

## «CDR» - High Voltage Cable Monitoring and Diagnostic System

The widespread introduction of the power cables with an operating voltage of 110 kV and above, which are critical components of the distribution network, increasingly raises the questions of effective cable condition diagnostics, especially on-line monitoring.

There are two types of monitoring systems for HV cables: one is based on thermal monitoring and the other is on PD measuring in insulation. The first method is more useful for cables thermal load monitoring; the second way has maximal sensitivity for defect diagnostics. Using a complex monitoring system with both the methods is optimal.



«CDR» (Cables Diagnostics Relay) complex device by DIMRUS meets the requirements. This device is used in monitoring systems for cable condition monitoring and troubleshooting.

**«CDR» system has got the following functions:**

- Continuous monitoring of HV cable insulation condition based on measuring and analyzing PD level and distribution; identifying the defect type and degree.
- Automatic on-line defect location in the insulation of both joints and cables.
- Continuous temperature measurements of the cable terminations, situated near the measuring device.
- Monitoring the value of the phase currents passing through the cables shield, with a supplementary current sensor. These currents are negative for cable load due to the increased thermal stress on the insulation.

**Two types of sensors can be used with «CDR» system in dependence of the cable line design and installation.**

1. «CDR-S» sensor. This is a PD and joints temperature sensor installed on the cable surface. «CDR-S» sensor is a flexible metalize ring up to 200 mm wide. «CDR-S» installation is simple – the

sensor is wrapped around the cables near joints and terminals.

The sensor operates in UHF frequency range, so it has the highest sensitivity to the closely located defects. That is, the sensor measures PD in the nearby joint correctly, but has lower sensitivity to remote defects, because of PD damping in cables.



2. «RFCT-7» sensor.

This is a current transformer for measuring high-frequency pulses in the cable shield grounding. «RFCT-7» sensor is a split-core sensor, consisting of two parts, and it is easily installed on the cable shield grounding conductors or joints. So, «RFCT-7» sensor is installed without breaking the ground circuit.

«RFCT-7» sensor operates in high-frequency range, that is why it is sensitive to the defects that may be located at a distance of up to several kilometers. But «RFCT-7» sensor is less sensitive to the closer defects than «CDR-S» sensor.



**The features of PD pulses measuring and analyzing by «CDR» system.**

«CDR» system has 6-channel device for measuring and analyzing the cables parameters. It is modern and effective device for PD measuring.

The features of «CDR» device are:

- PD pulse measuring in wide frequency range – from 50 kHz to 1 GHz. The frequency range is so wide because the PD pulses reduce in amplitude and grow up in length while moving along the cables.

If a pulse arises near the sensor, then its frequency is very high, up to hundreds of MHz. The frequency of a remote pulse may be several hundreds of kHz "only". The longer are the cables - the lower is the frequency of the measured PD pulses can be.

- «CDR» system has two modern methods of defect location in cable insulation. The first method is based on analyzing the reflectograms of PD pulse distribution in cables; the second method is based on analyzing the time of arrival of the PD

pulses from the defect place to the ends of the monitored cables.

- «CDR» system includes «PD-Expert» expert diagnostics system. It allows identifying the defect type and degree.

«CDR» system has the following specific solutions:

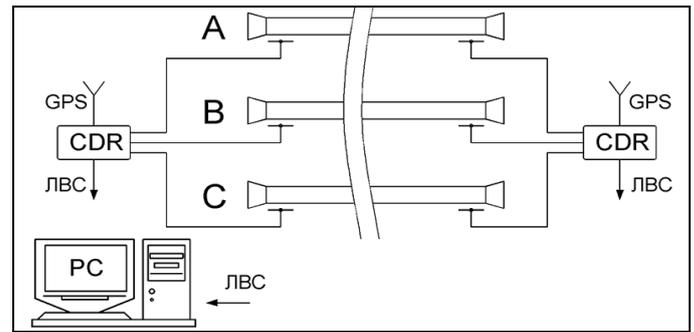
1. PD pulses are measured synchronically in all the 6 measuring channels of «CDR» device. This is a compulsory condition for all the diagnostic algorithms to operate.

2. If there is the need to monitor several cables, then several «CDR» devices should be use in the monitoring system. In this case, the problem of PD measurement synchronization becomes global.

Such synchronization can be achieved in two ways. At the distance of up to 1 km the PD measurements are synchronized by fiber optic: the synchronization pulses are sent through the fiber optic and the information exchange is done through the fiber optic. If the cable is more than 1 km long, or there is no possibility to lay fiber optic, then the measurements can be synchronized by GPS/GLONASS, the GPS receiver is built into «CDR» device.

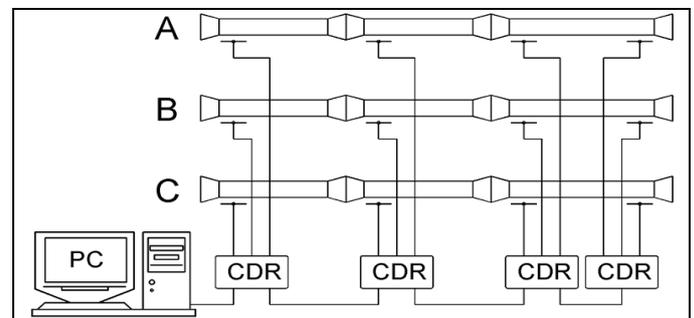
### Cable monitoring systems with synchronization by fiber optic.

In the first figure, there is a scheme of the monitoring system for the cable with two joints in each phase. The monitoring system consists of 4 «CDR» devices and a computer with the special software. The cable length is small and the fiber optic can be used for the measurement synchronization.



**Cable monitoring system with synchronization by GPS.**

In the second figure, there is a scheme of the monitoring system with global synchronization. In this case the information is transmitted through the usual media (local network, global network, etc.), which are not shown in the figure.



**«CDR» system can be connected to SCADA in two ways:**

- By fiber optic.
- By RS-485 interface.

For monitoring of both one cable or several cables, «iNVA» software is supplied together with the devices.

ModBus RTU or IEC 61850 protocols are used for information transmission from monitoring systems to SCADA.

### Specifications of «CDR» system

Parameter	Value
Rated voltage of monitored cable line, kV	10 ÷ 500
Insulation condition monitoring method	PD
Cable temperature monitoring method	Pt100
Currents-in-cable-shield monitoring method	CT
The number of the cables (phases) monitored by one device	Up to 6
The length of the cables monitored by one device, m	Up to 6000
PD measuring range, MHz	0.1 ÷ 1000.0
SCADA connection	RS-485 interface, fiber optic
Synchronization of several devices	GPS, fiber optic
Temperature range without heating, °C	-40 ÷ +60
Supply voltage, V	AC/DC 120 ÷ 260
Device dimensions, mm	400 * 230 * 110