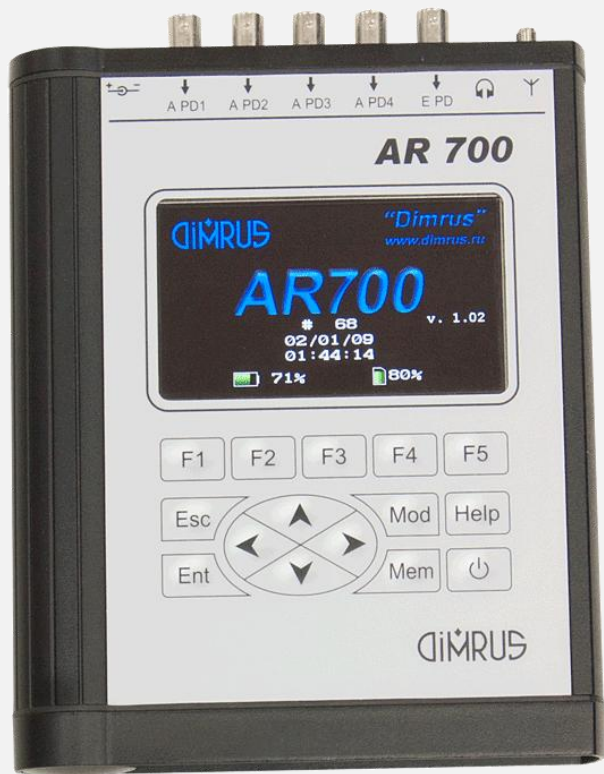




# **AR700 – The Device for PD Measurements and Signal Analysis by Acoustic Method**

"DIMRUS" Company  
[www.dimrus.ru](http://www.dimrus.ru)

# The «AR700» Device Purpose and Use



The «AR700» device is used for measurement and analysis of acoustic signals on the external surface of oil-filled transformers tanks, connecting and terminal joints, gas-insulated switchgear and other high-voltage equipment.

The 4 synchronic channels for signal measuring in the device allow not only to reveal the defects, but also to locate the place of their origin.

The device allows keeping the measured signals in FLASH memory for the following storing and analyzing by PC.

The device controls provide “user friendly” interface and consistency of its operation.

# The «AR700» Device Delivery Set



The portable AR700 device is supplied in strong transportation case.

The delivery set includes the measuring device, the set of PD sensors, the PFR-1 transceiver for synchronization of measurements to supplied voltage, connecting cables, charging, technical documentation, and also CD with software for information keeping and PC connection.

The delivery set is sufficient for PD acoustic signals measurements in different types of high-voltage equipment.

# Sensors

The RFCT sensors are not expensive and simply installed in the grounded circuits. The standard delivery set includes:

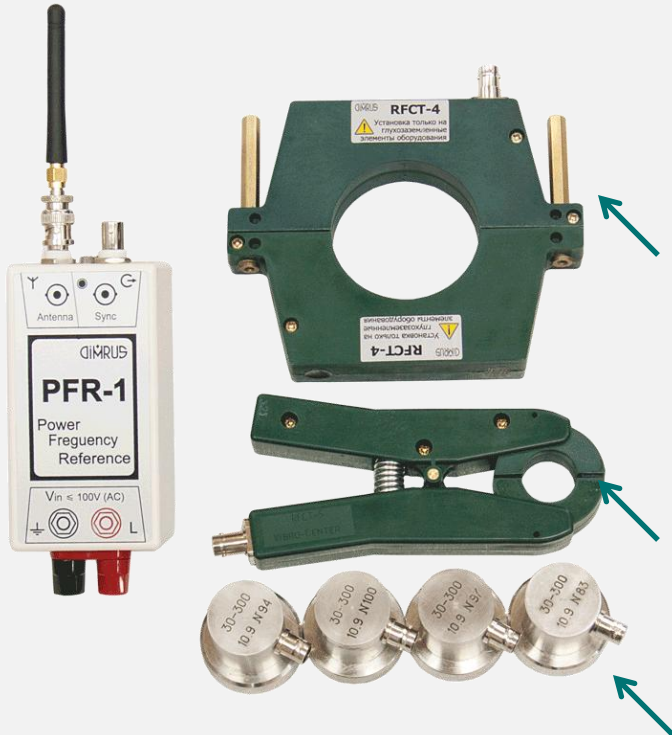
- RFCT-4 – split-core high-frequency current transformers used for installation without disassembling of primary circuits on conductors and grounded buses of big cutting.

- RFCT-5 – high-frequency clamp for operative PD measuring in grounded conductors.

- Acoustic sensors with built-in magnet fixing.

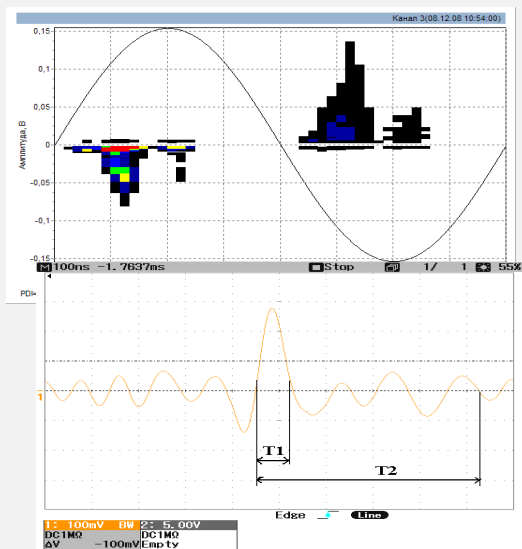
- The PER-1 reference signal transmitter.

- The sensors are connected to the device with 6 meter coaxial cables with BNC slots.



# Partial Discharge (PD) Measurements in Transformer Equipment

PD measurements in transformers and reactors is a part of complete diagnostic inspection or continuous monitoring. The main task of PD measurement is the PD detection and the risk level evaluation.



The dissolved gases analysis in oil allows confirming the presence of PDs (heightened level of hydrogen) or spark discharges (heightened level of acetylene) in the insulation of transformer equipment.

There are many measuring methods allowing to evaluate the PD level and to determine the defect type by analyzing the amplitude-phase pulse distribution and frequency.

BUT, PDs with similar features can arise in the insulation winding and in transformer elements. PDs in different places of equipment have different danger level: some of them demand urgent measures to be taken, others could wait.

# PD Location in Transformer Equipment



For evaluation of PD danger level in the insulation, it is necessary to reveal all the PD activity zones and to assess PD risk level in every zone. The analysis of transformer construction is very important for PD danger level evaluation.

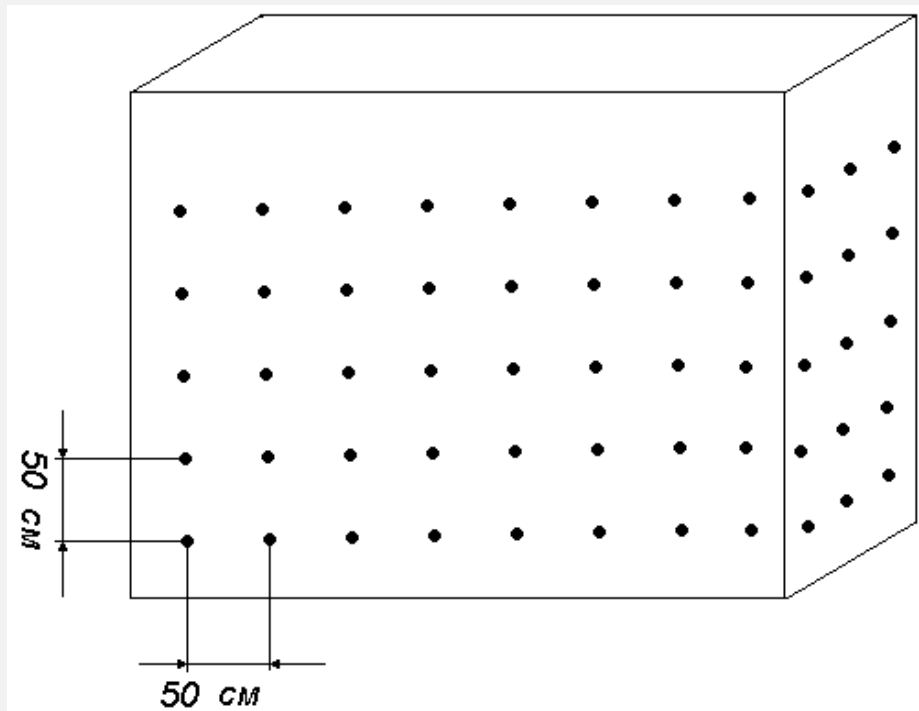
The most dangerous are the PDs in the transformer windings, but they are the most rare as well. PDs often arise on bushing connecting pipelines and ground loops.



It is also very useful and important to carry out the PD activity zone location before the equipment is de-energised for repair, even if the PD level is not critical. The purpose of that is the closer inspection of PD activity zones, which allows to do full-scale repair work and prevent the defect development.

# The Method of Acoustic Inspection of Transformer Equipment

## 1. The Inspection of Tank Surface with One Acoustic Sensor



The first stage of the PD location is the detection of the zones where the acoustic signals are of the highest level on the transformer tank surface.

The purpose is the detection all the possible PD activity zones. During PD measurement the signal amplitude is analyzed, in order to reveal the zones suitable for subsequent location.

For detection of all the PD activity zones it is recommended to measure the signal over each 50 cm (if possible) with one acoustic sensor.

# The Example of the Transformer Preliminary Inspection for PD Activity Zone Detection



The preliminary inspection is convenient for making by two people.

The first person will work with the device (operator) and the second person will install the sensors and mark the PD zones.

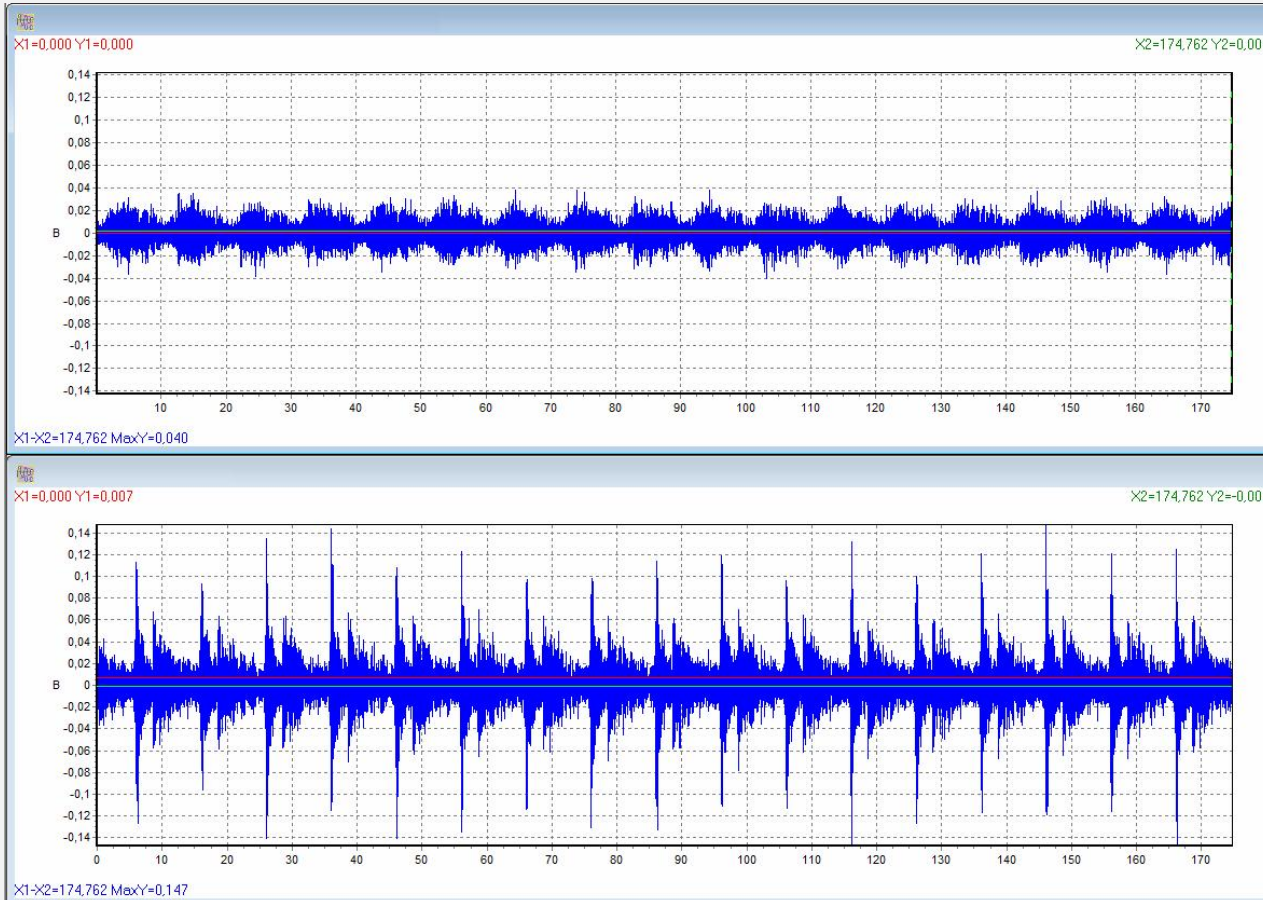
Sensors installation in the top part of transformer tank should be made with insulating rod for safety.

If there is some acoustic signal from PD, it is necessary to mark this place on the transformer and store the information about the maximal signal amplitude at this point.

Then the sensor should be transferred to the next place in accordance with the inspection plan. These actions should be repeated till the transformer is inspected from all the sides.



# The Detection of PD Activity Zones



The example of the measured acoustic signals:

1. The acoustic signal without the PD pulses.

2. The acoustic signal of PD pulses. Pulses are repeating and are synchronized with supply power frequency of 50 Hz.

# The Analysis of Signal Amplitude and Detection of Activity Zones for Location



The preliminary inspection of the transformer gives the full information about the places for acoustic PD measuring.

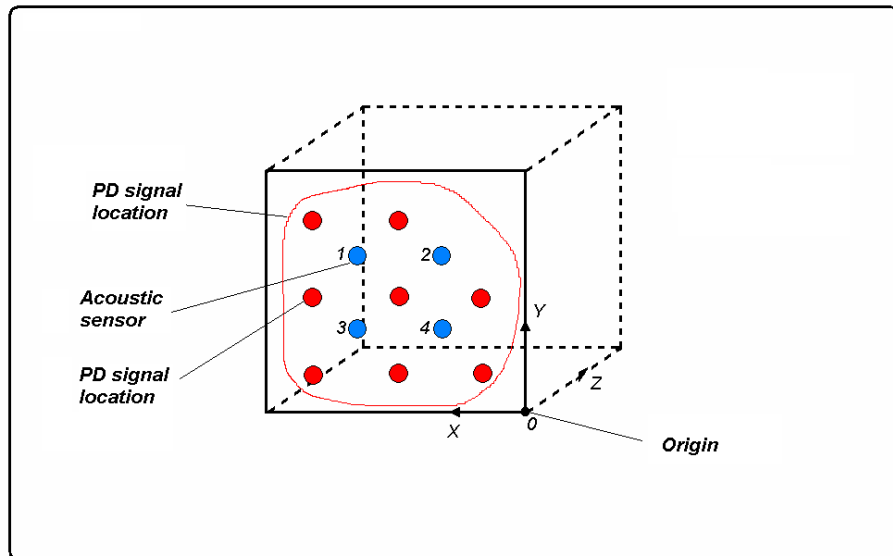
The pulses can be measured at several points of each activity zone. It is necessary to analyze pulse amplitude in every zone and make decision about the location of PD origin places in the places with the maximal amplitude.

Some supplementary measurements in PD activity zones could also be required for the detection of the place with the maximal signal level.

The specific features of PD measuring by acoustic methods is the difficulty of the measured signals calibration, because it is almost impossible to model the ways of signal distribution from the defect to the tank wall; it is also impossible to put a calibrator inside of transformer tank. That's why all the analysis is done by comparing of pulse amplitudes.

# The Method of Acoustic Inspection of Transformer Equipment

## 2. PD Location by 4 Acoustic Sensors



For location, put all the 4 acoustic sensors into the centre of one of the revealed zones.

For correct location it is recommended to install the sensors in the form of a rectangle (square), but considering the transformer construction in the place of installation.

Then choose the zero reference point. All the coordinates will be calculated relative to it and the report about PD source location will be issued. This point always should be to the right and lower than the zone with the detected acoustic PD.

# The Example of PD Activity Zone Location



The acoustic sensors have magnetic holders, which allows to carry out measurements and location easily and without the use of any additional facilities.

Before installing the sensor, the surface should be lubricated with special oil or some other lubricant. This is necessary for creating of acoustically impermeable environment without air penetrating.

The signal analyses and the PD zone location could be carried out both in manual and automatic modes. Saving the measured signal allows to carry out the detailed analyses and to create the report on the PC.

# Additional PD Activity Monitoring with High Frequency RFCT Sensors



The use of high frequency sensors of RFCT type allows to additionally filter the noise signal and to make sure, that it is the PD pulse that produce the acoustic noise. The confirmation of this is the simultaneous coming of the pulse to the acoustic and high frequency measurement channels.

The RFCT-4 and RFCT-5 high frequency current transformers, supplied together with AR700 have protecting insulation of up to 1000 volt , so they should be mounted at the ground circuits or the circuits of low potential.

For the measurements under high potential the specialized tested sensors should be used. The specialized sensors are supplied optionally.

The sensors are often connected to the dead-grounded neutral of the transformer or directly to the transformer tank grounding.

# PD Measurement Synchronization Through the Radio Channel with «PFR-1» Transceiver



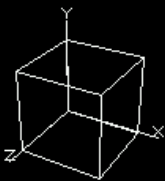
For the PD measurements in HV insulation to be more informative, and for the defect type identification there is the function of measurement synchronization to the supplied voltage phase in the device. Only in this case it is possible to correctly identify the defect type in the insulation and its progress.

In practice the synchronization can be complicated, because of the device remoteness from the supplied voltage, which is necessary for synchronization.

In this case the measurement process is synchronized to the supplied voltage by the use of some special reference signal passed through the radio channel. The PFR-1 reference signal transmitter is set at the place where the supply voltage is present, at the distance of 100 meters from the place of measurement. As a source of the reference signal the usual supplied voltage as well as the secondary winding of the instrument transformer can be used.

# PD Activity Zone Location

Tank dimens.		Sensors coordinates, cm		
X=	100 cm	#1 X	Y	Z
Y=	100 cm	#1	50	50
Z=	100 cm	#2	100	50
		#3	50	100
		#4	50	100
		Synchronisation		
		OFF		



F5 NEXT

Acquisition		Stop set.	
Ch1	ON	Ch1	OFF 0.50V
Ch2	ON	Ch2	OFF 0.50V
Ch3	ON	Ch3	OFF 0.50V
Ch4	ON	Ch4	OFF 0.50V
Ch5PD	ON		

V, m/s		Noise set.	
Thresh.	343.0	Ch1	0.01V
	70%	Ch2	0.01V
		Ch3	0.01V
		Ch4	0.01V
		Mode	Hand

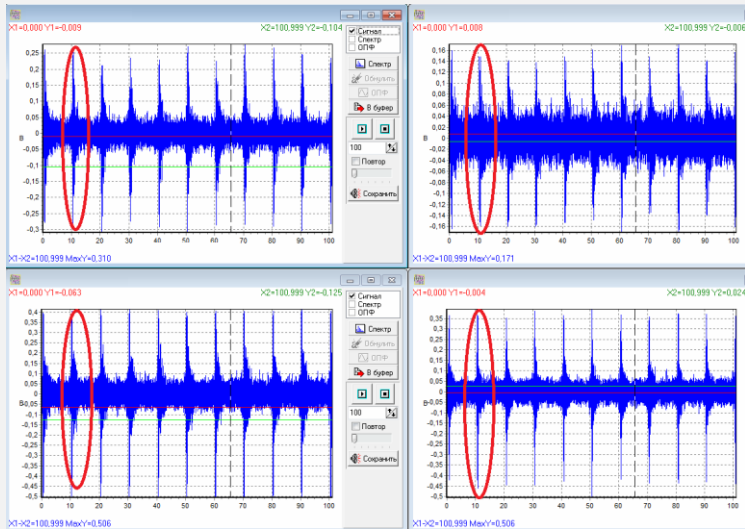
F4 BACK      F5 NEXT

For PD measurement and location with «AR700» device it is necessary:

- to specify the parameters of the transformer tank, thus limiting the defect zone. This is also the additional method of noise rejection;
- to specify the coordinates of the sensors relative to the zero point chosen;
- to choose the type of synchronization to the power supply;
- to specify the parameters of the noise rejection thresholds and the informative signal for the automatic location.

The device set-up allows to effectively configure and save the measurement parameters for all the input measurement channels on site.

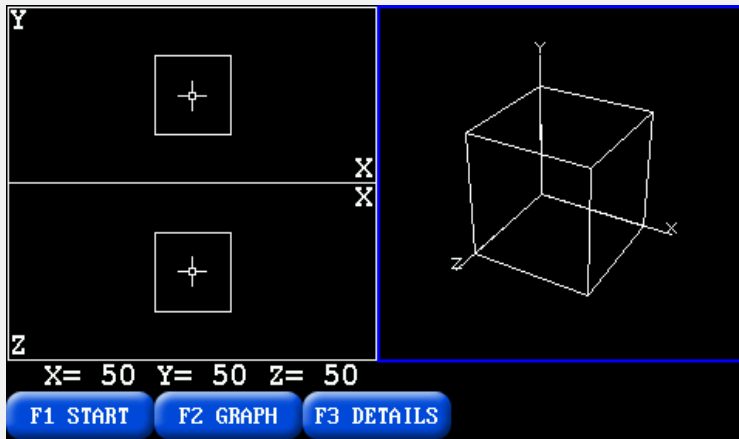
# The Synchronic PD Measurement in the Zone of Increased PD Activity



The device synchronically measures the signals from the 4 acoustic and one high frequency sensors with the frequency of 3 MHz for the channel.

The measurement is done constantly and the signal is constantly displayed at the device screen.

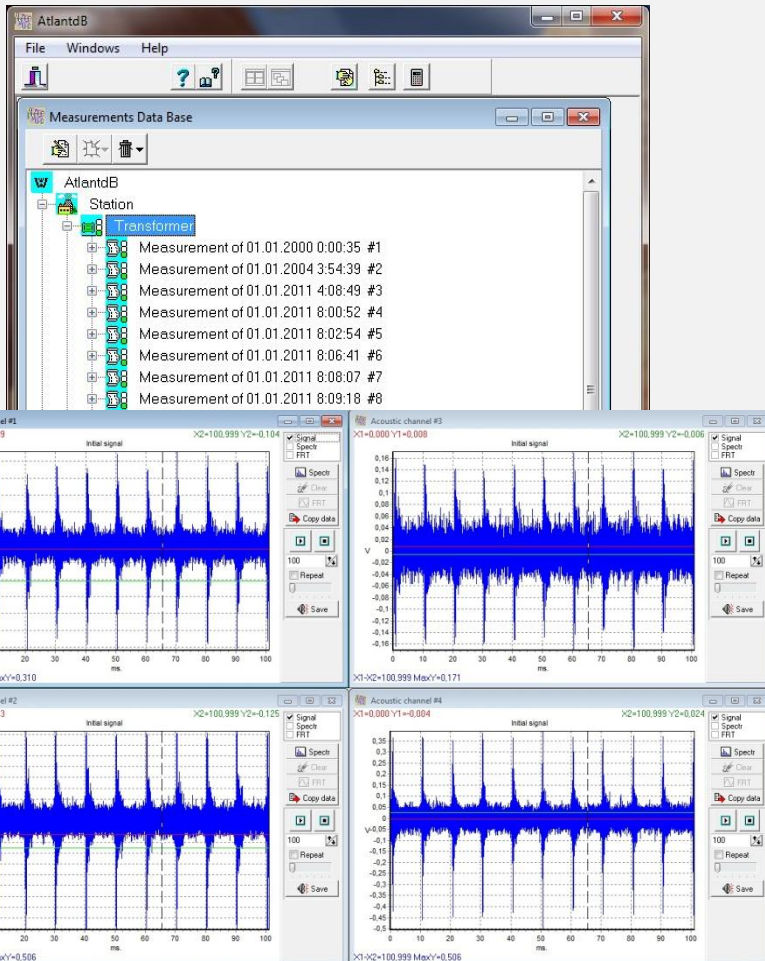
It is possible to view the data in the «graph» mode, with constant amplitude control, and in «scheme» mode. In «scheme» mode the device automatically singles out the PD pulses according to the algorithm; the device also does the location of all the pulses by the «time of arrival». The calculation is done with the accumulation of the calculated data, and displaying it as dots in 2D and 3D diagram.





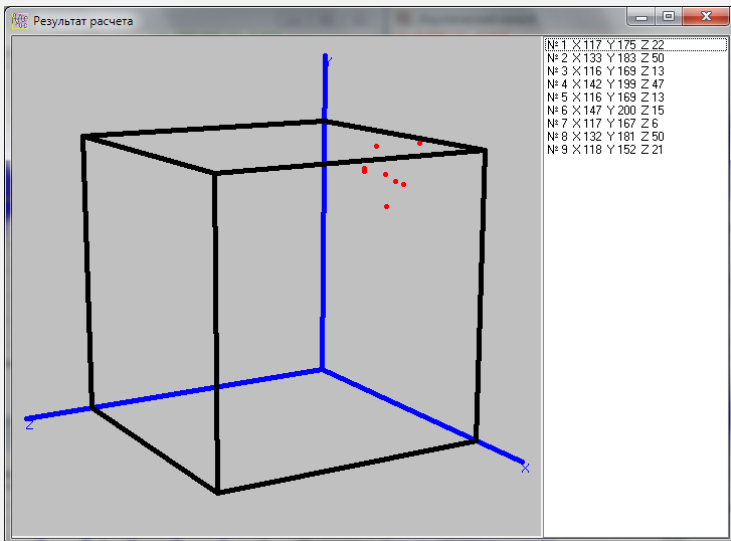
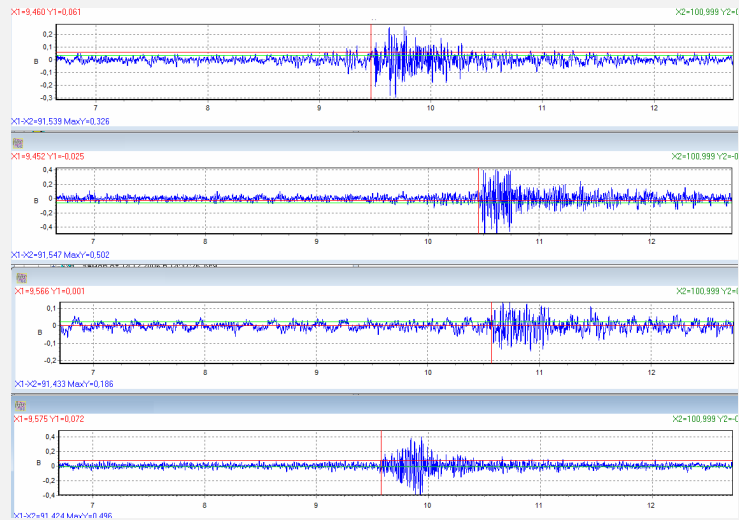
# The Method of the Acoustic Inspection of the Transformer Equipment

## The Analysis of the Acoustic Signals with Atlant-DB Software



- The specialized software allows:
- to administer the signal database;
  - to look through the signals;
  - to analyze the frequency parameters of the pulses with the Fourier spectrum;
  - to filter out the informative signal by specified frequencies in the spectrum and the Fourier inversion;
  - to carry out the location in automatic and manual modes on the base of the «filtered» signal;
  - to listen to the signals with the use of the standard PC means and to administer the defect database;
  - to create the report on the analysis.

# The Detection of PD Activity Zones with «Atlant-DB» Software



The detailed analysis of PD signals can be made by special «Atlant-DB» software.

For the more accurate location it is possible to filter out pulses and to select the groups of pulses specific for one defect type.

The results are shown on 3D graph as a group of points, each point corresponds to the calculated origin place of one PD pulse. You'll see clear all calculated PD activity zones.

The original signals and the calculation results can be added to the report in convenient form.

# Using Acoustic Location for Joint Insulation Monitoring in HV Cables

The «AR700» device can be used for insulation monitoring of high-voltage cables. Connecting and terminal joints are the weakest element in the insulation.

PDs arise in joints because of gas inclusions in joint insulation, which appear during installation or as a result of shield grounding violation. In process of time, PDs can cause insulation destruction and breakdown.



The measurements are done along the whole the surface of the cable joint with one acoustic sensor and the RFCT sensor, if the cable joint shield is grounded.

The use of the two sensors allows to measure PD pulses only inside the cable joint and to reject noises efficiently.

# Using Acoustic Location for End Joints Insulation Monitoring in HV Cables



The measurements can be done on cable joints of different types and voltage class.

Thus, the measurements can be done at the bottom of the cable terminal joints.

Listening to the signal with headphones can help in finding PD source. In this mode the signal being measured is transferred to the zone of hearing sounds by changing the sound frequency. The signal can be slowed down 20 – 1000 times. It allows the User to store the «acoustic signal shape» base using his own ear as a means of expertise.

# Gas-Insulated Switchgear Insulation Monitoring



The «AR700» device can be used for PD measuring and location in the insulation of gas-insulated switchgears.

PD acoustic sensors are installed on insulating spacer between separate parts of switchgears.

The preliminary measuring by one sensor allows to reveal PD pulses. The use of 2 - 4 sensors on different elements of one phase of switchgear allows to locate the PD source by the «time of arrival».

Using the «AR700» device for PD analysis in the insulation of gas-insulated switchgear allows to operatively and accurately define the possible source of problems in the insulation.

# The «AR700» Device Specifications

№	Parameter	Value
1	Acoustic channels for PD measuring	4
2	Frequency range of acoustic sensors	30 ÷ 300 kHz
3	High-frequency channels for PD measuring	1
4	Frequency range of high-frequency sensors	0,5 ÷ 10 MHz
5	Measuring frequency on channel	3 MHz
5	PD pulses measuring synchronization	Radio channel
5	LCD resolution, pixel	480x272
6	PC connection	USB
7	Operating temperature range	-20 ÷ +40 °C
8	Operating time from build-in accumulator, hours	8
9	Device weight, without sensors, kg.	1,1
10	Dimensions of transportation case, mm	520x435x230
11	Device weight in transportation case, kg.	12

# The Advantages of the «AR700» Device

- Light and convenient device in strong metallic case.
- Combined feed of device from power supply and build-in accumulator.
- Operating from accumulator up to 8 hours.
- Full and universal set of sensors.
- Location of PD pulse source directly on the site.
- Possibility to “listen” to PD signals and using signals for creation shapes of defects and expertise by “hearing”.
- Software for archive, location of PD source, possibility of analysis of sound shapes of defects.
- Good balance between the device cost and capability.



DIMRUS Ltd.

70 Kirova street, Perm

Phone: (342) 212-23-18

Phone/fax: (342) 212-84-74

[www.dimrus.ru](http://www.dimrus.ru)

dimrus@dimrus.ru