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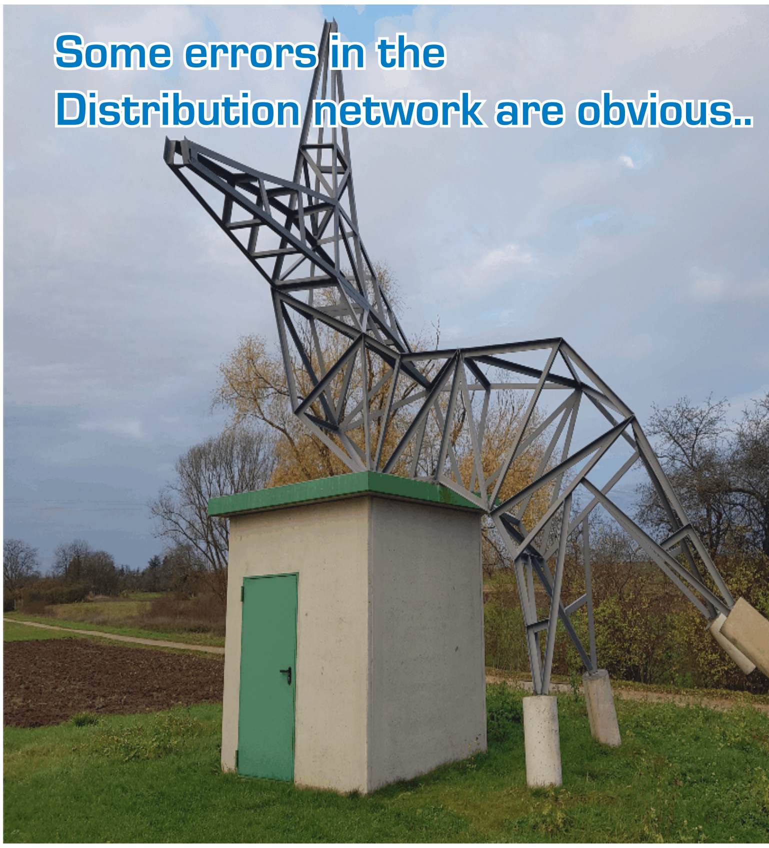


Partial discharges are the most common cause of faults in medium and high voltage systems. Our solution: CAPDIS (R5)

Measurement procedures for partial discharge detection differ not only in methodology but also in their suitability for the respective measurement location and the operating condition of the measurement object. In switchgear production, PD testing serves as a quality standard for the insulation strength of a new system and is tested under laboratory conditions, whereas such tests cannot be performed on systems in operation. Temporary PD measurements of plants in operation provide only a momentary picture, but are often not sufficient for a general risk assessment.

With partial discharge detection in CAPDIS (R5), the partial discharge level of equipment and systems can be permanently monitored and partial discharges can be detected at a stage before they lead to stationary faults and thus cause consequential damage or power failures.

If a partial discharge is detected by the CAPDIS (R5), the system can be examined in detail using an online diagnostic procedure to locate the partial discharge source..

CAPDIS (R5) with Parital-Discharge Detection

Partial-Discharge Sources

Main causes for partial discharges in medium and high voltage systems are

- Assembly errors during installation (e.g. loose connections, incorrectly installed terminations, ...),
- Insulation losses in the insulation materials (early failures due to air inclusions in casting resins, missing oil in terminations, sleeve defects due to ageing)
- Environmental influences (moisture and dust)

While partial discharges due to environmental influences occur less frequently in SF6 switchgear, they can be observed and in some cases even eliminated, especially in older air- or solid-insulated systems, provided that they are detected in time..

In gas-insulated systems, on the other hand, there are often installation failures but also the loss of insulating gas, which can lead to an increase of the partial discharge level.

The IEEE Gold Book Table 36 provides a percentage evaluation for individual components of their failures due to insulation failures caused by aging, environmental influences and wear and tear, and lack of maintenance.

Percentage of components that have failed due to insulation failure:

- Transformers 84 %
- Circuit breaker 21
- Disconnect switch 15
- Insulated busbars 95%
- Bushings 90%
- Cable 89%
- Cable sleeves 91%
- Cable terminations 87%

Capacitive signal decoupling for partial discharge detection with CAPDIS-Sx (R5)

For the decoupling of the voltage and partial discharge signal, various capacitive coupling electrodes are available.

In factory-made GIS switchgear these can be the already existing bushings which are also used for voltage testing.

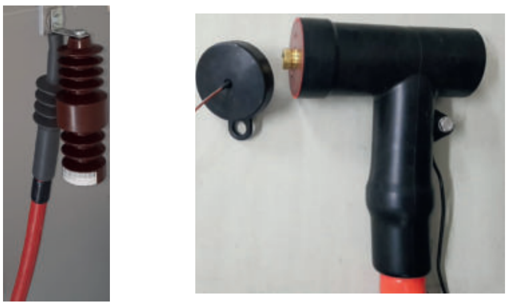
For PD detection on transformers or for retrofitting voltage testing systems on switchgear, adapter sets for elbow connectors are used, which also allow voltage testing and partial discharge detection.

In air-insulated switchgear, capacitive dividers are often installed, which capacitively decouple the voltage signal in addition to their static function. These are also well suited for PD detection.

If no capacitive coupling electrodes are available and a voltage test with or without PD detection is to be retrofitted, we offer either retrofittable coupling electrodes or capacitive sensors which can be installed on unshielded terminations.

It is recommended to provide partial discharge detection as well as voltage testing in each field of a switchgear. A partial discharge usually spreads over several fields in an installation and can usually be assigned to one field by selective switching operations.

PD can be detected at capacitive dividers and bushings

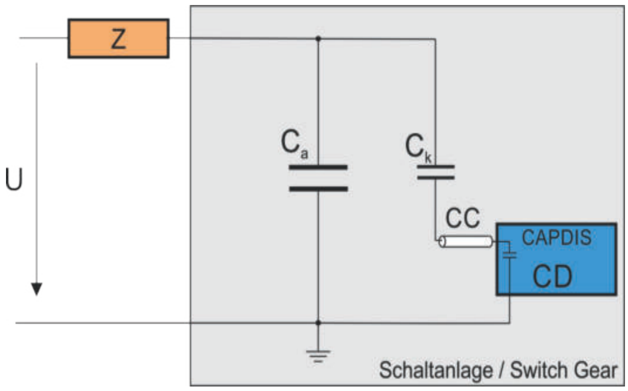


Retrofit of capacitive sensors at terminations and elbow-plugs

Capacitive decoupling by combined sensors for V and I

Partial-Discharge Detection according DIN EN 60270 (VDE 0434)

The PD measurement method in CAPDIS is derived from EN 60270 (VDE 0434) and, like the voltage measurement in CAPDIS, is based on the capacitive decoupling of the signals via a coupling capacitor Ck. However, the partial discharge signal is a high-frequency signal (30 kHz to some MHz), which is superimposed on the 50 Hz (60 Hz) useful signal for voltage testing. The coupling capacitor Ck is the capacitive tap (also known as C1), which also decouples the voltage test signal. Since this coupling capacitor is system-specific and can be designed between approx. 1 pF and 100 pF in practice, the PD signal also has a different strength. In order not to react too sensitively to uncritical disturbances, four pick-up ranges have proven to be useful. These can be successively adjusted in CAPDIS (R5) to be less sensitive if a PD display occurs without obvious error.



Comparison to PD-Detecting acc. EN 602770
Z = Filter corresponds to cable network
Ca = plant capacity
Ck = C1 = Coupling capacitance
CD = Coupling unit integrated in CAPDIS
CC = Connection line to CAPDIS

The CAPDIS-Family

The CAPDIS family with the standard devices CAPDIS-S1 (R4.5) and CAPDIS-S2 (R4.5) without partial discharge detection is extended by the family members CAPDIS-S1_55 (R5) and CAPDIS-S2_55 (R5) with PD detection. Also available are the high voltage devices CAPDIS-S1_HV (R5) and CAPDIS-S2_HV (R5) with PD detection.
All CAPDIS devices feature the three-stage voltage test as well as the integrated maintenance test; i.e. the devices are exempt from cyclic maintenance testing.
No auxiliary power or battery is required for partial discharge detection and indication on the LC display. The energy for partial discharge detection and display is taken exclusively from the 50Hz (60Hz) measurement signal.

In the CAPDIS-S2_xy (R5) versions, the partial discharge is indicated on the LC display as with the CAPDIS-S1_xy (R5). In addition, the fault message function is activated in the CAPDIS-S2_xy (R5) when partial discharge is detected. This collective fault can be transmitted directly to a Scada-System or by IKI-23 / IKI-50 also via Modbus. Auxiliary power is required for remote transmission of the PD information.

CAPDIS-S1 (R4.5) CAPDIS-S2 (R4.5)

CAPDIS-S1_55 (R5) CAPDIS-S2_55 (R5)

CAPDIS-S1_HV (R5) CAPDIS-S2_HV (R5)

IKI-23 CAPDIS-S2_55(R5)

Retrofit of CAPDIS (R5)

Universal adapter for retrofitting

Furthermore, we have attached importance to easy retrofitting. The CAPDIS (R5) can of course be used instead of existing CAPDIS. For retrofitting to HR or LRM interfaces, we offer an universal retrofit adapter that takes into account all system configurations known to us.
The universal adaption capacity on the back of all CAPDIS units allows easy adaptation of the secondary capacity to the primary capacity without any calculation or preliminary calculation. This is particularly helpful for retrofitting. The value is set so that three full flash arrows are visible on the display when the nominal voltage is present. If only half of the arrow appears, the adaption capacity must be reduced, if a framed arrow appears, the adaption capacity must be increased.
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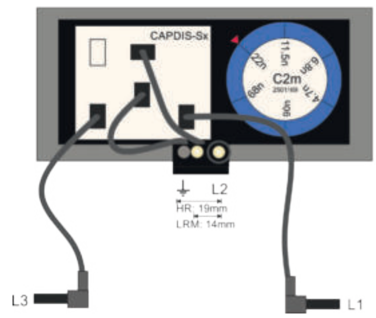
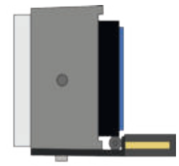




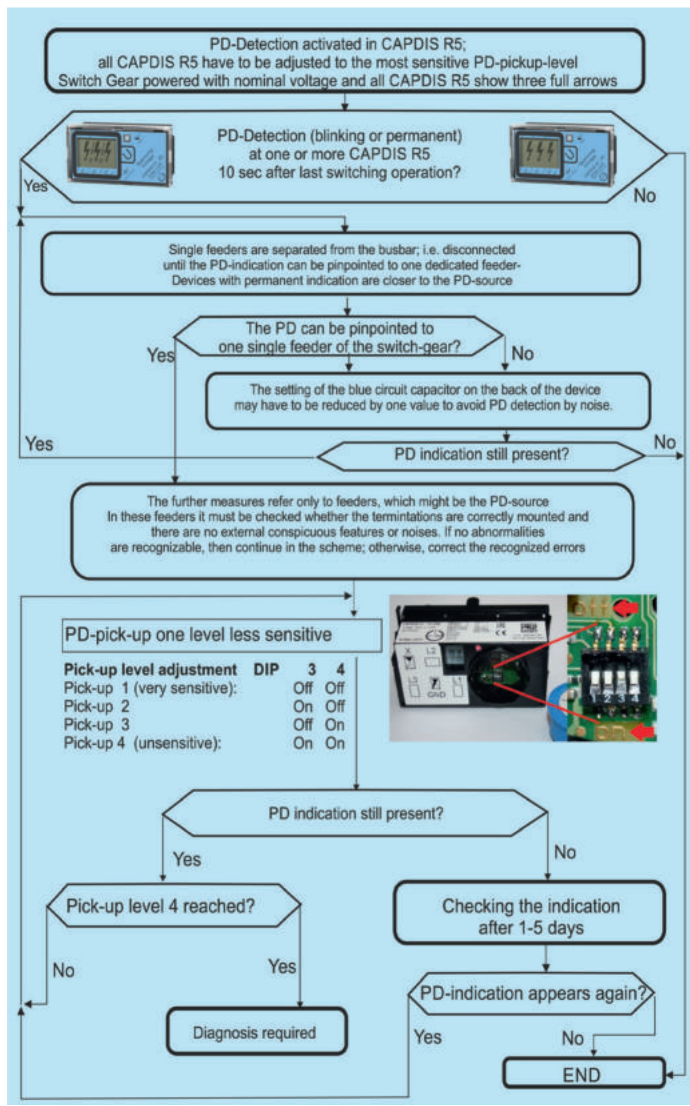
Why CAPDIS (R5)?

The use of CAPDIS (R5) increases personal safety and the safety of the switchgear, whose insulation can be monitored with PD detection.

If the CAPDIS (R5) is retrofitted to an existing HR or LRM interface, its service life is extended by the permanent load impedance. In addition, the cyclic maintenance test for voltage detecting systems, which is already integrated in all CAPDIS and permanently performed, is no longer necessary.

CAPDIS (R5) does not replace a PD diagnosis, as specific PD diagnosis systems offer, but it does provide an indication when such a PD diagnosis is urgently recommended.

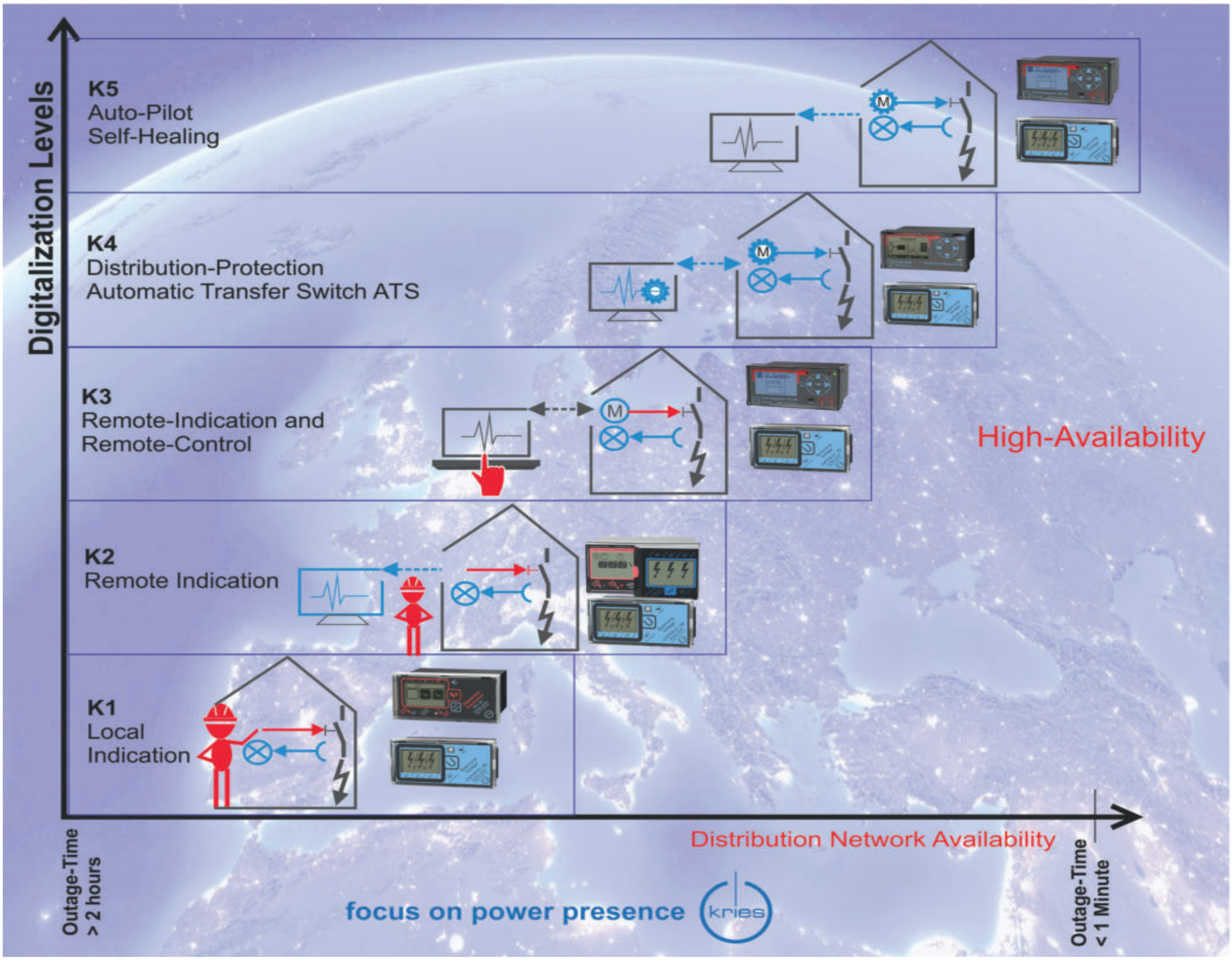
In addition, the PD display in the field-related CAPDIS devices can be used to quickly determine the panel affected by the partial discharge. A corresponding procedure is shown in the adjacent flow chart from the operating instructions.



Extract from Manual: Scheme for pre-localization of PD

Distribution network operators, who have recognized that their greatest capital and skills are buried in the distribution networks, have also learned that the networks must be digitized for the energy turnaround. In order to cope with this, leading distribution network operators worldwide have now opted for a combination of remote-controlled stations (digitization level K3) and remote-monitored stations (digitization level K2).

Here, the remote control technology together with CAPDIS, IKI-5x and PSU-Hybrid is consistently used in new motorized switching systems, while existing systems are retrofitted with monitoring systems like CAPDIS, IKI-2x or IKI-5x. A target network planning, which provides for sufficient retrofitting of voltage and fault detection systems with remote transmission in existing switch gears, enables the interaction with the new remote controlled switch gears. This allows for rapid fault location and selective activation, which reduces SAIDI and increases availability and personal and switch gear safety.



In order to detect system faults before they cause a power failure, partial discharge detection has proven its worth in practice. Partial discharges are the harbingers of failures in medium and high voltage systems. There are different types of partial discharges (internal and external discharges), but they have one thing in common: a breakdown of an insulation section, i.e. there is no direct contact between two electrodes (phase-phase or phase-earth), but insulation is reduced.

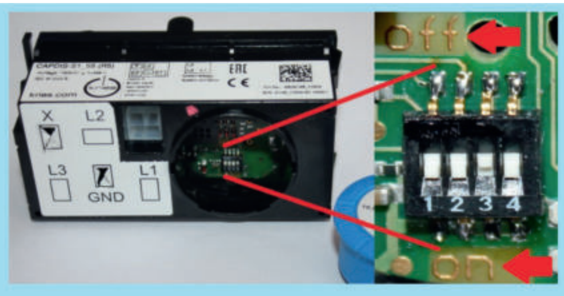
Partial-Discharge Detection with CAPDIS (R5) in Practice

Partial discharges do not cause a tripping from the protection relay and therefore often remain undetected. We have made it our task in the new CAPDIS (R5) to detect these nevertheless.
The insulation loss is caused by an increased field strength concentration, which leads to a partial breakdown of the insulation. This process is rarely reversible and often turns into a static fault over time if it is not detected and stopped early. The partial discharge detection in CAPDIS (R5) is realized with an active bandpass whose gain can be adjusted. The detected partial discharge level depends on the decoupling capacity of the switchgear C1 and the set threshold in the device. Typical PD detection thresholds that are reached are between 300 pC and 1000 pC. Weak partial discharges are indicated by a flashing signal, stronger partial discharges by a continuous signal. The threshold value for partial discharge detection in CAPDIS can be set by means of a DIP switch accessible on the rear of the device. Alternatively the partial discharge detection can be deactivated. Tests on systems in nominal operation have shown that partial discharges in the medium voltage cable are also detected. However, the sensitivity of PD detection decreases rapidly along the medium voltage cable. Already at a distance of 3 m only partial discharges larger than 1000 pC can be detected. If a remote transformer is to be monitored as well, it is recommended to provide voltage and PD detection directly at the medium voltage connection of the transformer.

Diagnosis of the cause of PD

A diagnostic socket is available on CAPDIS (R5). The diagnostic socket allows a more detailed examination of the partial discharge.
In addition, there are mobile PD diagnostic systems from various suppliers as well as specialized service providers who can perform advanced PD diagnosis.
Even an oscilloscope diagnosis can determine which conductor is actually affected and whether it is an internal or external discharge or an external disturbance.

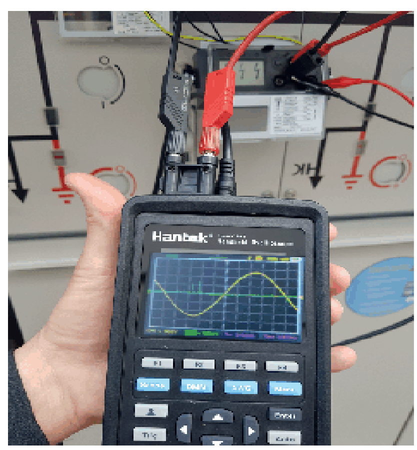
CAPDIS-indication without / with detected PD

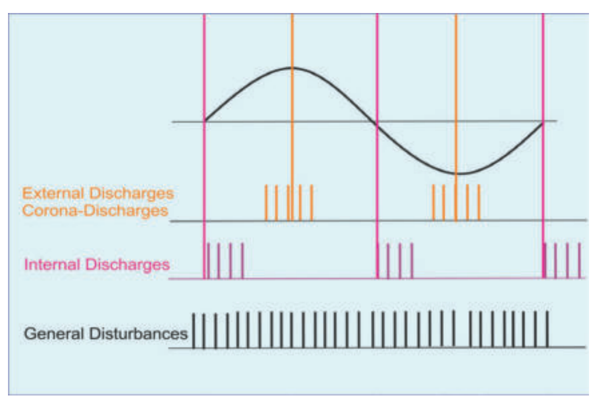


DIP-Switch-Adjustment
1 MLB (ON) OLB (Off)
2 TE/PD (ON) TE/PD (Off)
3 TE/PD pick-up value
4 TE/PD pick-up value

PD-Pick-up adjustment DIP		3 4	
Pick-up	a (sensitive =20mV)	off off	Attenuation 0 dBm
Pick-up	b	on off	Attenuation -1 dBm
Pick-up	c	off on	Attenuation -3 dBm
Pick-up	d (unsensitive)	on on	Attenuation -7 dBm


TE-Diagnose-Buchse geeignet für Oszilloskop
PD-Diagnostic-socet suitable for Oscilloscope





PD-Diagnosis with Scope