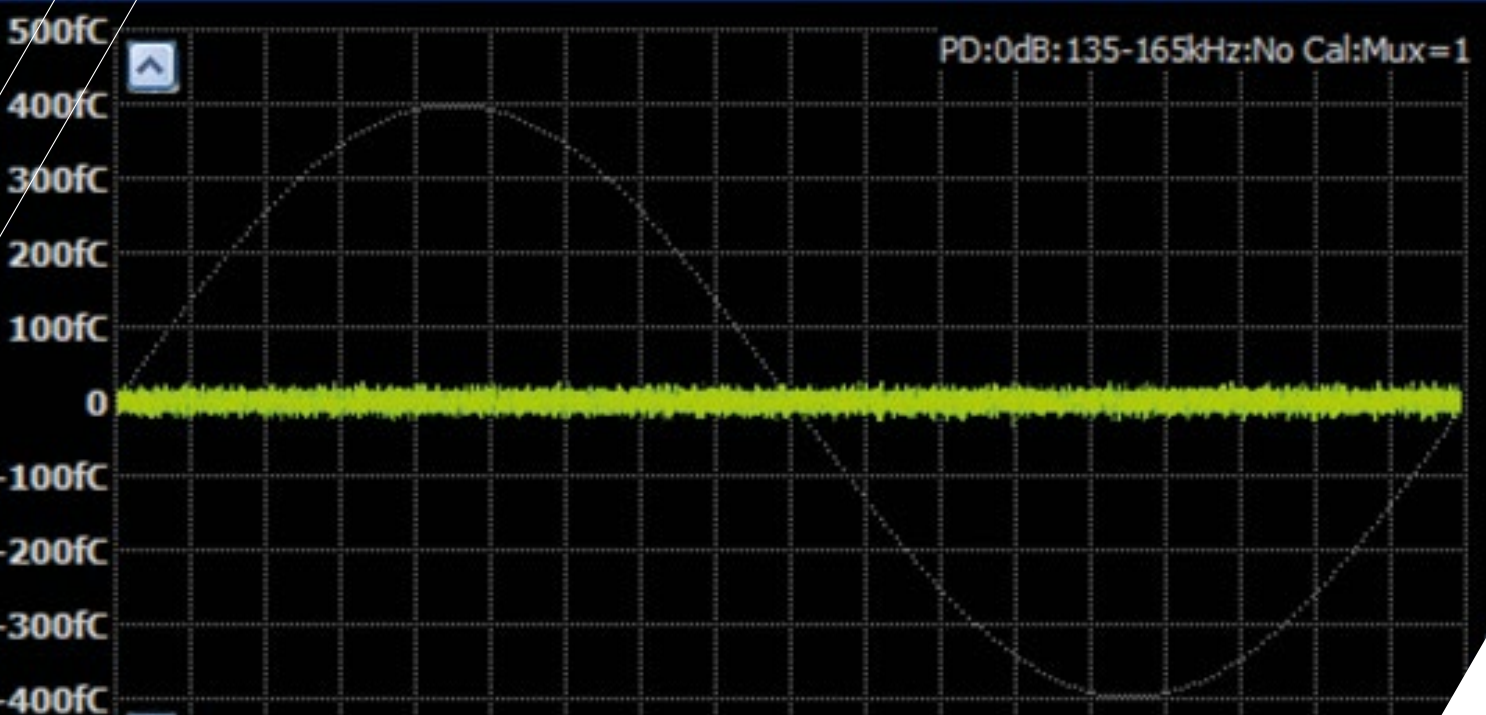


PARTIAL DISCHARGE



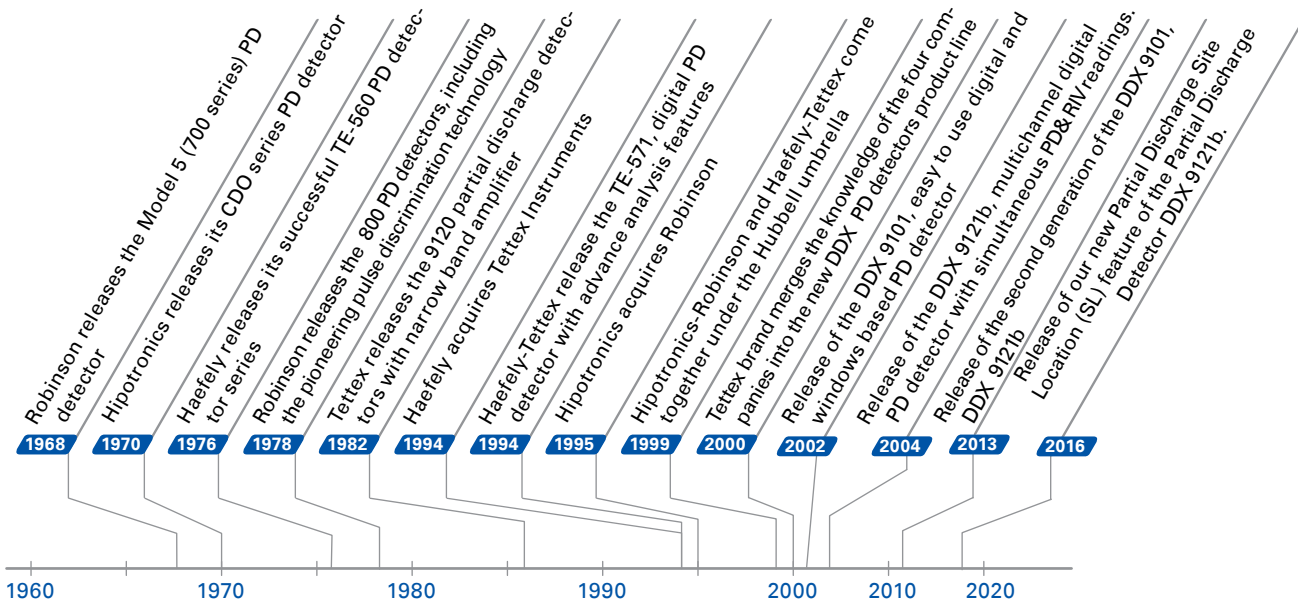
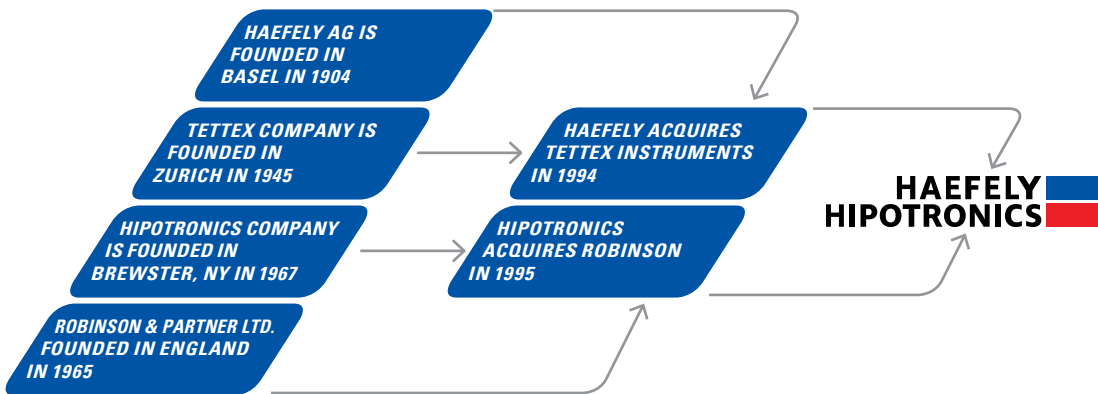


CONTENT

| | |
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| Standard configurations | 13 |
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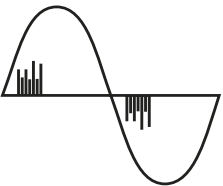
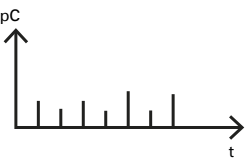
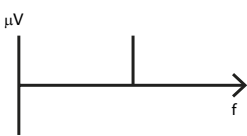

THE BEST TEAM IN THE BUSINESS

Since our merger in 1999, Hipotronics-Robinson and Haefely-Tettex melded the best of both worlds in the release of the DDX™ Series of Partial Discharge Detectors, powerful yet easy to use units. Our partial discharge product offering includes all one needs for factory testing. When it comes to partial discharge testing, you can't beat the Haefely Hipotronics instruments team.



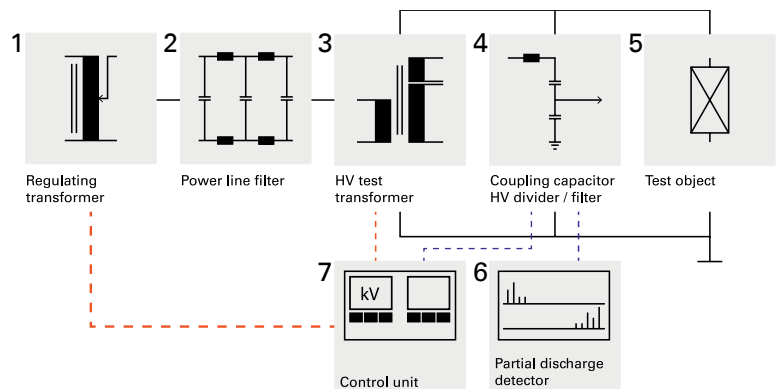


PRODUCT LINE OVERVIEW

| | DDX-9101 | DDX-9121b |
|---|----------|-----------|
|  <p>Partial discharge AC</p> | • | • |
|  <p>Partial discharge DC</p> | | • |
|  <p>Radio Interference Voltage (RIV)</p> | | • |
|  <p>PD Cable Site Location</p> | | • |

PARTIAL DISCHARGE MEASUREMENT

Partial discharge testing is a standard method of determining the quality of electrical insulation. Partial discharges can be caused by poor design, manufacturing faults, mechanical damage, aging, etc. The ability to measure low levels of partial discharges is referred to as sensitivity. As partial discharges happen inside the test object, only indirect effects can be quantified. Back in 60's the general layout (see beside diagram) and technical specifications of the measuring device were defined. The IEC60270, successor to the earlier standards, specifies the today's requirements to perform a reliable partial discharge test. Special care has to be taken in fulfilling all requirements, because wrong results can be caused by non conforming test layout or configurations.



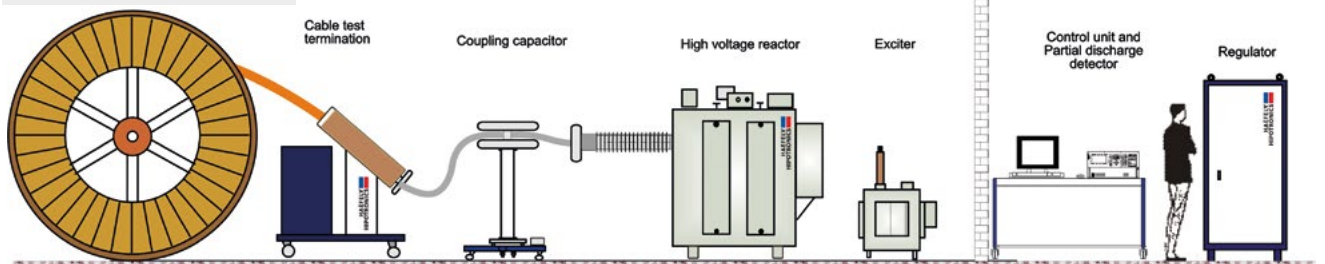
1. Regulating transformer
2. Line filter
3. High voltage transformer
4. Coupling capacitor
5. Test object
6. Partial discharge detector
7. Control unit

PARTIAL DISCHARGES AND NOISE

A partial discharge is a small current pulse which circulates inside the circuit created by the test object, the coupling capacitor and the measuring impedance. Electrical interferences, if large enough, could affect the sensitivity of the measuring system. Although several techniques exist for noise reduction, the optimization of the test circuit is the most efficient procedure to increase the sensitivity.

Our long experience of more than 50 years performing partial discharge test will provide you with the best solution to fulfill your particular needs.

Radiated Noise picked by the measurement loop. Reducing measuring loop inductance will help



Induced noise, coming through the mains, band-rejecting filters could help.

Ground Noise, coming from ground circulating currents, independent earthing could help

MEASURING BAND

The frequency measuring band affects drastically the partial discharge test. A measurement band which is within the IEC or ANSI requirements has to be selected to get reliable measuring results. All our detectors measure within the IEC/ANSI defined frequency band.

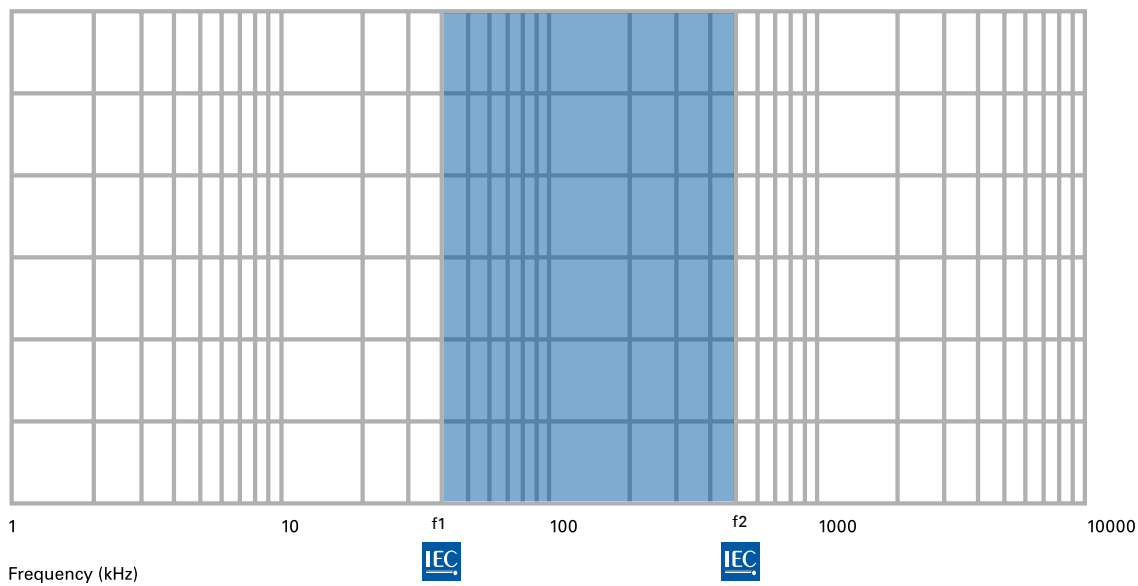
IEC60270 RECOMMENDED VALUES

| | | |
|---------|-----------------|----------------|
| 30 kHz | $\leq f_1$ | ≤ 100 kHz |
| | f_2 | ≤ 1 MHz |
| 100 kHz | $\leq \Delta f$ | ≤ 900 kHz |

f_1 = Lower limit frequency

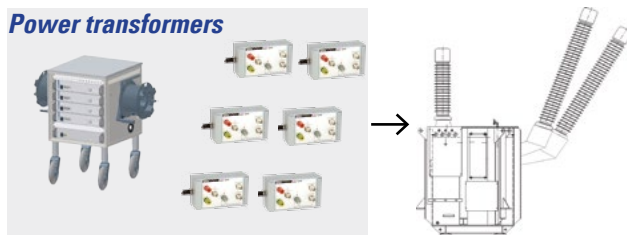
f_2 = Upper limit frequency

Δf = Measurement band

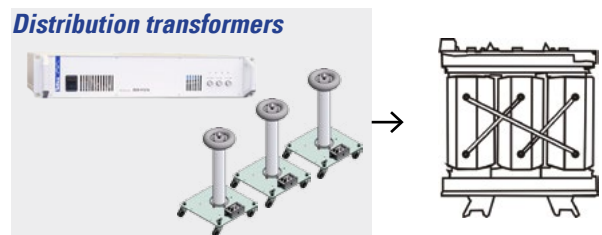


APPLICATIONS

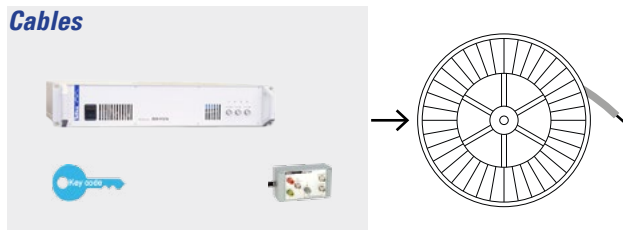
Power transformers



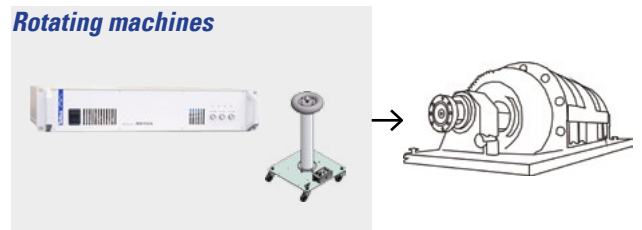
Distribution transformers



Cables



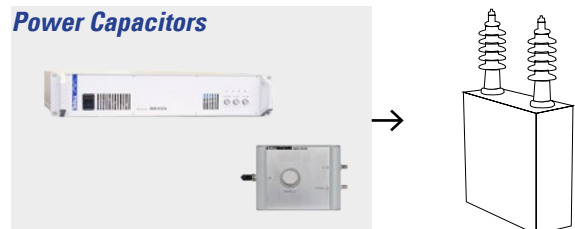
Rotating machines



Instrument transformers



Power Capacitors





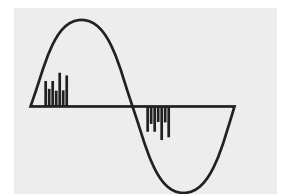
DDX 9101

DIGITAL PD DETECTOR

The DDX 9101 is the ideal solution for pass/fail partial discharge testing; incorporating all the basic functions of an analog detector and meeting all IEC and IEEE/ANSI standards for PD testing. This simple-to-use detector is controlled via 8 control buttons on the front panel. With the data acquisition/remote control software you can record PD pulses and create test reports easily.

APPLICATIONS:

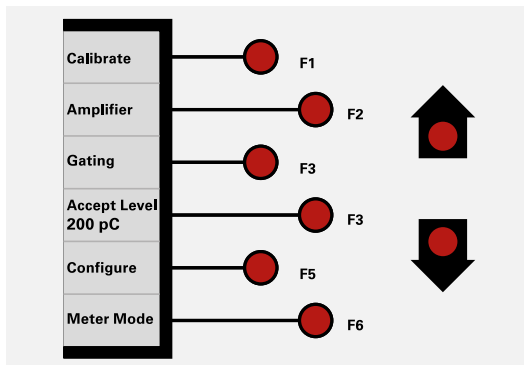
- Distribution Transformers
- Current and Potential Transformers
- Rotating Machines
- Power Capacitors
- Switchgears
- Surge Arrestors
- Research & Development



Partial discharge AC

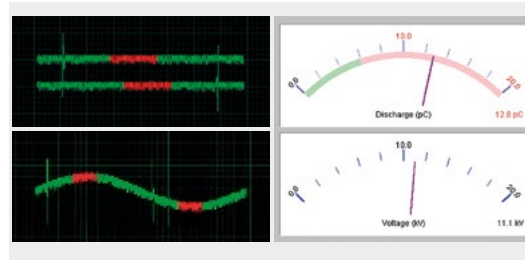
ALL IN ONE

A 3U height rack unit contains all you need to perform a PD test. The digitalizer, the computer, the screen and the control keys are all included. No additional hardware needed beyond the coupling capacitor.



TWO GRAPHICAL MODES

Two graphical modes are available to view the test results: meter mode and scope mode. The threshold shown graphically (in color) together with different meter modes makes monitoring of the test results simple.



SIMPLE TO USE

Calibrate the measurement setup, set the maximum acceptable PD level and you are ready to start the test. Once the voltage is applied, an indicator on the screen tells you if the test object passed or failed the test.

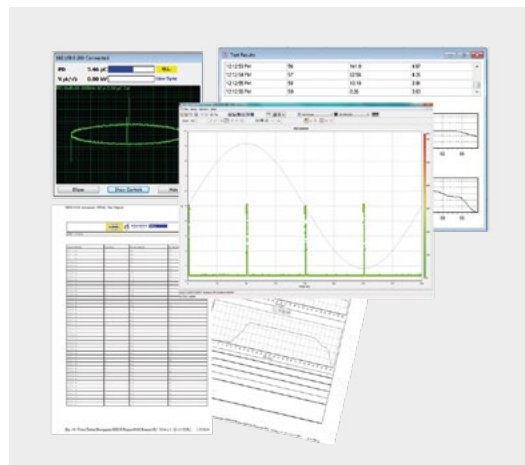


DDX9106a 3 CHANNELS MULTIPLEXER

An optional 3 to 1 manual multiplexer in a separate housing stackable with DDX 9101 allows manual switching, for example while testing distribution transformers.

DATA ACQUISITION & ANALYSIS

The optional advanced data acquisition and analysis software allows a wide variety of possibilities like recording PD pulses occurring during each and every test voltage cycle and analyzing them both in the time and phase domain.





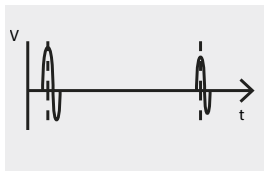
DDX 9121b

MULTICHANNEL DIGITAL PD DETECTOR

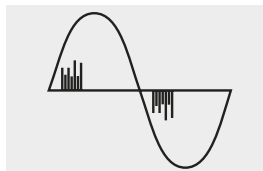
The DDX 9121b is the latest in the DDX family for partial discharge & radio interference voltage testing. With the DDX 9121b you can setup, control, test, monitor and generate test reports from a single computer. Its modular design makes the DDX 9121b flexible for any application. From single measuring input to simultaneous 9 measuring inputs. From traditional partial discharge according to IEC60270 to RIV measurement or PD under DC. From pass/fail test to advance phase resolution time analysis. The DDX 9121b includes all you need, and has all you want.

APPLICATIONS:

- Power and Distribution Transformers
- Instruments Transformers
- Rotating Machines
- Power Capacitors
- Switchgears
- Surge Arrestors
- Research & Development
- Cables



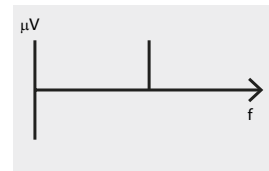
PD Cable Site Location



Partial discharge AC



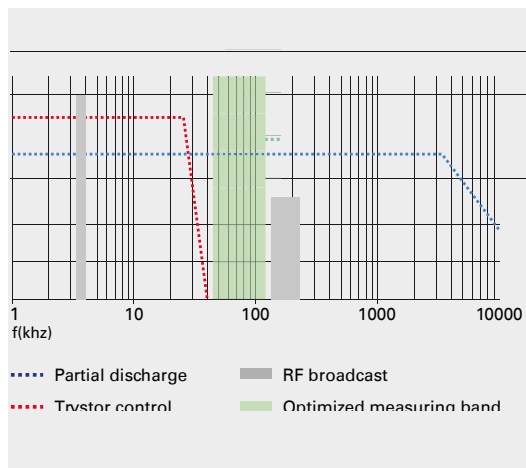
Partial discharge DC



RIV

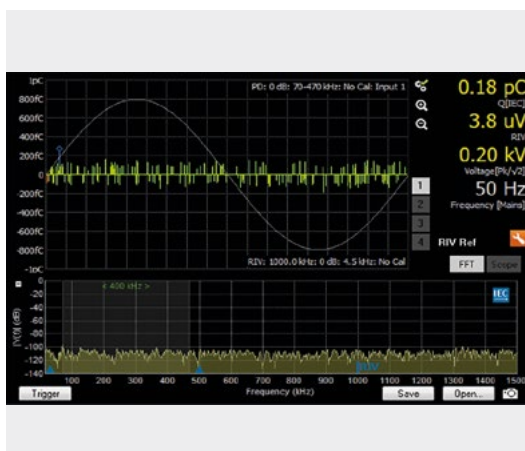
INCREASE THE SENSITIVITY

The built in frequency spectrum analysis and selectable frequency band let you optimize your setup in seconds.



USER ORIENTED INTERFACE

The user interface has been designed to make PD readings easy. All options are grouped by categories, and the scope window shows all test related information. Even specific colors have been selected to reduce the strain on the user's eyes during long term testing.



MODULAR DESIGN

For normal partial discharge test on single phase test objects the basic DDX 9121b is equipped with one measuring input. For distribution transformers, the DDX 9121b/SKMX option (enable by software code) add an embedded manual switch.

For three phases test (for example power transformers), several detectors (up to 9) can be combined and connected to a single computer providing simultaneous PD readings. Trolley on wheels for multi-detector configurations, trolley can be located in the test room and connected to the computer through fiber optic cables.



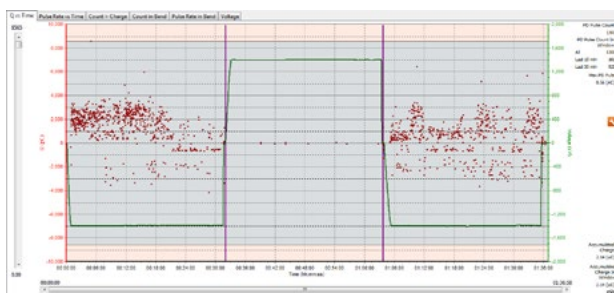
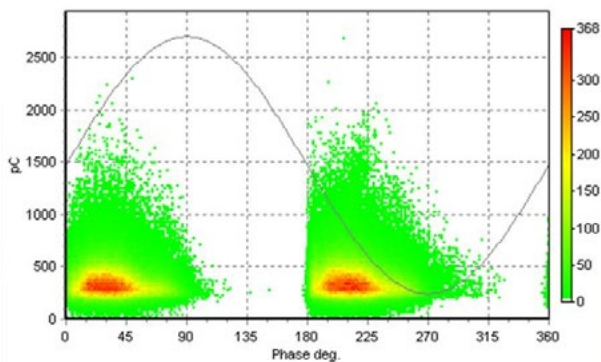
PD CABLE SITE LOCATION

The DDX 9121b-SL function is a significant advancement in PD site location. Thanks to the pre-set automated cursors it is not only extremely easy to use, but its real-time display window and data averaging function renders insignificant the background noise by increasing the Signal to Noise Ratio (SNR). Thanks to the sampling rate 100 MS/s (interpolated) and minimum time resolution 10 ns, approximately 1 m resolution is possible.

PD INTERPRETATION

The advanced data acquisition and analysis software allows a wide variety of possibilities such as recording PD pulses of each and every test voltage cycle and analyzing them both in the time and phase domains.

With the pattern acquisition and analysis module, several two- and three-dimensional PD pulse patterns of all the monitored channels (when equipped with a multiplexer) can be displayed and recorded. Snap shots of the 3D patterns can be saved into a windows gallery for further use like generation of customized test reports.



SIMULTANEOUS PD AND RIV LEVELS

Both RIV voltage (mV, according to NEMA 107-1987) and partial discharge (pC, according to IEC 60270) measurements are done simultaneously, therefore both are performed in a single test without over-stressing the test object. In addition, real time comparison between PD level and RIV is possible.

PD UNDER DC

While measuring with PD on DC test voltage, an accurate recording of each PD event is of maximum importance. The DDX 9121b is a trusty device while doing this particular test.

ANALOG OUTPUTS

Analog outputs allow connecting any external device for further post-processing of raw data for e.g. external oscilloscopes, data loggers etc. Outputs might be used also for triggering the PD signal during the acoustic PD fault location with external oscilloscope.

- **Signal-** PD Amplifier Output (raw signal, bandwidth limited by measuring setup)
- **Filter-** Digital PD Filter Output (filtered signal, bandwidth defined by remote software settings)
- **Trigger-** 3.3 V TTL Output (triggering by phase position or pulse amplitude as defined by remote software settings)

DDX 9121b-1




DDX 9121b-1/RIV



DDX 9121b/ TROLL



STANDARD CONFIGURATIONS



| | DDX 9121b-1 | DDX 9121b-1/RIV | DDX 9121b-3 | DDX 9121b-3/RIV | DDX 9121b-4 | DDX 9121b-4/RIV | DDX 9121b-6 | DDX 9121b-6/RIV | DDX 9121b-8 | DDX 9121b-8/RIV |
|--|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|
| Simultaneous PD inputs | 1 | 1 | 3 | 3 | 4 | 4 | 6 | 6 | 8 | 8 |
| Non-simultaneous PD inputs Option DDX 9121b/SKMX | Opt 4 | Opt 3 | Opt 12 | Opt 11 | Opt 16 | Opt 15 | Opt 24 | Opt 23 | Opt 32 | Opt 31 |
| Simultaneous RIV inputs | Not | 1 | Not | 3 | Not | 4 | Not | 6 | Not | 8 |
| Non simultaneous RIV inputs Option DDX 9121b/SKMX | Not | Opt 3 | Not | Opt 11 | Not | Opt 15 | No | Opt 23 | Not | Opt 31 |
| PD on DC Option DDX 9121b/SKDC | Opt | Opt | Opt | Opt | Opt | Opt | Opt | Opt | Opt | Opt |
| Phase resolve analysis | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Spectrum analyzer and scope | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Selectable measuring band | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Opt -> Option

Other configurations than the ones below in regards to number of detectors or options are available upon request.

RIV calibrator included in the device picture is required

OPTIONS

DDX 9121b/SKMX

Software key to enable the 4 embedded non-simultaneous inputs

DDX 9121b/SKDC

Software key to enable PD measurement under DC

DDX 9121b/TROLL

Trolley on wheels for multi-detector configurations, trolley can be located in the test area and connected to the computer (control room) through fiber optic cables

DDX 9121b/SKSL

Software key to enable PD Site Location

DDX 9121b/FO

Fiber optic adapter to connect the DDX9121b and the computer

LAPTOP

Laptop with DDX 9121b software preinstalled and configured. Windows 7 in English included.

PARTIAL DISCHARGE TESTING ACCESSORIES

MEASURING IMPEDANCES

The coupling capacitor together with the coupling impedance separates the PD pulses (high frequency) from the normal AC signal (low frequency).

| | AKV 9310 | AQS 9110a | AKV 9330 |
|-----------|----------|-----------|----------|
| DDX 9101 | | • | |
| DDX 9121b | • | | •* |

* only for power capacitors application

AKV 9310 The AKV 9310 measuring impedance is a fully passive measurement system optimized for use with the DDX 9121b. It is equipped with an internal voltage divider and a dedicated 4mm output connector for an external low-arm device.

AKV 9310



AQS 9110a The AQS 9110a measuring impedance is a fully passive measurement system optimized for use with the DDX 9101. It is equipped with a user selectable three positions internal voltage divider.

AQS 9110a



AKV 9330 The AKV 9330 is used for PD testing of large power capacitors. It is an ideal IEC 60270 compliant solution for this particular application.

AKV 9330



RIV CALIBRATORS

KAL 9530 The RIV calibrator KAL 9530 has been designed to perform an RIV calibration together with our DDX 9121b PD detector. The unit injects a calibration signal at the desired frequency into the test object through a specially designed RIV calibration set (cable set, probe and clamp).



PARTIAL DISCHARGE CALIBRATORS

KAL 9510 The KAL 9510 is a basic PD calibrator covering most of the common demands. It fulfills IEC 60270 requirements. Pulse output range is from 1 pC to 50 nC and it provides internal and external synchronization.

Haefely Hipotronics is accredited to calibrate and certify PD calibrators according IEC 17025, an SCS certified. A calibration certificate can be delivered optionally with the KAL 9510.



KAL 9520 The KAL 9520 has been designed to exceed the normal requirements of a PD calibrator. Its wide range (from 100fC to 50nC), its small injection capacitor and its advanced features (double pulse, polarity pulse selection, internal and external synchronization, linear range selection, etc) make the KAL 9520 unique.

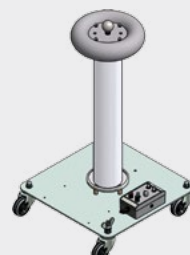
Haefely Hipotronics is accredited to calibrate and certify PD calibrators according IEC 17025. A calibration certificate can be delivered optionally with the KAL 9520 and it can be used by inspectors and quality departments to easily perform a PD installation performance check.

9230

COUPLING CAPACITORS

Coupling capacitors is a part of the partial discharge measuring circuit. A closed loop for the high frequency PD signals is established between the test object and the coupling capacitor. The PD pulses are then captured by the measuring impedance and brought to the PD detector.

9230



VOLTAGE*

CAPACITANCE*

COUPLING
IMPEDANCE

| | VOLTAGE* | CAPACITANCE* | COUPLING IMPEDANCE |
|-----------------------------|----------|--------------|-----------------------|
| 9230/25/1-AQS9110a | 25kV | 1nF | AQS 9110a |
| 9230/25/1-AKV9310 | 25kV | 1nF | AKV 9310 |
| 9230/50/1-AQS9110a | 50kV | 1nF | AQS 9110a |
| 9230/50/1-AKV9310 | 50kV | 1nF | AKV 9310 |
| 9230/100/1-AQS9110a | 100kV | 1nF | AQS 9110a |
| 9230/100/1-AKV9310 | 100kV | 1nF | AKV 9310 |
| 9230/100/10-AQS9110a | 100kV | 10nF | AQS 9110a |
| 9230/100/10-AKV9310 | 100kV | 10nF | AKV 9310 |
| 9230/200/1-AQS9110A | 200kV | 1nF | AQS 9110a |
| 9230/200/1-AKV9310 | 200kV | 1nF | AKV 9310 |

*other voltages or capacitances
on request

TECHNICAL SPECIFICATIONS

DDX 9101

Amplifier

| | |
|---------------------|---|
| Gain (Attenuation) | 0 dB to 75 dB in 5 dB steps |
| Attenuator Accuracy | 1% |
| Gain | 3000 |
| Input Impedance | 50 Ω |
| System Noise | < 12 μV referred to input on highest gain range |
| Filters | High Pass-20, 30, 50, 60, 80 kHz |
| | Low Pass-100, 200, 400, 500 kHz |

PD Measurement

| | |
|---------------------|----------------------|
| PD Meter Resolution | 10 bits displayed |
| PD Capture | 8 bits (7 plus sign) |
| Phase Resolution | 0.1% |
| Linearity Error | < 1% |

Voltage Measurement

| | |
|-----------------------------|------------------------------------|
| Uncertainty of Scale Factor | < 1% |
| Linearity (10-100% FS) | < 1% |
| Resolution | 11 bits |
| Measurement modes | Peak/√2, true RMS |
| Synchronization | Local Mains, HV source (automatic) |
| Sync Lock range | 20 Hz to 400 Hz |

Mechanical

| | |
|--------------|---------------------------|
| Weights | 5 kg |
| Dimensions | 19" 3 U case, 280 mm deep |
| Power Supply | 100-240 V, 40-70 Hz |

DDX 9121b

Amplifier

| | |
|---------------------|---|
| Gain(Attenuation) | 0 -20dB -40dB |
| Attenuator Accuracy | 1% |
| Gain | 9000 |
| Input Impedance | 50Ω |
| Frequency band | 30kHz-1.5MHz (-6dB) |
| System Noise | < 0.1 pC |
| Filters (IEC) | Center frequency and band, Available BW |
| | -4, 4.5, 9kHz |
| | -10 to 100 kHz in 10 kHz steps |
| | -100 to 500 kHz in 50 kHz steps |
| | -0.6 to 1 MHz in 100 kHz steps |
| Filters (IEEE) | 100-300 kHz |

PD Measurement

| | |
|---------------------|----------------------|
| PD Meter Resolution | 10 bits displayed |
| PD Capture | 8 bits (7 plus sign) |
| Phase Resolution | 0.1% |
| Linearity Error | < 1% |

Voltage Measurement

| | |
|-----------------------------|------------------------------------|
| Uncertainty of Scale Factor | < 1% |
| Linearity (10-100% FS) | < 1% |
| Resolution | 11 bits |
| Measurement modes | Peak/ $\sqrt{2}$ true RMS |
| Synchronization | Local mains, HV source (automatic) |
| Sync Lock range | 20 Hz to 400 Hz |

RIV measurement

| | |
|--------------------------------|----------------------------------|
| Measurement frequency range | 850 to 1150 kHz |
| Bandwidth | 9 kHz (-6 dB) |
| Output level | 1 mV onwards |
| RIV system linearity (1 range) | < 2% FSD |
| Quasi peak detector response | As per NEMA 107, ANSI C63.2-1996 |

Mechanical (per detector)

| | |
|--------------|----------------------------|
| Weight | 6.2 kg |
| Dimensions | 19" 3 HU case, 340 mm deep |
| Power Supply | 90–260 V, 47–63 Hz |

ACCESORIES**Impedances****AKV 9310**

| | |
|--------------------------|------------------------------------|
| Max. Current | 3 A |
| PD upper limit frequency | >8 MHz |
| Mechanical dimensions | 90 mm x 160 mm x 80 mm (W x L x H) |

AQS 9110a

| | |
|--------------------------|-------------------------------------|
| Max. Current | 6 A |
| PD upper limit frequency | >5 MHz |
| Mechanical dimensions | 160 mm x 260 mm x 90 mm (W x L x H) |

AKV 9330

| | |
|--------------------------|-------------------------------------|
| Max. Current | 300 A |
| PD upper limit frequency | >8 MHz |
| Mechanical dimensions | 160 mm x 130 mm x 70 mm (W x L x H) |

Calibrators

KAL 9510

| | |
|-----------------|-------------------------------------|
| Range | 1 pC to 50,000 pC (50 nC) |
| Pulse Polarity | positive, negative |
| Basic Functions | 2 pulses/cycle, PRF 15 - 250 Hz |
| Dimensions | 120 mm x 200 mm x 42 mm (W x L x H) |

KAL 9520

| | |
|--------------------------|---|
| Calibration pulse ranges | 100 fC to 50 nC (any value) |
| Pulse Polarity | positive, negative, bipolar |
| Basic Functions | Double Impulse, Impulse Burst Mode, 1-12 pulses, PRF 0.1-600 Hz |
| Dimensions | 120 mm x 200 mm x 35 mm (W x L x H) |

KAL 9530

| | |
|------------|--|
| Frequency | 850-1150 kHz |
| Amplitude | 50-3000 uV |
| Waveform | Sine |
| Dimensions | 3 RU unit (19" standard rack); 340 mm deep |

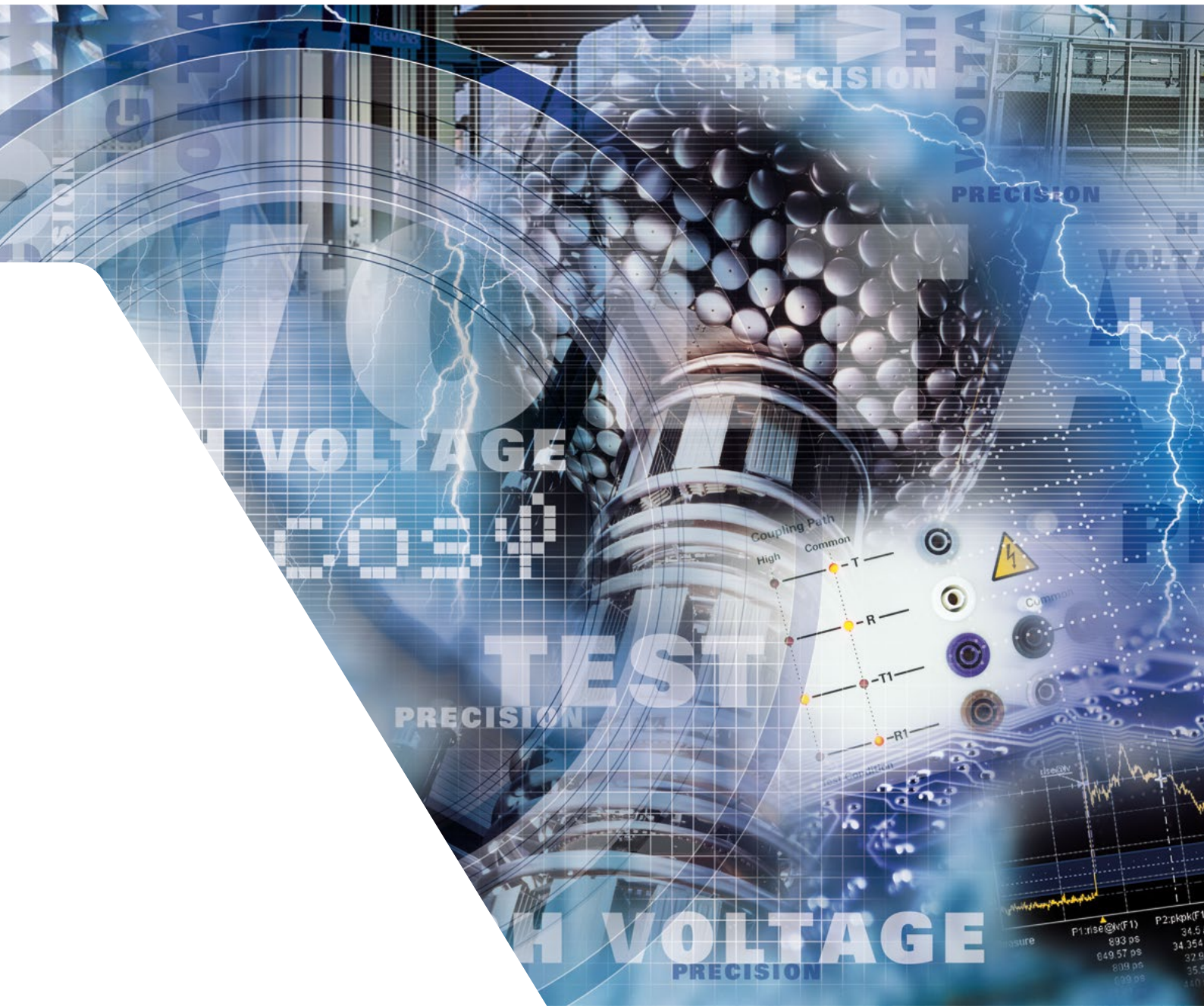
Coupling capacitors



| | VOLTAGE* | CAPACITANCE | PD LEVEL AT UN | HEIGHT APPROX. |
|-------------|----------|-------------|----------------|----------------|
| 9230/XX/25 | 25kV | 1nF | ≤ 1 pC | 619 mm |
| 9230/XX/50 | 50kV | 1nF | ≤ 1 pC | 619 mm |
| 9230/XX/100 | 100kV | 1nF/10nF | ≤ 1 pC | 896 mm |
| 9230/XX/200 | 200kV | 1nF | ≤ 1 pC | 1322 mm |

All coupling capacitors include a suitable coupling impedance.

*Voltage ratings above 200kV available on request



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