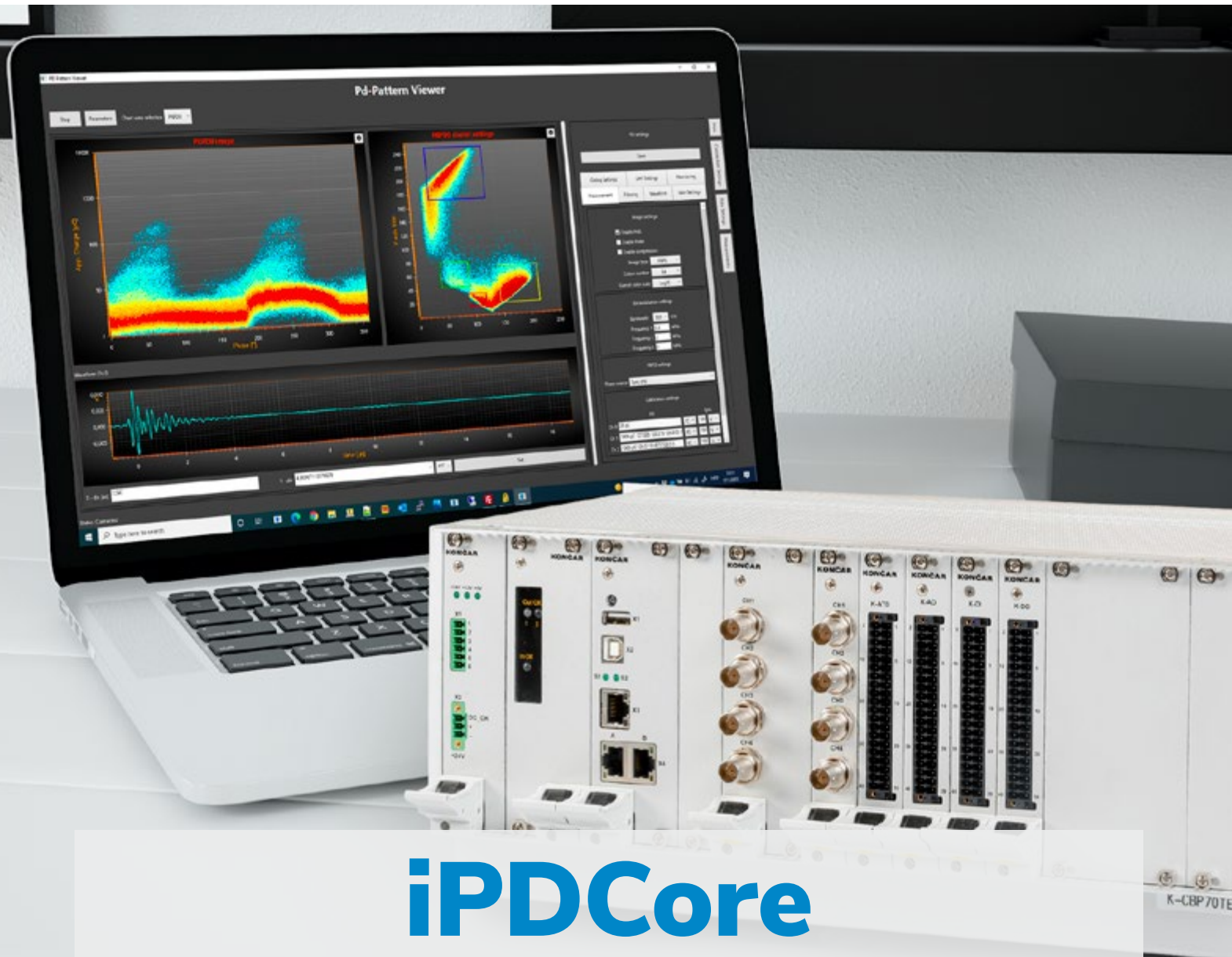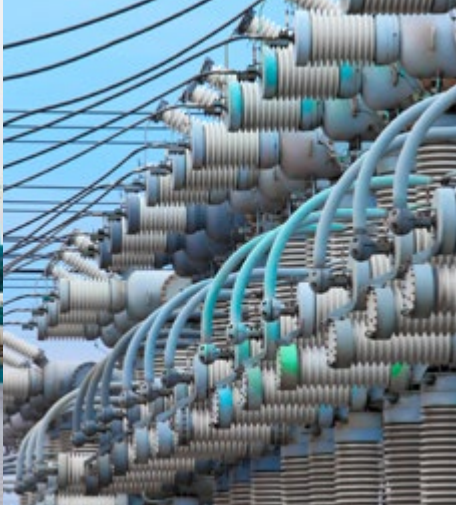# KONČAR

ELECTRICAL ENGINEERING INSTITUTE

iPDCore

PARTIAL DISCHARGE MEASUREMENT AND MONITORING SYSTEM - iPDCore

THE MOTIVATION BEHIND OUR SOLUTION

Insulation plays key role in every asset in power generation, transmission or distribution. In majority of cases, lifetime of asset is defined by its insulation state. Failure of insulation is very often accompanied with fire or explosion which leads to heavy damage of asset itself and nearby objects. This leads to great expenses due to the damage on asset and reduced availability. Every asset manager wants to minimize risks of such events and to keep maintenance expenses as low as possible.

Partial discharge activity is the earliest sign of deterioration or defects in transformers, generators, motors or cables. It is present well in advance of failure. By detecting or monitoring it, scheduled maintenance can be planned and catastrophic events avoided.

iPDCore provides insight in insulation state by measuring partial discharges activity. It comes with vast portfolio of accessories and sensors which enables measurement on every asset. Its state of the art processing algorithms provide reliable measurement results and unparalleled real-time processing performance.

iPDCore SOLUTION

- Fully synchronous high-speed acquisition
- Wide Input range
- Wide bandwidth
- Adjustable digital filtering
- Smart self-adjustable gain control in 15 levels
- State of the art fully digital signal processing from telecom technologies
- Automatic noise suppression and source separation
- Automatic PD event classification
- Real-time processing with up to 2.000.000 pulses/second per channel
- Intuitive interface and configuration
- One solution for every asset
- Compliant with latest IEC and IEEE standards
- Industrial Rugged Design operating up to +70°C

iPDCore is one solution for all types of partial discharge measurements. Built upon rugged hardware, it can be used for both indoor and outdoor applications and for measurements on every type of electrical assets such as transformers, HV cables, generators and motors. **iPDCore** is fully digital instrument characterized by synchronous, wide range and bandwidth acquisition and innovative processing algorithms. It utilizes innovative **DSync** technology used for noise suppression and PD source separation.

DSync Technology

DSync Technology is key technology used by **iPDCore** to extract spectral components of PD pulse while preserving synchronization across all channels and parallel signal processing branches across one channel. It utilizes state of the art processing algorithms originating from modern telecom infrastructure technologies. **DSync** comes from **D**emodulator**Sync**ronization. It utilizes state of the art demodulator, consisting of, but not limited to, low pass or bandpass filter and frequency mixer. Each processing branch has variable mixing frequency and bandwidth. Intuitively understandable parameters enable simple correlation with IEC60270 standard.

- Filter cut-off frequency, corresponds to measurement bandwidth of bandpass filter described in IEC60270
- Mixer frequency, corresponds to central frequency of bandpass filter described in IEC60270

DSync processing branch provides better suppression of spectral noise that is out of band of interest than common digital or analog filters used by competitors. Its superior real-time processing performance of up to 2.000.000 pulses/second, ensures that there will be no missed PD pulses like in devices currently available on the market.

Each **DSync** branch output can be used to present standard PD measurements like apparent charge, NQS and Phase Resolved PD Pattern diagram. Using outputs from simultaneously processed **DSync** branches, multi-dimensional clusters can be made and used for noise suppression and PD source separation.
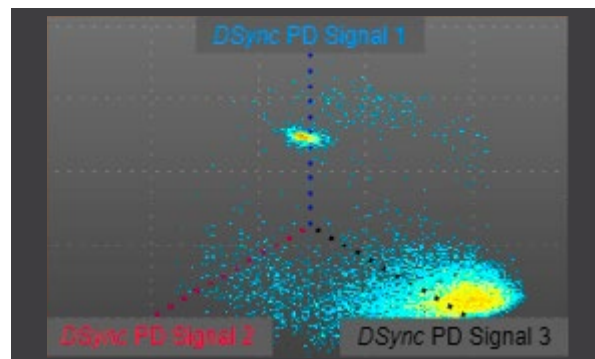
DSync Clustering

For single channel measurement, clusters are made using multiple **DSync** branches where each branch extracts spectral components from different part of spectrum. That cluster is named **DSync** Demodulator Cluster. For multi-channel measurements, additional cluster space is made using **DSync** processing branches with same **DSync** processing settings on all channels. It is named **DSync** Multi-Channel Cluster.

Dsync Demodulator Clusters*

Each PD pulse or noise can be characterized by its spectral signature. Using simultaneous measurements on different parts of spectrum, noise or different PD sources can be clustered and therefore separated and/or suppressed.

DSync Demodulator Clusters uses that fact and provide useful tool for reliable PD measurements. For visualization purposes, outputs from different **DSync** branches are vector summed where angles between consecutive branches is equal to 360°/N with N being total number of **DSync** branches. Example of single channel clustering using 3 **DSync** branches is given in the picture.

*Demodulator Clusters technology is not available in USA, United Kingdom, Germany, Austria, Switzerland, Italy and Lichtenstein.


Single channel DSync cluster formed by 3 DSync branches

DSync Multi-Channel Clusters

In 3-phase power transformer or 3-phase bank of single phase transformer, partial discharges originating in one winding, can be seen on all channels/phase. Acquired PD input signal will be higher on channel/phase that is closer to PD source and will be attenuated on channels/phases that are farther from PD source. Having that fact in mind, **DSync** Channel Clusters are formed and can be used to suppress noise or separate PD sources.

For visualization purposes, outputs from different **DSync** branches are vector summed where angles between consecutive branches is equal to 120°. Block scheme is shown on diagram below.
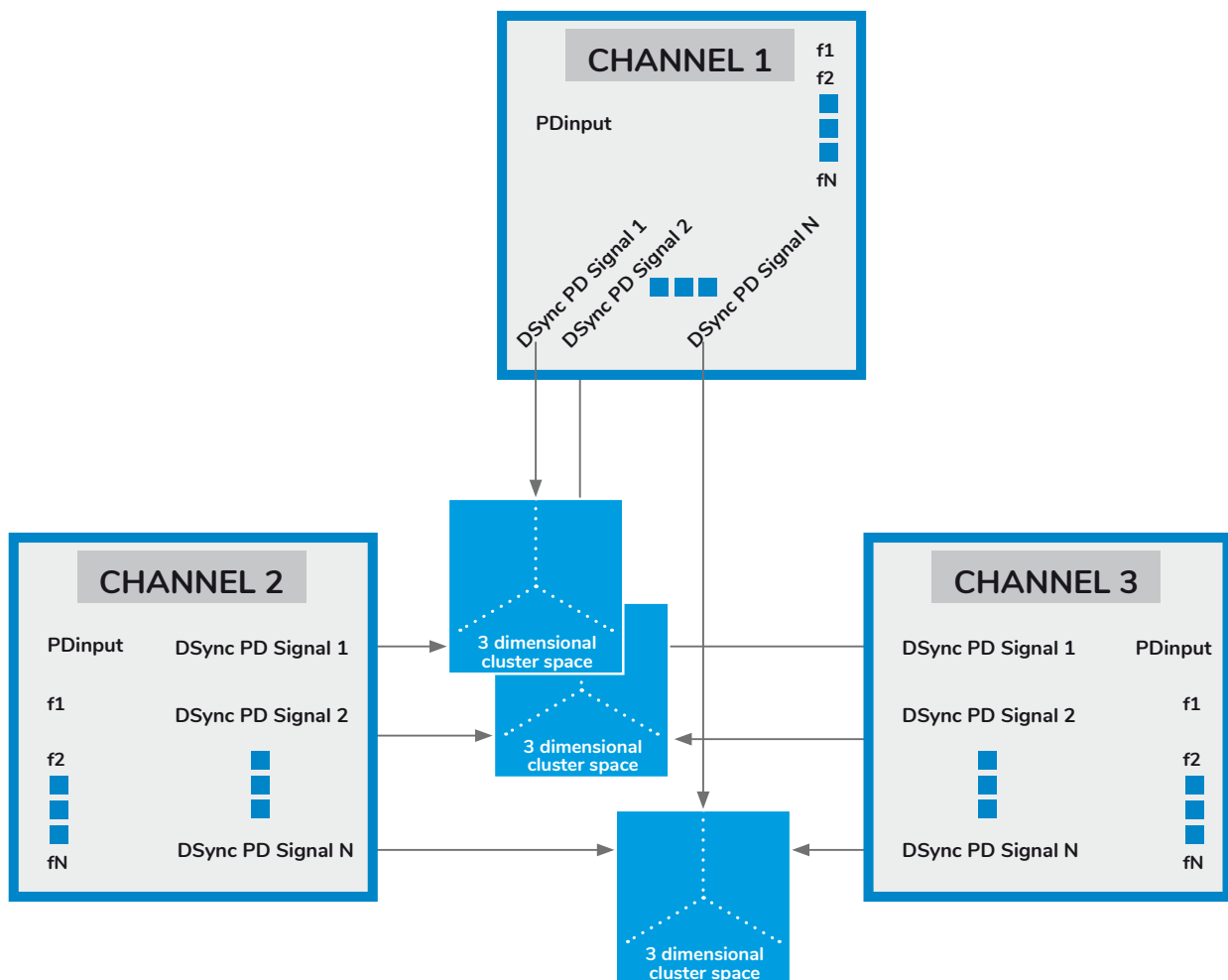
Channel cluster example which creates N 3 dimensional cluster spaces

Real-time noise suppression and source separation using DSync clusters

Not depending on which clustering, or noise suppression tools are used, iPDCore is processing them in real-time providing superior response and measurement results.
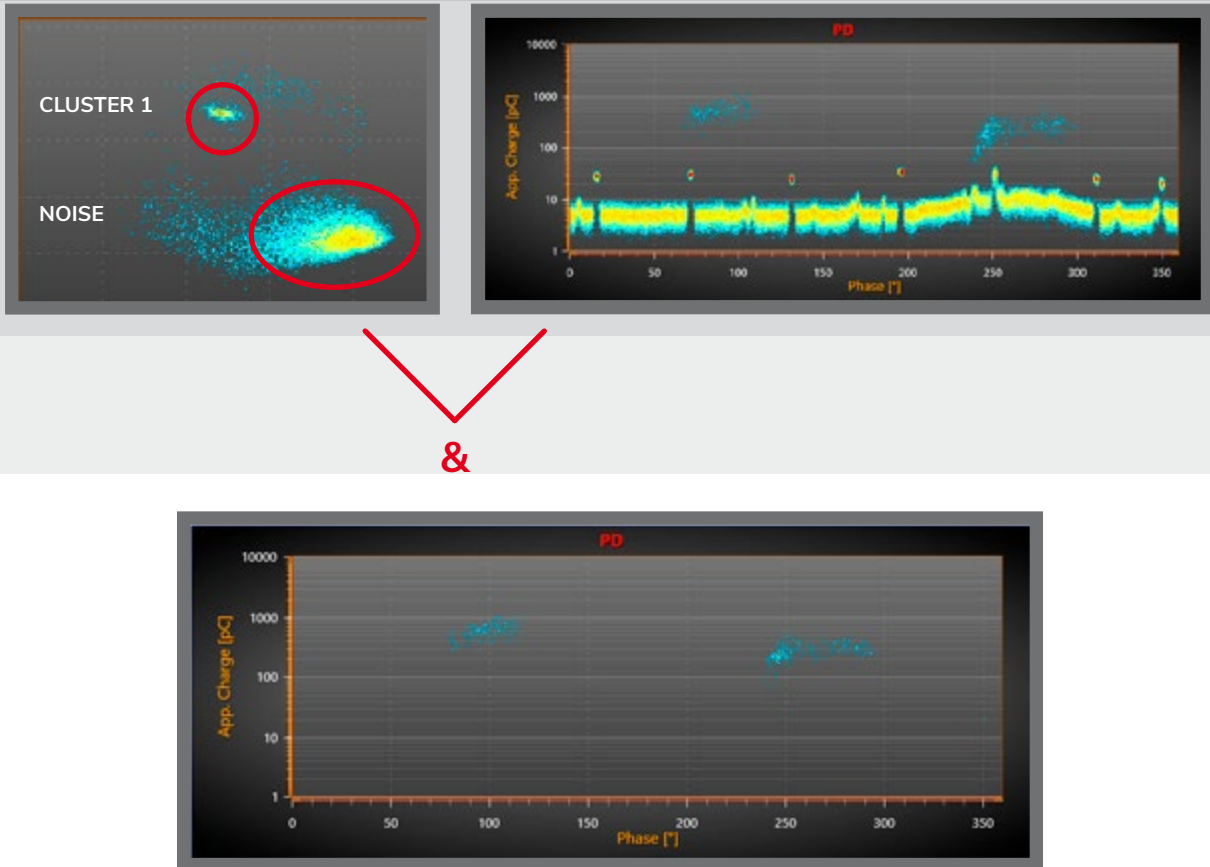
Example of single Channel Filtering using 3 DSync branches

Automatic noise suppression and source separation

Afore mentioned clustering technology provide extraordinary tool for noise suppression and source separation, but when it comes to monitoring devices, process of selecting and using clustering technology must be automated. Although, cluster selection can be manual when using iPDCore as laboratory or portable instrument, iPDCore provides automatic clustering technology using latest machine-learning algorithms. Phase-Resolved PD Patterns gathered using clustering, can additionally be classified using automatic PD Pattern classifier.

Intuitive configuration and visualization using iPDViewer

Real-Time data processing and high-speed connectivity interfaces enables fluent and eye-friendly visualization of PD measurements. Each instrument is equipped with default Gigabit Ethernet interface and optional Wi-Fi Interface. High resolution PRPD patterns or clusters are simultaneously generated for all channels at very high frame rate.
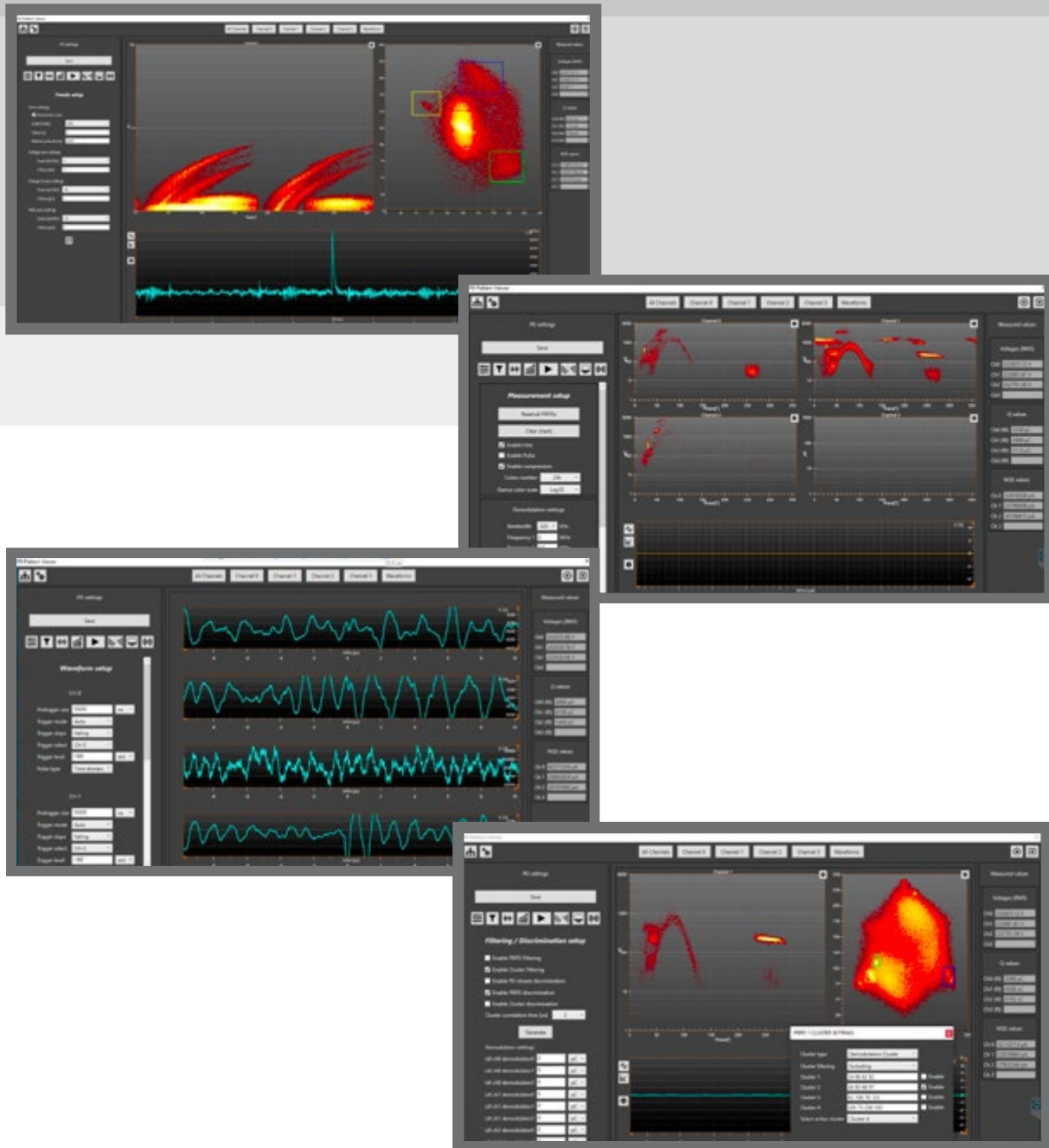
iPDViewer screenshot

MULTIPLE ACCESSORIES AVAILABLE IN iPD PRODUCT FAMILY

Sensors

iPD VDBD

VDB-D is coupling impedance used to connect iPD Core to coupling capacitor, bushing or capacitive instrument transformer. It synchronizes PD measurements with DUT or asset applied voltage. When used for decoupling signals from bushings, test-tap adapters must be used. Test-tap adapters are available for various bushing types.

SPECIFICATIONS	
Capacitance range	150nF – 10uF
	Other ranges are available on request
U Output Voltage Range	0 – 300Vpp
PD output frequency range	20kHz to 7 MHz
U and PD connectors	BNC or TNC
Input connector	Banana 4mm Fixed cable gland
Overvoltage Protection	150Vpp
Dimension	120x120x90 mm
Weight	1.9 kg
Operating temperature range	-40°C – 90°C

iPD HF50

iPD HF50 is a medium size split core high frequency current transformer used for sensing PD pulses. It can be connected around grounding strap of DUT or shield of medium and high voltage cables.

SPECIFICATIONS	
Bandwidth	70kHz to 50 MHz
Saturation current	200 A
Transfer impedance	14mV/mA
Opening diameter	50mm
Dimension(φ x Height)	145x36 mm
Weight	0.85 kg
Working temperature	-40°C – 90°C

iPDCore

iPD HF100

iPD HF100 is large size split core high frequency current transformer used for sensing PD pulses. It is typically used for measurements on large diameter high voltage cables.
Available from Q2 2024

SPECIFICATIONS	
Bandwidth	100kHz to 50 MHz
Saturation current	250 A
Transfer impedance	12.5mV/mA
Opening diameter	100 mm
Dimension	188x36 mm
Weight	1.43 kg
Working temperature	-40°C – 90°C

iPD TEV

iPD TEV is a transient earth voltage sensor used for sensing high frequency current pulses flowing around metallic casing. It is typically used for measurements on medium voltage switchgear.

| SPECIFICATIONS	
Operating principle	Capacitive sensor
Bandwidth	5MHz to 100MHz
Output connector	BNC female
Dimension	66x95x33 mm
Weight	0.230 kg
Working temperature	-40°C – 90°C
Mounting	Using permanent magnets and/or bracket

iPD-UHV100

iPD UHV100 is used for detecting internal partial discharge activity in transformers with oil/paper insulation. It decouples electromagnetic waves in UHF range and in combination with iPD-UC300 converter enables PD measurements for iPD Core. It is mounted on transformer oil valves or valve flanges. Decoupled signals can be used for UHF PD measurements and as gating method for PD measurements according to IEC60270.

SPECIFICATIONS	
Oil pressure	Max 5 bar
Bandwidth	150 MHz to 1500 MHz
Insertion Depth	55 - 450mm
Weight	4.3 kg
Flange type	DN50/DN 80 standard
	Other on Request
Working temperature	-40°C – 110°C
Connector	N-Type
IP protection	IP68
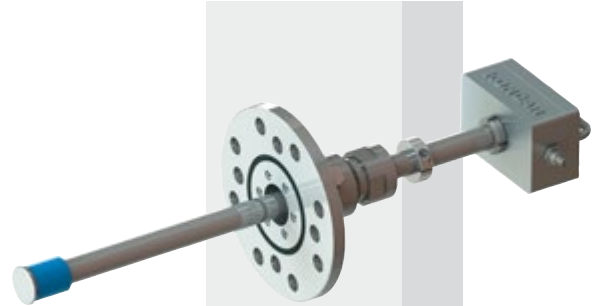
iPD UWT100

iPD UWT100 is used for detecting internal partial discharge activity in transformers with oil/paper insulation. It decouples electromagnetic waves in UHF range and in combination with iPD-UC300 converter enables PD measurements for iPD Core. It is mounted on dielectric window which is welded on transformer tank during production. Decoupled signals can be used for UHF PD measurements and as gating method for PD measurements according to IEC60270.

SPECIFICATIONS	
Oil pressure	Max 5 bar
Bandwidth	150 MHz to 1500 MHz
Weight	4.3 kg
Working temperature	-40°C – 110°C
Connector	N-Type
IP protection	IP68

iPDCore

iPD UC300

iPD UC300 is used as frequency down converter for UHF PD measurements. It adapts UHF RF signal from UHF frequency range to frequency range acceptable by iPD Core. It has switchable low-noise preamplifier and high dynamic range RF detector. There are 2 versions of the device: Lite and Full version*. The Lite version detection range is wideband and cannot be adjusted. The Full version* has programable UHF central frequency and bandwidth.

Available from Q1 2024

SPECIFICATIONS	
Preamplifier Gain	20 dB
Input frequency	100 MHz to 3000 MHz
Adjustable bandwidth	Wideband 100 MHz – 2GHz
	80 MHz (available in Q1 2024)
Dimension	200x120x60 mm
Weight	2.2 kg
Power Supply	24V
Operating temperature range	-40°C – 70°C

iPD TB300

iPD TB300 is used as termination box for online or periodic monitoring. It is connected to 3 capacitive couplers or bushings and contains 3 built in measuring impedances like iPD VDBD. The primary purpose of the termination box is to provide a controlled environment for connecting the PD measurement equipment to the generator's or transformer's insulation system. It helps to minimize external interference and ensures reliable and accurate PD measurements.

SPECIFICATIONS	
Capacitance range	80nF – 2uF
	Other ranges are available on request
U Output Voltage Range	0 – 300Vpp
PD output frequency range	20kHz to 10 MHz
U and PD connectors	BNC
Overvoltage Protection	150Vpp
Dimension	360x160x90 mm
Weight	4.2 kg
Operating temperature range	-40°C – 90°C

iPD CP Capacitive couplers

iPD CP Capacitive Couplers play a crucial role in PD monitoring setups by enabling the non-intrusive measurement of partial discharge activity within generator insulation systems. These couplers are specifically engineered to capture and transmit electromagnetic signals generated by PD events occurring within the monitored insulation. They find extensive application in both laboratory and on-site setups, and primarily for continuous or periodic monitoring of generators. Couplers are thoroughly tested and are compliant with IEC60270, IEEE1434, IEC60034-27-1 and IEC60034-27-2 standards

SPECIFICATIONS	
Capacitance range	80pF 1000pF
PD	<2pC
Voltage	7/16/25kV
Working temperature	-40°C – 80°C
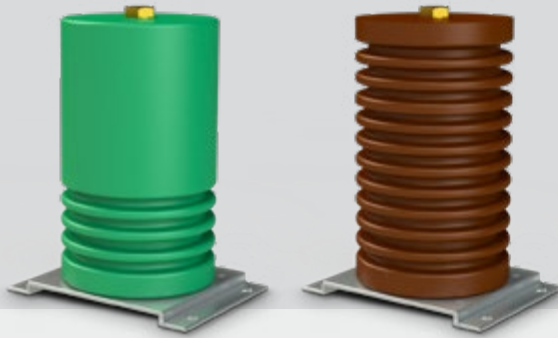
iPD Embedded GIS antenna

Will be available in Q1 2024

iPD Horn GIS antenna

Will be available in Q1 2024

iPDCore

iPD Core - Portable version

Accessories

iPD RG

iPD RG is an artificial reflection pulse generator used for cable fault localization. It is placed on HFCT at the far end of cable and when it senses PD pulses it generates large amplitude pulse. When iPD Core detects artificially generated pulse at near end of cable it can calculate cable fault location from time difference of arrival of PD pulse and artificially generated pulse.

SPECIFICATIONS	
Output amplitude	100 – 500V Other on request
Rise Time	<20 ns
Pulse Width	200-500ns
Pulse repetition rate	Adjustable Trigger based
Trigger threshold	Adjustable level Adjustable polarity
Dimension	225x125x95 mm
Weight	1.85 kg
Working temperature	-40°C – 60°C
Connector	BNC
Power Supply	110-240 VAC V-Mount Battery

iPD Inductive power Supply

Power supply used for powering iPD Core by harvesting power from HV cables.
Available from Q3 2024

iPDCore

iPD SyncTx / iPD SyncRx

Devices used to wirelessly transmit and receive information about network grid phase to provide phase input for creating PRPD diagrams at remote location where connection to grid is not possible. In some applications such as PD underground cable monitoring, connection to HV line is not possible at measurement site. In such cases, signal can be generated and transmitted from switchyard and received through RF receiver at measurement site.

SPECIFICATIONS	
Range	200 – 500 m
Output (RX)	TTL
Dimension iPD SyncRx	130x120x55 mm
Weight iPD SyncRx	0.4 kg
Dimension iPD SyncTx	180x120x55 mm
Weight iPD SyncTx	0.56 kg
Power supply	Battery 4.5V(3xAA) USB powered
Working temperature	-40°C – 60°C

iPD CPS

iPD CPS is phantom power supply used for powering acoustic emission sensor with integrated preamplifier through coaxial cable. It injects low noise DC power supply into the coaxial cable going to AE sensor and filters it on another end going to iPD Core.

SPECIFICATIONS	
Power Supply	12-30VDC
Dimension	165x140x57 mm
Weight	0.75 kg
Working temperature	-40°C – 60°C
Connector	BNC
Channels number	4

iPD CC 100

iPD-CC 100 is partial discharge calibrator. It used to apply well defined charge to DUT/asset and to calibrate PD measuring path according to IEC60270.

SPECIFICATIONS	
Charge range	20pC – 2000pC Other on request
Rise Time	<20 ns
Dimension	195x79x45 mm
Weight	0.95 kg
Working temperature	-40°C – 60°C
Connector	BNC
Battery	9V

iPD CCU200

iPD CCU200 is a partial discharge calibrator used for calibration and sensitivity checking of UHF sensors.

Available from Q1 2024

SPECIFICATIONS	
Charge range	0.5 – 5V Other on request Special terms may apply
Rise Time	<300 ps
Decay Time	<200 ns
Dimension	195x79x45 mm
Weight	0.95 kg
Working temperature	-40°C – 60°C
Connector	BNC
Battery	9V

iPDCore

Extension Modules for complete monitoring or laboratory automation solution

iPDCore can easily be upgraded with voltage/current, RTD or digital input and output modules to form a complete monitoring solution for every type of asset or to automate laboratory measurements. It is an integral part of transformer monitoring system Končar TMS as well as rotating machines monitoring system Končar MCM. **iPDCore** is also successfully implemented as a platform for automation of laboratory measurements.

AVAILABLE I/O EXTENSIONS

High Speed (5Ms/s) Voltage Inputs	Up to 16
Low Speed (100s/s) 4-20mA Inputs	Up to 85
Low Speed (100s/s) Voltage Inputs	Up to 85
Pt-100 4wire Inputs	Up to 102

Digital Inputs	Up to 136
Analog U/I Outputs	Up to 136
Relay Outputs	Up to 136
Operating temperature range	-40°C to +70°C

* All product, product specifications and data are subject to change without notice to improve reliability, function or design or otherwise.

GENERAL SPECIFICATIONS

POWER SUPPLY	90 – 264 VAC, 50 Hz 24V DC Lion Battery 98 Wh (portable instrument option). Battery life of up to 4 hours.
PHYSICAL CHARACTERISTIC (Rack version)	
Rack Format Height	3U
Rack Width	42 / 70 HP
Weight	4120g
PHYSICAL CHARACTERISTIC (Portable version)	
Width x Depth x Height	488mm x 386mm x 289mm
IP Protection	IP67
Weight	11570g
PD INPUTS	
Number of channels	4
Connector	BNC, 50 Ω
Input signal characteristics	
Input range	10 mVpp to 160 Vpp (selectable in 15 levels)
Bandwidth	20 kHz to 50 MHz
PD Measurement bandwidth	10, 20, 40, 80, 160, 320, 640 or 1280 kHz
PD Measurement Adjustable Central frequency	20kHz to 50MHz
A/D resolution per each gain level	14 bits (1.2μV in the range ±10mV)
Sampling rate	100 MS/s
Measurement Accuracy	± 2 % of calibrated value
VOLTAGE INPUTS	
Number of channels	4
Connector	(BNC, 1MΩ)
Input range	300 Vpp
Bandwidth	700kHz
A/D resolution	16 bits
Sampling rate	5 MS/s
Measurement Accuracy (20-1000Hz)	RMS ± 0.1%
	Peak ± 0.4%
FAULT LOCALIZATION	Cable lenght - up to 4000m Pulse voltage - 500V Sensors types - HFCT and/or TEV
COMMUNICATION INTERFACES	WIFI, GIGABIT ETHERNET, USB2.0
TEMPERATURE RANGE	
Operating temperature range	-40 °C to +60 °C
	(EN 60255-1:2014)
Storage temperature range	0 °C to +60 °C
Humidity	≤90%
SHOCK AND VIBRATION	
IEC 61373:2010, Category 1, Class B	
ELECTROMAGNETIC COMPATIBILITY	
EN61000-6-2:2016, EN61000-6-4:2018	

Contact us for more information!

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