

GEONICS LIMITED

LEADERS IN ELECTROMAGNETICS



GEOPHYSICAL INSTRUMENTATION
FOR EXPLORATION & THE ENVIRONMENT

GEONICS LIMITED
1745 Meyerside Drive, Unit 8
Mississauga, Ontario
Canada L5T 1C6

Telephone: +1 (905) 670 9580
Telefax: +1 (905) 670 9204
E-mail: geonics@geonics.com



EM39 CONDUCTIVITY

The EM39 provides measurement of the electrical conductivity of the soil and rock surrounding a borehole or monitoring well using the inductive electromagnetic technique. The unit employs coaxial coil geometry with an intercoil spacing of 50 cm to provide a substantial radius of exploration into the formation while maintaining excellent vertical resolution. Measurement is unaffected by conductive borehole fluid or the presence of plastic casing. The instrument operates to a depth of 500 metres.

The combination of a large conductivity range, high sensitivity and very low noise and drift, allows accurate measurement of subsurface conditions. Typical applications include groundwater contamination monitoring, groundwater and mineral exploration, and general geotechnical investigations.

The 4-conductor EM39 probe can be used with many commercially available borehole logging systems, or with a dedicated winch and console system from Geonics.

Measurements can either be recorded with a digital data logger, or viewed in real-time using the EM39RT program with field computer.

Specifications

MEASURED QUANTITIES	Apparent conductivity in millisiemens per metre (mS/m)
PRIMARY FIELD SOURCE	Self-contained dipole transmitter
SENSOR	Self-contained dipole receiver
INTERCOIL SPACING	50 cm
OPERATING FREQUENCY	39.2 kHz
MEASURING RANGES	100, 1000, 10,000 mS/m
DEPTH	200 m (500 m cable optional)
MEASUREMENT RESOLUTION	0.1 % of full scale
MEASUREMENT ACCURACY	± 5 % at 30 mS/m
NOISE LEVELS	<0.5 mS/m
POWER SUPPLY	10 disposable "D" cells, or 12 VDC external power source
DIMENSIONS	Probe: 3.6 cm diameter, 163 cm length
WEIGHTS	Probe: 2.2 kg, Console: 7 kg Shipping: 90 kg (2 boxes)

GAMMA39 NATURAL GAMMA

The EM39 Borehole Conductivity Probe has been designed for rapid, accurate measurements of groundwater contamination in the earth and rock surrounding monitoring wells. Since clays also increase the electrical conductivity, Geonics introduced the GAMMA39 Natural Gamma Ray Probe to resolve this ambiguity. Whereas conductivity highs with coincident gamma ray highs often indicate enhanced clay content, conductivity highs not associated with a gamma ray high can be expected to be due to enhanced TDS in the groundwater.

Like the conductivity probe, the gamma ray probe is unaffected by plastic casing in the well. It requires no special licences, can be used anywhere, is relatively fast to operate and can, of course, also be employed to detect radioactive wastes in the ground.

Specifications

MEASURED QUANTITY	Naturally occurring gamma-radiation, in counts/second
SENSOR	Thallium-activated sodium iodide crystal
COUNTS RANGE	100, 300, 1000 counts/second
DEPTH	200 m (500 m cable optional)
MEASUREMENT PRECISION	one count/second
POWER SUPPLY	10 disposable "D" cells, or 12 VDC external power source
DIMENSIONS	Probe: 3.6 cm diameter, 100 cm length
WEIGHTS	Probe: 1.6 kg Console: uses EM39 console

EM39S MAGNETIC SUSCEPTIBILITY

The EM39S probe provides measurement of the magnetic susceptibility of the formation in the vicinity of a borehole or monitoring well. The EM39S, with intercoil spacing of 50 cm, provides good vertical resolution while still achieving a reasonable range of investigation into the surrounding medium. High sensitivity and low noise performance characteristics ensure an excellent range of measurement for most geological applications.

The susceptibility response is unaffected by plastic casing, and unlike conventional magnetometers, is unaffected by either variations in remanent magnetization of the surrounding soil or rock, or in the strength of the earth's magnetic field.

Specifications

MEASURED QUANTITY	Magnetic susceptibility in parts per thousand (ppt)
PRIMARY FIELD SOURCE	Self-contained dipole transmitter
SENSOR	Self-contained dipole receiver
INTERCOIL SPACING	50 cm
OPERATING FREQUENCY	39.2 kHz
MEASURING RANGES	30, 300 ppt
DEPTH	200 m (500 m cable optional)
MEASUREMENT RESOLUTION	0.1 % of full scale
MEASUREMENT ACCURACY	± 5 % at 30 ppt
NOISE LEVELS	0.02 ppt
POWER SUPPLY	10 disposable "D" cells, or 12 VDC external power source
DIMENSIONS	Probe: 3.6 cm diameter, 163 cm length
WEIGHTS	Probe: 2.2 kg Shipping: 90 kg (2 boxes)

GROUND CONDUCTIVITY METERS



EM31-MK2

The EM31-MK2 maps geologic variations, groundwater contaminants or any subsurface feature associated with changes in ground conductivity, using a patented electromagnetic inductive technique that allows measurement without electrodes or ground contact. With this inductive method, surveys can be carried out under most geologic conditions including those of high surface resistivity such as sand, gravel and asphalt.

Ground conductivity (quad-phase) and magnetic susceptibility (in-phase) measurements are read directly from an integrated data logger (which can easily be removed from the console for data transfer). Real-time (RT) graphical presentation of data is possible by connecting a computer directly to the RS232 output port on the front panel with an optional RS232 interconnect cable.

The effective depth of exploration is about six metres, making it ideal for geotechnical and environmental site characterization. Important advantages of the EM31-MK2 over conventional resistivity methods are the speed with which surveys can be performed, the precision with which small changes in conductivity can be measured and the continuous readout and data collection while traversing the survey area. Additionally, the in-phase component is particularly useful for the detection of buried metallic structure and waste material.

EM31-SH

The EM31-SH is a "short" version of the EM31-MK2 providing an effective depth of exploration of about four metres. With a smaller coil separation (2 m) and lighter weight, the EM31-SH offers improvements in sensitivity to smaller near-surface targets, lateral resolution and portability, while maintaining the high levels of accuracy and stability provided by the standard EM31-MK2. A "trailer-mount" (inset) is available for either instrument, offering greater convenience in field operation.

Specifications

MEASURED QUANTITIES	1: Apparent conductivity in millisiemens per metre (mS/m) 2: In-phase ratio of the secondary to primary magnetic field in parts per thousand (ppt)
INTERCOIL SPACING	3.66 metres
OPERATING FREQUENCY	9.8 kHz
POWER SUPPLY	8 disposable alkaline "C" cells (approx. 20 h continuous)
MEASURING RANGES	Conductivity: 10, 100, 1000 mS/m; In-phase: ± 20 ppt
MEASUREMENT RESOLUTION	± 0.1 % of full scale
MEASUREMENT ACCURACY	± 5 % at 20 mS/m
NOISE LEVELS	Conductivity: 0.1 mS/m; In-phase: 0.03 ppt
DATA STORAGE	10,000 records (2 components); 16,500 records (1 component); ext. memory available
DIMENSIONS	Boom: 4.0 m extended, 1.4 m stored Shipping Case: 145 x 38 x 23 cm
WEIGHTS	Instrument: 12.4 kg; Shipping: 28 kg



EM34-3

The EM34-3 is a simple-to-operate, cost-effective instrument for the geologist and hydrogeologist alike; applications have been particularly successful for the mapping of deeper groundwater contaminant plumes and for the exploration of potable groundwater resources.

Using the same inductive method as the EM31-MK2, the EM34-3 uses three intercoil spacings - 10, 20 and 40 m - to provide variable depths of exploration down to 60 metres. With three spacings and two dipole modes (horizontal as shown, and vertical) at each spacing, vertical electrical soundings can be obtained. In the vertical dipole (horizontal coplanar) mode, the EM34-3 is very sensitive to vertical geologic anomalies, and is widely used for groundwater exploration in fractured and faulted bedrock.

The EM34-3 includes connectors for an analog signal output, as well as an input which can be used with a rechargeable battery option. Digital signal output, required for data collection with the DAS70 system, is available as an option for all models of the EM34-3.

In regions of particularly high cultural and/or atmospheric noise, the EM34-3XL - including increased transmitter power and a larger transmitter coil - improves the signal-to-noise ratio by a factor of 10 at the 40 m spacing, and by a factor of 4 at the 10 m and 20 m spacings.

Specifications

MEASURED QUANTITIES	Apparent conductivity in millisiemens per metre (mS/m)
PRIMARY FIELD SOURCE	Self-contained dipole transmitter
SENSOR	Self-contained dipole receiver
REFERENCE CABLE	Lightweight, 2 wire shielded cable
INTERCOIL SPACINGS & OPERATING FREQUENCY	10 m at 6.4 kHz 20 m at 1.6 kHz 40 m at 0.4 kHz
POWER SUPPLY	Transmitter: 8 disposable or rechargeable "D" cells Receiver: 8 disposable or rechargeable "C" cells
CONDUCTIVITY RANGES	10, 100, 1000 mS/m
MEASUREMENT RESOLUTION	± 0.1 % of full scale
MEASUREMENT ACCURACY	± 5 % at 20 mS/m
NOISE LEVELS	0.2 mS/m (can be greater in regions of high power line interference)
DIMENSIONS	Receiver Console: 19 x 13.5 x 26 cm Transmitter Console: 155 x 8 x 26 cm Receiver & Transmitter Coil: 63 cm diameter EM34-3XL Transmitter Coil: 100 cm Shipping Case: 27.5 x 75 x 75 cm
WEIGHTS	Instrument: 20.5 kg; XL: 26.5 kg Shipping: 43 kg; XL: 51 kg



EM38

Designed for relatively shallow applications - specifically within the agricultural root zone - the EM38 provides measurement of ground conductivity (quad-phase) and magnetic susceptibility (in-phase) within two effective depth ranges: 1.5 m in the vertical dipole mode (shown above); and 0.75 m in the horizontal dipole mode. Based on the same induction principle as the EM31-MK2, the EM38 can survey large areas quickly without any requirement for ground-to-instrument contact.

For agricultural applications, measurement of ground conductivity is particularly useful in the mapping of variations in important soil properties such as salt and soil moisture content.

The EM38 has proven to be useful for many near-surface applications, including archaeology, wherein use can also be made of the information available in the measurement of soil magnetic susceptibility.

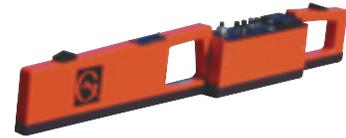
Very lightweight and only one metre long, the EM38 provides rapid surveys with excellent lateral resolution. Measurement is generally made by placing the instrument on the ground and recording the indicated reading. Either stationary or continuous measurements can be obtained from a standing position using the optional extender arm (shown above) with cable connection to a data acquisition system. In this mode of operation, several thousand data points can easily be obtained in one hour.

For large-area surveys, the EM38 can be easily mounted on a platform and towed behind a vehicle. Real-time (RT) data acquisition, with direct connection to computer-based acquisition systems, is available with an optional modification.

Specifications

MEASURED QUANTITIES	1: Apparent conductivity in millisiemens per metre (mS/m) 2: In-phase ratio of the secondary to primary magnetic field in parts per thousand (ppt)
PRIMARY FIELD SOURCE	Self-contained dipole transmitter
SENSOR	Self-contained dipole receiver
INTERCOIL SPACING	1 metre
OPERATING FREQUENCY	14.6 kHz
POWER SUPPLY	9 V battery
MEASURING RANGE	Conductivity: 1000 mS/m In-phase: ± 29 ppt
MEASUREMENT RESOLUTION	± 0.1 % of full scale
MEASUREMENT ACCURACY	± 5 % at 30 mS/m
NOISE LEVELS	Conductivity: 0.5 mS/m; In-phase: 0.02 ppt
BATTERY LIFE	30 hours continuous
DIMENSIONS	Instrument: 106 x 15 x 3.6 cm Shipping Case: 117 x 19 x 13 cm
WEIGHTS	Instrument: 3 kg Shipping: 10 kg

EM38B



For any one measurement, the standard EM38 provides measurement of either quad-phase (conductivity) or in-phase (magnetic susceptibility) component data, as selected by the operator. Comparatively, the EM38B provides simultaneous measurement of both phase components at all times. For surveys which include measurement of both components - common for archaeological investigations - the EM38B significantly reduces the amount of time required.

EM38-DD



The standard EM38 is operated in either the vertical or horizontal dipole mode at any given time. The EM38-DD provides simultaneous measurement of both dipoles at all times. The time required to complete any survey which includes the measurement of both dipole modes, therefore, is significantly reduced.



DAS70-CX DATA ACQUISITION SYSTEM

The DAS70-CX Data Acquisition System is available as an option for any Ground Conductivity Meter with the real-time (RT) modification for digital signal output, and all models of the EM61 and EM61-HH Metal Detectors. A complete DAS70-CX system includes a rugged, waterproof Allegro CX field computer; interface cables; and utility software, with programming for data transfer and management.

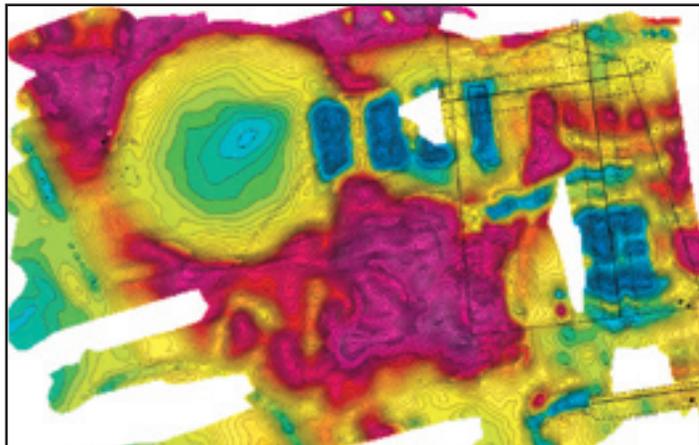
The Allegro CX field computer provides several benefits for field operations including a real-time graphic display of collected data for quality control; high capacity (256M) internal data storage, PC card compatibility and rechargeable NiMH batteries for extended survey time; and additional input connections to support the simultaneous collection of EM and GPS data.

Important specifications of the Allegro CX include an Intel XScale 400 MHz processor; 128M RAM; the intuitive Windows CE operating system; and an active matrix TFT colour display that is highly visible in direct sunlight. Included Bluetooth is available for custom applications.

For survey applications that include the use of multiple (e.g. EM61) units as a single sensor array, the **DAS70ML-CX** Data Acquisition System, including the Allegro CX field computer, supports simultaneous EM and GPS data collection through six available input connections.

Specifications

PROCESSOR	Intel XScale 400 MHz
OPERATING SYSTEM	Windows CE.NET 4.2
DATA STORAGE	256M internal disk storage; PC card compatible
COMMUNICATIONS	Two 9-pin RS-232
DISPLAY	High visibility active matrix TFT colour display (320 x 240 pixels)
KEYBOARD	Large keys for use with gloved hands; Touchscreen enabled
OPERATING TEMPERATURE	-30° to +54° C
POWER SUPPLY	Rechargeable NiMH high capacity battery pack
DIMENSIONS	25 x 15 x 3.8 cm
WEIGHT	<1 kg



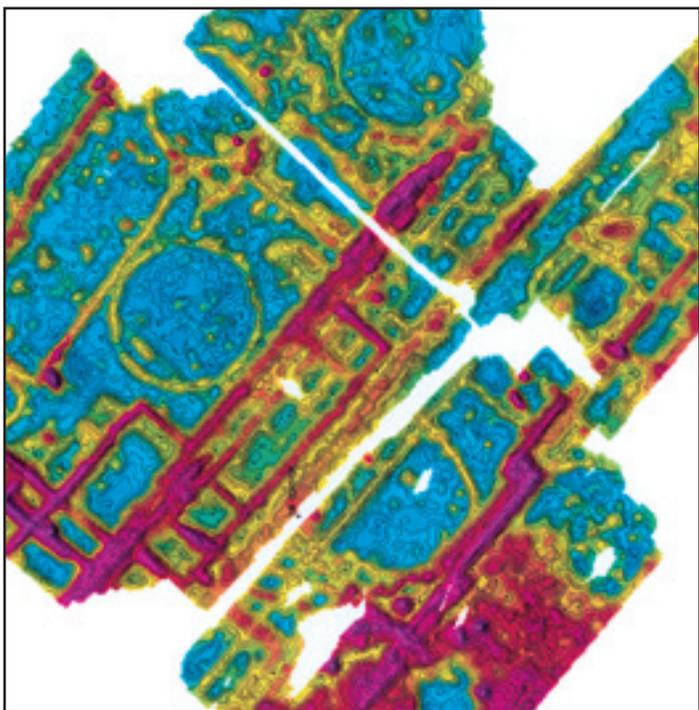
Geonics recommends any contour program which can generate both colour image and shaded relief maps in addition to the standard isoline contour maps. The gridding algorithms should be best suited to line-based data of high density and high dynamic range. The following are two programs recommended by Geonics.

Surfer

Surfer is a grid-based contouring and three dimensional surface plotting graphics program produced by Golden Software, Inc. Surfer interpolates your irregularly or regularly spaced XYZ data onto a regularly spaced grid, and places this data in a grid file. Surfer combines sophisticated gridding and data interpretation with a variety of presentation capabilities that allow the user to produce quick and customized maps.

OASIS montaj

OASIS montaj is a comprehensive PC-based earth science data processing software package produced by Geosoft Inc. This program is ideally suited for line-based data of high density and dynamic range. Presentation formats include standard contour maps, colour image maps and shaded relief maps. Any combination of formats can be merged into a single plot file for customized presentation. Plot files can be easily converted to AutoCad.DXF format for transfer to AutoCad facilities.



EM61-MK2

The EM61-MK2, an enhanced version of the patented EM61, is a time domain metal detector which detects both ferrous and non-ferrous objects with excellent spatial resolution. Target response is a single, sharply defined peak, facilitating quick and accurate target location. A single 200 litre (55 gal.) drum can be detected at depths greater than three metres; modification for increased power, to increase both the sensitivity to smaller targets and depth of detection, for all targets, is available.

Data from multiple time gates - three or four, user-selectable - are recorded to provide a more complete measurement of the response decay rate for improved target characterization (and discrimination). Early time gates increase the maximum depth of detection for all targets; a mid-range time gate, at the same position as the original EM61, offers comparison with, and continuation of original EM61 data sets.

Data acquisition is supported by the Allegro CX field computer. Important features include real-time graphic display of data for review and quality control; high capacity (256M) data storage for extended survey time; increased rate of data collection; and additional input connections for simultaneous collection of EM and GPS data.

The system is immediately GPS compatible; a fully integrated Trimble AG114 - with no requirement for a separate GPS receiver console - is available as an option.

The system can be pulled as a trailer, in single or multiple unit configurations, or carried by an operator with a belt harness.

For applications in marine environments, the **EM61S** (Submersible), available as either an attachment to a standard EM61-MK2 (or EM61) or a complete stand-alone unit, is a submersible coil and cable system capable of operation to depths of more than 60 metres.

Specifications

MEASURED QUANTITIES	Four time gates of secondary response in mV
EM SOURCE	Air-cored coil, 1 x 0.5 m size
CURRENT WAVEFORM	Unipolar rectangular current with 25 % duty cycle
EM SENSORS	a) Main: Air-cored coil, 1 x 0.5 m in size, coincident with EM source b) Focusing: Air-cored coil, 1 x 0.5 m in size 30 cm above main coil
MEASURING RANGES	10,000 mV
DYNAMIC RANGE	18 bits
OUTPUT MONITORS	Colour TFT active matrix LCD (320 x 240 pixels), and audio tone
DATA STORAGE	256M internal disk storage; PC card compatible
POWER SUPPLY	12 V rechargeable battery for 4 h continuous operation
OPERATING WEIGHT & DIMENSIONS	Backpack: 60 x 30 x 20 cm; 8 kg Coil Assembly: 100 x 50 x 5 (bottom), 100 x 50 x 2 (top); 14 kg (23 kg in trailer mode)
SHIPPING WEIGHTS & DIMENSIONS	112 x 61 x 26 cm (box 1) 54 x 59 x 63 cm (box 2) with trailer option only 48 kg (74 kg with trailer)



EM61HH-MK2

The EM61HH-MK2 is a "hand-held" complement to the EM61-MK2, providing greater sensitivity to smaller targets at shallow depths. A single 20 mm projectile can be detected to a depth greater than half a metre. Comparatively, a single 200 litre (55 gal.) drum can be detected to depths of greater than 2 metres.

Data is collected from a single receiver at four time gates after transmitter turn-off. Information from four gates provides for the discrimination of targets based on the response decay rate; the early-time data will detect both small and large targets with short and long decay rates respectively, while the late-time data will detect only larger targets with relatively long response decay.

Calculation of the decay apparent time constant, proportional to the ratio between early- and late-time signal response, allows for the identification of targets with similar physical characteristics such as material, size and shape; inherently, information is provided for improved target discrimination.

With a narrower spatial focus than the standard EM61-MK2, the EM61HH-MK2 is relatively less sensitive to sources of potential interference. As a result, data can be collected in closer proximity to structural features such as fences and buildings. Additionally, the narrower focus provides enhanced target resolution, and consequently improves discrimination of multiple targets.

The EM61HH-MK2 can be operated either with or without wheels. In either configuration, the smaller, more portable design offers improved access to areas of difficult terrain and dense vegetation.

Specifications

MEASURED QUANTITIES	Four time gates of secondary response in mV
EM SOURCE	Air-cored coil, 17 cm diameter
CURRENT WAVEFORM	Unipolar rectangular current with 25 % duty cycle
EM SENSOR	Air-cored coil, 17 cm diameter
MEASURING RANGES	10,000 mV
DYNAMIC RANGE	18 bits
OUTPUT MONITORS	Colour TFT active matrix LCD (320 x 240 pixels), and audio tone
DATA STORAGE	256M internal disk storage; PC card compatible
DATA OUTPUT	RS232 serial port
POWER SUPPLY	12 V rechargeable battery for 4 h continuous operation
OPERATING WEIGHTS & DIMENSIONS	Backpack: 60 x 30 x 20 cm; 8 kg Sensor Assembly: 33 x 20 cm; 2.8 kg (7.5 kg with wheels)
SHIPPING WEIGHTS & DIMENSIONS	50 kg 117 x 50 x 54 cm



EM63

The EM63 Metal Detector advances the application of time domain electromagnetics (TDEM) methods to the detection of unexploded ordnance. Measurement of the full transient electromagnetic response offers improved detection capability and information on target characteristics.

Comparable to the EM61-MK2, the EM63 generates a pulsed primary magnetic field which induces eddy currents in nearby metallic objects. The decay of these eddy currents with time generates a secondary magnetic field with a specific rate of decay that is determined uniquely by the character - the size, shape, orientation and metal composition - of the object itself.

Measurement of the secondary magnetic field decay (the transient response), therefore, will provide important information toward: a more complete characterization and classification of the target; identification and rejection of the characteristic response from certain geologic materials (e.g. magnetite); and, consequently, a reduction in target selection error (the "false positive rate").

The EM63 accurately measures the complete transient response over a wide dynamic range of time: measurements are recorded at 26 geometrically spaced gates, covering a time range from 180µs to 25ms. Data acquisition is supported by the Allegro (DOS) field computer (32M data storage capacity) which is able to simultaneously receive GPS data for location control.

Software is available and provided to facilitate the collection and basic processing of data; data inversion software for target characterization/classification is expected to become available sometime in 2006.

Specifications

MEASURED QUANTITIES	26 time gates of secondary response in mV covering range from 180 µs to 25 ms
EM SOURCE	Air-cored coil, 1 x 1 m size
CURRENT WAVEFORM	Bipolar rectangular current
EM SENSORS	a) Main: Air-cored coil, 0.5 x 0.5 m in size, coincident with EM source b) Focusing: Air-cored coil, 0.5 x 0.5 m in size 60 cm above main coil c) Compensation coil, 0.5 x 0.5 m in size
MEASURING RANGES	10,000 mV
DYNAMIC RANGE	18 bits
OUTPUT MONITORS	Colour TFT active matrix LCD (320 x 240 pixels), and audio tone
DATA STORAGE	>100,000 data sets
DATA OUTPUT	RS232 serial port
POWER SUPPLY	12 V rechargeable battery for 4 h continuous operation
OPERATING WEIGHT & DIMENSIONS	Sensor: 100 x 100 x 60 cm; 32 kg Console: 38 x 19 x 6 cm; 4.5 kg Battery: 23 x 21 x 14 cm; 10 kg
SHIPPING WEIGHTS & DIMENSIONS	104 x 104 x 22 cm (box 1); 60 kg 58 x 48 x 47 cm (box 2); 46 kg

PROTEM TIME DOMAIN EM SYSTEMS



PROTEM RECEIVER

It is well known that there is a trade-off between depth of exploration and target definition in terms of conductivity, extent and orientation. Greatest depth is obtained with large fixed loop Turam-type systems which generate large half-space responses that, along with current gathering, make target detection difficult. Better spatial resolution is obtained with a moving transmitter configuration with a short intercoil spacing, but is limited to a shallower depth of exploration. These variations in survey requirements make system flexibility an important design consideration.

Time domain systems are also routinely employed for general geological exploration, such as for freshwater aquifers in bedrock fractures, and mapping groundwater contaminant plumes. Exploration to shallow depths, as necessary in these applications, requires a very wide bandwidth and many narrow sampling gates.

Recognition of such diverse requirements led to development of the extremely flexible PROTEM time domain system. The digital, three-component receiver is used with any of the three TEM transmitters and choice of receiver coils to cover all applications. With true 24-bit resolution (at a single gain), system bandwidth of 270 kHz, microsecond sampling gates and simultaneous three-component (XYZ) component measurements, the PROTEM receiver provides the ultimate in time domain capability.

The PROTEM Receiver enables the selection of either 20 gates per base frequency covering two decades of time, or 30 gates for a three decade range. If three decades of time are required to cover the decay, then this selection saves switching frequencies and repeating the measurement; if only two decades are required, using the 20-gate range reduces the measurement time by a factor of 10.

Automated measurements during the on-time, in addition to off-time measurements, is a standard feature of every receiver.

Specifications

MEASURED QUANTITY	Rate of decay of induced magnetic field along 3 axes, in nV/m ²
EM SENSOR	Air-cored coils
CHANNELS	1 channel used sequentially for 3 components or optionally, 3 channels for 3 components simultaneously
TIME GATES	20 gates covering 2 time decades, or 30 gates covering 3 time decades
DYNAMIC RANGE	24 bits (138 dB)
BASE FREQUENCY	0.3, 0.75, 3, 7.5, 30, 75 and 285 Hz or 0.25, 0.625, 2.5, 6.25, 25, 62.5 and 237.5 Hz
INTEGRATION TIME	0.5, 2, 4, 8, 15, 30, 60 or 120 s
DISPLAY	240 x 64 dot graphic LCD
DATA HANDLING	Solid-state memory for 3300 data-sets, RS232 output
SYNCHRONIZATION	Reference cable or, optionally, highly stable quartz crystal
POWER SUPPLY	12 V rechargeable battery for 8 h continuous operation
WEIGHT	15 kg
DIMENSIONS	34 x 38 x 27 cm



TEM47 TRANSMITTER

Three interchangeable transmitters - TEM47, TEM57-MK2 and TEM67 - are used with the PROTEM receiver and the appropriate receiver coil to make up different PROTEM systems for various applications such as mineral exploration, structural mapping, resistivity sounding and contaminant plume mapping.

The TEM47 is the smallest and lightest transmitter, battery powered, with a very fast turn-off time to enable measurement of the near-surface response. The PROTEM 47 (including PROTEM receiver, TEM47 transmitter) is most often used for shallow resistivity sounding of groundwater contamination, saline intrusion and geologic units. In this configuration, single turn transmitter loops from 5 m up to 100 m on a side, with turn-off times as short as half a microsecond, can be used to give maximum near-surface resolution.

The transmitter output current of 3 A into a 100 m x 100 m loop gives good response and resolution to depths of 150 m, making this the ideal instrument for resistivity sounding over a large area. The 30 gate, three time-decade measurement is usually enough to cover the full decay curve including the early time gates, without changing base frequency.

The TEM47 uses a reference cable to achieve the high synchronization accuracy required for shallow sounding. Regardless of application, a high-frequency receiver coil is used in PROTEM 47 systems - the high-frequency receiver coils have the bandwidth necessary to capture the earliest portion of the transient decay.

For greater consideration of structural response within complex geologic environments, the three-component high-frequency receiver coil is recommended.

When used in a PROTEM 47 system for profiling, the TEM47 supplies 2.5 A to an 8-turn, 5 m x 5 m moving transmitter loop to provide a dipole moment of 500 Am². With base frequency of 75 Hz, and 20 gates from 49 μ s to 2.9 ms, this configuration is optimal for Slingram (horizontal loop) surveys for mineral exploration to shallow depths, and for groundwater exploration in bedrock fractures. Electrical sounding is performed simultaneously with the search for fault or dike-like targets.

Specifications

CURRENT WAVEFORM	Bipolar rectangular current with 50 % duty cycle
BASE FREQUENCY	30, 75, or 285 Hz where powerline frequency is 60 Hz 25, 62.5 or 237.5 Hz where powerline frequency is 50 Hz
TURN-OFF TIME	2.5 μ s at 3 A into 40 x 40 m loop; faster into smaller loop
TRANSMITTER LOOP	5 x 5 to 100 x 100 m single turn loop, or 5 x 5 m 8-turn loop
OUTPUT VOLTAGE	0 to 9 V, continuously variable
POWER SUPPLY	Internal 12 V rechargeable battery
BATTERY LIFE	5 h continuous operation at 2 A output
WEIGHT	5.3 kg
DIMENSIONS	10.5 x 24 x 32 cm



TEM57-MK2 TRANSMITTER

The TEM57-MK2 Transmitter is the upgraded version of the TEM57, and combined with the PROTEM digital receiver are the principal components of the PROTEM 57-MK2 system. The design and performance of the TEM57-MK2, with increased power of 1,500 W, makes it a highly portable, powerful, mid-range time domain transmitter. The internal power supply has variable voltage range from 18 to 60 V so that it can be precisely matched to the transmitter loop for optimum performance. An external battery source increases performance to 3,800 W and 160 V.

The TEM57-MK2 is the perfect mid-range power transmitter for sounding depth, thickness and conductivity of geologic layers down to 500 m for a wide variety of applications such as mapping of aquifers and aquitards, water quality and stratigraphy. In coastal areas, the PROTEM 57-MK2 system has defined depth to saline intrusion as accurately as chemical well samples.

The PROTEM 57-MK2, with a short reference cable, portable transmitter and 3D receiver coil, can delineate complex ore bodies within 200 m of surface. Deeper conductors can be characterized by profiling with a crystal-synchronized receiver and a large, fixed transmitter loop. Modelling provides conductivity, thickness, dip and extent of the ore body.

For measurements during the turn-off (T/O) ramp, an optional T/O controller, connected externally to the transmitter, can variably increase the turn-off time, typically within the range of 200-1000 microseconds.

Specifications

CURRENT WAVEFORM	Bipolar rectangular current with 50 % duty cycle
BASE FREQUENCY	3, 7.5, or 30 Hz (powerline frequency 60 Hz) 2.5, 6.25, or 25 Hz (powerline frequency 50 Hz) Rates below 1 Hz available from PROTEM receiver through reference cable
TURN-OFF TIME	20 to 115 μ s, depending on size, current and number of turns in transmitter loop
TRANSMITTER LOOP	Single turn: any dimension (minimum resistance 0.7 ohms) up to 300 x 600 m 8-turn: 5 x 5 or 10 x 10 m
OUTPUT CURRENT	25 A maximum
OUTPUT VOLTAGE	18 V to 60 V continuous control with motor generator; up to 160 V (3,800 W) with external power supply
SYNCHRONIZATION	Reference cable or, optionally, quartz crystal
POWER SUPPLY	1,800 W, 110/220 V, 50/60 Hz single-phase motor-generator or, optionally multiple 12 V batteries
TRANSMITTER PROTECTION	Electronic and electromechanical protection
TRANSMITTER SIZE	43 x 25 x 25 cm
TRANSMITTER WEIGHT	15 kg
MOTOR GENERATOR SIZE	51 x 29 x 42 cm
MOTOR GENERATOR WEIGHT	21 kg



TEM67 TRANSMITTER

The TEM67 Transmitter is the most powerful of the current PROTEM transmitters, replacing the TEM37 of the previous generation. Not only is the TEM67 (3,800 W) more powerful than the TEM37 (2,800 W), but it also offers a degree of flexibility not previously available with time domain transmitters.

The TEM67 is comprised of two principal components: a complete TEM57-MK2 transmitter; and an integral, but separate, power module with a larger (4,500 W) power generator. Such modular design allows for easy upgrade from the TEM57-MK2, by the addition of the power module and larger generator. Alternatively, when applications do not require the full capabilities of the TEM67, the more portable, mid-range TEM57-MK2 can be operated independently.

The PROTEM 67 is appropriate for deep soundings in ground water exploration, saline intrusion mapping, geothermal exploration, and regional geological research where structures and layer information is required to depths of 1,000 m or more.

The PROTEM 67 system with the 3D receiver coil is the ideal time domain system for profiling deeply buried conductive ore bodies, such as massive sulphides, to depths in excess of 500 metres, and with the three-axis BH43-3 borehole probe for time domain logging to 2 kilometres.

For increased depth of exploration, the addition of a second, optional power module, increasing the output voltage from 150 V to 240 V, can extend the range of measurement for any application.

For measurements during the turn-off (T/O) ramp, an optional T/O controller, connected externally to the transmitter, can variably increase the turn-off time, typically within the range of 200-1000 microseconds.

Specifications

CURRENT WAVEFORM	Bipolar rectangular current with 50 % duty cycle
BASE FREQUENCY	0.3, 0.75, 3, 7.5 or 30 Hz (powerline frequency 60 Hz) 0.25, 0.625, 2.5 or 25 Hz (powerline frequency 50 Hz) Rates below 1 Hz available from PROTEM receiver through reference cable
TURN-OFF TIME	20 to 750 μ s, depending on transmitter loop size, current and number of turns
TRANSMITTER LOOP	Up to 2,000 x 2,000 m maximum
OUTPUT CURRENT	25 A maximum
OUTPUT VOLTAGE	18 to 150 V continuously adjustable
SYNCHRONIZATION	Quartz crystal and reference cable
POWER SUPPLY	4,500 W, 110/220 V, 50/60 Hz, single phase with 8h continuous operation motor generator
TRANSMITTER PROTECTION	Electronic and electromechanical protection
TRANSMITTER SIZE	43 x 25 x 25 cm (TEM57-MK2); 42 x 20 x 31 cm (TEM67 Power Module)
TRANSMITTER WEIGHT	15 kg (TEM57-MK2); 12 kg (TEM67 Power Module)
MOTOR GENERATOR SIZE	60 x 50 x 49 cm
MOTOR GENERATOR WEIGHT	62 kg

BOREHOLE TDEM PROBE



BH43-3

The BH43-3 provides three-dimensional time domain EM exploration from boreholes, in conjunction with a PROTEM system. Boreholes as deep as 2 km can be surveyed using a PROTEM system with a 500 x 500 m transmitter loop. (At developed mines, the transmitter loop can be laid out in underground workings.)

The probe has three sensors which measure orthogonal components of decay. Along the hole, spatial resolution as fine as 1 m can be obtained - the actual measurement interval depends on the desired resolution of the response.

The wide bandwidth of the probe, coupled with the excellent temporal resolution and large dynamic range of the PROTEM system, provides maximum diagnostic information with a high degree of rejection of powerline and other noise sources.

Computer programs for editing, displaying and interpreting BH43-3 responses are supplied with the probe, including a program for calculating all field components in a conductive earth. Third party software is available to successfully transform data collected with the BH43-3 to a step response.

The BH43-3 probe is available separately, or as a complete borehole system with cable, main winch, dummy probe, test cable and winch, and retrieval tools.

Specifications

SENSOR	Three orthogonal coils (one axial and two radial)
SENSOR AREA-TURNS PRODUCT	10,000 m ² for axial and 2,500 m ² for radial sensors (with amplification)
SENSOR-PREAMPLIFIER RESONANT FREQUENCY	10 kHz for all sensors
PROBE ROTATION CORRECTION	Two orthogonal tilt meters with range from ± 1° to ± 80° (from vertical)
OPERATING TEMPERATURE	-30° C to +80° C
POWER SUPPLY	Rechargeable nickel cadmium battery sealed pack for 20 h continuous operation
CONTROL BOX	Channel selection, impedance and gain matching network between probe and PROTEM receiver (normalizes sensor effective area to 100 m ² for all three sensors); comes with VLF filter
CABLE	Two-conductor shielded; polyurethane jacket; Kevlar strength membrane, 5.6 mm diameter with weight 40 kg/km and breaking strength 500 kg
WEIGHT	Probe: 9.5 kg Control Box: 1.5 kg
DIMENSIONS	Probe: 3.8 cm diameter, 234 cm length Control Box: 22 x 13.5 x 8 cm

VLF RECEIVER / TRANSMITTER



EM16 / EM16R / TX27

The EM16 VLF Receiver is the most widely used EM geophysical instrument of all time. Local tilt and ellipticity of VLF broadcasts are measured and resolved into in-phase and quadrature components of VLF response. The EM16 has discovered several base and precious-metal orebodies and many water-bearing fractures and faults.

The EM16R Resistivity Attachment uses a pair of electrodes to measure the apparent resistivity of the earth. The combined EM16/16R instrument can detect a second earth-layer if the layer occurs within the VLF skin-depth. In addition, the EM16/16R can map resistive alteration for gold exploration.

The TX27 is a portable VLF transmitter supplying a VLF field for surveying with either the EM16 or the EM16/16R if remote broadcasts are weak, intermittent or poorly coupled with the target. For EM16 surveys, the TX27 antenna consists of a long (typically 1 km) grounded wire.

Specifications (EM16 / EM16R)

MEASURED QUANTITY	EM16: In-phase and Quadrature components of the secondary VLF field, as percentages of the primary field EM16R: Apparent resistivity in ohm-metres, and phase angle between E _x and H _y
PRIMARY FIELD SOURCE	VLF broadcast stations
SENSOR	EM16: Ferrite-core coil EM16R: Stainless-steel electrodes, separated by 10 m: impedance of sensor is 100 MΩ in parallel with 0.5 pf
OPERATING FREQUENCY	15 to 25 kHz (optionally to 30 kHz) depending on VLF broadcasting station
MEASUREMENT RANGES	EM16: In-phase: ±150 %; Quadrature: ±40 % EM16R: 300, 3000, 30000 Ω-m, Phase: 0-90°
POWER SUPPLY	EM16/EM16R: 6 alkaline "AA" cells
DIMENSIONS	EM16/EM16R: 53 x 30 x 22 cm
WEIGHTS	EM16: Operational: 1.8 kg; Shipping: 6.2 kg EM16R: Operational: 1.5 kg; Shipping: 6 kg

Specifications (TX27)

PRIMARY FIELD SOURCE	Grounded wire or 500 x 500 m loop, current adjustable, 0 to 2 A
OPERATING FREQUENCY	18.6 kHz
POWER SUPPLY	120/220 V, 350 W motor generator
DIMENSIONS	Transmitter and loop; Shipping: 89 x 29 x 39 cm Generator; Shipping: 50 x 27 x 36 cm
WEIGHTS	Transmitter and loop; Shipping: 32.5 kg Generator; Shipping: 17 kg



GEONICS LIMITED

1745 Meyerside Drive, Unit 8, Mississauga, Ontario, Canada L5T 1C6

Tel: +1 (905) 670-9580 • Fax: +1 (905) 670-9204 • E-mail: geonics@geonics.com • Website: <http://www.geonics.com>