signal provided by the quadrupole.



Typical test sequence for HV transformer

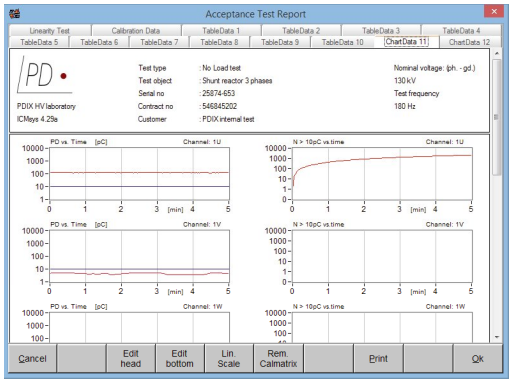
Pattern Acquisition

In addition to the parallel acquisition of the PD activity for the meter and strip-chart displays, the pattern acquisition core offers the defect identification capabilities of the phase-resolved partial discharge analysis. The influence of power frequency harmonics on the PD pattern, often found with power transformers, can be clearly identified, as the waveform of the AC voltage is available for each channel.

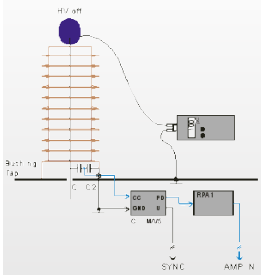
Specialized Software

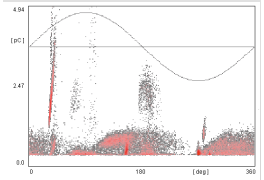
The ICM*system* control software for transformer acceptance testing offers manual and automatic modes for the acceptance test.

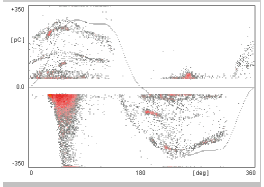
Reporting is simplified with MS Word and plain text output formats. The reports are based on user-selectable templates.

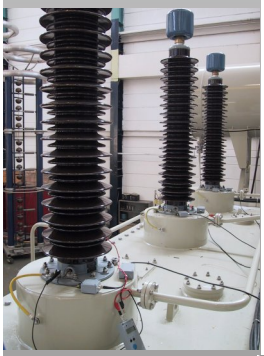


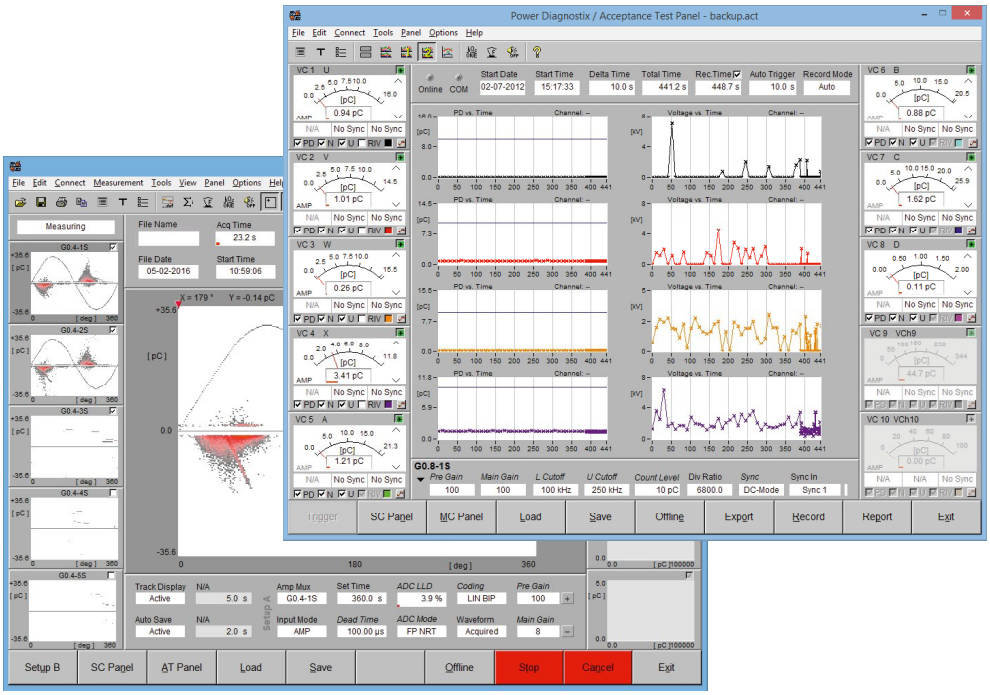
Report data



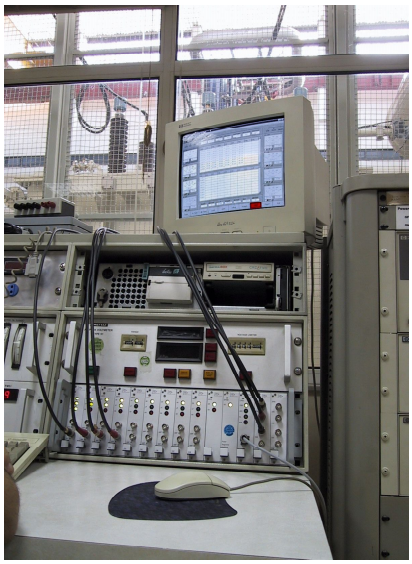








In acceptance test mode, the software shows up to ten meter displays, each indicating PD level, voltage, and frequency of the specific channel. With the center display, the automatically or manually triggered values are presented in list mode or as a strip-chart. Further, during calibration, the cross-coupling matrix between the channels is built up, which offers essential information in case of PD location measurements on transformers Additionally, the multi-channel ICM*system* software provides the user with all the features known from the standard ICM*system*, such as multi-channel consecutive pattern acquisition, movie-like replay, or statistical evaluation, for instance.



*Multi-channel ICM*system *installed in a control room*

The ICM*system* for power transformer acceptance testing is the first commercially available partial discharge detector with true parallel acquisition on eight channels. The instrument and its software greatly simplify the testing procedures and, thus, reduce the time the transformer needs to stay in the acceptance test lab.

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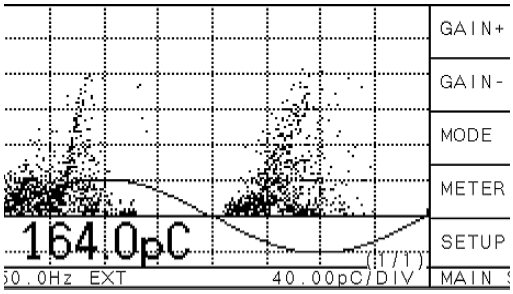
ICM*compact*

The ICM*compact* is part of the Power Diagnostix ICM series of digital partial discharge detectors. Itis a compact, stand-alone instrument for evaluating the condition of medium and high voltage insulation. The ICM*compact* is often used in quality assurance and quality control tests in manufacturing.

Stand-Alone Instrument

Partial discharge (PD) measurements are a proven method for effective, nondestructive evaluation of electrical insulation. The Power Diagnostix ICM*compact* provides a simple push-button interface and on-screen menus in an embedded LCD panel. The LC display modes include a simple PD charge meter with adjustable "needle" sensitivity, monochrome phase-resolved PD patterns for classification of defects, and a scope-like display showing phase-summed charge pulses superimposed with a sine wave.



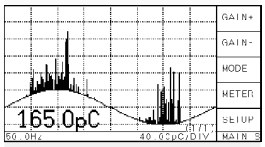
Phase-resolved PD pattern

Although the ICM*compact* is an autonomous unit, it can be connected to a computer installed with Power Diagnostix software to capture screenshots or to implement remote control of the unit.

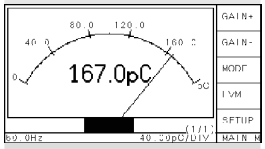
Applications

Instantly displaying information in an intuitive interface, the ICM*compact* is a good choice for applications such as quality control tests in manufacture of electrical products and for quality assurance of industrial and utility equipment; from capacitors and bushings to gas-insulated switchgear, voltage transformers, and others. A wide range of accessories adapts the ICM*compact* to specific testing applications and noise conditions.

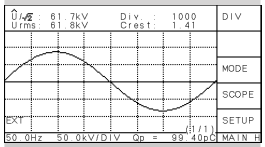
The ICM*compact* DSO option can be used to locate partial discharge defects in power cable. Using time domain reflectometry, in which the PD and its "echoes" travel the length of the cable under test, the ICM*compact* provides the proportional distance of the PD fault along the cable.



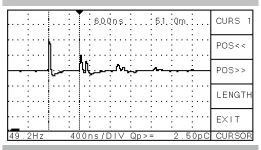
SCOPE display (SINE mode)



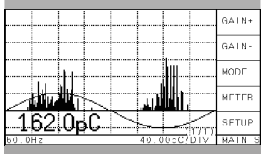
METER display



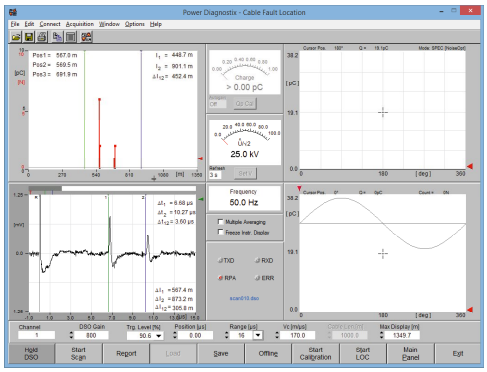
HVM display



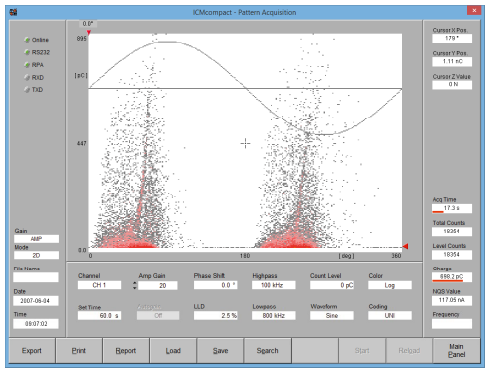
DSO display



SCOPE display (NORM mode)



Software panel for cable fault localization



Software panel for pattern acquisition

PD Spectrum Analysis Option

Observing the frequency spectrum of a harshly disturbed PD signal allows selecting frequency bands with fewer disturbances. Using this selected frequency for a PD acquisition gives a largely improved signal-to-noise ratio resulting in a clear pattern acquisition. The combination of spectrum analyzer and PD detector within one instrument opens a broad field of new possibilities when analyzing isolation defects even with large noise.

The SPEC mode shows the frequency spectrum of the input signal with a selectable span of up to 10 MHz. Three spectrum traces of the current input channel can be stored, compared, and analyzed. A variable cursor serves to set the center frequency for the PD pattern acquisition.

Further Options

To adapt the basic ICM*compact* unit to suit special measurement requirements, it can be equipped with various options:

• Voltage measurement. Adds the HVM oscilloscopic display showing the waveform of the high voltage and calculates Û, Û/√2, U_{rms}, etc.

• Cable PD localization. This option allows sampling the PD signal at 100 MSamples.

• Analog gating to cancel external disturbance. This option offers sensitive measurements even in noisy environments.

• MUX4. Four-channel multiplexer for testing three-phase equipment, such as power transformers. For each channel the unit maintains an individual setup and calibration.

• MUX12. This option a built-in 12-channel multiplexer or a remote 12-channel switching box offers cost-efficient acceptance testing on large power transformers.

• AUX4. For long-term testing up to eight additional parameters can be captured as 0(4)-20 mA or 0-10 V signals.

• RIV measurement. Adds a radio influence voltage measurement function to the instrument (needs the SPEC option and includes the MUX4 option).

The easy portability, simple operation, and flexibility of the Power Diagnostix ICM*compact* make it a good choice for routine PD testing in a variety of utility and industrial applications.

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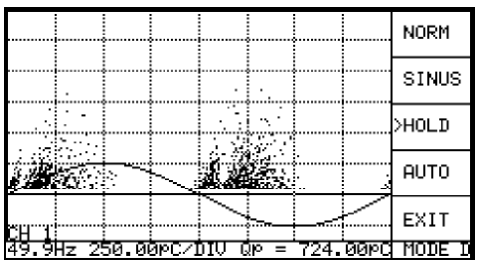
ICM*monitor*

The ICM*monitor* is a compact, stand-alone instrument for evaluating the condition of medium and high voltage insulation. It comprises a spectrum analyzer, an acoustic detector, and a conventional PD monitor in one instrument. This combination enables PD measurements even with high levels of background noise. A built-in four- or eight-channel multiplexer offers scanning of three-phase systems or multiple sensors. It is used principally for permanent, continuous on-line monitoring of rotating machines, cable systems, and power transformers.

Partial discharge (PD) measurements are a proven method for effective, non-destructive evaluation of electrical insulation, preventing expensive unplanned outages by detecting insulation problems before they can cause breakdowns. The Power Diagnostix ICM*monitor* is a digital PD detector for permanent installation and continuous monitoring of medium and high-voltage insulation.

Embedded Display

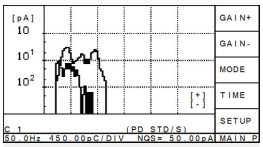
The ICM*monitor* has a easy to use push-button interface to navigate on-screen menus displayed on an embedded LCD panel. The LCD modes include a monochrome phase-resolved PD pattern display for classification of defects, a scope-like display showing charge pulses as a vertical line at the phase angle where they occur, a time trending display, and a monitoring display showing bar graphs of two key partial discharge quantities (Qp and NQS). Qp is the apparent charge value of the PD activity, and NQS is the absolute discharge current obtained by integrating the discharge values (summing up the total charge moved and dividing by the time interval, Q/t = [As]/[s]).



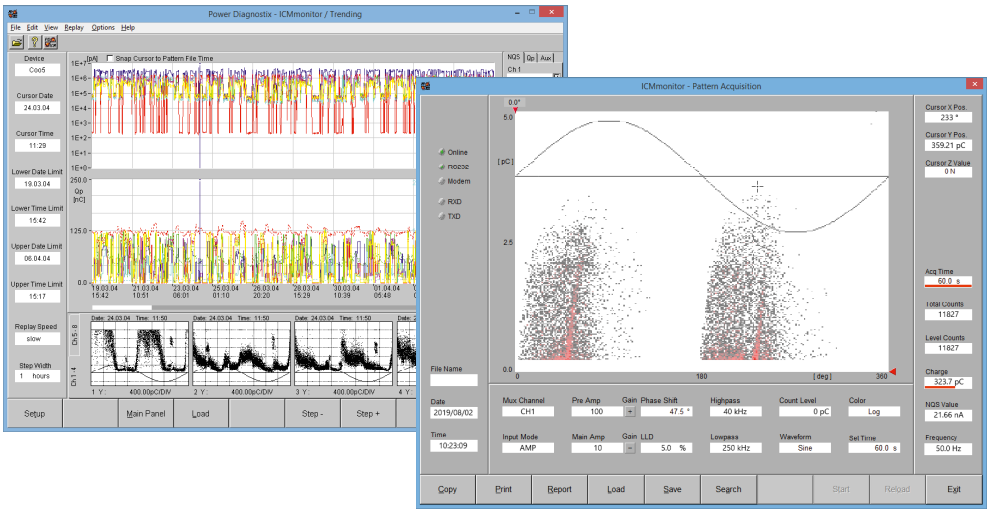
Monochrome PD pattern display

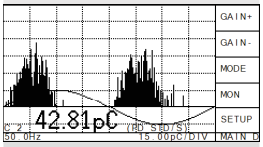
Noise Rejection

The ICM*monitor* features various noise handling techniques. The noise gating module can be connected to an antenna or a current transformer to sense and remove noise without losing significant PD data. Another method available is simple windowing, that suppresses phase-stable pulses occurring in the defined windows. Additionally, an appropriate choice of external preamplifiers can limit PD acquisition to a frequency band with less background noise.

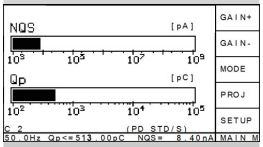


Projection display

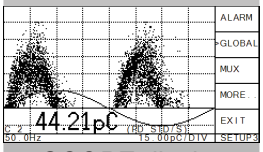




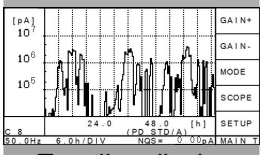
SCOPE display (NORM mode)



Monitoring display



SCOPE display (HOLD mode)



Trending display

Alarms and Trending

Users can set alarm levels of NQS or Qp that will trigger when those values are exceeded. A triggered alarm will appear on the LC display and activate an output relay on the ICM*monitor* that can be used to drive a local alarm system. The ICM*monitor* also collects and displays PD data over a specified time interval for easy trending and observations of changes in the Qp and NQS levels in the monitored system. Optionally, up to eight DC signals such as temperature or load can be added to this trending.

Telemonitoring

Although the ICM*monitor* is an autonomous unit, it can be connected to download data or to implement remote control of the unit. With its built-in TCP/IP interface or an analog modem, the ICM*monitor* can be controlled and observed remotely over a telephone or Internet connection anywhere in the world. Optionally, if a monitored system exceeds an alarm level set by the user, the ICM*monitor* can place a call to a user-selected number. The ICM*monitor* software automatically maintains the trending information as well as the phase-resolved pattern of a multitude of ICM*monitor* units.

ICM*monitor with modem (Explorer case version)*

The multifunctional ICM*monitor,* with its embedded display, convenient trending, and settable alarms, is an ideal solution for continuous on-line monitoring of rotating machines and other electric devices in industrial and utility applications.

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Spectrum Analysis

Observing the frequency spectrum of a harshly disturbed PD signal allows selecting frequency bands with fewer disturbances. Using this center frequency for a PD acquisition, gives a largely improved signal-to-noise ratio resulting in a clear pattern acquisition. The combination of spectrum analyzer and PD detector within one instrument greatly expands the measurement possibilities when analyzing the insulation systems in a noisy environment.

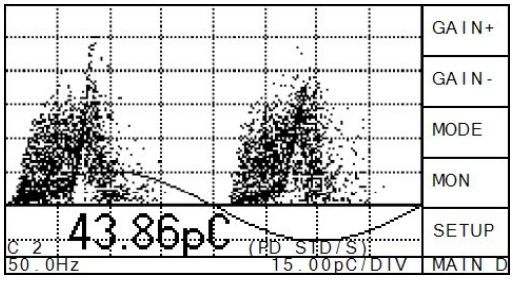
The ICM*monitor* with spectrum analysis comes with a four- or eight-channel multiplexer to directly select the input signal. The instrument provides five different display modes as well as a variety of connectivity options, including TCP/IP and USB.

SPEC Mode

The SPEC mode shows the frequency spectrum of the input signal up to 10 MHz. Three traces for the current input channel allow storing, comparing and processing of this spectrum. The bandwidth of the demodulated signal can be set to 9 kHz or 270 kHz, respectively.

SCOPE Mode

The SCOPE mode displays the PD pattern versus phase as known from the ICM series. Hereby, the selected center frequency and bandwidth of the SPEC mode is used, in order to disregard frequency ranges occupied with disturbances. The SCOPE mode offers viewing an oscilloscopic display (below) as well as a pattern display.



Scope display

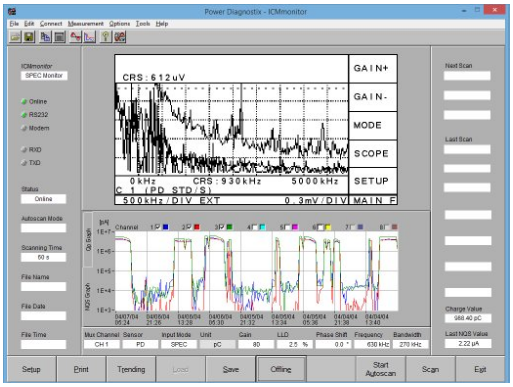
½ 19" rack mountable version without display

MON Mode

The monitoring display allows setting alarm levels of NQS or Qp that will trigger when those values are exceeded.

TIME Mode

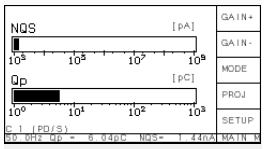
Additionally, the ICM*monitor* collects and displays PD data over a specified time interval for easy trending and observations of changes in the Qp and NQS levels of the monitored system.



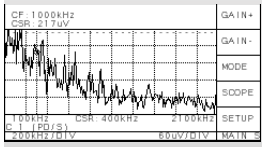
ICM*monitor software*

Software

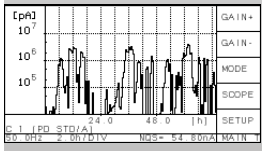
Besides these autonomous functions, the instrument can be connected to a computer via serial interface, modem, or TCP/IP. Special software allows the remote control of the instrument and the download of the stored data. An autoscan function takes the trending information as well as the phase-resolved pattern of one or multiple units.



Monitoring display



Spectrum display



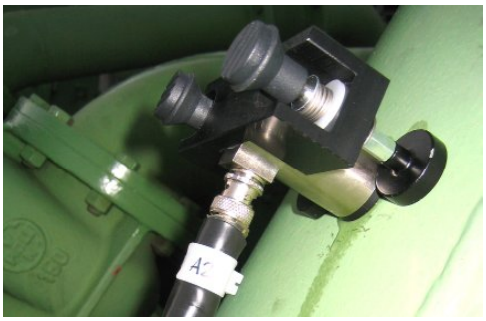
Trending display

Bushing adapter and coupling unit

19" rack mountable version

Accessories

It is possible to connect acoustic sensors (AS), UHF sensors, or the standard coupling unit from the bushing test tap to the ICM*monitor*.
Different preamplifiers like RPA1F, RPA1L or FCU2 can be used in case of weak signals or to drive long cable lengths.

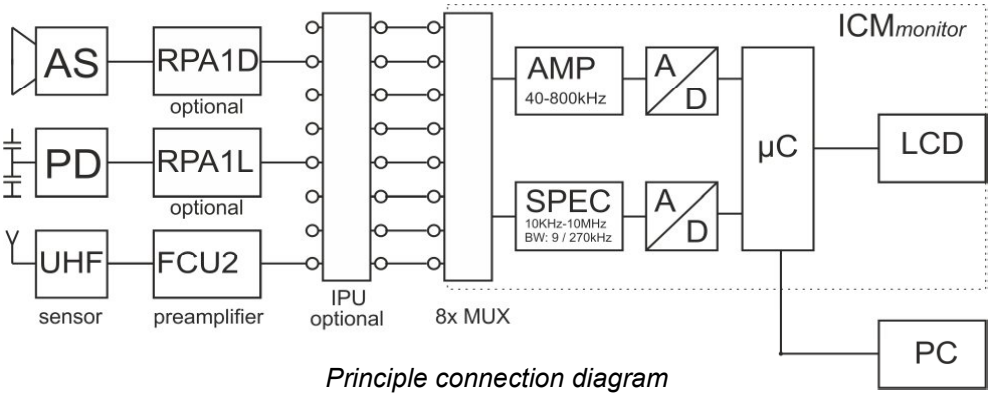


Acoustic sensor with magnetic holder

Options

- MUX8/MUX12. 8- oder 12-channel multiplexer
- AUXIN4/AUXIN8. 4- oder 8-channel analog input that adds monitoring capability of isolated 0(4)-20 mA trending signals
- AUXOUT4/AUXOUT8. 4- oder 8-channel analog output enabling external monitoring of NQS or Qp levels
- IEC61850. Hardware based protocol converter for communication with the instrument according to IEC 61850
- Built-in 57.6kBit/s modem for remote communication

ICM*monitor in a full 19" rack*



Principle connection diagram

The multifunctional ICM*monitor*, with its embedded display, convenient trending, and settable alarms, is an ideal solution for continuous on-line monitoring of rotating machines and other electric devices in industrial and utility applications.

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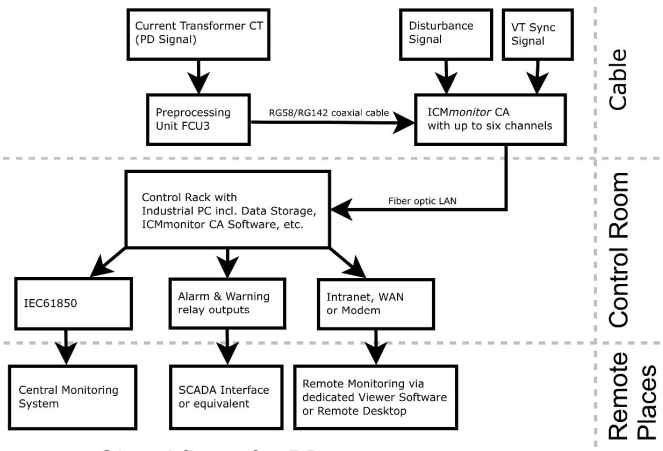
ICM*monitor* CA

The main task of the partial discharge monitoring system type ICM*monitor* CA is to detect internal partial discharge in power cables caused by cracks in joints and terminations or degradation in the insulation system at an early stage. PD signals are picked up by a current transformer and preprocessed by an FCU3.

A monitoring control rack (PDMCR) with ICM*monitor* CA software installed receives the measured data from the monitoring units and processes it.

Due to the dielectric properties of cable materials and their attenuation, partial discharge activity in power cables is typically measured in a frequency band of several tenth of MHz. The frequency converter unit (FCU3) is a signal conditioning unit with a demodulating logarithmic transfer function. It picks up the HF signal from a current transformer (CT). The output of the FCU3 is the envelope of the HF signal down-converted into the frequency range of the instrument (< 1 MHz). The FCU3 is mainly used with monitoring applications and for gating purposes. This unit is remote powered by a DC phantom voltage provided by the ICM*monitor* CA. A malfunction of the FCU3 will be detected automatically by the monitoring unit and will be indicated in the main panel of the software.

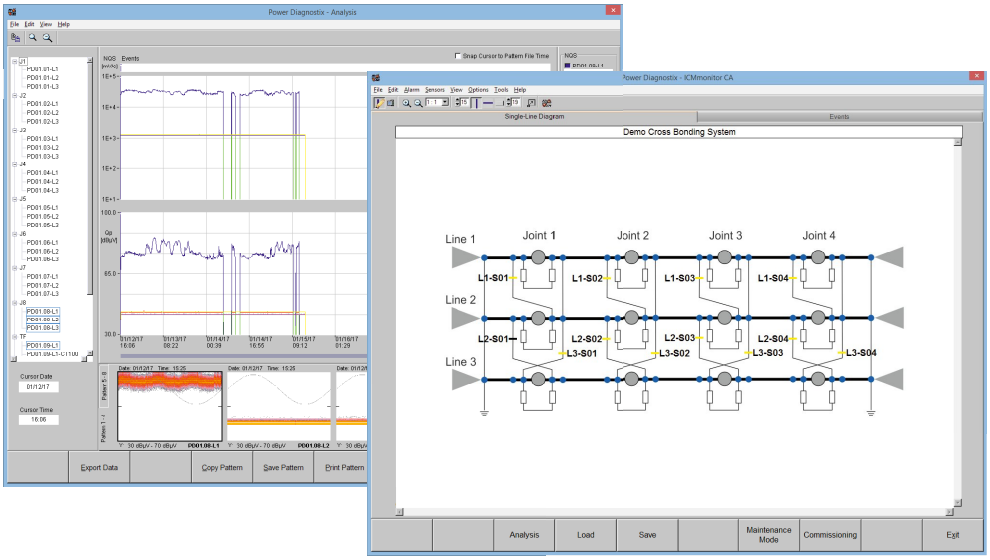
An external synchronization signal is usually derived from a VT, which is installed in short distance to the PD measuring device. If such a short distance installation isn‘t possible, due to space restrictions e. g., Power Diagnostix offers a special synchronization unit FSYNC1, which allows transmission of synchronization signals over long distances via fiber optic cables.

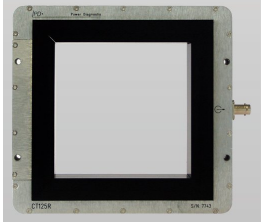


*Signal flow of a PD measurement system with ICM*monitor *CA units*

FCU3

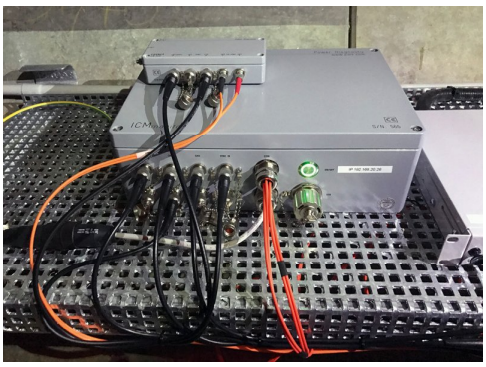
FSYNC1





CT100 R

The number of current transformers to be monitored depends on the type of cable and the individual specification of the customer. Up to six signal cables from current transformers are brought together into one ICM*monitor* CA instrument. All monitoring instruments are interconnected via a fiber optic LAN ring, providing n+1 communication redundancy. A monitoring control rack (PDMCR) receives the measured data and processes it. With this system architecture, a nearly infinite number of current transformers can be continuously monitored and observed.



*ICM*monitor *and FSYNC1 unit*

ICM*monitor* CA Software

In combination with the monitoring software installed on the industrial PC (IPC), the trending data of peak values (U_{pp}) and averaged pulse values (U_{pavg}) of years can be archived. Additionally, data like PD patterns, system health information, or alarm events can be stored and evaluated. If connected to a local intranet it allows remote diagnosis and control of the full PD monitoring system. Different functional levels can be set for administrative, operational, or evaluation purpose.

Each ICM*monitor* CA offers PD monitoring on HV cable systems on up to six channels in parallel. The acquisition unit is remote controlled via fiber optic connection or USB. The ICM*monitor* CA software allows archiving of the trending data of several years.

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AIA*compact*

The AIA*compact* is a portable unit for in-service acoustic and electric (UHF) partial discharge measurements on gas-insulated switchgear (GIS), transformers, and cable accessories. It is fitted with a battery pack for independent operation up to three hours. The instrument adapts to a variety of piezo-electric acoustic sensors and is supplied with a versatile sensor fixture. Additionally, the AIA*compact* allows partial discharge measurements on external UHF sensors.

Acoustic partial discharge measurements can be easily applied on gas-insulated switchgear and other high voltage equipment without the need of interrupting the operation. Such online measurements help to identify internal imperfections of the insulation system, which may lead to breakdown and system failure in the future.

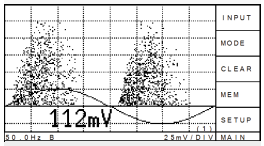
Easy-to-apply substation condition assessment

Acoustic partial discharge measurements rely on the close acoustic contact of the area producing the discharge to the point of access, where the sensor is placed. Most of the partial discharge activity in GIS offer such a good contact and, hence, can be detected at a good sensitivity.
Therefore, discharges from sharp points or cones as well as discharge activity from delaminations can be identified at a sensitivity that is mostly comparable to the conventional electrical detection according to the IEC 60270. For some defect types, such as the so-called hopping or bouncing particles, the acoustic detection is by far superior to the electrical detection.

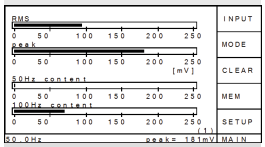
Based on the proven hardware core of the ICM*compact*, the AIA*compact* offers automatic detection of the sensor or preamplifier used. Normally, the instrument is operated with acoustic sensors with remote supplied embedded preamplifiers directly connected to the signal input. Alternatively, the RPA1F can be inserted close to the sensor to boost the signal, in case longer signal cables are used or in case of low-level measurements. UHF measurements on embedded or external sensors are possible with the use of the FCU2, a logarithmic frequency converter, which covers 100 MHz to 1800 MHz. As with the preamplifiers, the AIA*compact* automatically detects the FCU2 and changes into the logarithmic display for the UHF detection. To protect the instrument's hardware it is advisable to connect an input protection unit like IPU2B to the sensor's output.

The instrument offers three display modes, which are selected using dedicated control buttons: SCOPE, METER, and TIME.

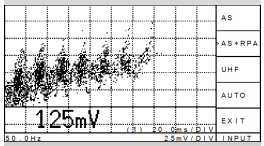
SCOPE
In SCOPE mode, the AIA*compact* shows the phase-resolved partial discharge signal or pattern. Here, the 'Freeze' function allows keeping such a captured pattern for



SCOPE display



METER display

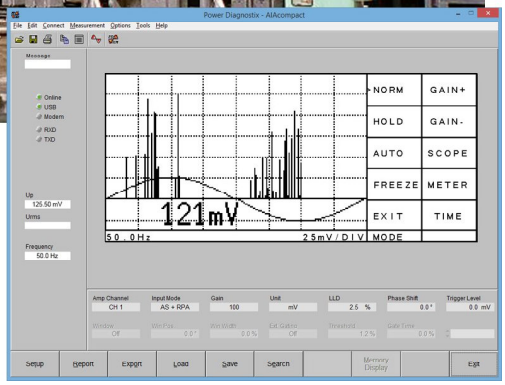


TIME display

FCU2 & IPU2B

RPA1F & AS75I

DA2



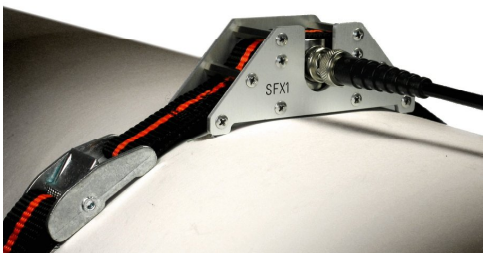
further evaluation or for taking screen-shots.

METER

The METER mode offers four bar graph displays showing derived quantities of the captured activity. The graphs display the RMS and the peak PD level, as well as their 50 Hz (60 Hz) and 100 Hz (120 Hz) content. The instrument automatically synchronizes to the line frequency.

TIME

Within the TIME mode, the AIA*compact* displays five or ten AC cycles triggered by a partial discharge event. Thus, this display shows the pattern of consecutive partial discharge events and, hence, offers a clear identification of bouncing particles and the severity of their activity.



Options

- AIA*compact* software: All captured patterns and displays can be transferred to a notebook via an USB interface using the optional AIA*compact* software. Optionally, the software allows acquisition of color PD patterns.

- Gating: Software controlled noise reduction for PD measurements in environments with high frequency disturbance.

- MUX12: Every AIA*compact* comes with a 4-channel multiplexer to split the PD signal and the voltage signal, with individual setup and calibration factor for each channel. On customer request we also deliver the device with a 12-channel-multiplexer.

- 57kB modem: A built-in analog modem allows to access the AIA*compact* via a common phone line.

Offering easy-to-use acoustic partial discharge analysis of gas-insulated switchgear (GIS) and other high voltage equipment plus the optional analysis on embedded or external UHF sensors makes the AIA*compact* the ideal solution for convenient in-service substation condition assessment.

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ICM*flex*

The ICM*flex* high voltage instrument family offers inherent operator safety and greatly simplifies distribution-class cable testing and other field tasks involving partial discharge and loss factor testing. With the unique concept of the ICM*flex* instruments, the entire acquisition hardware is placed on high voltage potential right at the position where the signals are. Thus, no signal cables are needed, as the instrument is fully self-contained and battery operated. The instruments are fully remote controlled via Bluetooth or fiber optic communication.

Unique Concept
The ICM*flex* instrument family is available with different options and for different voltage levels. Additionally, the self-contained ICM*flex* acquisition unit can be placed on top of any third-party coupling or reference capacitor. The option TD offers tanδ and power factor (PF) measurements. The option PD provides partial discharge measurements according to IEC 60270, whereas the option LOC includes partial discharge localization for power cables.

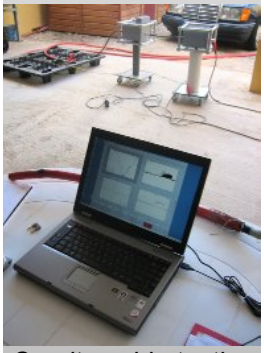
Wireless signal transmission via Bluetooth communication

Finally, the optional high voltage T-filter for sensitive partial discharge measurements can reduce disturbance signals from a high voltage supply. The detachable NiMH battery provides more than eight hours of continuous operation, while a second battery is charged. Any high voltage AC source can be used including resonant test sets and VLF high voltage sources.

Testing distribution-class cables in a field environment becomes an easy and inherently safe task. The ICM*flex* unit is simply placed between high voltage source and the cable to be tested – no further leads required. Thus, with one unit requiring only high voltage and ground connection all essential measurements on laid power cable are performed in one step: Tanδ, partial discharge, and partial discharge localization.

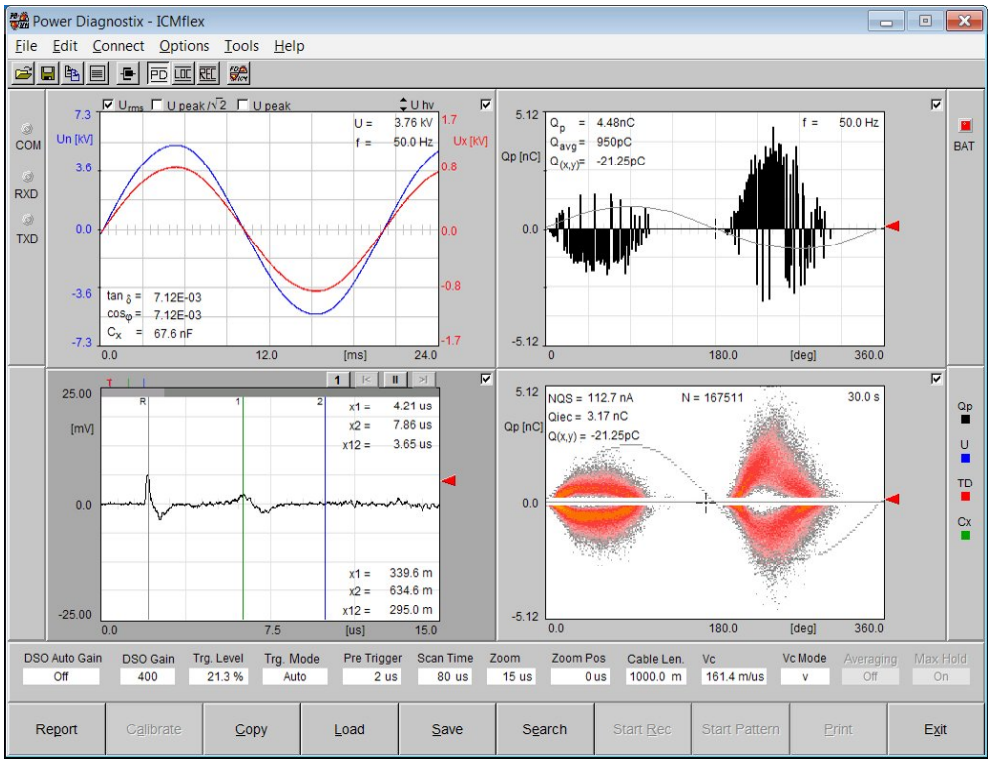
Off-line testing of generator and motor stator coils is simplified in the same way. Using any high voltage source, the critical AC measurements on the stator coil are done simultaneously: Tanδ, PF, and partial discharge.

ICM*flex & HV filter*



On-site cable testing

TD measurement on motor bars



ICM*flex software*

Option TD
The tan delta analyzer uses an unbalanced bridge formed by internal shunt capacitors, the reference capacitor, and the device under test. Here, the ICM*flex* software shows tanδ, PF, capacitance, voltage, and frequency.

Option PD
With the option PD the ICM*flex* software offers a meter display according to IEC 60270 and an oscilloscopic display of the partial discharge activity as well as a colored *φ-q-n* pattern (above) based on the data received via Bluetooth or fiber optic connection. Placing the quadrupole and acquisition unit on high voltage potential greatly improves the sensitivity and avoids any noise pickup on signal cables.

Option LOC
The partial discharge localization option uses high speed (100 Msample) sampling of the PD pulses traveling the cable. Along with the analog bandwidth of 20 MHz this enables precise localization and mapping of the discharge activity along the cable.

Option TF
The ICMflex unit can be equipped with a high voltage T-filter to block high frequency noise signals from the HV supply.

Using wireless Bluetooth or fiber optic technology the ICM*flex* tanδ and partial discharge analyzer family increases operator's safety and greatly simplifies off-line testing and analysis of distribution-class cables and rotating machine stator windings.

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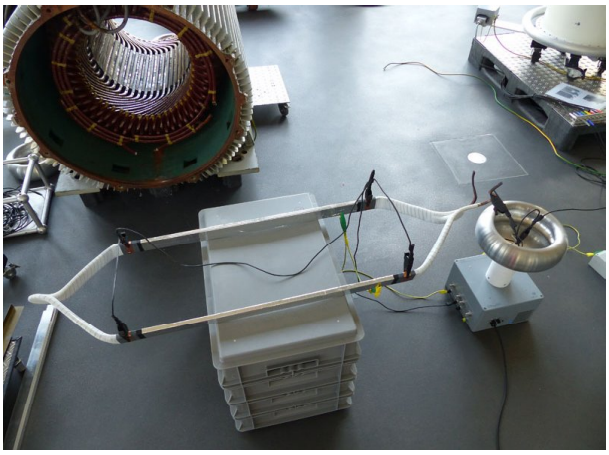
ICM*flex* GRC

In order to meet with the requirements of the existing IEEE 286-2000 and the new upcoming IEC 60034-27-3 standard for dielectric dissipation factor testing (also known as tanδ testing) on rotating machine stator windings and individual bars, Power Diagnostix made a re-design of the existing ICM*flex*, so called ICM*flex* GRC "Guard Ring Control".

Both standards mentioned above apply to rotating machinery with a rated voltage of 6 kV and higher and describe the test procedures and evaluation criteria for tanδ testing of individual stator bars and complete assembled stator windings. The testing as described applies to the common insulation system techniques in use, such as the resin rich and global vacuum pressure impregnated systems. However, the standards are not applicable for non-impregnated stator bars, also called green coils.

IEC 60034-27-3 ready

The main purpose of tanδ and tanδ tip-up testing is determining the overall condition of the stator winding or bar´s slot section also called ground wall insulation. The test results mainly show the performance in terms ionization losses versus the applied voltage of the ground wall insulation under the slot's conductive outer layer, acting as the ground electrode to the stator core. Usually, the stator bars with a rated voltage of 6 kV and higher are provided of a field grading junction, consisting of a semi-conductive material, e. g. silicon carbide, at the slot-exit area. In order to grade the surface potential were the stator bar leaves the grounded core. Depending on the rated voltage, this high resistance material with non-linear resistive voltage characteristic needs to be overlapped for a certain length with the slot's linear resistive layer applied to the ground wall. Based on such design, the tanδ measurement, which is intended for the ground wall insulation only, may be affected by the resistive losses of the field grading junction. For complete assembled stator windings the contribution of the losses generated by the semi-conductive material in the overall tanδ level cannot be neglected, and, hence, the regular ICM*flex* can still be used. However, as the evaluation criteria are specified for the slot section of individual bars only, guarding techniques have to be applied in order to minimize the influence of the field grading junction's losses on the overall tanδ value.



Stator bar testing with ICM*flex* GRC

Several techniques have been studied during the past such as the foil wrap methods and the slot-end gap method. Nowadays, with automatized bar manufacturing processes, it is practically not feasible to make an interruption at the slot exit and to provide the semi-conductive material after the tanδ test, since this will cause tremendous delays and, in worst case, essential failures affecting the integrity of the insulation system. Besides this, both standards recommend performing the measurement on the end product, i. e. the individual bar provided with the field grading junction, and, hence, using both techniques as mentioned above are not an option. The only technique left is the driven guard method.

The new GRC (Guard Ring Control) option provides such driven guard inputs on the ICM*flex*' digital tanδ bridge. Beside this new feature, the instrument still keeps its versatility by enabling the simultaneously updated partial discharge and tanδ measurement results with the highest precision. This flexible unique concept strongly reduces the (re)winding and testing times in rotating machine manufacturing companies and service groups and can even be used in quality assurance labs for non-destructive evaluation of the ground wall performance of individual stator bars.

The ICM*flex* GRC is optimized for the capacitance range of stator bars and for smaller asynchronous induction motors up to Roebel bars for larger synchronous turbo generators.

Furthermore, the embedded voltage divider for up to 30 kV_{RMS} comes with a DAkkS (former DKD) calibration certificate. The instrument is battery operated (up to ten hours) and equipped with a fiber optic link for communication with the computer via USB. The advanced software provides manual and automatic record modes, even a step-by-step guidance structure with customized report after completing the test sequence. The data tables, phase resolved PD patterns, different charts, and graphs can be exported into common text and spreadsheet processing packages such as MS Excel.

Using wireless Bluetooth or fiber optic technology the ICM*flex* tanδ and partial discharge analyzer family increases operator's safety and greatly simplifies off-line testing and analysis of distribution class cables and rotating machine stator windings.

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RIV*meter*

The RIV*meter* is an instrument for the measurement of radio influence voltage (RIV) according to the relevant standards (NEMA 107-1987, IEC CISPR 18-2:2010, EANSI 63-2-1996, VDE 876, DIN EN 55016-1-1). The instrument has a bandwidth of 9 kHz and a tunable center frequency of 100 kHz to 2 MHz. Technically, the RIV*meter* is a selective µV-meter. However, the meter reading is weighted according to the CISPR weighting curve, whereas the repetition rate has a strong impact on the reading. The RIV*meter* is an ideal instrument to replace outdated RIV measurement instruments in a transformer testing lab, for instance.

Some routine PD measurements are still done according to IEEE standards requiring the measurement of radio influence voltage. The RIV value is given in µV (interference voltage). A narrow band filter performs a quasi-integration of the PD pulses with a quasi-peak detection at the center frequency. This center frequency can be adjusted between 100 kHz and 2 MHz. The narrow-band pass filter allows to suppress external noise e. g. in non-shielded laboratories by varying the center frequency of the filter.

Two factors determine the RIV in µV: the transferred charge and the repetition rate of the PD impulse (number of PD pulses per second). Because of this proceeding, a direct translation of the measured RIV values (µV) into values of apparent charge in pC is not possible.

Historically, the RIV technique is based on measurement receivers to estimate the disturbance of communication lines.

New RIVmeter supporting old standards

Thus, properties of those instruments then available became part of the NEMA standards. However, both the 9 kHz bandwidth and the CISPR weighting curve put emphasis on some partial discharge activity, while they tend hiding others.

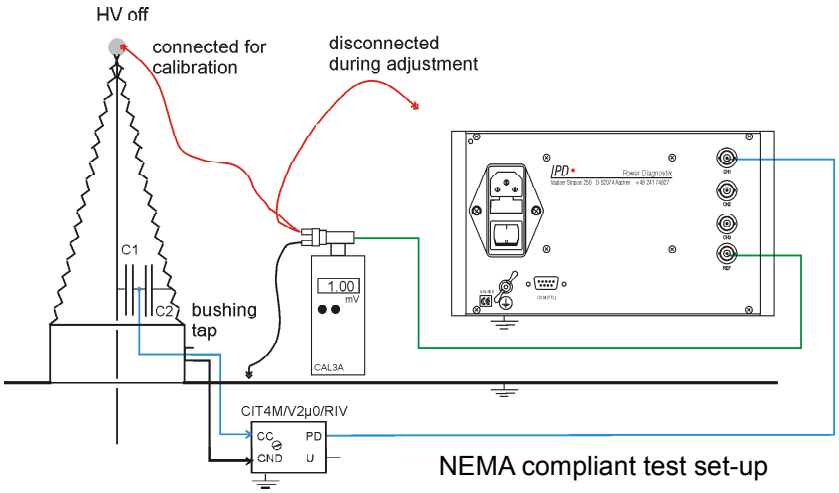
Rejection filter RF1/500

Quadrupole CIT4M/V2µ0/RIV

Old Stoddart NM-25T

Old Siemens B83600-B40

The calibration of the RIV measurement is done using an RIV calibrator, injecting a sine wave of typically 100 µV into the bushing. The multiplexer of the RIV*meter* is used to conveniently determine the correction factor according to NEMA 107-1987 and other standards. Here, the unit compares the voltage injected, i. e., loaded by the bushing's impedance, with the voltage detected at the bushing tap to automatically determine the k-factor. This correction factor is then stored independently for each channel during calibration. The standard calibrator for RIV calibration, CAL3A, offers a selectable frequency range of 600-1350 kHz in steps of 50 kHz. The output voltage covers 10 µV to 10 mV in 1-2-5 steps. The CAL3B calibrator offers a frequency range of 400 kHz to 1.9 MHz with the same output voltage but in steps of 100 kHz. Having the same frequency range as the CAL3B, the CAL3D comes in contrast with a high impedance output (> 20 kΩ) according to IEC CISPR 18.2:2010.



NEMA compliant test set-up

CAL3A and CAL3D

RIV*meter rear panel*

The RIV*meter* is an instrument for the measurement of radio influence voltage according to NEMA 107-1987, IEC CISPR 18-2:2010, and other relevant standards. It is the ideal instrument to replace outdated RIV measurement instruments in a transformer testing lab.

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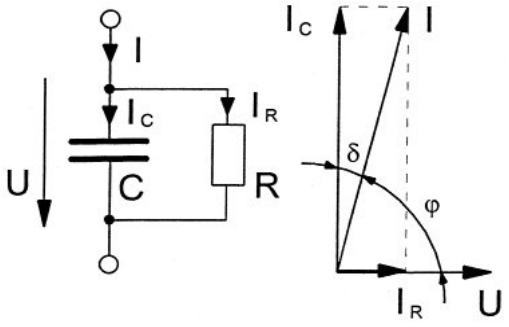
TDA*compact*

The TDA*compact* is a portable capacitance and tanδ analyzer. The focus of the instrument's application is on the analysis of the epoxy-mica insulation of rotating machines. Besides this, the unit is applicable for oil-paper insulation systems and especially for mass-impregnated cables.

Analyzing the dissipation factor (tanδ) is a traditional method to assess the condition of an insulation system. With the analysis of the dissipation factor, emphasis is more put on the overall health of the insulation system, whereas with partial discharge analysis, the focus is on individual defects producing discharge activity. Therefore, the application of tanδ measurements concentrates on insulation systems, which are relatively stable against partial discharge.

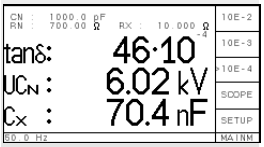


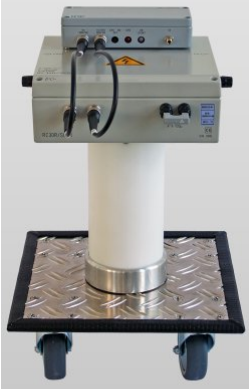
Dissipation factor

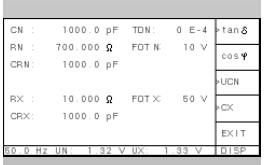
Most prominently, the health of an epoxy-mica insulation of a rotating machine can be assessed using a tanδ analyzer. Especially, the presence of humidity within the winding, the surface contamination of field grading elements, or the polarization losses of improperly cured resin, can be detected. Thus, the tanδ analysis is still a good complement to the partial discharge testing.

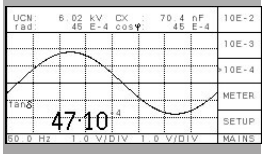
Portable and accurate tanδ analysis

Principle of Operation
The TDA*compact* simultaneously samples the AC current drawn by the device under test and the current drawn by a reference capacitor. Subsequently, the two current traces are evaluated and the capacitance, the tanδ, and the level of the high voltage are calculated. The unit continuously displays and refreshes these results.









Therefore, the instrument does not require any user interaction as with the traditional Schering Bridge, nor does the refresh of the display take that long as with automatic adjusting bridge-type analyzers. The basic resolution of the tanδ measurement is 10^{-4}, which fulfills the requirements for rotating machine testing as well as for testing on mass-impregnated cables.

Stand-alone Instrument

The TDA*compact* is designed as a stand-alone instrument. To measure the two currents the basic configuration of the TDA*compact* comes with a standard capacitor, that has a built-in shunt capacitor, in combination with an external shunt. Optionally, the unit can be supplied with further shunt capacitors.

Generally, the TDA*compact* is with digital fiber-optic links to the precision shunts, which allow operation on any potential including the high voltage connection of the device under test. The measuring frequency can vary between 20 and 500 Hz or is fixed to 0.1 Hz (VLF). Upon request, Power Diagnostix can supply complete portable tanδ testers including the high voltage transformer.

Modular Concept

Besides the stand-alone field test application of the TDA*compact*, the instrument can also become a part of a larger and automated test system. Using the software HV*pilot*, the instrument will be read according to a pre-programmed test sequence. Besides tanδ measurements, such automated test systems further include partial discharge measurements and so-called step tests.

Offering adequate resolution and accuracy as well as an unmatched portability, the TDA*compact* is an excellent choice for field-type dissipation factor measurements. Additionally, the TDA*compact* can be used as a module of a flexible automated test system.

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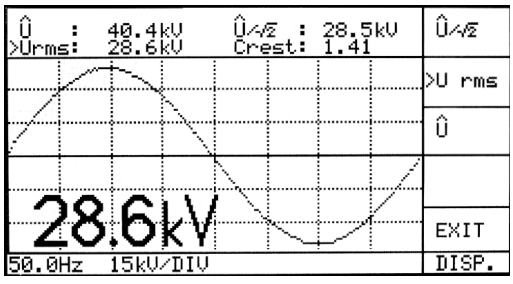
HV*compact*

The HV*compact* is a high voltage meter with an auto-ranging oscilloscope display of the voltage waveform. The unit displays Û, Û/Ö2, U_{rms}, frequency, and the crest factor. To improve the readability, one selected measurement is displayed using larger characters. To protect test specimens, the unit offers a pre-settable voltage limit, which trips a relay output. The divider ratio is widely adjustable and is kept with a non-volatile memory.

Mostly, the HV*compact* is used in case of modernization or upgrade of high voltage test sets. With conventional analog or digital panel meters, usually, solely the voltage is displayed. The HV*compact* adds several helpful functions.

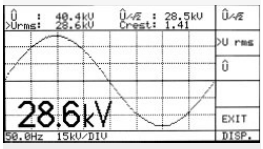
Oscilloscopic Display
The input voltage is sampled in high resolution and one cycle is displayed as an oscilloscopic trace. Any distortion of the high voltage due to transformer core saturation or power frequency harmonics, for instance, are clearly identified with this display. The screen is automatically synchronized with the measured voltage and the amplitude deflection is controlled by an auto-range function.

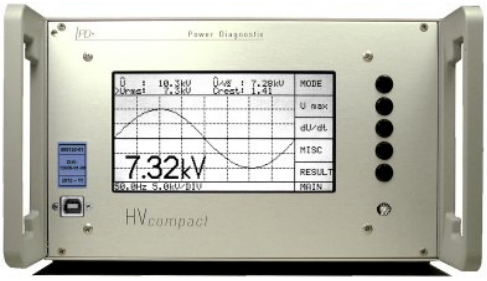


Scope display of the waveform

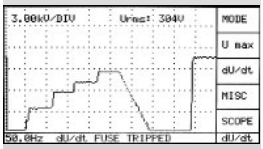
All voltage information at a glance

Measurements
Usually, the instrument connects to capacitive or resistive divider. With larger high voltage transformers, the capacitance of the condenser bushing can be used. Within the menu of the HV*compact* the divider ratio can be adjusted. It is kept with a non-volatile memory. The nominal input range of the HV*compact* is 100 V_{rms}. In order to cover correctly even strong harmonics, peak voltages of up to 200 V are accepted and sampled.



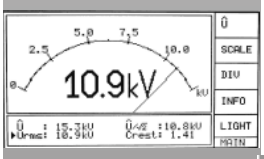


Using the sampled voltage, the instrument calculates based on the preset divider ratio the characteristic quantities of the high voltage signal. With the upper two lines of the display the peak voltage Û, the peak voltage divided by the square root of two Û/√2, and the effective voltage U_{rms} is shown. Additionally, the crest factor is calculated and displayed. With the bottom line of the display, the frequency of the captured voltage signal is shown. This bottom line further shows the scaling of the Y-axis grid of the oscilloscopic display. One selected value is displayed using larger characters for improved readability.



Safety Features

A voltage limit can be set with the instrument in order to avoid that a test specimen is stressed above its allowable voltage. In case the voltage then exceeds this limit, a relay is tripped. This relay can be used to block the 'UP' button of the control circuit or to disconnect the main circuit breaker.
Additionally, the instrument detects incipient breakdown or flashover. Therefore, a maximum permissible voltage change per second (dU/dt) can be set. Each individual cycle of the high voltage signal is analyzed. Especially with long-term voltage endurance tests, this feature can minimize the thermal destruction of the breakdown channel and, thus, improves the analysis of the defect.



Optional REC OUT

The HV*compact* is available with an optional recorder output. In case, a connector carries a re-converted analog (DC) signal of 0-10 V, which corresponds to the high voltage signal. This signal can be fed to a paper recorder, for instance. A screw terminal carries the optional relay output signals for voltage limit and breakdown detection.

Calibration

11030006-01
D-K-15068-01-00
2020-04

DAkkS Deutsche Akkreditierungsstelle D-K-15068-01-00

By end of 2003, Power Diagnostix received the accreditation as calibration By end of 2003, Power Diagnostix received the accreditation as calibration laboratory within the German Calibration Service (Deutscher Kalibrierdienst, DKD). The audit was held by 'Physikalisch Technische Bundes-anstalt' PTB, the German authority of standards. In 2006, Power Diagnostix extended the accreditation by AC high-voltages up to 100 kV. On order the HV*compact* can be calibrated on site together with its divider impedance.

In January 2012, Power Diagnostix passed over to the newly introduced German accreditation authority DAkkS (DAkkS = **D**eutsche **Akk**reditierungs-**s**telle). Power Diagnostix' accreditation is filed under D-K-15068-01-00.

Giving an instant display of all relevant parameters of a high voltage signal including an oscilloscope trace makes the HV*compact* an ideal upgrade for high voltage test rooms. Additionally, the HV*compact* detects incipient breakdown and keeps a record of the voltage history.

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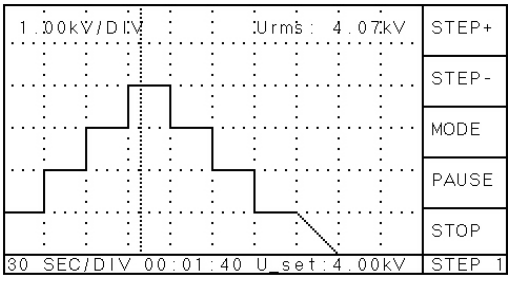
STEP*compact*

Increasing the high voltage stepwise is a task that is often required during type testing and production testing of high voltage products. The STEP*compact* is an instrument to automate such step tests. The unit combines the control function with the measurement capabilities of a high voltage meter. As a stand-alone instrument, the STEP*compact* can be easily moved between different high voltage test sets. The STEP*compact* measures the voltage signal derived from a capacitive or resistive divider. Using a fiber optic transmission, the UP and DOWN relay contacts of the voltage regulator are actuated to adjust the high voltage according to the programmed test sequence.

Features

Similar to the HV*compact*, the instrument calculates and displays the characteristics of the captured high voltage signal such as Û, Û/Ö2, U_{rms}, frequency, and the crest factor. The unit accepts a nominal input voltage of 100 V_{rms}. In order to correctly acquire even excessively distorted high voltage signals, the STEP*compact* samples up to 200 V peak signals.

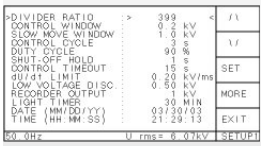
Using the five menu-driven control buttons, up to 35 different test sequences can be programmed and stored in a non-volatile memory. A test sequence consists of steps and ramps in any order. Besides the automatic mode, a manual mode can be used to set a specific voltage and keep it over time. In factory environments with strongly varying load situations, this function can be very helpful to maintain a stable high voltage level with long-term tests.

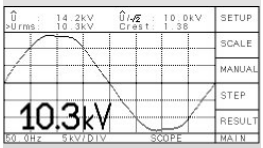


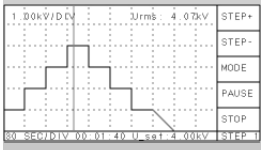
Running step test sequence

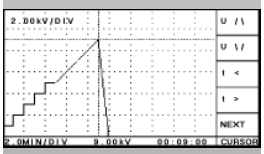
Safety and automation for step test sequences

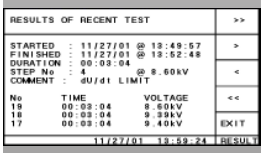
Up to seven configurations can be stored in the non-volatile memory in order to adapt the instrument to the properties of different high voltage test sets. Besides the divider ratio, a configuration setup contains settings such as the control cycle or the control window to tune the instrument to the properties of the high voltage test set.

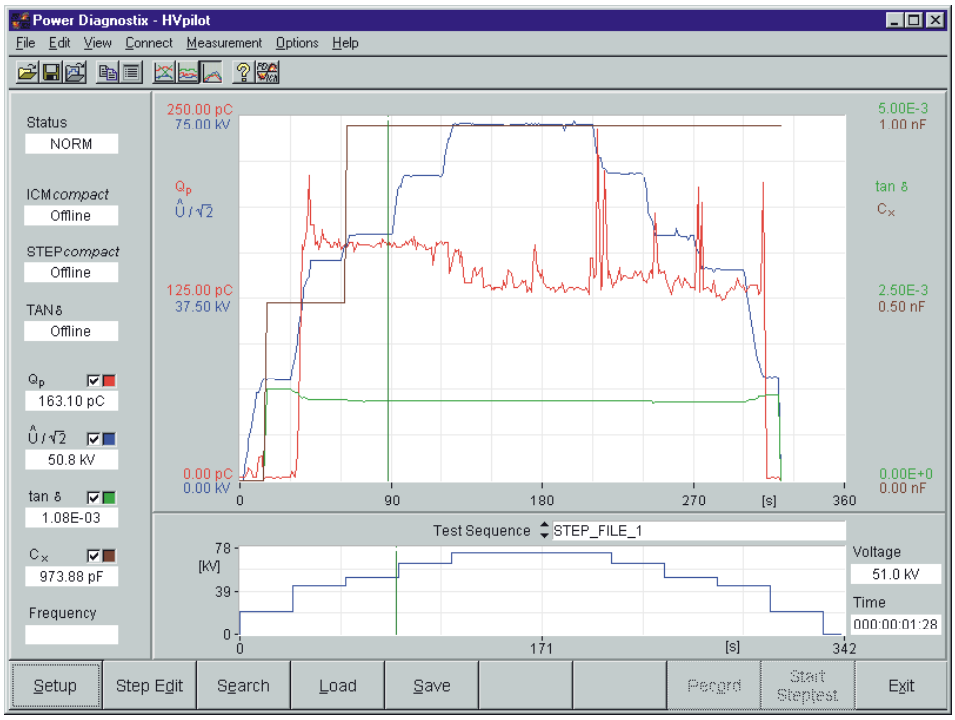












HV*pilot software*

In the standard configuration, the STEP*compact* comes with a self-contained relay box that is remotely controlled via a fiber optic cable. Alternatively, a direct connection to the HV*control*, Power Diagnostix standard control unit for high voltage test sets, can be provided.
To ensure a safe unattended processing of a step test, the STEP*compact* offers several safety features. Incipient breakdown is detected by monitoring the change of the voltage (dU/dt). Further, timeout limits can be set. The instrument keeps a record of the recent test to validate its successful completion or to indicate the point of breakdown or cancellation.

HV*pilot* Software

The HV*pilot* software allows the complete supervision of a high voltage test sequence. Using a serial interface, the software connects to the STEP*compact* for the voltage control and measurement. Further, the HV*pilot* software offers convenient programming and editing of the test sequences. Additionally, this software can connect to the ICM*compact* to read the partial discharge level and to the TDA*compact* to read the tanδ, as well as the capacitance of the device under test. An export function allows to save the acquired data in file formats for MS Excel and MS Word.

Offering complete measurement of high voltage signals plus flexible programming of step test sequences makes the STEP*compact* an ideal and cost-effective solution to automate high voltage test sets. The optional software HV*pilot* offers convenient programming and reporting.

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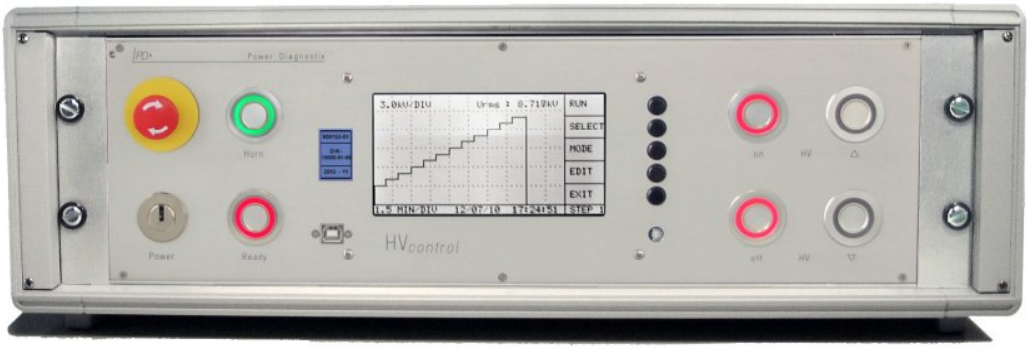
HV*control*



The HV*control* unit combines all standard functions required to manually operate a high voltage transformer. It includes a safety contact loop, the measurement of primary and secondary current, as well as of the primary voltage. User-settable limits for the primary and secondary current trip the main circuit breaker. The safety loop, as well as the emergency stop is hard-wired and equipped with forced contacts.

Due to its flexible design, the HV*control* can be used on any high voltage test set. Especially, in case of the modernization of old test sets, the HV*control* offers a multitude of improvements if compared with conventional relay based controls.

The unit comes with rigid solid-state piezo push buttons. Each of these control buttons has an illuminated ring to indicate the state of the function controlled by this specific button. This allows an easy and intuitive operation of the HV*control*.

The HV*control* comes in a 19"-subrack (3HU). This makes it an easy replacement of older controls having the same size. On its rear panel, the HV*control* offers conveniently detachable screw terminals for the different controls and optional instruments.

Drop-in replacement of old control units

HV*control embedded in a control desk*

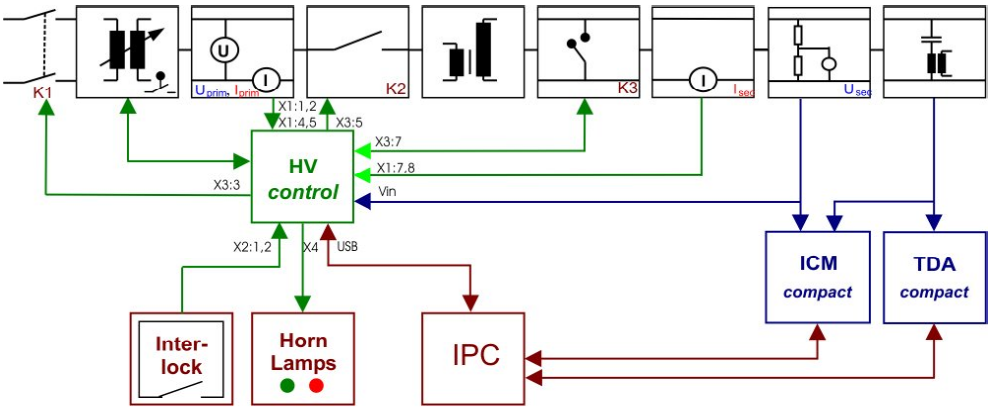
Modular Concept

Besides a mere drop-in replacement of an old control, the HV*control* can be combined with other test instruments of Power Diagnostix to build a fully automated acceptance test environment.

The instrument can be combined with the ICM*compact* for partial discharge testing and with the TDA*compact* for tanδ and capacitance measurements.

HV*control* - High Voltage Test Control Unit

Power



Block diagram for the connection of a HV*control*

Power Diagnostix also provides industrial PCs to control the combination of instruments. Depending on the application and its requirements, the instruments can be mounted in desktop enclosures, 19" racks, or control desks fitted with 19" mounts.

Fully automated test systems

The standard HV*control* offers an output for TTL gating and a SCOPE display. It can be ordered with an optional feature for STEP tests.

HV*pilot* Software

The HV*pilot* software allows the complete supervision of a high voltage test sequence if the HV*control* is equipped with the option for STEP tests (voltage control and measurement). Further, the HV*pilot* software offers convenient programming and editing of the test sequences. Additionally, this software can connect to an ICM*compact* to read the partial discharge level and to a TDA*compact* to read the tand as well as the capacitance of the device under test.

Control and measurement system

Easily replacing out-dated control Easily replacing out-dated control units of high voltage test sets make the HV*control* a good choice when modernizing high voltage test labs. Additionally, the HV*control* is prepared to interface with the STEP*compact* for automated high voltage tests.

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FO*system*

The FO*system* is a complete set of instruments for convenient fiber optic transmission of different types of analog signals from a variety of sensors. The FO*system* allows easy implementation of fiber optic transmission to solve noise, safety, and signal quality issues in high-voltage measuring environments and other demanding conditions. The signal bandwidth covers DC up to 10 MHz.

Fiber Optics vs. Wiring

Harsh electromagnetic conditions prevalent in high-voltage and high-current laboratories seriously interfere with the use of conventionally wired measuring equipment. Fiber optic cables that are not prone to electromagnetic interference can replace even long BNC cables.
Applying fiber optic isolation with high impulse-current applications allows the ground potential to have dramatically transient changes without affecting the integrity of the signals captured and transmitted.

Fiber optic transmitter FOT1/5

System Components

The Power Diagnostix FO*system* comes in four basic variations to fulfill the needs of different signal types:

- FOS1 for analog transmission of analog signals from DC up to 10 MHz
- FOS2 for digital transmission of analog signals from DC up to 20 kHz
- FOS3 for pulsed digital transmission of slowly changing signals such as temperatures.
- FOS4 for digital transmission of analog signals from DC up to 20 MS/s

All versions consist of transmission units, receiver units, and sturdy fiber optic cable.
The fiber optic transmitter modules (FOT) are small individual modules for installation at sensors or signal sources. The fiber optic receiver modules (FOR) are mounted side-by-side in a 19-inch or half 19-inch rack.

Acoustic sensor

Transmitter unit

Receiver (3 channels)

Temperature measurement (including receiver)

Operation

The output signal of the signal source or sensor (for example, voltage, dynamic pressure, current, or partial discharge) is fed to the input of the FOT. The transmitter then either modulates the infrared light emitted by the transmitter diode according to the value of the input signal (amplitude modulation, FOS1), or digitizes the signal and transmits a digital telegram. This optical signal is transmitted via the fiber to the receiver, which converts it back to voltages for further processing.

The transmitter is installed in a cast-aluminum enclosure. The FOT is fitted with a NiMH-battery for a minimum operating time of twenty hours (FOT1 and 2), whereas the FOT3 offers up to two years of operation while sending a telegram every five seconds.

Several options are available for the FOS e. g. pre-dividers, different racks, and adaption of the FOT/FOR for special applications.

Type	Option	FOS1	FOS2	FOS3	FOS4
FOT1	Analog transmitter 0.2 Hz-5 MHz (-3 dB)	X			
FOT2	Digital transmitter 0-20 kHz (-3 dB)		X		
FOT3A	Transmitter for temperature measurement			X	
FOT3B	Transmitter for voltage and current			X	
FOT4A	Digital transmitter up to 20 MS/s, (0.2-2 MHz bandwidth)				X
FOT/S2	Pressure measurement	X			
FOT/S3	Fixed DC coupling	X	X		X
FOT/S4	Switched DC coupling	X	X		
FOT/S6	Remote activation	X			X
FOT/S7	Special input range	X	X		X
FOT/S8	Pressure measurement (Kistler 6203 sensor)	X			
FOT/S9	Displacement measurement	X			
FOT/S10	Bandwidth 10 MHz	X			
FOT/S12	Ultrasonic measurement	X			X
FOT/S14	EMC enclosure			X	X
FOT/S15	Additional BNC connector for external power supply	X	X	X	X
FOT/S16	Pressure measurement (Kistler 4043A sensor)	X			
FOR1	Receiver plugin 0.2 Hz-5 MHz	X			
FOR2	Receiver plugin 0-20 kHz		X		
FOR3	Receiver plugin FOR3			X	
FOR4	Receiver plugin up to 65 MS/s, (30 kHz bandwidth)				X
FOR/E2	DC coupling, track/hold switch	X			
FOR/E3	DC coupling, adjust button	X			
FOR/E5	1.2" width, output on rear side	X	X		
FOR/E6	Bandwidth 10 MHz	X			
FOR/E7	Bandwidth limit 1 MHz, noise reduction	X			
FOR/E8	1-channel remote transmitter	X			

Conveniently providing robust fiber optic transmission of analog signals in high-voltage environments, the Power Diagnostix FO*system* solves signal integrity problems and safety issues found with severe electromagnetic conditions and long distances.

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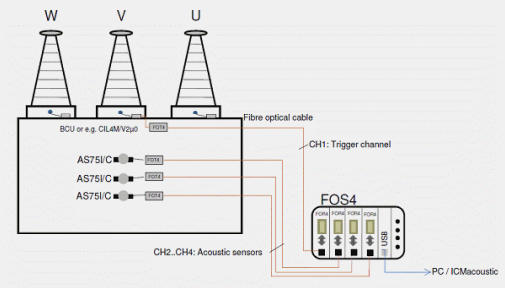
FO*system* (FOS4)

The latest family member of Power Diagnostix' fiber optic transmission systems, FOS4 offers high speed data acquisition via fiber optic cables on multiple channels in parallel. The scalable system allows the acquisition of acoustic PD signals or other measurement signals under AC, DC, or impulse testing in laboratories as well as on site. The modular system accepts up to twelve optical channels and comes with high-speed controller card to communicate with a notebook. Besides this, the FOS4 system has additional signal output on the rear side and can be used as a digital isolated amplifier without the use of any software.

Application Example

PD localization by acoustic travel time ana-lysis (ICM*acoustic*)

The ICM*acoustic* system comprises of FOT4 transmitter units and FOR4D receiver units. Each channel acts as an independent transient recorder with its own storage and settable acquisition speed and storage depth. The sampling rate is 20 Msample/sec. and, hence, sufficient to even acquire the pointing vector of the incoming acoustic wave, when using a two-dimensional three-sensor configuration.

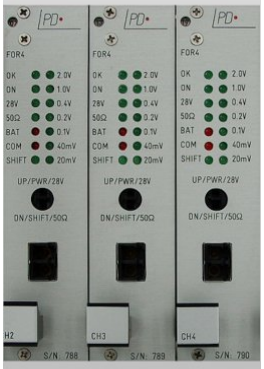


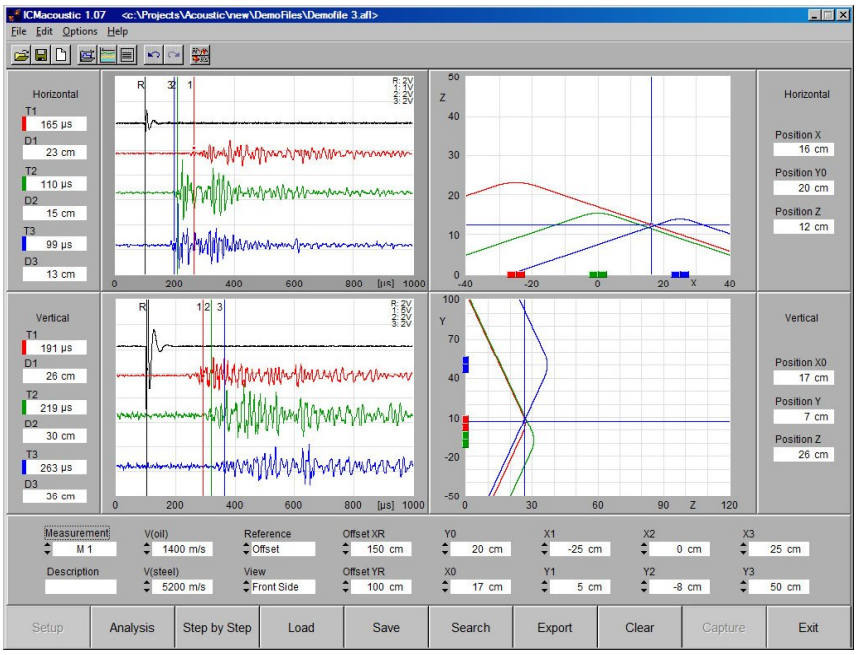
Acoustic localization of PD on up to 12 channels in parallel

For PD localization purposes the ICM*acoustic* software offers full control of the system.

Features:

- Sampling rate: 20 MS/s
- Up to 12 receiver units with independent optical channels
- Remote controlled via high speed USB port

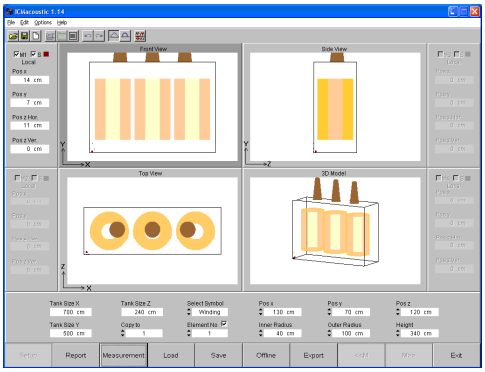


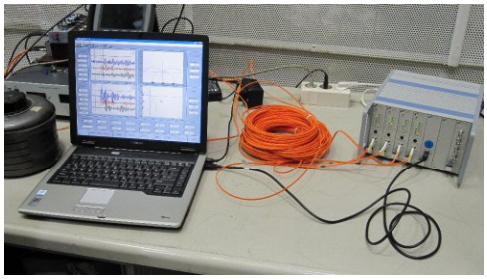


Measurement panel for horizontal and vertical triangulation

ICM*acoustic* Software

The ICM*acoustic* software offers full control of the FOS4 system including averaging and trigger logic. It is designed for the acoustic localization of transformer partial discharge with the triangulation method. The basic idea is to reduce the localization to a “flat problem”. I. e., to horizontally position three sensors on a line to firstly get the horizontal position of the layer (see upper graph of the software’s measurement panel, left). Here, the position of the sensors are entered and assigned to their channel. In a second step the sensors are placed on a vertical line at the found vertical position. In the lower graphs the sensor positions are entered accordingly.





ICM*acoustic system*

With its versatile front end the FOS4 is a stand-alone fiber optical measurement equipment that allows to easily perform electrically isolated measurements with a variety of setting options. All parameters can be set either from the front side of the FOR4 device or via the ICM*acoustic* software.

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ATT*analyzer*

The Power Diagnostix ATT*analyzer* is a simple and effective stand-alone tool to aid in commissioning tests of gas-insulated switchgear (GIS) systems and power transformers. The ATT*analyzer* reduces delays in commissioning and maintenance by locating flaws in GIS systems and transformers acoustically.

Gas-insulated switchgear systems occasionally contain flaws that go unnoticed during installation or maintenance but that lead to immediate breakdown when high voltage is applied. These flaws can include floating particles, gaseous impurities, faulty insulator discs, sharp metal burrs, or other defects. If a gas-insulated switchgear system contains such a flaw when brought on-line, sparking and breakdown occurs at the flaw, forcing de-energization and repair. Without diagnostic aids, localization of the flaw can lead to costly delays and unnecessary opening of unflawed gas chambers bearing the risk of causing new imperfections, while searching for the chamber containing the flaw.

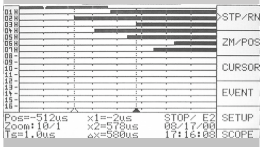
Using the ATT*analyzer*, the flaw can be located by mounting acoustic sensors to the outside of the GIS or transformer tank in several locations. When high voltage is applied to the GIS, if a breakdown occurs, the acoustic sensors pick up the disturbance and transmit a corresponding optical signal to the ATT*analyzer* acquisition unit. The ATT*analyzer* then compares the relative travel times of the sound signals to determine which sensor is the closest to the flaw.

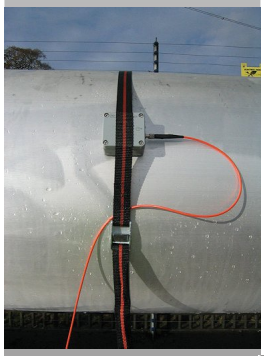
Following initial localization of the breakdown's origin, the acoustic sensors can

Fiber optic connectors of the ATT*analyzer*

optionally be repositioned closer to the flaw to narrow the location further, to within a few centimeters. Comparing the resulting display with the display of the breakdown while using a hammer to trigger a similar pattern on the ATT*analyzer*, further helps to narrow down the location of the flaw.

ATT*analyzer monitors a long-term test on GIS spacers and insulators (SIEMENS)*





System Components

The ATT*analyzer* consists of a compact central acquisition unit, acoustic sensors, and sturdy fiber optic cable to connect the sensors to the acquisition unit.
The stand-alone ATT*analyzer* acquisition unit, mounted in a half-19-inch rack, receives and internally processes signals picked up by the sensors. The acoustic sensors for external mounting on the GIS system can be easily attached and removed for reuse. Up to sixteen sensors can be connected to the ATT*analyzer*.
Fiber optic cables, up to 200 meters in length, provide galvanically isolated connection of the sensors to the ATT*analyzer* acquisition unit.

Features

The ATT*analyzer*'s embedded LCD panel displays the relative travel times from the sensors as horizontal bars. Cursors and settings are manipulated through pushbuttons and on-screen menus.

The display screen also shows relevant quantities such as sampling rate, time between cursors, time and date stamp, etc.
Using simple menus, users can adjust the sampling rate of the acquisition unit appropriately depending on how widely or closely spaced the sensors are to each another.The ATT*analyzer* features storage of up to sixteen GIS fault events with time and date stamps. Users can choose one of three operating modes:

AUTO This mode considers each trigger event. Thus, the instrument's memory contains the most recent 16 events.

NORM Using this mode, the unit changes to the STOP mode after 16 events captured. Therefore, the memory contains the first 16 events.

SINGLE This mode changes after each captured event into STOP mode. Changing manually back into RUN mode re-enables triggering.

Offering easy implementation and convenient data analysis, the Power Diagnostix ATT*analyzer* aids in cost-efficient localization and repair of gas-insulated switchgear and transformer defects during commissioning tests.

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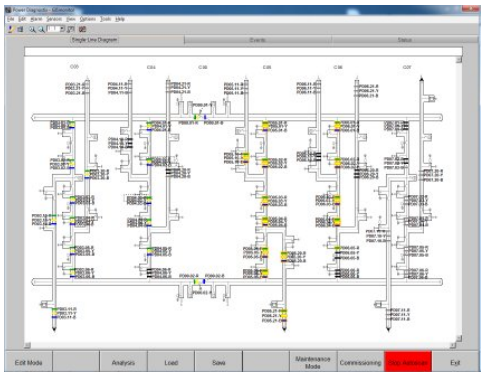
GIS*monitor*



The GIS*monitor* builds on more than 20 years of experience in online PD monitoring on rotating machines, transformers, cables, and especially GIS. It combines proven technology of the ICM*monitor* with new processor technology and embedded hardware capabilities. The hardware core of the system has been optimized for parallel, real time PD acquisition on multiple channels. Any UHF signal can be detected and digitized within micro seconds. A separation of PD events from external disturbances or internal switching pulses is calculated in real time and therefore an effective PD and alarm detection is given.

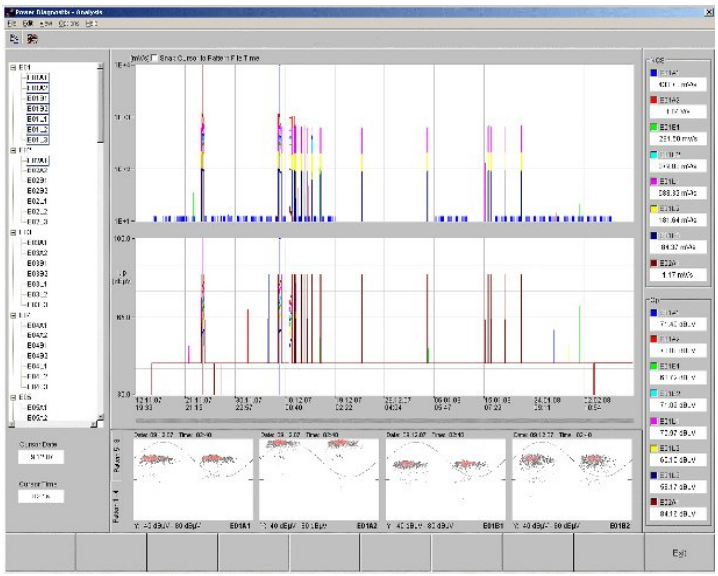
Each 8-channel acquisition plug-in board operates fully stand alone, but can be com-bined with a virtually unlimited number of units, to monitor all PD sensors in one or even multiple GIS in parallel. A partial discharge monitoring acquisition rack (PDMAR) carries up to 15 plug-in boards – each with eight channels – providing up to 120 channels. An industrial type PC installed in a partial discharge monitoring control rack (PDMCR) reads all data of the instruments via the high speed fiber optic LAN ring, providing communication redundancy. Storage redundancy is provided due to a RAID controller and data mirroring on multiple drives.

Real time parallel PD acquisition on multiple channels

Each cabinet comes with an uninterruptible power supply, a network switch and temperature controlled cooling or heating. Cabinets for indoor applications feature a protection class of IP54, while cabinets for outdoor applications reach a protection class of IP65.

Features

- Parallel UHF PD measurement on all channels
- Parallel reading of PD peak values, PD scope amplitudes, and PD patterns
- Separate gating input channel
- Automatic alarm detection algorithm
- System redundancy
- Suitable for embedded and external retrofit UHF sensors
- Scalable system configuration
- Automatic noise suppression mode
- Network-based communication



GIS*monitor software*

The GIS*monitor* is designed to suit all currently available UHF sensors for GIS PD monitoring. This includes embedded and external retrofit UHF sensors. A special input protection unit (IPU2) blocks strong transients (VFT). The frequency converting unit FCU2 de-modulates UHF signals into a lower frequency band. These lower frequency signals can be transmitted by coaxial cables and allow a compact and centralized design of the system.

The user interface software panel of the GIS*monitor* monitoring system is installed on the local industrial PC and can be installed additionally on any remote computer for data evaluation and diagnosis. The graphical user interface is customized for each system and provides a user friendly overview of the current system status

Software Features

- User friendly software panel including a customized GIS overview diagram indicating all sensors and its current activities
- Additional analysis and trending panel displaying U_{pp}, U_{pavg}, scope, and pattern information of each channel at every time stamp
- Alarm event list indicating peak levels, PD patterns and trend information
- PD trending and PD pattern information of the full history
- Typical PD failure database
- Automatic data storage
- Interface to third party control systems, such as SCADA, IEC61850, and others.

The GIS*monitor* is a scalable monitoring device for continuous monitoring of gas-insulated switchgear (GIS) using true parallel, real-time acquisition techniques.

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GIS*monitor* Portable

This version of the GIS*monitor* is a portable unit for partial discharge measurements on gas-insulated switchgear (GIS) caused by hopping particles, floating potentials, cracks in insulators or spacers, or other degradation in the insulation system. The instrument offers parallel real-time PD acquisition on up to 40 channels. To eliminate disturbance signals from the measurement, the instrument can be connected to a disturbance antenna that provides a gating signal.

Measuring Principle

Partial discharge measurements can be easily applied on gas-insulated switchgear without the need of interrupting the operation. Such online measurements help to identify internal imperfections of the insulation system, which may lead to breakdown and system failure in the future.

Due to the dielectric properties of the SF6 gas, partial discharge activity in gas insulated switchgear covers a bandwidth of well beyond 2 GHz. The mechanical properties of the components of gas insulated switchgear further allow transmission of such signals over a distance of a couple of meters. Thus, the partial discharge monitoring of GIS equipment is done preferably in the UHF range.

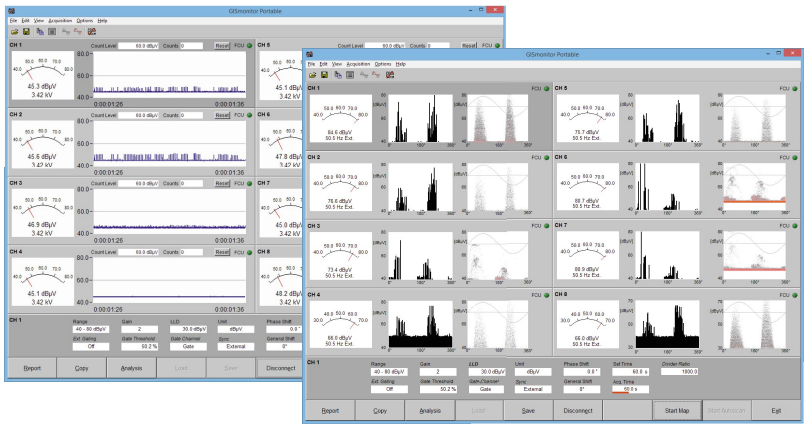
Sensors

The GIS*monitor* is designed to suit all currently available UHF sensors for GIS PD monitoring. This includes embedded and external retrofit UHF sensors. A special input protection unit (IPU2) blocks strong transients (VFT). The preprocessing unit FCU2 demodulates UHF signals into a lower frequency band for easy submission over longer distances.

Enclosure Models

The instrument is available with different housings: Portable, lightweight desktop enclosures of ½ 19" and 19", shock resistant and watertight outdoor cases, and a black mini aluminum box.

*GIS*monitor* Portable as desktop and mini box version*



GIS*monitor* Portable software

GISmonitor in a 19" desktop enclosure

Software

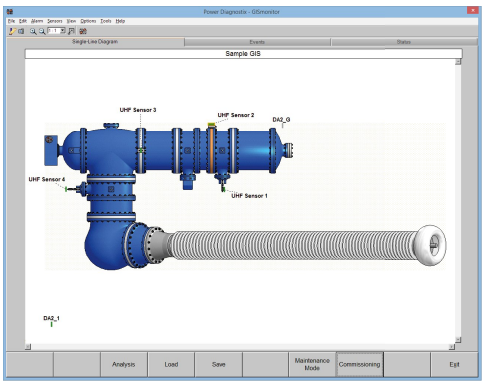
The instrument can be connected to a PC or laptop via USB or an optional LAN interface for data evaluation and diagnosis with the GIS*monitor*Portable software. The service program software visualizes the current readings of eight partial discharge sensors of a GIS in parallel. Each sensor is linked with a specific input channel of the GIS*monitor*.

In AC mode the acquisition of partial discharge pulses is done versus phase position. The external or internal synchronization signal determines the phase position of every PD pulse. The panel in this mode shows the partial discharge activity of all eight channels in parallel. The meter displays the current highest amplitude and the black and white display shows the partial discharge activity versus phase position.

In addition to the standard acquisition of partial discharge versus phase position, the GIS*monitor* Portable software offers the possibility to acquire partial discharge at DC voltage. In this mode the partial dischar ge pulses are displayed versus time. The time resolution can be set to 1, 10, or 100 ms.

Every version of the GIS*monitor* Portable an also be used with the software of the non-portable GIS*monitor* systems.

Map display



GIS*monitor* software, non-portable version

FCUs and IPUs

The GIS*monitor* Portable offers parallel real-time acquisition on gas-insulated switchgear (GIS) on up to 40 channels.

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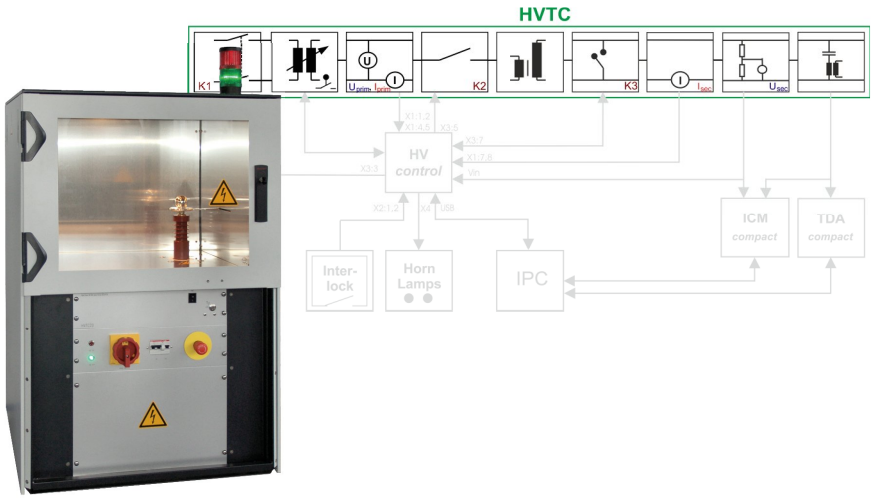
HVTC & TCU



Partial discharge testing – well established for high voltage equipment – becomes increasingly important for insulation systems of a lower voltage level. Changing to switching power supply and to IGBT control of induction motors, for instance, raise demands and testing needs for the insulation system. The modular concept of Power Diagnostix' instruments allows offering customized solutions for automated and semi-automated testing.

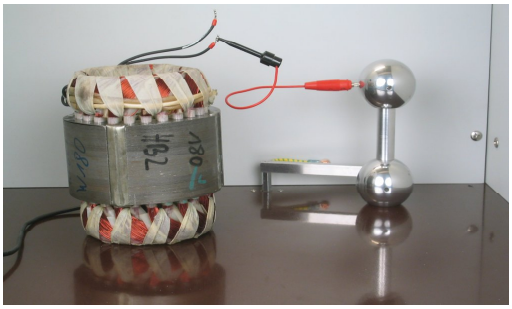
Modular Concept

Different levels of automation can be provided depending on the testing needs. In case of full production testing a high level of automation and simple go/no go decision are needed, whereas manual control offers a higher level of flexibility when testing samples or sample variants during development.

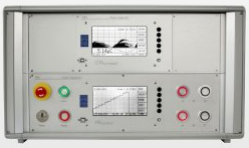
Generally, such test arrangements consist of a test chamber and instruments to control and measure voltage and partial discharge. Different levels of automation are offered combining the basic HV*compact* for voltage measurement with the HV*control* for regulating the HV transformer and for programming voltage steps, ramps, or more complex functions. Installed on an industrial PC, the HV*pilot* software then optionally controls these instruments, and the ICM*compact* for the PD signal and automatically prepares the test report. Additionally, Power Diagnostix designs special test fixtures, dual test chambers for increased performance, and customer specific software.

HVTC

The high voltage test chamber HVTC is designed for PD testing on e. g. transformers, semiconducters, and micro samples. Depending on the built-in HV transformer, testing up to 20 kV_{rms} is possible. The test chamber provides sufficient space to test samples up to a maximum size of 500x500x400 mm^3. The main components of this system are: a high voltage transformer, a regulating transformer, a coupling capacitor of 1 nF, an automatic grounding system, a security interlock loop, and multiple warning lamps.



Testing of stator coils of small induction motors



Control and measurement unit

Depending on the needs the instruments and controls can be compiled in different versions:

Level A:
PD test bench for sample testing consisting of a test chamber and manual voltage control equipped with an ICM*compact* for PD measurement with voltage option or an HV*compact* for voltage measurement.

Level B:
As level A, but instead of the HV*compact* with the HV*control* for automated voltage control.

Level C:
As above, but with an industrial PC and the HV*pilot* software for fully automated control and test report generation.

Level D:
Modernization of test rooms using HV*control*, HV*compact* or STEP*compact*, and ICM*compact*. Software control as with level C.

Typical Package

Test set-up for level C:

- 1 x ICM*compact* with gating
- 1 x HV*control* with STEP functionality, 19" rack
- 1 x Test chamber HVTC, incl. 10 kV voltage transformer, regulator, manual control buttons, horn, lamps, emergency stop, grounding system, coupling capacitor, ...
- 1 x Industrial PC
- 1 x Software ICM*compact*
- 1 x Impulse calibrator CAL1A
- 1 x Preamplifier RPA1
- 1 x Set of cables

Typical test set

TCU7,5

TCU

Power Diagnostix TCU is made for controlling of high voltage transformers. Together with the HV*control* it combines all standard functions required to manually or automatically operate a high voltage transformer, including safety loops, door locks, and all voltage and current measurements.

Examples for TCU models:

Type	Voltage	Power	Current	Connection	Height	Dimensions W x H x D
TCU3	0–230 V	3 kVA	16 A_{max}	CEE 400/16A (L-N)	9 HU	553 x 506 x 600 mm
TCU7.5	0–230 V	7.5 kVA	34 A_{max}	CEE 400/32A (L-N)	9 HU	553 x 506 x 600 mm
TCU10	0–230 V	10 kVA	48 A_{max}	CEE 400/63A (L-N)	9 HU	553 x 506 x 600 mm
TCU10/2	0–400 V	10 kVA	25 A_{max}	CEE 400/63A (L1-L2)	9 HU	553 x 506 x 600 mm
TCU15/2	0–400 V	15 kVA	38 A_{max}	CEE 400/63A (L1-L2)	25 HU	553 x 1218 x 600 mm

HV test cabinet

Partial discharge testing is increasingly applied for testing insulation systems of lower voltage levels. Power Diagnostix offers ready-to-use test chambers for easy and safe partial discharge testing on components and small samples.

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Calibrators

Power Diagnostix offers a range of calibration charge injectors suitable for use in calibrating partial discharge measurements. The appropriate choice of a calibration instrument depends on the range of typical charge values of the PDs being measured. Calibrators can also be used for time domain reflectometry in cables to determine cable length and location of joints.

DAkkS
Deutsche
Akkreditierungsstelle
D-K-15068-01-00

CAL1A

Conformity to International Standards

By end of 2003, Power Diagnostix received the accreditation as calibration laboratory within the German Calibration Service (Deutscher Kalibrierdienst, DKD). The audit was held by 'Physikalisch Technische Bundesanstalt' PTB, the German authority of standards. In January 2012, Power Diagnostix passed over to the newly introduced German accreditation authority DAkkS (DAkkS = **D**eutsche **Akk**reditierungs-**s**telle). Power Diagnostix' new accreditation is filed under D-K-15068-01-00.

New charge calibrators are tested and calibrated in Power Diagnostix' laboratory, which is certified according to ISO 17025:2018. The DAkkS calibration certificate ensures the traceability to international standards.

Simple to Use

The calibrator is switched on with the pushbutton On/Off. Both amplitude (Range) and polarity (Pos/Neg) of the single charge pulse per cycle are displayed and can be adjusted by pressing of the two buttons. Each calibrator is also available supplying two pulses per cycle, as well as with double impulse output with adjustable interval.

The instrument automatically synchronizes to line frequency by a photo diode. In case of insufficient pick-up of power frequency light, the calibrator automatically selects the internal quartz oscillator (50Hz and 60Hz versions available).

Available Calibrators

The standard calibration impulse generator CAL1A offers the charge range of 1/2/5/10/20/50/100 pC, while the CAL1B, mainly suitable for rotating machinery testing, covers the range of 100/200/500pC/1/2/5/10nC.

Special signal sources are available for GIS measurements, such as the CAL2A: 0.5/1/2/5/10/20/50 pC, $t_R \leq 200$ ps, $f_{3dB} \geq 1.5$ GHz, or with voltage output, the CAL2B: 2/5/10/20/30/40/50 V, R_L=50 Ω, $t_R \leq 200$ ps, t_F = 100 ns.

The Power Diagnostix line of calibration impulse generators is unique in that the charge pulse is generated by injecting a variable voltage step (correlated to an internal reference) via a fixed capacitor. This injection capacitor is relatively small, as the step voltage amounts up to 120 V for full range output. Therefore, the Power Diagnostix calibrators offer excellent impulse properties. Further, calculation of the correction factor is usually not necessary ($C_I << C_S$).

CAL3A

Standard calibrators with their ranges and key features:

Calibration Impulse Generator	Range	Injection Capacitor (C_I)	50Hz or 60Hz light sync.	IEC60270 compliant	2 pulses / cycle option	BNC connection	Remarks
CAL1A	1, 2, 5, 10, 20, 50, 100pC	<1pF	✓	✓	✓	✓	Cable and transformer tests
CAL1B	100, 200, 500pC, 1, 2, 5, 10nC	<100pF	✓	✓	✓	✓	High level application, e.g. rotating machines
CAL1C	1, 2, 5, 10, 20, 50, 100pC* at 100pF	V (50Ω)	✓	✓	✓	✓	Incl. ext. capacitor 100pF; cable tests
CAL1D	10, 20, 50, 100, 200, 500, 1000pC	<10pF	✓	✓	✓	✓	Laboratory use, transformer tests
CAL1E	0.5, 1, 2, 5, 10, 20, 50nC	<500pF	✓	✓	✓	✓	See CAL1B
CAL1F	0.2, 0.5, 1, 2, 5, 10, 20nC	<200pF	✓	✓	✓	✓	
CAL1G	0.02, 0.05, 0.1, 0.2, 0.5, 1, 2nC	<20pF	✓	✓	✓	✓	Transformer tests
CAL1H(/V+S)	0.5, 1, 2, 5, 10, 20, 50pC* at **pF	V (50Ω)	✓	✓	✓	✓	GIS, live injection via stray capacitance
CAL1J	10, 20, 50, 100, 200, 500, 1000pC* at 100pF 100, 200, 500, 1000, 2000, 5000, 10000pC* at 1nF	V (50Ω)	✓	✓	✓	✓	Incl. ext. capacitor 100pF/1nF, switchable; transformer tests
CAL2A	0.5, 1, 2, 5, 10, 20, 50pC	<1pF	✓	✓	-	N	GIS & UHF
CAL2B(/500)	2, 5, 10, 20, 30, 40, 50V (into 50Ω)	V (50Ω)	✓	-	-	N	
CAL2C(/500)	1, 2, 5, 7, 10, 12, 15, 17, 20V (into 50Ω)	V (50Ω)	✓	-	-	N	
CAL2D(/500)	5, 7.5, 10, 15, 20, 30, 40V (into 50Ω)	V (50Ω)	✓	-	-	N	
CAL3A	600kHz to 1.35MHz, 10µV to 10mV	V (50Ω)	✓			✓	RIV calibration; NEMA 107 compliant
CAL3B	400kHz to 1.9MHz, 10µV to 10mV	V (50Ω)	✓			✓	RIV calibration; NEMA 107 compliant
CAL3D	400kHz to 1.9MHz, 10µV to 10mV (into 300Ω)	V (>20KΩ)	✓			✓	RIV calibration; CISPR 18-2 compliant

* with external high voltage capacitor, ** value to be specified by customer

Power Diagnostix calibrators enjoy all the advantages of 20 years' experience in calibration services. The broad range of easy-to-use and robust units for many different applications ensures reliable PD measurements compliant to international standards, such as IEC 60270 and CISPR 18-2.

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Mobile HV AC Test System

On-site transformer testing is the main application of Power Diagnostix' mobile high voltage AC test system. However, it can be used as well for other on-site testing, such as of GIS, rotating machines, or high voltage cables.

The system stays within the load and size limitations for permission-free road use. Additionally, the matching transformer and the reactor are filled with ester instead mineral oil. Thus, it can be easily transported to a substation, power plant, or other high voltage areas for testing HV components after installation

On-site testing according to international standards

or repair. Additionally, it is applicable for condition assessment and fault investigations. PD measurements can be performed in non-shielded environments as part of the on-site acceptance test on a power transformer, or as a method to locate PD failures acoustically, or by electrical measurement.

It is designed for performing routine and special tests according to standards as IEC 60060-3, IEC 60076, and IEEE Std. C57.113-2010 and, thus, giving accurate and reliable test results as known from acceptance tests performed in a static test field of a factory.

Applicable Tests:

- Applied voltage tests in a resonant circuit up to a test level of 500 kV
- Induced voltage test (single- or three-phase) up to a test level of 90 kV.
- Electrical and acoustical partial discharge (PD) measurements
- Measurement of no load losses
- Heat run with up to 1.3 MVA

On-site transformer testing

Test system with moved out reactor

HV filters TVC100/123

Step-up-Transformer

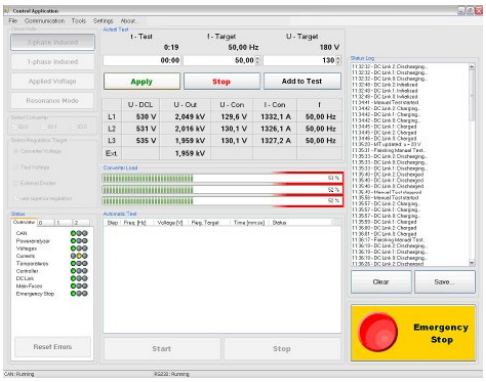
FO*system* and ICM*sys8*

Measuring Equipment:

- ICM*sys8* with spectrum analyzer and PD calibrator
- Three-channel FO*system* (current measurement)
- Power analyzer
- Three HV filters TVC100/123 with integrated voltage divider and current shunts
- DAkkS calibrated voltage and current measurement

Quadrupoles, couplers, preamplifiers, calibrators, and further accessories are also included.

Main component of the Power Diag-nostix mobile HV AC test system is a frequency converter based on the IGBT technology, that provides the power in a frequency range of 15 to 200 Hz. It consists of three identical converters that can be operated in parallel (0° phase shift) or as a three-phase system (120° phase shift). Thus, always the full power of the converter can be used. The system comes with an inductive and capacitive compensation, and with a step-up-transformer, that can be switched manually to different configurations. Disturbances from the power supply will be filtered by Power Diagnostix T-Filter TVC100/123. The special design of these filters allows current measurement on HV potential and voltage measurement from a capacitive divider. Both, current and voltage measurements, are DAkkS-calibrated and the precise values are displayed by a power analyzer.



Control application

Tests can be performed with the container placed on a trailer (additional stairs are included) or on the ground. The system includes all cables for HV connections as well as corona shields for the HV bushings. Thus, it is ready to use.

The Power Diagnostix three-phase mobile HV AC test system is the optimal solution for field services providing e. g. condition accessment on high-valued, important, and critical units during maintenance shut-downs.

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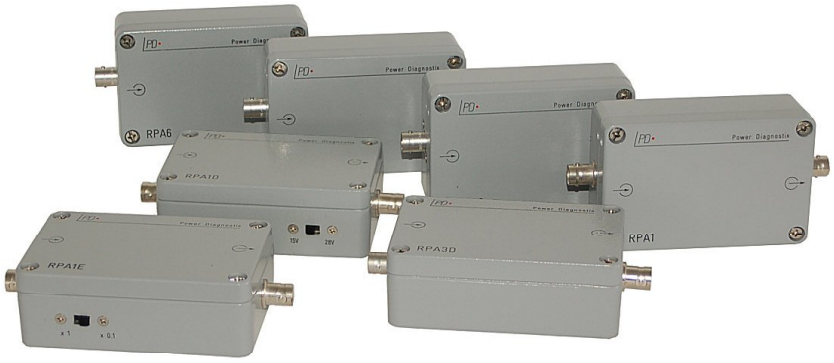
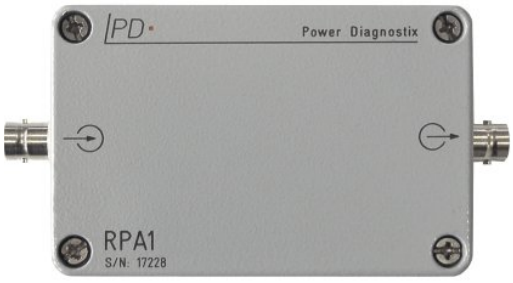
ICM series Accessories:
Preamplifiers & Preacquisition Units



Some preamplifiers of the RPA series

Preamplifiers serve to condition, filter, and amplify the partial discharge signal to be measured. Because the frequency range in which PD signals are measured is strongly dependent on the preamplifier used, proper selection of a preamplifier is an important part of noise mitigation and can have a strong effect on the appearance of the partial discharge pattern itself.

Power Diagnostix provides a complete line of modular preamplifiers for various testing applications. The mos t significant difference among the preamplifiers is the frequency range in which they detect partial discharge signals. Other features that distinguish one preamplifier from another are: options for transparency and on/off switching, unipolar vs. bipolar charge detection, and the possibiltiy of galvanic isolation in the test setup.



The RPA1 preamplifier

All of the Power Diagnostix external signal conditioning modules and preamplifiers are remote supplied and remote controlled through a simple coaxial signal cable (RG58). This technique allows placement of these units close to the sensor or signal source. Furthermore, as these modules act as impedance converter and line driver, the weak signal source, such as voltage divider or coupling impedance, is not loaded by the cable capacitance or impedance.

This technique also provides enhanced over-voltage protection. All preamplifiers of the RPA series can drive a 50 W cable up to 50 m long.

The **RPA1** is the standard preamplifier for measurements in the low frequency range according to standards such as the IEC 60270. The **RPA1D**, **RPA1E**, **RPA1F**, and **RPA1G** are variations on the RPA1.

The **RPA1D** and **RPA1G** are suited to connect directly to ultra-sonic acoustic sensors. To simplify connection, they provide selectable power supply for the sensor (15 or 28 V_{DC}).

The **RPA1L** and **RPA1H** are intended primarily for measurements on medium- and high-voltage power cables using the ICM*compact*.

The **RPA2** is primarily for measuring the PD signal spectra found with rotating machines, while the **RPA2B** is used with capacitive sensors to monitor cables and cable accessories at a higher sensitivity.

The **RPA3** module is well-suited for measuring PD signal spectra, detected by sensors and antennas installed with gas insulated switchgear (GIS).

The **RPA4** is a preamplifier set with fiber optic transmission, offering outstanding isolation properties.

The frequency converter units of the **FCU** series are ultra-wide band preacquisition units with logarithmic output (40–2000 kHz) and are mainly used for GIS applications. The **FCU2B** covers an input range of 100–1 GHz, while the **FCU2A** can be used for input signals of 1–2 GHz. For cable applications Power Diagnostix offers the **FCU3** covering an input range of 100 kHz to 50 MHz.

The **UHF1** and **UHF2** offer an amplification of 27 dB in the range from 200 MHz to 1 GHz resp. 300 MHz to 2 GHz and are suitable for boosting weak signals from GIS sensors.

Reference table for commonly used Power Diagnostix preamplifiers & preacquisition units

Type	Frequency Range	Input Impedance	Sensitivity Input	Roll-Off	Bipolar	Remarks
RPA1	40 kHz–800 kHz	10 kΩ//50 pF	<200µV	40dB/dec	✓	Standard preamplifier
RPA1D	40 kHz –800 kHz	10 kΩ//50 pF	<200µV	40dB/dec	✓	Built-in sensor supply, switchable (15/28 V)
RPA1E	40 kHz –800 kHz	10 kΩ//50 pF	<200µV	40dB/dec	✓	0/20 dB attenuation
RPA1F	40 kHz –800 kHz	10 kΩ//50 pF	<200µV	40dB/dec	✓	For the AIA*compact* only
RPA1G	40 kHz –800 kHz	10 kΩ//50 pF	<200µV	40dB/dec	✓	Built-in sensor supply, switchable (Off/15/28 V)
RPA1H	40 kHz–20 MHz	1 kΩ//50 pF	<400µV	40dB/dec	✓	Oil/paper cable, DSO
RPA1L	40 kHz–20 MHz	1 kΩ//50 pF	<200µV	40dB/dec	✓	Cable, DSO
RPA2	2 MHz–20 MHz	50 Ω//50 pF	<800µV	40dB/dec		Online measurements on rotating machines
RPA2B	2 MHz–20 MHz	50 Ω//50 pF	<200µV	40dB/dec		Cable sensors
RPA3	200 MHz–1 GHz	50 Ω//50 pF	<300µV	40dB/dec		GIS sensors
RPA3D	50 MHz–400MHz	50 Ω//50 pF	<300µV	40dB/dec		Nearfield detection
RPA3E	20 MHz–200MHz	50 Ω//50 pF	<300µV	40dB/dec		Nearfield detection
RPA4	40 kHz–800kHz	10 kΩ//50 pF	<200µV	40dB/dec	✓	Fiber optic isolation
FCU2	100 MHz–1.8 GHz	50 Ω//50 pF	<200µV	40dB/dec		Logarithmic output
FCU2A	1 GHz–2 GHz	50 Ω//50 pF	<200µV	40dB/dec		Logarithmic output
FCU2B	100 MHz–1 GHz	50 Ω//50 pF	<200µV	40dB/dec		Logarithmic output
FCU3	100 kHz–50 MHz	50 Ω//50 pF	<200µV	40dB/dec		Logarithmic output, cable sensors
UHF1	200 MHz–1 GHz	50 Ω//50 pF	--	--		GIS sensors
UHF2	300 MHz–2 GHz	50 Ω//50 pF	--	--		GIS sensors

The versatility of the Power Diagnostix line of PD detection equipment is due in large part to the range of accessories available for the ICM series instruments. Each ICM*series* data acquisition unit can be combined with different accessories to suit specific applications.

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ICMseries Accessories:
Quadrupoles & Isolation Transformers

When a quadrupole and a coupling capacitor are used together as the coupling device, high voltage is applied both to a test object and to the coupling capacitor in parallel with the test object. A quadrupole (sometimes called a measuring impedance) can then be placed in series with either the coupling capacitor or in series with the test object. Some quadrupoles also output a low-voltage copy of the applied high-voltage wave for synchronizing the PD detector. The three basic models of available Power Diagnostix quadrupoles are briefly described here.

CIL Quadrupole

The **CIL** quadrupoles consist of an inductor in parallel with a damping resistor. The inductor and resistor are calculated to form, together with a high-voltage coupling capacitor, a second order high pass filter. Therefore, matching the range of the CIL with the size of the coupling capacitor with which it will be used is important.

CIL/V Quadrupole

The **CIL/V** quadrupoles are similar to the CIL quadrupoles but also contain a capacitor acting as a voltage divider together with the high voltage coupling capacitor. This provides a low-voltage copy of the applied high-voltage wave that can be used through a HST to synchronize the PD detector and monitor the quality of the applied high-voltage wave.

CIT Quadrupole

The **CIT** coupling units are transformer type units, where a preamplifier's input resistance serves as the required damping resistor. CIT units offer a higher sensitivity than the CIL coupling units, so they are suitable for measurements at HV cables with high C_x values. Furthermore, CIT units are available for bridged configurations to connect to two similar test objects (CITxy2 models).

Optionally, the quadrupoles with built-in divider capacitor for voltage measurement can be supplied with a rotary switch to select the divider capacitor. Especially, when connected to the measurement tap of transformer bushings, the selectable capacitors expand the applicable voltage range.

Reference table of standard Power Diagnostix quadrupoles

Type	Coupling Capacitor Range	Max. AC Current	Voltage Divider Capacitor (to be specified)
CIL1H	20 pF – 90 pF	50 mA	All CIL and CIT units are avalable with one, two, or multiple (switachble) built-in divider capacitors to provide a voltage output signal, marked by '/V'
CIL2H	60 pF – 250 pF	100 mA	
CIL3L	200 pF – 900 pF	50 mA	
CIL3M	200 pF – 900 pF	200 mA	
CIL3H	200 pF – 900 pF	500 mA	
CIL4L	600 pF – 2.5 nF	100 mA	
CIL4M	600 pF – 2.5 nF	400 mA	
CIL4H	600 pF – 2.5 nF	1100 mA	
CIL5L	2 nF – 9 nF	400 mA	
CIL5M	2 nF – 9 nF	1600 mA	
CIL5H	2 nF – 9 nF	3200 mA	
CIL6L	6 nF – 25 nF	1000 mA	
CIT4M	600 pF – 2.5 nF	400 mA	
CIT4H	600 pF – 2.5 nF	1100 mA	
CIT5M	2 nF – 9 nF	1600 mA	
CIT5H	2 nF – 9 nF	3200 mA	
CIT6M	6 nF – 25 nF	4000 mA	
CIT6H	6 nF – 25 nF	8000 mA	

IT Isolation Transformer

The IT series allows the permanent isolation of 250 Volts between input and output. Its high frequency behavior is optimized for 50Ω systems and the use with a multiplexer and RPA2 or RPA2B type of preamplifier. An extra voltage output '/V' with the 50/60 Hz fundamental frequency is available on request.

Type	Max. AC Current	Max. Voltage (< 1 minute)	-6dB LF Cut-Off	-3dB LF Cut-Off	-3dB HF Cut-Off	-6dB HF Cut-Off	Input Connector
IT2C	500mA	10 kV_{AC}	300 kHz	500 kHz	30 MHz	80 MHz	BNC
IT3B	1000mA	1 kV_{AC}	100 kHz	200 kHz	30 MHz	50 MHz	BNC
IT4B	1000mA	1 kV_{AC}	100 kHz	200 kHz	30 MHz	50 MHz	Banana

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ICMseries Accessories: Coupling Devices

The Power Diagnostix line of coupling devices includes quadrupoles, current transformers, and coupling capacitors to adapt Power Diagnostix PD detectors to different measurement tasks. The coupling device in a PD measuring circuit provides the means of sensing the partial discharge pulse and sending it as a voltage signal to a preamplifier for conditioning.

The coupling device can be a capacitor and a quadrupole, a capacitor and a current transformer, or a current transformer alone. The standard capacitor for tanδ measurements, such as the SC30, consists of a capacitor and a built-in shunt capacitor, only. Additionally, combined units for tanδ and partial discharge measurements are available.

Coupling Capacitors

Power Diagnostix standard coupling capacitors (CC) are mounted on sturdy cast aluminum enclosures and can be used for on-line and off-line measurements on rotating machines as well as for a variety of smaller test setups. Usually, the CC units are connected to a coupler termination box (CTB), which provides protective grounding for the signal cable.The table on the right-hand side below lists some standard models of coupling capacitors provided by Power Diagnostix, along with their built-in circuits, if present. Coupling capacitors for special applications, e. q. ATEX couplers for areas exposed to explosion hazards, are also available.

CTB1A

Type	Channel	Spark gap	IN	OUT
CTB1A	3x	350 V	BNC	BNC
CTB1C	3x	350 V	TNC	BNC
CTB2A	4x	350 V	BNC	BNC
CTB2C	4x	350 V	TNC	BNC

Coupler termination boxes

Type	Capacitance	Nom. Voltage	Built-in Quadrupole	Built-in Voltage Divider	Built-in RF CT	Max. Height [mm]
CC7B	440 pF	7 kV	✓	✓		152
CC14B	220 pF	14 kV	✓	✓		190
CC20B	145 pF	21 kV	✓	✓		300
CC25B	1 nF	25 kV	✓	✓		300
CC25B/V	1 nF	25 kV	✓	✓		300
CC25C/V	1 nF	25 kV	✓	✓	✓	300
CC35B/V	145 pF	35 kV	✓	✓		310
CC50B/V	1 nF	50 kV	✓	✓		500
CC50C/V	1 nF	50 kV	✓	✓	✓	500
CC100B/V	1 nF	100 kV	✓	✓		695
CC150B/V	1 nF	150 kV	✓	✓		1210
CC200B/V	0.5 nF	200 kV	✓	✓		1300
CC300B/V	0.5 nF	300 kV	✓	✓		2425

Standard coupling capacitors and supplementary circuits

Various CT models

CT1 fixed current transformer

CT100 clamp-on current transformer

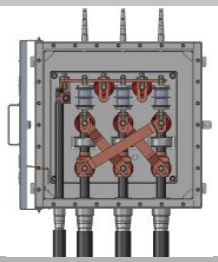
CT100 & RPA1

Current Transformers

When a current transformer is used instead of a quadrupole, the current transformer can be placed around a coupling capacitor terminal or around a part of the test object itself. A current transformer has the advantage of providing galvanic isolation between the ICM*series* PD detector and the high voltage circuit. Power Diagnostix offers current transformers as separate modules or integrated with a coupling capacitor into a single unit.

CT33 for on-site installations in cable cross link boxes

The CTs are a low-impact PD sensor option since no interruption of the power connection is required. Such installation is even possible under on-line conditions, as the CT100 is a clamp-on current transformer that can be opened and clamped around a connecting cable, a ground lead, or even a feeding medium-voltage cable with a high-voltage motor installation.



Three CT33s in a cross link box

Type	Transfer ratio at 50 Ω	Primary window	Bandwidth at -3 dB	Bandwidth at -6 dB
CT1	1:10	15 mm	0.5 – 80 MHz	0.3 – 100 MHz
CT33	1:10	33 mm	0.7 – 75 MHz	0.4 – 77 MHz
CT50/10	1:10	50x10 mm	2 – 90 MHz	1.7 – 93 MHz
CT60R	1:10	60 mm	2 – 25 MHz	1.2 – 40 MHz
CT100(R)	1:10	100 mm	2 – 25 MHz	1.2 – 40 MHz
CT125R	1:10	125 mm	2 – 25 MHz	1.2 – 40 MHz
CT150R	1:10	150 mm	2 – 25 MHz	1.2 – 40 MHz

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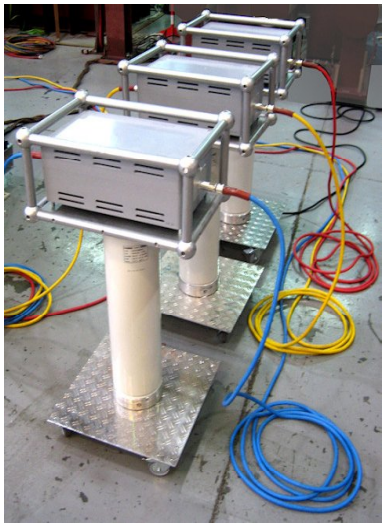
ICMseries Accessories: Filters

HV Filters

Partial discharge measurements are conducted in frequency ranges, which are partly covered by radio transmission. Further, impulse noise interference hamper sensitive measurements. Besides using small filters in the acquisition chain, power filters allow removing such disturbance from the high voltage supply. Power Diagnostix offers a range of different high voltage filters.



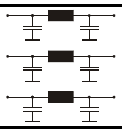
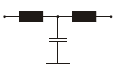
HV filter T100/100

π-Filters are for three-phase systems up to 2 kV, whereas the single-phase T-filters are used for testing with higher voltages. Those filters are installed inline between voltage source and device under test.

The typical frequency range of Power Diagnostix HV filters is 0–300 Hz. For a short time they can be operated with frequencies up to 400 Hz.

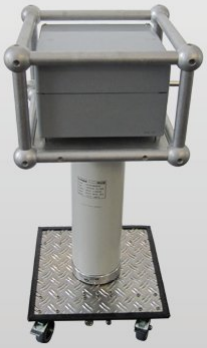
For gating purposes, filters that are used in combination with an ICM*flex* can be equipped with a high freqency current transformer (HF CT) and a BNC output.

Examples for standard filters:

Type	Name	$U_{N,rms}$	$I_{N,rms}$	Size (W x H x D) mm
3x π-Filter 	3PI1/20	1 kV	20 A	400 x 170 x 460
	3PI1/50	1 kV	50 A	400 x 170 x 460
	3PI2/20	2 kV	20 A	400 x 170 x 460
T-Filters 	T30/1	30 kV	1 A	357 x 620 x 357
	T30/5	30 kV	5 A	357 x 620 x 357
	T30/20	30 kV	20 A	357 x 620 x 357
	T30/100	30 kV	100 A	507 x 620 x 357
	T50/1	50 kV	1 A	357 x 800 x 357
	T50/5	50 kV	5 A	357 x 800 x 357
	T50/20	50 kV	20 A	357 x 800 x 357
	T50/100	50 kV	100 A	500 x 800 x 450
	T100/1	100 kV	1 A	357 x 1000 x 357
	T100/5	100 kV	5 A	357 x 1000 x 357
	T100/20	100 kV	20 A	357 x 1000 x 357
	T100/100	100 kV	100 A	507 x 1000 x 457

HV filters of different ratings (U_N, I_N) are available on request.

3PI 2/20 Filter

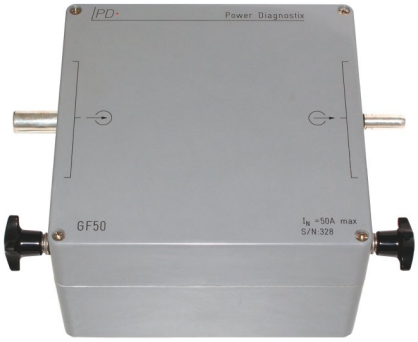


T 50/1

T100/100

T30/100

GF50 Ground Filter



Ground filter GF50

Partial discharge (PD) measurement requires a reasonable noise-free environment. Power Diagnostix' GF50 filter box is designed to reduce high frequent disturbance signals from the ground leads. It can be used for HF separation of the test specimen from the ground potential of the power supply or other HV equipment within the environment without influencing the power frequency. The efficiency strongly depends on the general earthing within the laboratory. A splitted ground lead or copper band can be connected to the multi contact connectors or alternatively to the wing screws beside.

Filter Models for Special Applications

Besides the standard HV filters, Power Diagnostix offers various filters for special high voltage applications, including line filters for cable testing (such as the LF15 and LF350) and filters with AC current and AC voltage measurement. With the latter a high voltage filter ist combined with a high voltage devider and a high current transformer in one unit; conventionally on rolls, or upside-down, as shown.

Different models of line filters

HV filter TVC100/123
with voltage and current measurement

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ICMseries Accessories: Sensors

SFX1

SFX2 and SFX3 with sensors

AS75I

Ultrasonic PD Sensors

The AS75I and AS150I are active sensors with very high sensitivity for measurements on GIS, transformer tanks, or cable joints. They come with a built-in 40 dB preamplifier and can be connected to the RPA1D, RPA1F, RPA1G or directly to the AIA*compact*, ICM*system*, ICM*compact* or ICM*monitor.*

The SFX1 is suited to secure the acoustis sensors on a GIS.The magnetic sensor fixture SFX2 and the sucking fixture SFX3 are for temporarily mounting of the acoustic sensors on a transformer tank.

WS Window Sensors

External window sensors are used to conveniently equip older GIS with UHF monitoring. Power Diagnostix offers such window sensors of different sizes to fit the inspection windows of older GIS. Instead of embedded sensors, additionally, modified earthing switches can be used. In case of non-shielded support insulator disks a proven method is to apply ring antennas to capture the UHF signals at the flanges.

EFS1 Sensor

The external flange sensor EFS1 is a wide-band UHF antenna for PD detection on GIS and GIL. Since it is wrapped around the unshielded flange connection, the flange dimensions are required on order. With the N-connector it can be directly jointed with a UHF preamplifier like the UHF1 and UHF2 or the preacquisition unit FCU2. Power Diagnostix offers two different models, for permanent and for temporary installation.

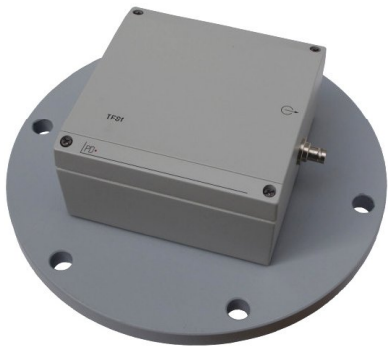
WS window sensors in different sizes

EFS1 sensor

UHF Transformer Sensors

UHF transformer sensors can be used to detect internal PD on power transformers in a frequency range between 300 MHz and 1 GHz. The UHF frequency range can be chosen under difficult on-site conditions, such as high impact of the measurements due to corona discharges or other disturbances within the typical HF range (100 kHz to 10 MHz). UHF sensors are suitable for retrofitting as well as for pre-installation. The sensitivity can be proven by injecting an impulse generator signal in the UHF range into the system. UHF PD signals can be used for PD pattern analysis as well as for triggering acoustic measurement systems, like the FOS4, for instance. Power Diagnostix provides the TFS1 for valve flanges and the TVS2 for oil valves. Both sensors can be modified and designed in accordance of special customer specifications.

Valve sensor TVS2



Flange sensor TFS1

DFS Differential Foil Sensor

Besides the embedded coaxial sensor of cable accessories, external sensors can be applied to joints and terminations. Especially on cross-bonding joints differential foil sensors serve to capture partial discharge signals in elevated frequencies. Such foil sensors can be permanently installed for monitoring or temporary applied for survey type measurements.

Foil sensor DFS1

The versatility of the Power Diagnostix line of PD detection equipment is due in large part to the range of accessories available for the ICM series instruments. Each ICM*series* data acquisition unit can be combined with different accessories to suit specific applications.

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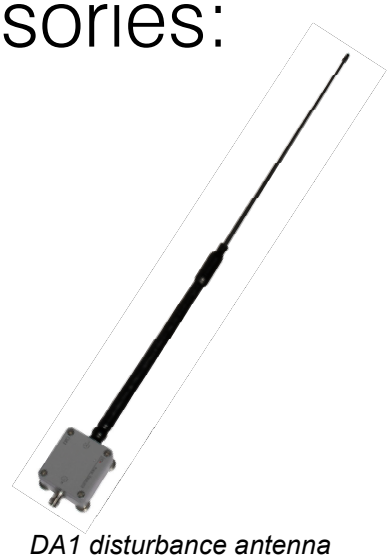
ICMseries Accessories: Miscellaneous

DA2 disturbance antenna



DA1 disturbance antenna

DA Disturbance Antennas

The disturbance antenna DA1 can be used to pick up noise signals caused by local corona discharge, or AM radio waves for instance. Its magnetic holder allows a flexible placement on a transformer tank or to other metallic parts close to the object under test. The output signal can be used to trigger the gate input circuit of all PD acquisition or monitoring devices.

The wideband antenna DA2 consists of a UHF antenna and a frequency converter unit. It is designed to filter HF signals e. g. emitted by GSM transmitting antennas. Therefore it is especially used for GIS monitoring.

DRA1 Discharge Radiation Antenna

With its built-in wide band logarithmic amplifier this antenna is suitable for the detection of discharge signals on air insulated switchgear (AIS) cabinets. It consist of a VHF antenna and a magnetic holder for simple fixture on visual inspection holes on metal housings.

GST1 Gate Signal Transmitter

The gate signal transmitter GST1 converts TTL or analog gate signals into a fiber optic TTL output signal. It has a logarithmic amplification and can be set to three different frequency ranges (40 to 800 kHz, 2 to 20 MHz, or 200 to 600 MHz), which can be selected with a push button. The active bandwidth mode is marked by a lit green LED. The trigger level can be adjusted by a rotary knob, while an LED bargraph indicates the actual signal strength.

AB1

IPU input protection units

AB1 Active Bridge Adapter

The active bridge adapter is an optional accessory that can be used in certain circumstances to “subtract” noise from the measurement setup.

The active bridge adapter AB1 serves to balance the signal picked up by two preamplifiers to reduce the common mode noise or disturbance. This method is applicable when two branches are available.

A mismatch of the signal strength can be adjusted with the AB1‘s control knob. With the preamplifiers of the two branches connected to the “Pos” and “Neg” input of the AB1, and the output connected to the AMP IN of the PD detector, the control knob is used to minimize the common mode signal.

CTB1 Coupler Termination Box

The CTB1 provides protective grounding of the cabling comming from the coupling capacitors. An over voltage protection of the signal path is included and ensures safe working on live test specimen.

IPU Input Protection Units

The protection units are designed to avoid damage of spectrum analyzer input circuits or of preamplifier input stages under the presence of strong transient signals.

They are available for indoor application (IP52 protection) and for outdoor use (IP65 protection).

CSC1 Signal Combiner

The CSC1 allows to select or combine signals from 4 BNC-inputs to one BNC-output. The input and output impedance is thereby kept to 50W, even if one channel is selected or if the sum of all four channels is selected.

CSC1

The versatility of the Power Diagnostix line of PD detection equipment is due in large part to the range of accessories available for the ICM series instruments. Each ICM*series* data acquisition unit can be combined with different accessories to suit specific applications.

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ICMseries Accessories: Miscellaneous

HV transformer HVT100/11

HVT High Voltage Transformers

Power Diagnostix offers miscellaneous transformers as voltage source for testing purposes. Depending on the customer's needs and the specific testing application Power Diagnostix high voltage transformers cover a voltage range up to 300 kV. Please contact us for detailed information.

TCU Transformer Control Units

Power Diagnostix TCU is made for controlling of high voltage transformers. Together with HVcontrol it combines all standard functions required to manually or automatically operate a high voltage transformer, including safety loops, door locks, and all voltage and current measurements.

The transformer control unit comes in a moveable 19" rack and includes a built-in regulating transformer. The delivery range of the TCU includes a warning lamp and a built-in horn.

Examples:

Type	Voltage	Power	Current	Connection	Height	Dimensions W x H x D
TCU7.5	0–230 V	7.5 kVA	34 A_{max}	CEE 400/32A (L-N)	9 HU	553 x 506 x 600 mm
TCU10	0–230 V	10 kVA	48 A_{max}	CEE 400/63A (L-N)	9 HU	553 x 506 x 600 mm
TCU10/2	0–400 V	10 kVA	25 A_{max}	CEE 400/63A (L1-L2)	9 HU	553 x 506 x 600 mm
TCU25/2	0–400 V	25 kVA	34 A_{max}	CEE 400/63A (L1-L2)	34 HU	556 x 1627 x 600 mm

Transportation Case for the ICM*series* Instruments

All instruments of the ICM*series* can be delivered with a solid transport case with cut-out foam to carry one instrument and its accessories.

Width: 67 cm
Height: 26 cm
Depth: 51 cm
Weight (empty): 11 kg

BCU Bushing Coupling Units

BCU2C

The bushing coupling units are for permanent installation on power transformers. Together with a matching bushing adapter they serve to make different signals available for measurement and monitoring. The bandwidth of the partial discharge signals extends to 20 MHz. The voltage signal of the built-in capacitive divider serves to synchronize the partial discharge acquisition and to measure the voltage. However, the excellent bandwidth of the voltage signal also allows transfer impedance measurements and loss factor measurements. The bushing coupling unit comes in a IP66 protected enclosure with a PTFE insulated input cable. Thus, it is suitable for indoor and outdoor use. The voltage range and bushing capacitances (C1 and C2) have to be specified on order.

BA Bushing Adapters

Type	Thread	Size	Conn.	Size	Suitable for
BA2	inside	G3/4"	female	4 mm	Micafil: RTKF, RTKG, RTKK, RTF, RTXF 21, RTXF 36
BA3	outside	M45x2	female	8 mm	ABB: GOB 1050-750-110-0.6-B
BA4 adapter	flange inside	-- M76x1,5	male	8 mm	Nanjing Electric: BRLW-500/1250-3
BA5	inside	M24	male	4 mm	HSP: ESKTFK 1050/245-A, OTFS 550/123-0
BA6	outside	M38x1,5	male	4 mm	Micafil: WTF 420/1800 (1978)
BA7C	outside	2¼"-12 UNF	female	8 mm	PCORE: CSA standard, POC ser. 2; ABB: GOE, GSB (245–550 kV)
BA7D	outside	2¼"-12 UNF	female	3.5 mm	Trench: OTA 363/1250/1300, OTA (72.5–1200 kV), COTA 1675-H016-23-AG3-01
BA8	inside	5/8"-11 UNC	--	3 mm	ABB: GOB 650/1250/L
BA9	outside	M30x1,5	female	4 mm	HSP: SETFt 600-123-2000, SETFt 1550/420-1800, SETFt 1550/420-2200
BA9B	inside	M30x1,5	female	8 mm	Alstom Grid P.F. Tap
BA10	outside	M16x1,5	female	4 mm	Trench: COT 125-X...1800-X (≥ 123 kV)
BA10B	outside	M16x1,5	female	4 mm	Trench: COT(C) 125-X...1800-X (< 123 kV)
BA10C	outside	M16x1,5	female	4 mm	Trench: COT 750-800
BA11	flange		female	8 mm	ABB: GOA 650, GOA 1050, GOA 1550 400 kV
BA12	outside	M30x2	female	6 mm	NGK: R-D5350D-KEW
BA14	outside	1 1/16"-12 UN	female	8 mm	Transelectrix
BA15	outside	M30x2	female	9 mm	NGK: R-C6200V-LN
BA17	outside	M30x2	female	4 mm	ABB: GOM, GOB 1050-750-1100-0.6-B, GOB 250 ... 750/1250, GSA-OA 52-0A/2000, GSA-OA 73/2000, GSA-OA 123/1600, GSA-OA 145/1600, GSA-OA 170/1600
BA18	flange	--	female	8 mm	Mozisolyator, GMTA-90-110/2000
BA19	flange	--	female	8 mm	Mozisolyator, GMTA-45-330/2500
BA21	outside	M24x1.5	female	4 mm	HSP: SETFt 750-170-4000, SESTFt 1050-245-B E6 B, SETFt 1200/245-1250, SETFt 1200/245-3000, SETFt 1425-420-1600, EKTG (72.5–800 kV)
BA21B	outside	M24x1.5	female	4 mm	HSP: OTF (420–800 kV)
BA23	inside	M36x3	female	5 mm	BHEL: Tap Inv. no. BCE-4-1232
BA25	outside	1¼"-12 UNF	spring	5 mm	PCORE: B-81515-57-70
BA26	outside	1 1/8"-12 UNF	female	1/4"	Electro Composites, 350-006-T-730-00
BA 27	outside	1 1/8"-12 UNF	female	8 mm	Passoni Villa PNO, POBO, PCTO, PAO (< 110 kV)
BA 28	outside	¾"-14 NPSM	spring	9 mm	ABB: O Plus C (O Plus Dry)

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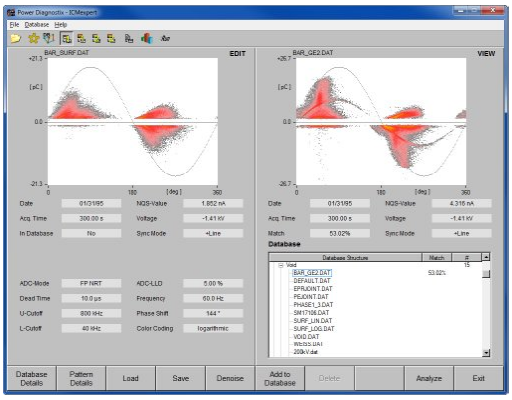
ICMseries Accessories: Special Software

ICM*expert*



Database overwiew panel of the ICMexpert software

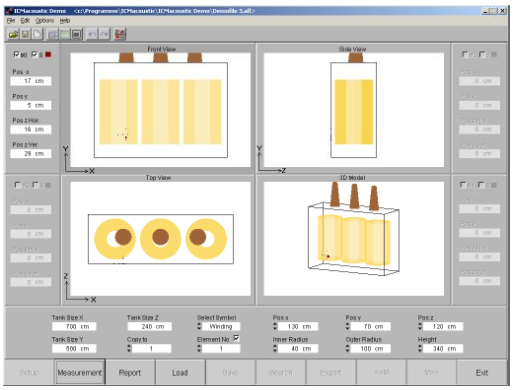
ICM*expert* is a database software for managing partial discharge (PD) patterns and extends the possibilities of Power Diagnostix programs like ICM*compact*, ICM*monitor*, ICM*system*, HV*pilot*, ICM*flex,* and GIS*monitor*. This easy-to-use tool offers functions for three main tasks occurring regularly when doing PD measurements:

- Classification of pattern according to their PD fault(s),
- Pattern editing to correct deficiencies of the set-up, erase disturbances, and highlighting pattern regions characterizing typical PD faults,
- Adding and maintaining additional information to recorded pattern.

For each of these tasks ICM*expert* provides a separate software panel.

The database structure is customizable according to different applications and user requirements. Additionally, the ICM*expert* software supports the export of complete clones or parts of the database. Clones can be used to operate with the same database structure on different computers staying compatible with each of the used database files.

ICM*acoustic*



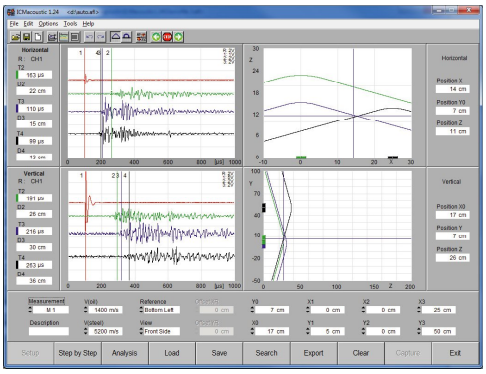
ICM*acoustic software, analysis panel*

For PD localization purposes the ICM*acoustic* software offers simple and full control of the FO*system* FOS4 or an oscilloscope of the Tektronix 20xx family. The software provides a virtual instrument to run the FOS4 or the oscilloscope under Windows XP/7 (32bit). Critical frequencies can easily be detected and filters can be set for in-depth analysis.

Contained functions are:

- Simultaneous display of up to 12 channels of the FOS4
- Accurate fault localization by triangulation with freely configurable parameters for the different propagation velocities in oil and steel
- Screenshot functions

- Analysis and visualization of measurement results through customizable 3D models
- Extensive report and export functions for measuring results and graphical representation of the fault localization
- Convenient step-by-step wizard during the measurement

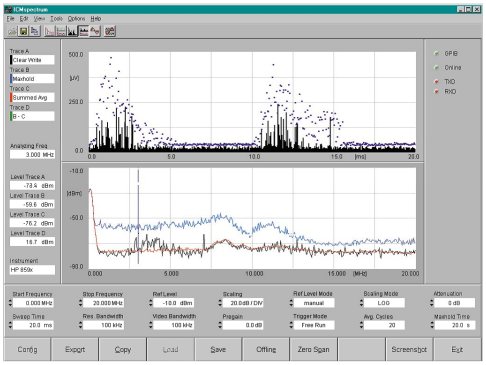


ICM*acoustic measurement panel*

ICM*spectrum*

Generally, a spectrum analyzer is an excellent tool to identify partial discharge and noise spectra, as well as the signal to noise ratio. Further, if appropriately used in zero-span mode, a spectrum analyzer offers an oscilloscope-like phase resolved display. However, as spectrum analyzers are designed primarily for other measurements, they are found in general not easy to use.

In order to ease this operation and to remove the hassle of controlling a multitude of menus and sub-menus, the ICM*spectrum* software was written. This software allows full control of analyzers of the Agilent/HP 856xE, 859xE and ESA family as well as the FSL3 (R&S). The software is reduced to the functions needed for on-site PD testing. It offers convenient data acquisition and storage. Graphs can be directly pasted into Word documents or Excel sheets. Screen shots can be taken, stored, and pasted.



Operation panel of the ICM*spectrum software in duplex screen mode*

Originally, the ICM*spectrum* software was written for the spectrum analyzers of the Agilent 859xE family that was discontinued in the meantime. Most of the new spectrum analyzers come with a Windows based operating system, which has an impact on response times and does not really improve the instruments. However, we have fully integrated the new analyzers as well. Thus, the ICM*spectrum* software controls the new units via the GPIB interface and offers comparable screenshots regardless the analyzer used.

Power Diagnostix' specialized control and analysis software extends the standard software for instruments of the ICM*series*. It runs on personal computers and laptops with Windows operating system.

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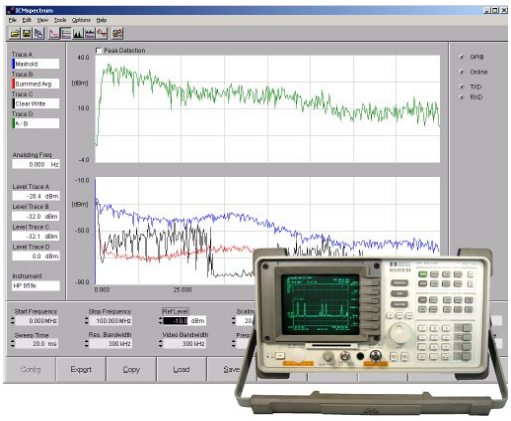
Applications - Transformers


110/220 kV transformer, RWE, Germany

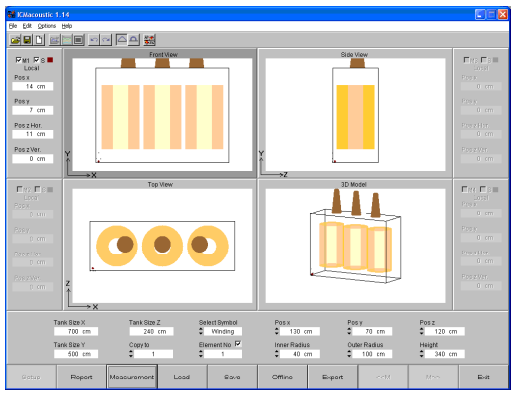
Partial discharge measurements on power and distribution transformer are a proven tool to identify and locate insulation defects within windings, instrument transformers, bushings, tap changers, or other accessories. Besides the required equipment for factory acceptance testing (FAT), Power Diagnostix offers a wide range of instruments for onsite investigations and for continous online monitoring.

8-channel ICM*system*

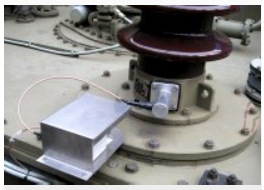
The multi-channel ICM*system* Gen. 5 greatly simplifies the PD acceptance tests on large power transformer. With its true parallel PD acquisition on up to ten channels, the overall testing period is substantially shortened by features such as the automatic calibration cross coupling matrix.
A typical package for advanced PD analysis consists of a multi-channel ICM*system* offering both narrow and wide band PD acquisition according to IEC 60270. The instrument comes with an embedded spectrum analyzer for PD analysis in frequency domain. Moreover, it is an excellent tool to use in case of noisy test environments. New in the 5th generation is the embedded oscilloscope (DSO) for time domain analysis of electrical and acoustic signals. The ICM*system* software further offers direct transmission of acoustic time domain measurements to the ICM*acoustic* PD localization software, providing an accurate graphical and mathematical triangulation functionality to locate PD defects in the main tank with high precision.



Remote SW with HP spectrum analyzer



ICM*acoustic software, analysis panel*



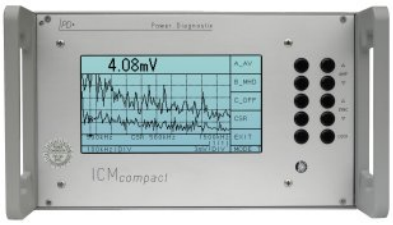
Bushing adapter

Transformer monitoring

Advanced PD test system

HV control room

The ICM*compact* with SPEC option is a good compromise for routine factory PD testing of distribution class transformers and instrument transformers. Its user friendly interface enables non-PD-experts to efficiently handle factory acceptance testing. The embedded 40 kHz–10 MHz spectrum analyzer and effective noise gating features are excellent tools to cope with noisy



ICM*compact*

factory environments. In addition to the noise supression functions of the instruments, Power Diagnostix offers a wide range of high voltage filters for induced or applied voltage testing.

PD Monitoring

Partial discharge monitoring has become increasingly important in the past few years. Besides other parameters such as gas in oil analysis, temperatures, vibrations, or load conditions, etc., the PD trending information completes a full set of monitoring data of a transformer in the field. A wide range of standard bushing adapters (BA) is available to connect the measurement system to the capacitive tap of condenser bushings. A good alternative for continuous monitoring are periodical online PD measurements using an ICM*system* or ICM*monitor* Portable. In such case, signal decoupling can be done by either temporary installed measuring impedances or a permanent setup with bushing adapters (BA) and bushing coupling units (BCU).

Typical Packages

Set for power transformer acceptance testing:
- 1 x ICM*system* Gen. 5
- 1 x Built-in TCP/IP interface
- 1 x GPIB interface
- 1 x Software ICM*system*
- 1 x Impulse calibrator CAL1D
- 9 x Preamplifier RPA1
- 8 x Quadrupole CIL4M/V0µ5/2µ0
- 3 x Quadrupole CIL5M/V4µ0
- 3 x T100/100 high voltage filter

Set for distribution transformer acceptance testing:
- 1 x ICM*system* Gen. 5 or ICM*compact* (inl. MUX4)
- 1 x GPIB interface (with ICM*system*)
- 1 x Software ICM*system/ICMcompact*
- 1 x Impulse calibrator CAL1D
- 4 x Preamplifier RPA1 or RPA1L
- 3 x Coupling capacitor CC100B/V
- 3 x T30/xx or T50/xx HV filter

Optional items:
- RIV measurement
- Built in spectrum analyzer
- Scope with remote control software
- Acoustic sensors and preamplifier
- CT1 or CT100 for gating purposes
- External spectrum analyzer

ICM*compact with multiplexer*

Partial discharge testing on power transformer is an efficient tool to evaluate the condition of the complex insulation system. Power Diagnostix offers various optimized instruments and accessories for laboratory tests, field measurements, and continuous monitoring.

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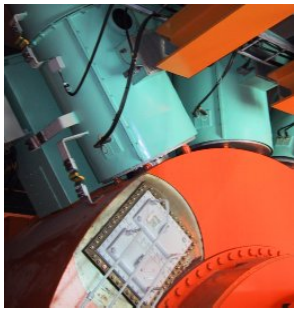
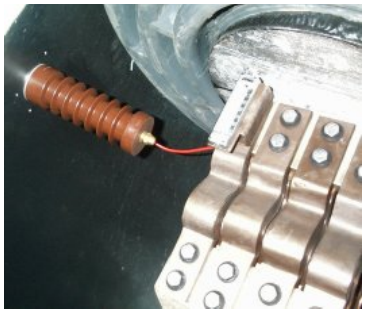
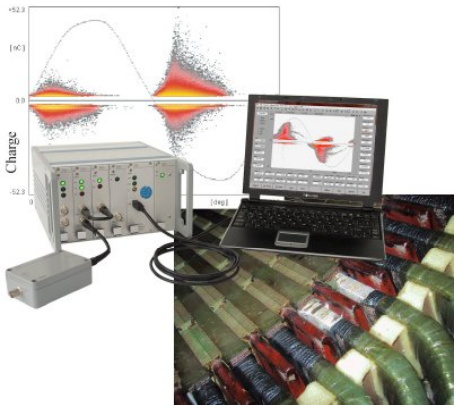
Applications - Rotating Machines


The typical epoxy-mica stator winding insulation of rotating machines is a 'forgiving' insulation system. Due to this dielectric stability, partial discharge activity acts as an indicator for a variety of defect mechanisms. Besides the normal thermal aging, further problems, such as end winding contamination, bar or overhang vibrations, deterioration of grading layers, loose wedges, or large internal delaminations are common practice and can be classified by analysis of the phase resolved pattern properties.

PD Measurements

Power Diagnostix offers various instruments for continuous monitoring, schedule-based routine testing and in-depth analysis of rotating machinery. The instruments and their control software were continuously improved, based on the feedback and requirements of the end users. Permanently installed partial discharge couplers greatly simplify periodical on-line testing using the ICM-*system* without any interruption or downtime. Continuous on-line PD monitoring with a permanently installed ICM*monitor* helps optimizing maintenance intervals and reducing costs, while improving the level of equipment dependability.



PD activity acquired with the ICMsystem showing the non-symmetrical discharge pattern of a heavily deteriorated slot-exit field grading.

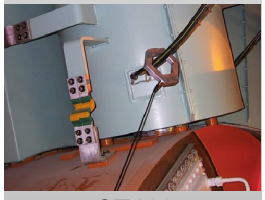
Tan Delta Measurements

The TDA*compact* is a digital tanδ and power factor analyzer for off-line dielectric testing to assess the overall health of the insulation system. Its fiber optic signal transmission simplifies connection even on grounded equipment. The unit comes with reference capacitor and can be combined with any external high voltage source.

TDA*compact*

ICM*monitor on-site*

Stator coil



CT100

Coupling units CC20

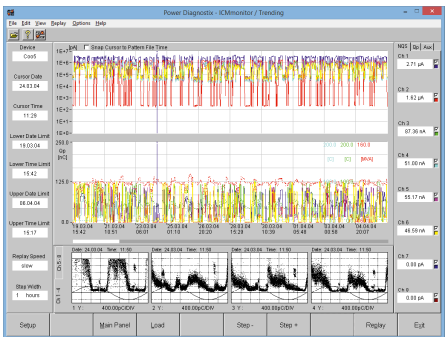
ICM*monitor display*

Partial Discharge Monitoring

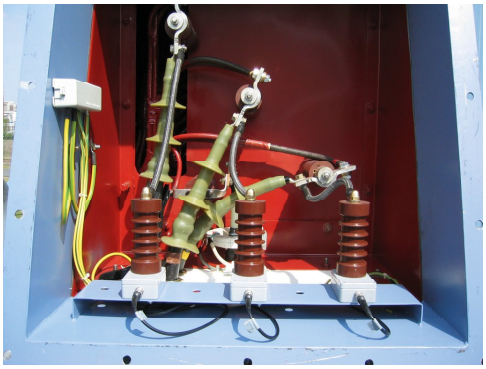
Based on the stand-alone ICM*monitor* unit connected to an individual machine, larger networks supervising a multitude of generators in combined-cycle thermal power plants or pump-storage hydro power plants have been realized. Such networks include full control of the local instrument via global Intranet access as well as visualization of the monitoring data in monitoring centers. The ICM*monitor* software offers automated scanning, pattern acquisition, and analysis of the trending data, while the ICM*server* software oprates in the background to supervise the communication between the individual instrument and data servers.

Large Motors

High voltage motors are the main assets to keep compressors, cooling pumps, extruders, and large fans running in refineries, oil and gas plants, chemical and petrochemical industry. Here, unplanned outages can cause immense losses. Further, such motors act as auxiliary drives in thermal and nuclear power plants to run the (emergency) cooling system, for example. Here, failure of a motor stator winding can cause critical subsequent damage. Given the typical 5-yearly outages for such setups, permanent installation of capacitive couplers offers periodical online PD measurements, and, hence, the possibility for an accurate and short follow-up. For the most critical trains, continuous monitoring can be installed from the early beginning.



ICM*monitor trending display*



Couplers CC14B installed on a motor terminal box

Typical Packages

Advanced PD measurement system (offline and online testing):

- 1x ICMsystem Gen. 5 (incl. SPEC)
- 1x ICM*system* software
- 1x GPIB interface
- 2x Preamplifier RPA1H
- 1x Preamplifier RPA2 (for online testing)
- 1x HF current transformer CT1 or CT100 (opt.)
- 1x Impulse calibrator CAL1B
- 1x Set of cables
- 1x Offline coupling capacitor, e. g. CC25B/V

Partial discharge testing and monitoring on generators and large motors offers the assessment of the condition of the stator winding. This helps avoiding unplanned outages as well as scheduling efficient maintenance outages.

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Applications - GIS / GIL

Besides factory partial discharge testing for quality assurance, field-testing becomes increasingly important for gas-insulated equipment. For the field applications UHF and acoustic detection methods complement the low frequency detection according to the IEC60270.

ICM*compact*
The ICM*compact* combines perfectly with small tank-type variable frequency test sets for the commissioning testing of gas-insulated substation equipment. Besides the flexible analog gating function, the ICM*compact* comes with a TTL gating input to effectively suppress the switching impulses of the resonant test set.

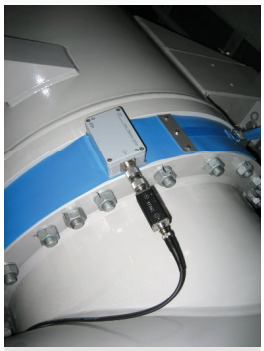
Field measurement set up

AIA*compact*
The AIAcompact combines the complimenting acoustical and electrical partial discharge detection for gas-insulated equipment in a lightweight and battery operated instrument. The measurement inputs provide the supply voltage for different pre-amplifiers and acoustic sensors. It automatically selects the appropriate operation mode for each test setup. The AIAcompact comes with a built-in display and can be operated via its integrated push-buttons.

ICM*system*
For in-depth field analysis of partial discharge activity the ICM*system* can be combined with a spectrum analyzer. Power Diagnostix has written the special software ICM*spectrum* to utilize and control spectrum analyzers of different vendors for partial discharge analysis (HP 859xE, Agilent E4000, R&S FSL).

ATT*analyzer*

ATT*analyzer*
The portable ATT*analyzer* is a simple and very effective tool to locate breakdown during the commissioning of GIS and GIL. Battery-operated acoustic sensors are externally mounted to the GIS and connected via fiber optic cable to the acquisition unit. In case of breakdown, the acoustic sensor transmits an optical signal to the ATT*analyzer*, when it has detected the sound wave. The ATT*analyzer* then displays the signals received from all sensors versus time like a logic analyzer. Following initial localization of the breakdown's origin, the acoustic sensors can be repositioned closer to the flaw to further narrow down the location.



Ring sensor on GIS

GIS window sensor

Breakdown sensor

Preamplifier FCU2

Accoustic sensor

Partial Discharge Monitoring

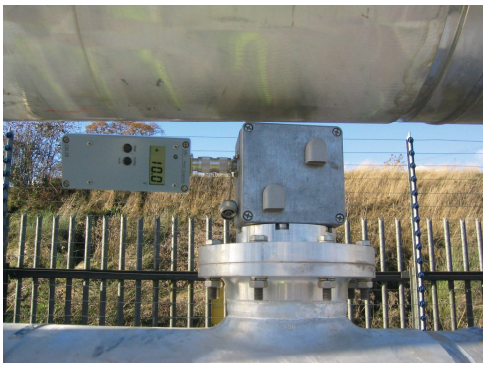
The same UHF sensors (external or internal) as used for commissioning can be used for continuous on-line monitoring of the partial discharge activity. Here, acquisition units perform a real-time parallel measurement on a number of sensors, each directly connected to a small frequency converter unit (FCU2). This preprocessing unit acts as a detector and converts the ultra-wide bandwidth signal into a low-frequency envelope signal, which is then conveniently transmitted via regular RG58 cable. The RG58 cable also provides the DC supply for the preacquisition unit. Embedded modem units or TCP/IP interfaces offer remote access to a multitude of monitoring units via the Internet, an Intranet, or the telephone network.

Monitoring system

Typical Packages

Standard PD test system for shop floor testing:

- 1 x ICM*compact* (opt. MUX, gating)
- 1 x ICM*compact* software
- 1 x Preamplifier RPA1
- 1 x Quadrupole CIL4M/V2µ0 (for GIS), or
- 1 x Coupling capacitor, e. g. CC50B/V (for AIS)
- 1 x Impulse calibrator CAL1A
- 1 x Set of cables
- 1 x Software for remote control, recording, and reporting



UHF impulse calibrator CAL2B

Standard PD test system for on-line and off-line testing:

- 1 x AIAcompact (opt. MUX4, gating)
- 1 x AIAcompact software
- 2 x Frequency converter unit FCU2
- 2 x Input protection unit IPU2
- 1 x Acoustic sensor AS75I incl. sensor fixture
- 1 x Disturbance antenna DA2
- 1 x Impulse calibrator CAL2B
- 1 x Set of cables

Power Diagnostix' range of instruments cover the entire needs of partial discharge testing on gas-insulated substation equipment from production testing and commissioning to maintenance and monitoring.

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Applications - Cables

Polyethylene is a 'non-forgiving' insulation system. Thus, close attention must be paid to partial discharge activity during factory testing, commissioning, and service. On-site measurement techniques have to cover the needs of an aging polymeric cable distribution net as well as an increasing application of polyethylene extra high voltage cables.

Extra High Voltage (EHV) Cables
Cables are generally factory-tested. The accessories of high voltage (HV) and extra high voltage (EHV) cables are usually also pre-tested. However, mechanical forces during the laying, hidden imperfections, and flaws caused by improper handling, for instance, require partial discharge commissioning tests. Ideally, the cable accessories of such transmission-class cables are equipped with embedded sensors. Power Diagnostix introduced this cost-effective principle in 1994 and numerous cable manufacturers have implemented it since then. The ICM*system*, especially if enhanced with the FO*system* for optical isolation, offers powerful tools for the analysis of the cable insulation system. Additionally, different preamplifiers and embedded or external spectrum analyzers complete the instrumentation.

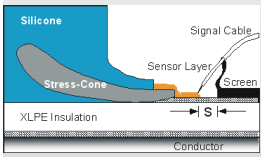
ICM*system*

Medium Voltage Cables
As with HV and EHV cables, the ICM*compact* is used for shopfloor production testing on medium voltage cables and ICM*flex* applications include HV/MV cable acceptance testing, MV/HV cable onsite testing and cable joints and accessories (laboratory/onsite). During the past decade numerous cable manufacturers have changed to this instrument during the modernization of their test room.

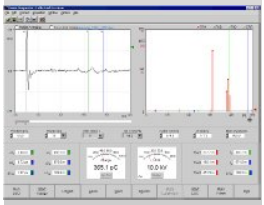
PD fault localization display

A large population of service-aged medium voltage or distribution-class cables has reached their projected service life, as polymeric cables were increasingly introduced since the 1970ies. The ICM*compact* is available in a ready-to-use package for field testing and partial discharge localization with any external high voltage source. Especially the combination with very low frequency (VLF) sources and the combination with variable frequency resonant test sets provide lightweight and cost-effective solutions to keep the distribution grid reliable. The package includes a combination of T-filter and coupling unit to reduce the HF disturbance signals from the HV source.

DFS for cable joints



Cable PD sensor



PD fault localization software

Cable monitoring with ICMmonitor CA

CT100 & RPA1

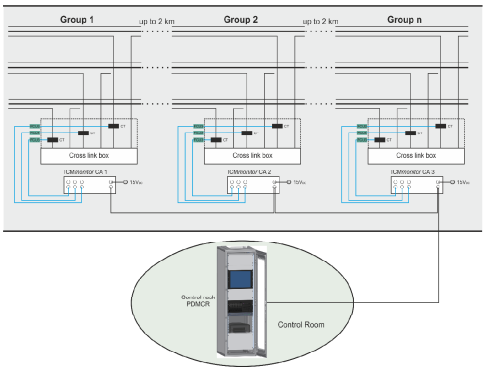
Special Sensors

Coupling capacitors, as used for factory testing and for off-line testing, are not applicable for on-line testing. Power Diagnostix offers several types of external sensors for PD measurements. The differential foil sensor (DFS) makes use of the stray capacitance of cross-bonding joints and offers comparable low-noise measurements at higher frequencies. The CT100 is a clamp-on HF current transformer that can be used to pick up partial discharge signals on ground leads and on cross-bonding connections. Further sensors including Rogowski coils can be tailor-made for any application. Power Diagnostix also assist with the design and implementation of embedded sensors.

PD Monitoring

Generally, partial discharge monitoring can take care of any high voltage insulation system to detect incipient breakdown and on-going degradation. The defect mechanisms for cable accessories and for the cable itself differ due to different material properties, for example. When monitoring EHV cables systems, a comparable long pre-warning time applies to EPR and EPDM accessories, while the cable insulation of a 400 kV XLPE cable, for instance, has a much shorter pre-warning time.

Further, an installed monitoring system can also be used for the commissioning tests of the cable system.



Monitoring system in a cable tunnel with FO interconnection

Typical Packages

Mobile PD fault localization system:

- 1x Portable ICM*compact* with built-in DSO board
- 1x Software ICM*compact* with fault PD fault localization
- 1x Coupling capacitor CC25D/V or CC100D/V
- 1x High voltage t-filter (opt.)
- 1x Impulse calibrator CAL1B
- 1x Preamplifier RPA1L
- 1x Preamplifier RPA1
- 1x Set of cables

Permanently installed monitoring system:

- 1x ICM*monitor* CA for each group of joints or terminations
- 1x Control rack PDMCR
- 1x ICM*monitor* CA software
- 1x Impulse calibrator CAL1B
- 1x Set of three HFCTs, e. g. CT33, CT80R, CT100R for each group of joints or terminations
- 1x Mounting kit for HFCTs
- 1x Set of cables

Combining the ICM*flex* or the lightweight ICM*compact* for partial discharge localization with portable VLF high voltage sources or variable frequency resonant test sets offers cost-effective survey testing of a distribution grid.

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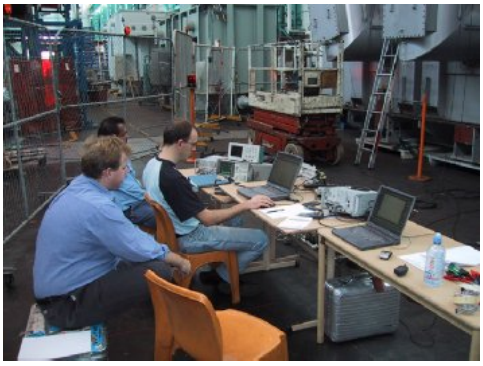
Services

Measurement in a transformer test bay

HV labs at our facilities in Aachen

Power Diagnostix provides various services such as on-site measurements, commissioning tests, DAkkS calibration of instruments, installation of couplers and monitoring systems, as well as rental of test equipment. Additionally, Power Diagnostix acts as a consultant to analyze defect mechanism or to improve high voltage insulation systems, for instance.

Consulting
Power Diagnostix assists to analyze encountered defects, failure mechanism, and helps to improve insulation systems. Further, support is provided to implement monitoring systems and to integrate embedded partial discharge sensors into insulation systems. Additionally, Power Diagnostix offers interpretation service for partial discharge pattern acquired by local testing groups. Instruments equipped with modem allow also having Power Diagnostix dialing in for performing remote measurements and diagnosis.



On-site measurements

On-site Measurements
Power Diagnostix engineers are available on short notice for on-site partial discharge measurements. Such on-site measurements cover on-line and off-line diagnostics on rotating machines including large motors, partial discharge mapping on cable systems, survey-type measurements on gas-insulated substation equipment, and partial discharge acceptance testing and PD localization on large transmission-class power transformers. All required instruments are provided, of course. VLF sources and smaller high voltage sources can be provided as well. However, rental of larger test sets needs to be subcontracted.

Seminars and Training
Standard shop-floor partial discharge testing is a comparable easy task. However, applying in-depth partial discharge

Seminar held in Aachen 2006

diagnostics requires knowledge and experience. Here, Power Diagnostix assists with training sessions for testing and engineering personnel and with seminars for larger service groups. Besides the mere installation and usage of the instruments, emphasis is put on understanding the theoretical background of partial discharge pattern, defect mechanism, and the interpretation of measurement results.

Installing couplers on site

Installation Service

Especially for monitoring systems a complete installation service is offered. Typically, this installation of couplers and instruments include the calibration of the entire setup and the base-line measurement.

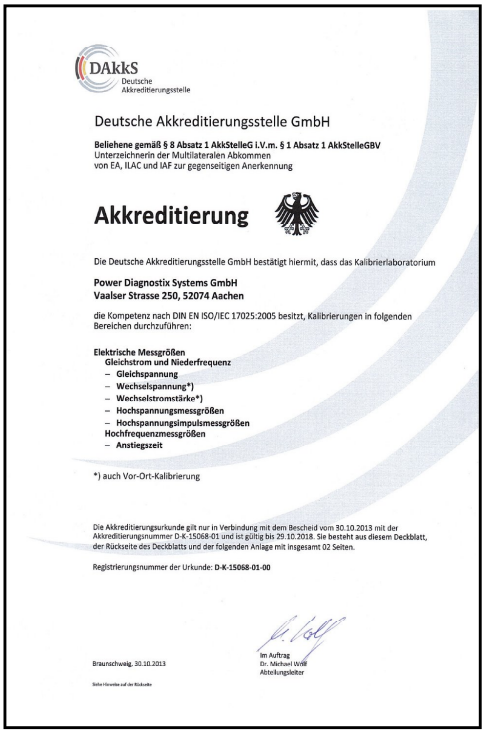
Rental of Equipment

Generally, Power Diagnostix testing equipment is available for rental or leasing, if budget constraints do not allow an investment, for instance.

Calibration Service

Power Diagnostix operates a calibration laboratory, which has received the accreditation within the German Calibration Service DKD by 2003. In January 2012, Power Diagnostix passed to the newly introduced German accreditation authority DAkkS (DAkkS = **D**eutsche **Akk**reditierungs**s**telle). The audit according to ISO 17025:2018 was held by 'Physikalisch Technische Bundesanstalt' (PTB), the German authority of standards. Power Diagnostix' new accreditation is filed under D-K-15068-01-00. The accreditation covers impulse charge (pC), voltages, and timing parameters, as well as on-site calibration of voltages up to 100 kV_{AC}.

The DAkkS calibration service is of course also available for instruments and calibrators of other vendors.



DAkkS
Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV
Unterzeichnerin der Multilateralen Abkommen
von EA, ILAC und IAF zur gegenseitigen Anerkennung

Akkreditierung

Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Kalibrierlaboratorium

Power Diagnostix Systems GmbH
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die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Kalibrierungen in folgenden Bereichen durchzuführen:

Elektrische Messgrößen
Gleichstrom und Niederfrequenz
- **Gleichspannung**
- **Wechselspannung*)**
- **Wechselstromstärke*)**
- **Hochspannungsmessgrößen**
- **Hochspannungsimpulsmessgrößen**

Hochfrequenzmessgrößen
- **Anstiegszeit**

*) auch Vor-Ort-Kalibrierung

Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 30.10.2013 mit der Akkreditierungsnummer D-K-15068-01 und ist gültig bis 29.10.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 02 Seiten.

Registrierungsnummer der Urkunde: **D-K-15068-01-00**

Im Auftrag
Dr. Michael Voßl
Abteilungsleiter

Braunschweig, 30.10.2013

Siehe Hinweise auf der Rückseite

Accreditation certificate

11030006-01
D-K-15068-01-00
2013-04

DAkkS calibration label

Kalibrierschein-Nr.
Calibration Certificate No.
PD-0001-01
01/2019

Factory calibration label

Power Diagnostix offers in-depth support including on-site testing and installation services as well as consulting on partial discharge issues. Training sessions and seminars are offered at Power Diagnostix factory in Aachen or on-site. The DAkkS calibration of instruments and calibrators is offered at a competitive price.

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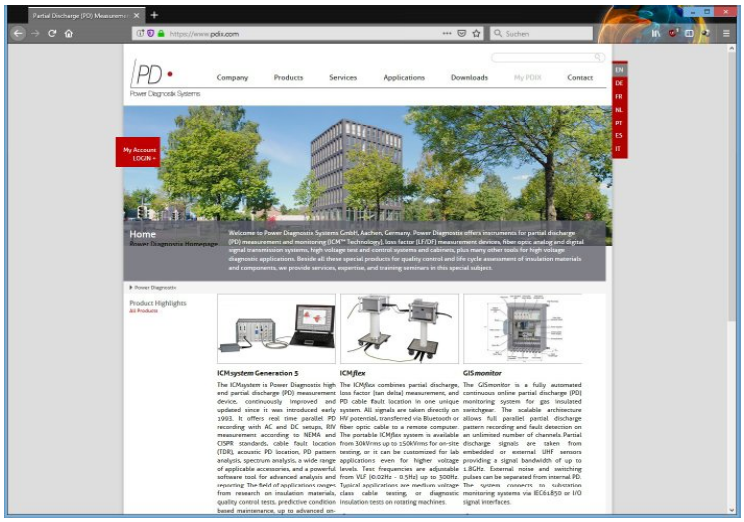
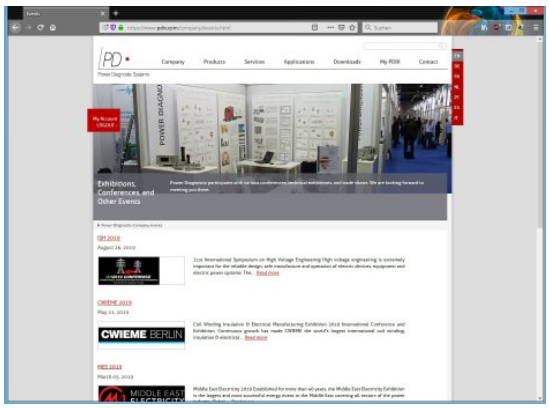
PDIX Web Site



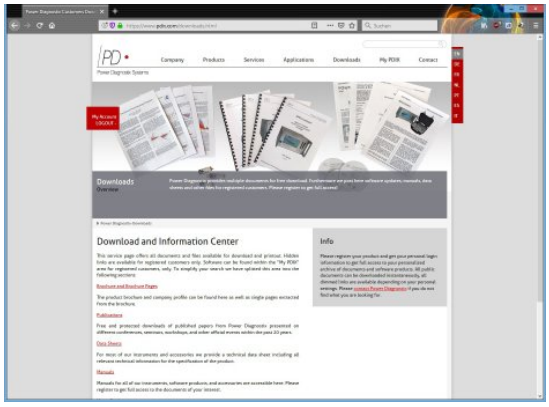
On our multilingual web site www.pdix.com we inform about news, recent developments within the company, and new instruments. The events section shows where to find us on upcoming national and international conferences, exhibitions, and trade shows.



Events section

A large products section presents information on every standard Power Diagnostix product with the possiblity to download the newest specifications and extra information as pdf file. Additionally, you can find a presentation of the services we offer, such as on-site measurements, calibrations, and commissioning.

The download section offers Power Diagnostix' latest product brochure as well as data sheets, user manuals, and application notes.



Download section

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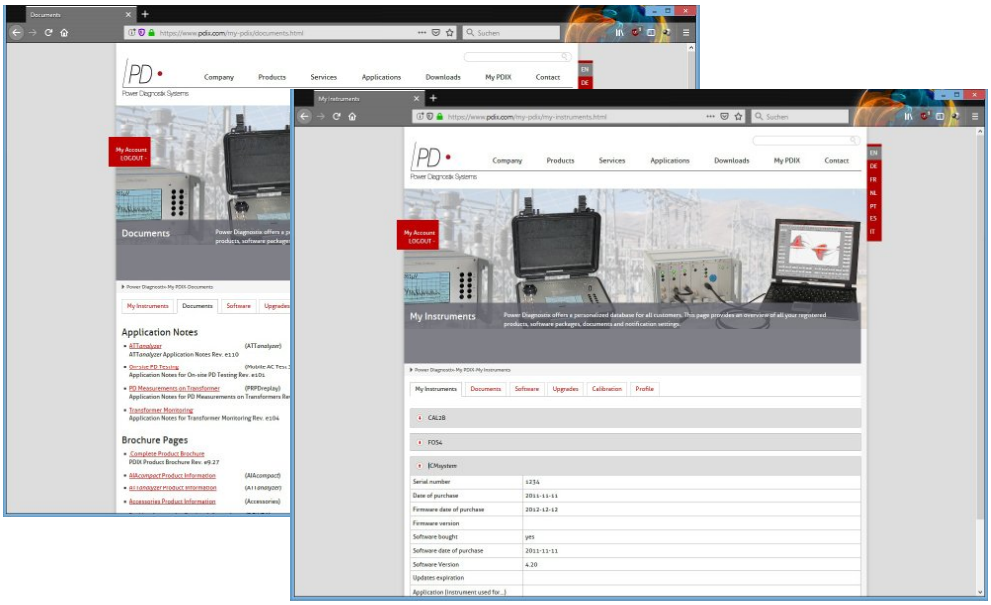


Document and instrument section within MyPDIX

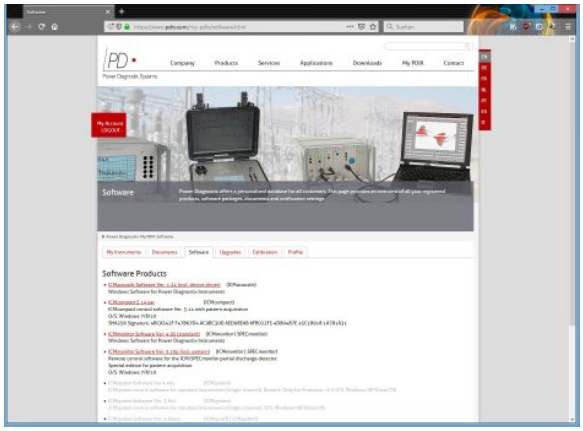
Customer Section MyPDIX

Power Diagnostix customers are encouraged to register for the restricted customer section "My PDIX". In this section customer have the possibility to register purchased PDIX instruments and benefit from many advantages resulting from these registrations.

Your benefits when registered:

Hold track of all your instruments including purchase, calibration, and upgrade information

- Free provision of software upgrades and updates within twelve months after software purchase
- Automatic provision of relevant data sheets, user manuals, papers, and application notes for registred instruments
- Automatic email notifications about updates and changes in your personal customer section



Software section within MyPDIX

Registered users of Power Diagnostix' restricted customer section MyPDIX benefit from various advantages, such as free software updates, automatic provision of data sheets, user manuals, and application notes as well as notifications about updates and changes in their personal customer section.

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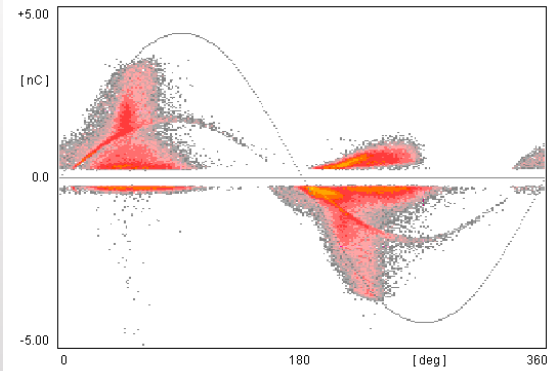
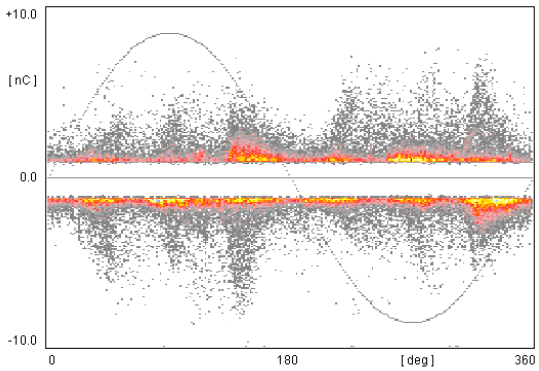
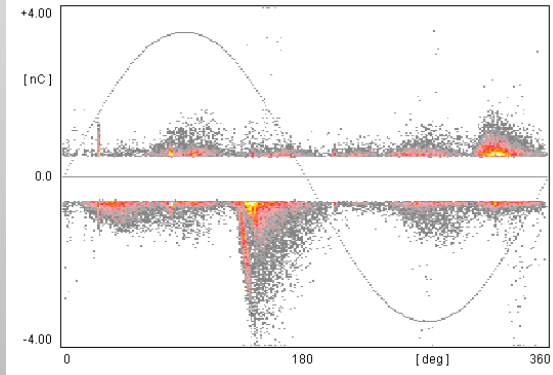
Typical PD Patterns



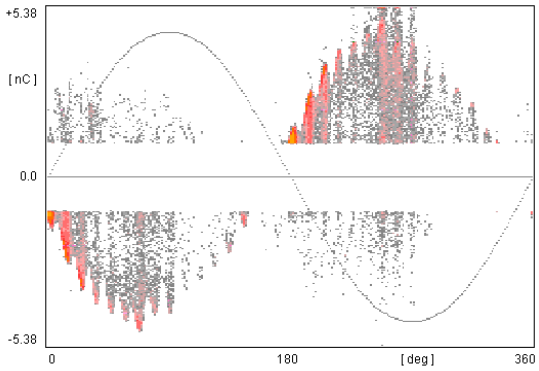
Single generator bar
Positive surface discharges for negative half-cycle in the coupling branch



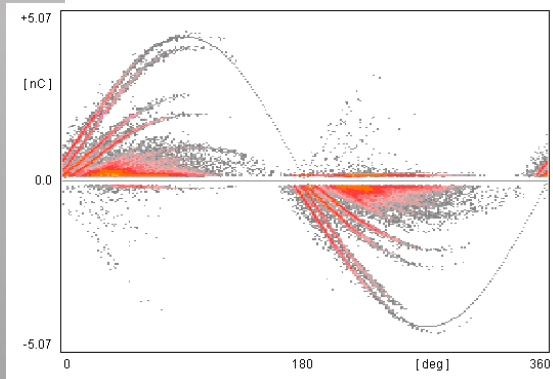
Asphalt-mica insulated hydrogenerator
Signal coupling on the neutral side
Activities for all three phases



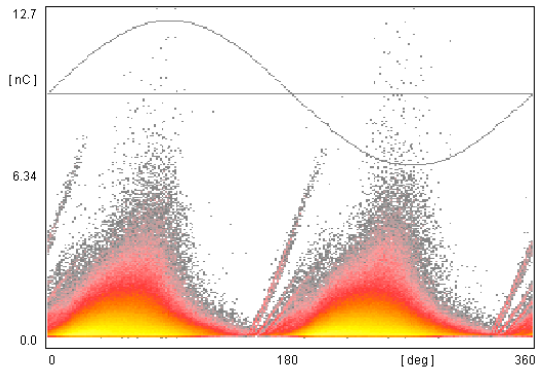
Large turbine generator
Signal coupling on the neutral side
Dominant activities for one phase



Small gas turbine generator
Line side coupling on one phase
Modulated PD pattern (33rd harmonic)



New motor coil
Several large voids



New motor coil
Strong surface discharge at the overhang
Remainder of void discharges

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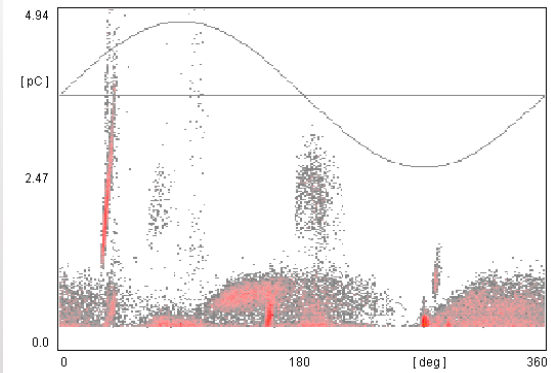
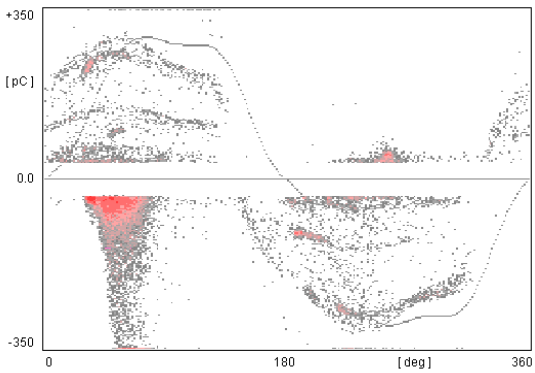
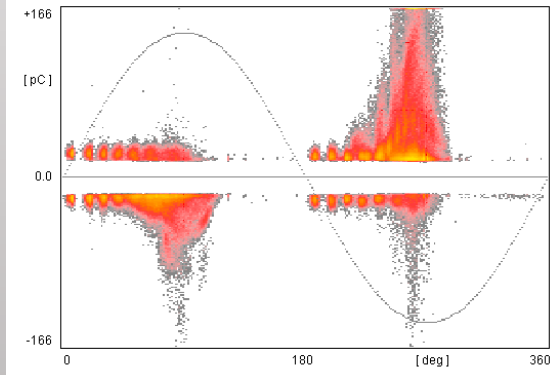


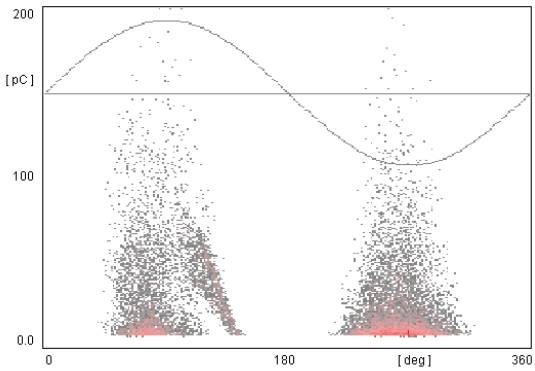
Power transformer (on-line)
Signal coupling at the bushing tap
Corona and internal discharge



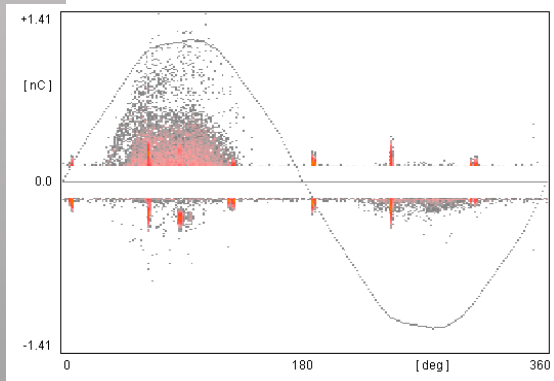
Voltage transformer
Void and surface discharge with a distorted voltage modulating the pattern



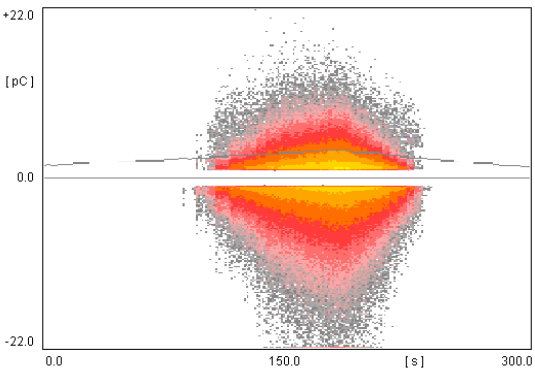
Transformer bushing
Contact problem of the field control layers



Transformer bushing
Corona discharge due to heavy rain



Transformer model
Point-plane assembly under oil



Surface discharge
Measurement versus time

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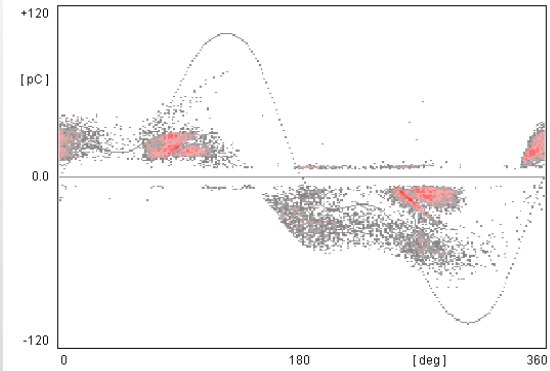
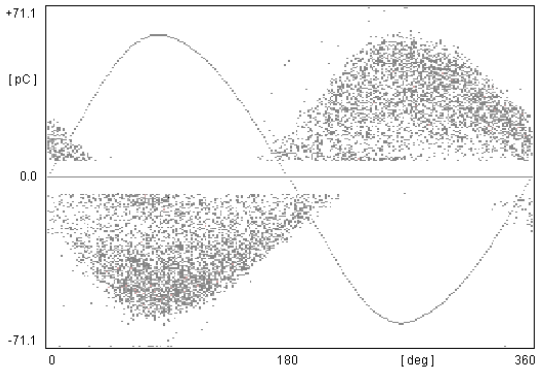
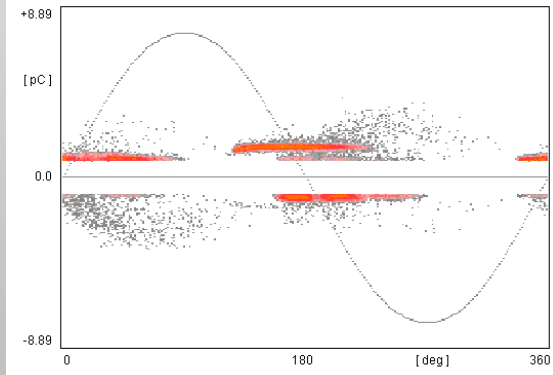


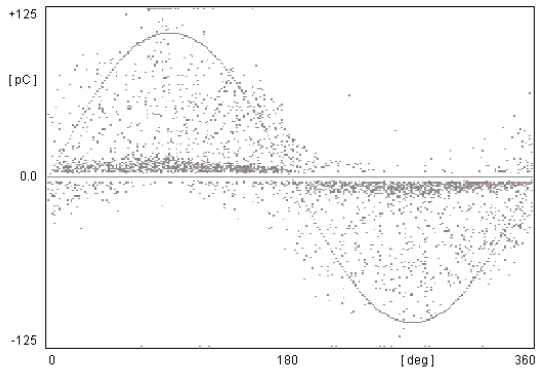
GIS instrument transformer
Excitation from the low voltage side
Influence of core saturation on the pattern



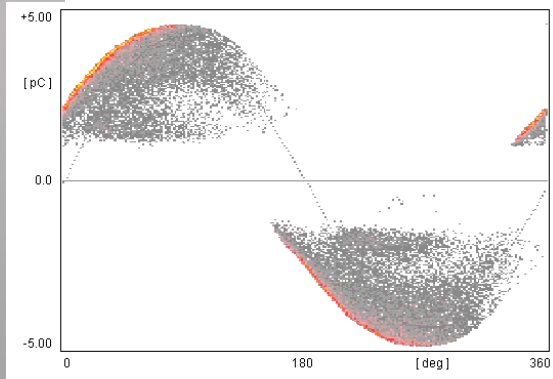
Gas-insulated switchgear
Hopping particle



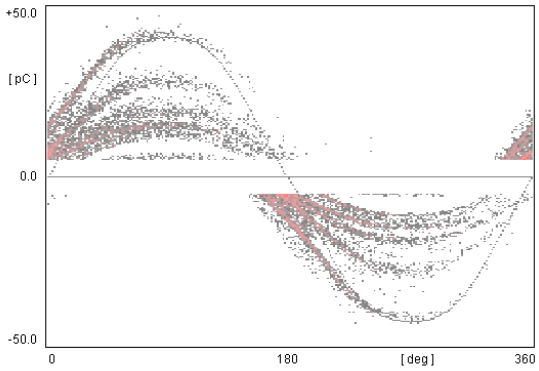
Gas-insulated switchgear
Superimposal of different PD pattern



Gas-insulated switchgear
Two hopping particles of different size and frequency of occurrence



GIS isolator model
Spherical void



Gas-insulated switchgear
Several voids in a support insulator disc

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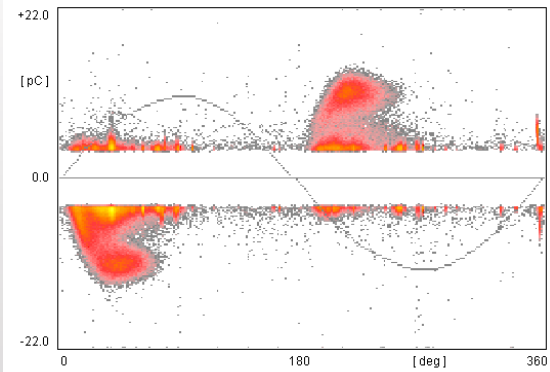
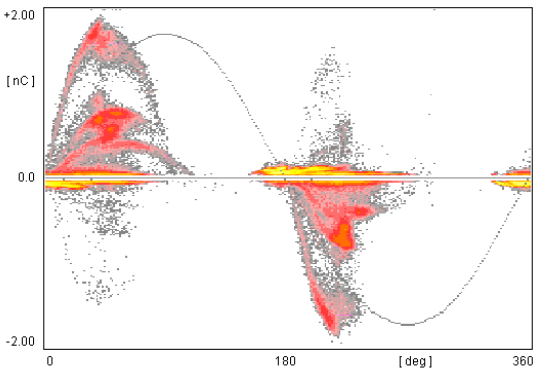
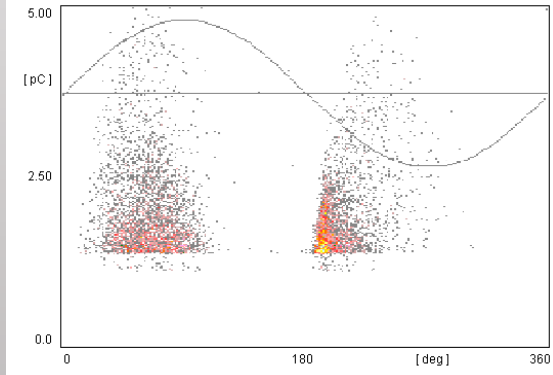
Typical PD Patterns



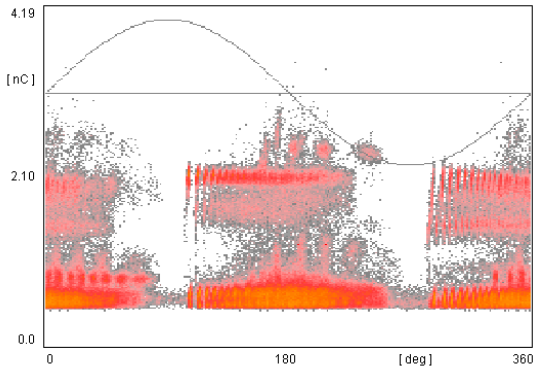
Cable joint
Internal discharges in a prefabricated EPR joint



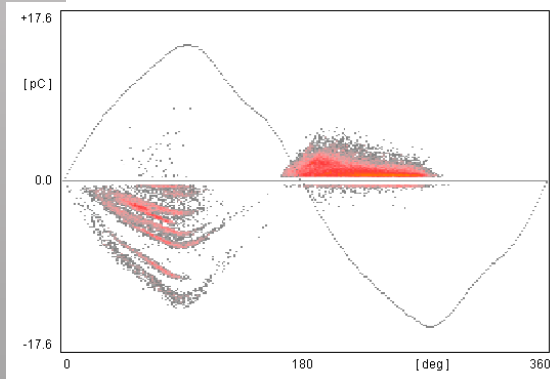
Cable termination
Several flat cavities in silicon fat due to improper mounting procedure



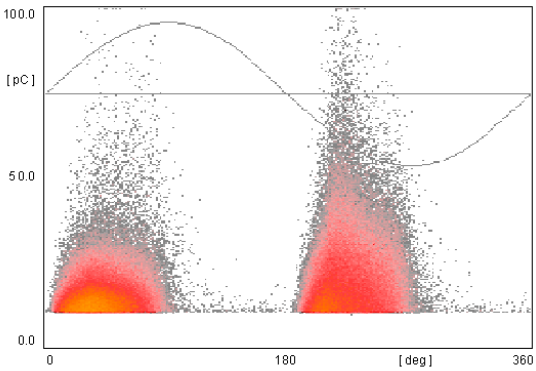
Cable joint
Discharges in a wrapped XLPE joint
Measured at 10 MHz



Cable termination
Contact problem of the field control of a wrapped termination (mass impregnated)



Laboratory setup
Small voids in the insulation at the interface to a semi-conductive layer



Cable joint
Delamination of the outer semi-conductive layer of a prefabricated EPR joint

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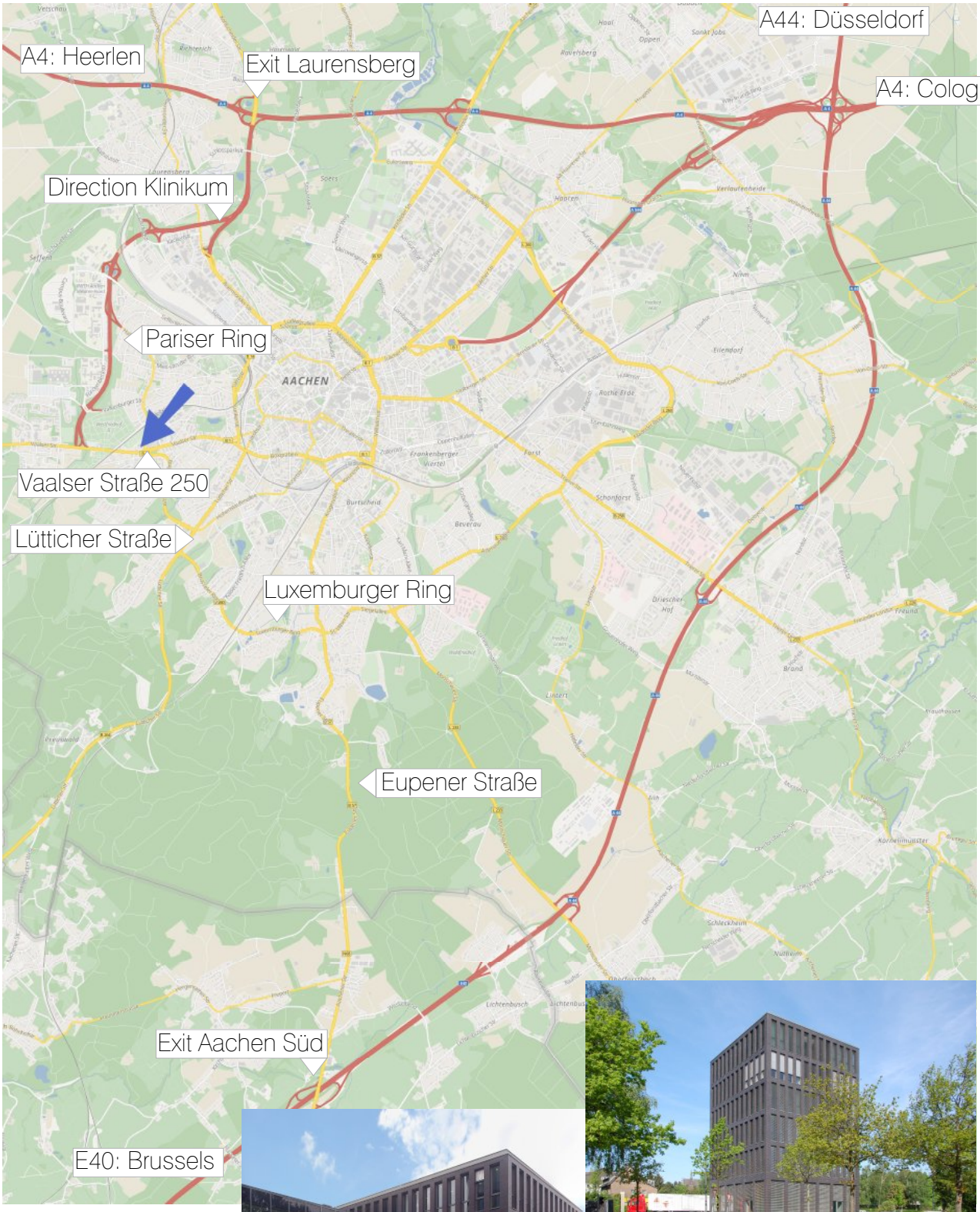
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A4: Heerlen
Exit Laurensberg
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Direction Klinikum
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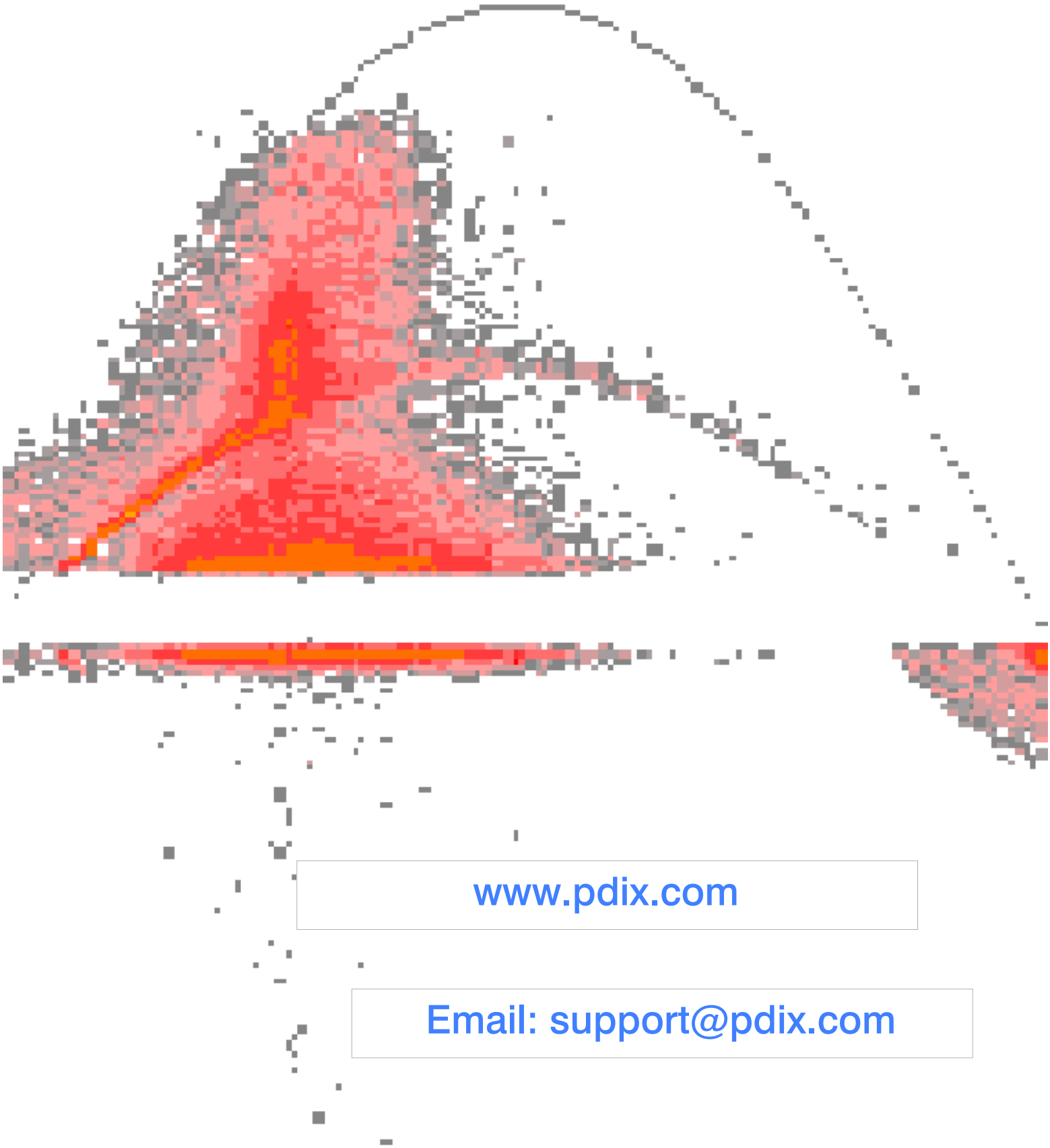
E40: Brussels



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