RESEARCH & PRODUCTION ENTERPRISE "ERA"

"ERA-MAX" - Active Electrode EM/Resistivity System

Features

- Low-frequency electromagnetic method for measuring resistivity.
- Operating frequencies: DC, 1.22; 2.44; 4.88 and 625; 1250; 2500 Hz.
- Earth is energized using either a straight ungrounded cable or an ungrounded loop.
- Electrical field can be measured by pairs of active electrodes capacitively coupled to the earth, or by the telescopic antenna in air.

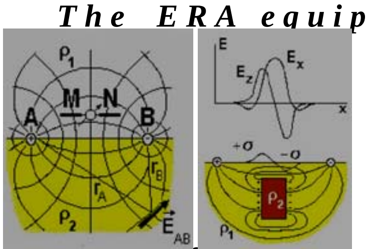
Applications

- Designed for electric prospecting using resistivity, mise-a-la-masse and self-potential methods.
- Geological mapping.
- Civil-engineering survey for design and maintenance of surface and underground structures (basement, water development works, pipelines and highways, power and communication lines)
- Archaeology.
- Search and exploration for ore and nonmetallic minerals (base, rare and precious metals, diamonds, graphite, coal, building materials, etc.).
- Ecological investigations (landslide and karst studies, definition of areas of toxic wastes seepage from waste storage areas, waterproof screen monitoring, etc.).
- Groundwater exploration, hydrogeology

General

For years poor grounding conditions for current and measuring electrodes presented a barrier to efficient applications of the resistivity and mise-a-la-masse methods in electric prospecting. For this reason surveys over snow and ice had to be abandoned in winter, while in summer the areas covered with screes and rocky soil, dry sands, asphalt and concrete pavements had to be excluded from survey programs.

The ERA equipment can be used for any type of surface cover.



Under adequate grounding conditions conventional steel, brass and nonpolarizable electrodes can be readily used at all operating frequencies (DC, 1.22; 2.44; 4.88 and 625; 1250; 2500 Hz).

In poor grounding, the versatility of the equipment in respect to any surface cove can be accomplished in three ways.

The first way (operating frequencies: 1.22; 2.44; 4.88 and 625; 1250; 2500 Hz) involves the use of measuring active point electrodes with very high input impedance. With such electrodes gradient array measurements are feasible using conventional procedures practically with any surface cover.

The second way (operating frequency: 625; 1250; 2500 Hz) consists in using capacitive nongrounded line electrodes spread on the ground. The electrodes (cable segments) have no galvanic contact with the ground and can serve both as measuring and current electrodes. The use of such electrodes allows to halve the field crew size.

The third way (operating frequency: 625; 1250; 2500 Hz) consists in measuring the electric field with the use of a telescopic active electric antenna with an effective length of 0,5 to 1,2 meters. The antenna is used for detailed survey with the gradient array. It makes possible electric field vector measurements, including measurements of the field vertical component in the air.

The two latter ways are accomplished using the technique of noncontact measurements of the electric field. This technique makes allowance for the distributed constant line behavior of the receiving (transmitting) lines.

The «ERA-MAX» equipment is portable, with digital data indication, automatic compensation of the electrode emf, a wide range of stabilized output currents, and increased transmitter output voltage. The operating frequencies enable the geoelectric profile to be investigated both at shallow (1 to 2 meters) and deeper (1 to 2 kilometers) depths, depending on rock resistivity, applied frequency, electrode array and separation.

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“ERA” Active electrode EM/Resistivity system

Specifications:

Operating frequencies		DC	1.22; 2.44; 4.88; 625; 1250; 2500 Hz
Measurement range of receiver input voltage to transmitter output current ratio (“q” parameter)		1.5×10^{-2} to 3.86×10^{3} Ohm	1.5×10^{-5} to 3.86×10^{3} Ohm
Operating temperature range		-20°C to +65°C	
Maximum reduced basic measurement error	for DC input voltage	2%	
	for “q” parameter	4%	

Receiver

Operating frequencies	DC	1.22; 2.44; 4.88; 50; 100; 625; 1250; 2500 Hz
Input voltage range	1×10^{-4} to 4V	1×10^{-7} to 2,8V
Minimum pure input resistance	100 MOhm	100 MOhm
Maximum input capacitance		10 pF (at 625 Hz)
Common-mode noise rejection	60 dB (min.)	60 dB (min.)
Rejection of 50-60 Hz and 10 kHz electric noise in measurements	60 dB (min.)	100 dB (min.)
Built-in storage capacity	30000 readings	
Supply voltage	12 V	
Power consumption	100 mW (max.)	
Interface	RS-232 (USB)	

Transmitters

Operating frequencies	DC; 1.22; 2.44; 4.88; 625; 1250; 2500 Hz
Output currents	0.5; 1; 1.5; 2; 5; 10; 20; 100; 200 mA
Minimum output voltage range	0 to 1000V (2000V peak to peak)
Maximum power output	12 VA (built-in power supply); 40 VA (external power supply, 24V)
Supply voltage	12 to 24 V

Input coupler for active electrode and electric antenna.

Input impedance	100 GOhm
Input capacitance	0.1 pF
Voltage transfer factor	0.99 to 1
Operating frequencies	1.22; 2.44; 4.88; 625; 1250; 2500 Hz

One of the distinguishing features of the ERA-MAX system is that it provides the possibility of contactless measurements of the electric field.

Problems solved with the "ERA-MAX" system:

- Geological mapping and mineral explorations.

Conventional areal and deep mapping becomes feasible in areas covered with screes, ice and snow, and in other poor grounding conditions. Of particular interest is the possibility of making measurements from the ice of frozen water basins.

- Engineering surveys for construction of building foundations.

When construction sites contain the remains of previous structures or roads galvanic grounding contacts are often impracticable. The application of nongrounded electrodes and appropriate measurement techniques offers the way out of this difficulty. Measurements can be made on concrete and asphalt pavements - airfields, motor roads, engineering surveying for construction of underground railways and service lines. Wide experience is available in application of the system equipment indoors for locating cracks in basements and groundwater infiltrations. Another radical advantage of the system is its high interference immunity in measurements at a frequency of 625 Hz. Addition of a magnetic field sensor to the system allows to detect and trace water and sewerage pipelines, power cables, telephone communication lines, etc., to determine electrochemical properties of soils, to measure industrial earthing resistances, to evaluate the intensity of stray currents and industrial electromagnetic fields.

- Environmental investigations and monitoring.

There is a number of examples of application of electric field contactless measurements for detecting leaks of toxic industrial wastes from the tailing ponds of operating mines, for locating salinization zones of agricultural lands, for classifying arable lands by filtration properties for land reclamation. There are prerequisites for applications of the new system to alert emergency conditions in mine workings and open cuts and probabilities of mud flows and landslides in mountainous areas.

- Archaeological investigations.

Electric microprospecting carried out with the "ERA-MAX" system provides solutions of typical archaeological problems such as locating disturbances of soil, cavities, wells, buried ancient stone structures. The version of the "ERA-MAX" system designed for measurements by the rotary electromagnetic field method allows to obtain the tomographic electrical image of the archaeological target through mathematical processing of the measurement data.

Some words about the history of procedure of alternating-current profiling and sounding with nongrounded transmitting and receiving.

Geological mineral explorations, civil engineering surveys, ecological and archaeological investigations, natural and man-made environment monitoring necessitate development of new and updating of existing nondestructive methods of investigations. Among the methods, which produce minimum adverse environmental impact, are geophysical methods of exploration with the electric resistivity method ranking as a high-performance versatile technique, which is based on differentiation of the geological section or inhomogeneity by their d.c. electrical properties.

Since its advent until the present day the resistivity method involved excitation and measurement of a d.c. field by means of galvanic grounding contacts spaced over the survey area in a specified geometrical arrangement. Of course, such groundings had to satisfy some specific requirements: these must be point groundings providing good galvanic contact with the ground and minimum self-potential EMF of the measuring electrode polarization. This traditional approach was applied for years and resulted in development of a number of field procedures, appropriate equipment and interpretation techniques.

First attempts to remove the limitations typical of this conventional approach date back to 1950-s in measurements of the quasi-permanent electric field at frequencies of several Hz to several hundred Hz aimed at eliminating the necessity to compensate the EMF of the measuring electrode polarization from the measurement procedure. In this case, d.c. field interpretation techniques were applied with observing frequency limits. A, so-called, low-frequency electric prospecting by the resistivity method appeared which found wide use for its good interference immunity and potentialities for increasing labor efficiency.

At the same time, however, the use of galvanic grounding contacts still imposed some limitations on application of the resistivity method in areas with bad grounding conditions, such as scree debris, frozen and loose ground, ice and snow, asphalt and concrete pavements, etc. Among the areas with hostile grounding conditions are vast territories in the East and North-East of Russia, deserts in Middle and Central Asia, permafrost areas of Canada and Alaska, desert of Africa and Australia. Apart from the necessity to expand the resistivity method applications geographically, of great practical importance is the increase of the fieldwork output due to measurements conducted in winter time over ice and snow. Winter fieldwork is indispensable in the areas inaccessible in summer time (lakes, swamps, agricultural lands).

During geological and archaeological explorations in urban areas injuries to pavements, brickworks, concrete constructions, buried cables and pipelines should be avoided wherever possible. Besides, measurements in urban areas are commonly carried out in high level of interference.

All abovementioned limitations and difficulties are responsible for development of a technique and appropriate equipment for contactless measurements of the electric field. B.G.Sapozhnikov since 1962 has worked out a unique procedure of alternating-current profiling and sounding with nongrounded transmitting and receiving lines of different geometry's and designs. He was the first to demonstrate the feasibility of contactless excitation and measurement of all three orthogonal components of the electric field, supported with appropriate theoretical foundations.

In 1991 "ERA" Enterprise developed an electric prospecting system "ERA" designed for a.c. contactless measurements of the electric field by the resistivity method. About 1000 sets of equipment have been produced and sold. The main users are geophysical and civil-engineering survey organizations of the CIS countries. The "ERA" Co. is specializing in developing of the instrumentation, field procedures and software for electric prospecting. The name of the company "ERA" is the acronym of the Russian words - Electric Prospecting Equipment. Since 1991 we have developed some modifications of the equipment for resistivity method survey. The distinctive feature of the ERA equipment is that it enables measurement in poor grounding conditions (i. e. contactless measurements). Since 2000 the "ERA" Co. produce the newest version of the ERA system – «ERA-MAX».

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