

«MDR-3/UHF» - Monitoring of HV Generators and Motors Insulation by Partial Discharges.

«MDR-3/UHF» (Motor and Generator Diagnostics Relay) monitoring system is a unique product of «DIMRUS» company. It is designed for on-line assessment of the stator winding insulation condition of high-voltage motors, turbo generators and hydro generators.

The assessment of stator winding insulation condition of the electric machine and on-line defects diagnostics in «MDR-3/UHF» system is based on partial discharge measuring and partial discharge distribution analysis in the UHF (Ultra High Frequency) range. Currently, it is the most sensitive method of diagnostics, which allows detecting almost any defects in high-voltage insulation at early stages of their development.

«MDR-3/UHF» features.

1. The most important «MDR-3/UHF» feature is that it uses the measuring tools operating in an extended frequency range from 0.5 to 700 MHz. This ensures the highest sensitivity of the monitoring system to various defects in the insulation of the end winding area and inside slots.

2. «MDR-3/UHF» uses simple and the most reliable electromagnetic antennas as PD sensors. The PD measuring antenna is a high-voltage insulated conductor, which encircles the stator end winding.

The electromagnetic antenna is easy to install and it is reliable in operation, as it has no galvanic connection to the electric machine winding, which is usual for coupling capacitors. Besides, unlike coupling capacitors, the antennas do not need to be disconnected during high-voltage stator testing.

3. The antenna installed around the stator end winding is equally sensitive to any defects in any phases and sections of the stator winding. It also allows measuring discharges in the rotor winding. Such high sensitivity comes from the antenna's close location towards all the windings. In addition, as the distance from the PD source to circular antenna is less than half the length of one conductor laid in the

stator slot, so the electromagnetic antenna is also highly sensitive to these defects.

If necessary, it is possible to locate an insulation defect in the stator slot quite precisely, by analyzing the difference in the time of pulses arrival to the end windings.

4. As the end winding area of large electrical machines is usually covered with metal lids, the antenna is not very sensitive to external electromagnetic high-frequency noises.



External Noise Rejection.

To reject the external noises coming from the power cable, the «time of arrival» method is used. For that three electromagnetic antennas are installed inside the stator of the electric machine –two of them are set around both the end windings and one is at the power cable (or busbar) input, as it is shown in the figure.

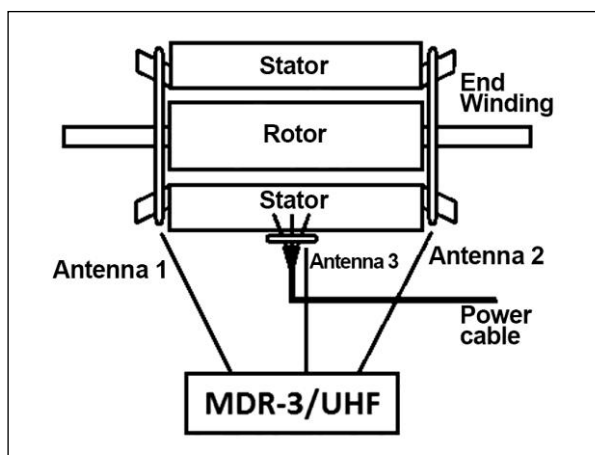
The «time of arrival» method works as follows. If the PD source is in the stator winding, then the high-frequency pulse comes to the end winding antennas first (to one or both), and later, with a certain time delay, the pulse comes to the antenna installed at the power cable input.

If the noise pulse, similar in parameters to the expected PD pulse, enters the stator from the power line, then it is measured by an input antenna first, and later by the antennas in the end winding areas. Due to the high time resolution of the measuring device, this

way of noise rejection is very effective.

Thus, «MDR-3/UHF» system, equipped with electromagnetic antennas, is specially designed for PD monitoring in the insulation of electrical machines, it has got maximum economic efficiency, the necessary sensitivity, and it is to the greatest extent protected from any external high-frequency noises.

«MDR-3/UHF» monitoring system has got no equivalent in the market due to its operational parameters and cost.



Diagnostic capabilities of «MDR-3/UHF» monitoring system.

An important part of «MDR-3/UHF» system is «PD-Expert» automated software, which allows on-line identifying of an insulation defect type and assessing the degree of its development. This software allows efficient and correct estimating the remaining lifetime of the monitored electric machine's insulation.

The defect type in the stator winding insulation is identified using the built-in database of standard defects' representations («fingerprints»). The database is adaptable. For the defect fingerprints to be the most reliable there are two ways of PD distribution representation used in «PD-Expert».

The ordinary PRPD (Phase Resolved Partial Discharges)-pulses distribution is more effective for identifying typical defects in the stator insulation. PRPD-distribution of each defect in stator insulation has got expressive features, so defect is easy to identify.

In case there are several defect zones in the insulation, and especially when noise influence is considerable, the use of PRPD-distribution method alone becomes rather less effective. To separate the pulses by time and frequency, the special PD pulses distribution, called «PD-Clouds», has been developed for «PD-Expert» system by «DIMRUS».

«PD-Clouds» is a 3D representation of PD pulse parameters, such as:

- Time and frequency characteristics of each measured PD pulse.
- Correlation between the time of PD pulses generation and the phase of voltage applied to the stator winding.
- Energy distribution of the measured PD pulses for all the diagnostic parameters mentioned above.

Due to «PD-Clouds» distribution it is possible to distinguish one defect from the other defect of the

same type but different location or similar defects of different types. All in all it adds to the stator insulation condition assessment reliability.

«MDR-3/UHF» design.

«MDR-3/UHF» device for PD measurement in the insulation of electrical machines is cased in metal, it can be mounted independently or inside an enclosure. It is desirable to set the device outside of the stator, however as close to the measuring antennas as possible to ensure a minimum pulse damping in the connecting cables.

All the external power and interface cables are connected to the device through standard terminal blocks. The electromagnetic antennas are connected by a flexible coaxial cable and HF slots, which reduce damping of the desired signal.

As the «MDR-3/UHF» system uses only electronic components for industrial temperature range, it can operate at the ambient temperature from -40 to +60 degrees even without additional heating.

The standard delivery set for «MDR-3/UHF» monitoring system includes:

- The measuring device without an enclosure.
- Three electromagnetic antennas in segments of high-voltage cable of required length.
- Terminal (protective, grounding) boxes for electromagnetic antennas connection.
- High-frequency coaxial cable antenna-to-device connection.

SCADA interface.

The information from the «MDR-3/UHF» monitoring system is uploaded into SCADA via separate RS-485 interface or fiber optic.

If the connection between the device and the SCADA is missing, the archive can be periodically copied from the device memory into a portable computer via built-in USB.

«MDR-3/UHF» System Specifications

No	Parameter	Value
1	PD measuring channels	3
2	Frequency range of measured pulses, MHz	0.5 ÷ 700.0
3	Measured pulse charge, pC	5 ÷ 50 000
4	Memory capacity, MB	256
5	Communication interfaces	RS-485, USB, Ethernet
6	Power supply, AC/DC, V	120 ÷ 260