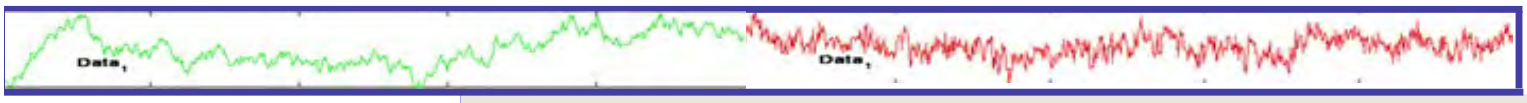
KMS Technologies
Innovating Solutions

Array data acquisition system
(Electromagnetics & microseismics)



KMS-820 data acquisition unit (land)
KMS-831 digital interface (32-bit)

KMS-870 broad-band seismic/EM marine deep-water node

LEMI-701 non-polarizable, lead-free electrodes

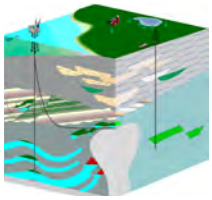
LEMI-120 induction coil sensor (0.0001 – 1,000 Hz)

LEMI-118 induction coil sensor (1 – 70,000 Hz)

KMS-029 fluxgate magnetic sensor 32-bit, (DC – 180 Hz)

3D software license & interpretation services

Reservoir monitoring



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Product overview

The Array Data Acquisition System is used for a variety of geophysical applications such as electromagnetics (EM) (MT, AMT, LOTEM, CSEM, CSAMT, TFEM, IP, etc.) and seismic data acquisition (microseismic, seismic/EM monitoring). This 2D/3D system consists of multi-channel acquisition units (KMS-820 or KMS-820 MESH or KMS-870 for marine) controlled by a central control unit and optional transmitter for multi-channel EM and seismic data acquisition. The system is fully expandable and is capable of several survey configurations. The system seamless allows land (KMS-820) and marine (KMS-870) acquisition as well as synchronization with KMS's borehole systems

System highlights:

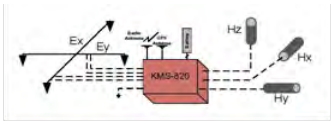
- Flexible and easy adaptable system configurations
- Lightweight, portable, rugged, low power consumption
- Wireless network (long range), GPS synchronized, wide bandwidth and dynamic range
- 24-bit or 32-bit digital resolution, DC to 50 kHz signal bandwidth
- Low cost with large channel count (unlimited)
- Efficient field operations without cables
- Each KMS-820 can be expanded to unlimited channels with KMS-831 (32-bit)
- High sampling rate to adapt to various geophysical methods (24 bit up to 100 kHz, 32-bit up to 4 KHz)
- Combined MT/AMT measurements to give high resolution mapping and great depth
- MT: Fully synchronized SIMULTANEOUS acquisition for ultra low frequencies (KMS-029: DC-180 Hz), standard MT band (LEMI-120: 0.0001 – 1000 Hz), AMT band (LEMI-118>: 1 – 50,000 Hz)
- Combined CSEM and natural source EM acquisition in one receiver deployment
- Acquire microseismic data independently or simultaneously with EM
- Same system is capable of acquiring different methods by adding optional transmitters or geophones

System configuration

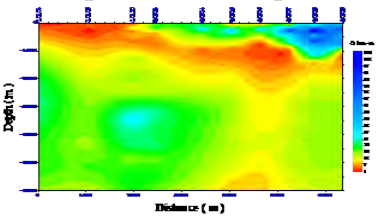
The KMS acquisition allows a variety of survey configurations, from single recording station to 3D acquisition arrays.

The multi-channel acquisition unit (KMS-820) is configured as 6 channels for MT/AMT, LOTEM, CSAMT, CSEM, TFEM, and IP applications or 6 channels for seismic/EM data. Additional channels can be added using the digital interface and the 32-bit KMS-831 interface. This takes digitizer closer to the sensor. The typical configuration of the 6-channel acquisition unit has two electric (E) field measurements and three magnetic (H) field measurements with one spare channel.

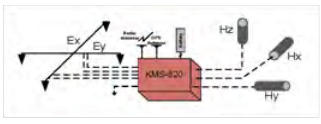
Additional acquisition units can be added for remote reference or array applications. Each unit can be expanded.



Single EM recording site

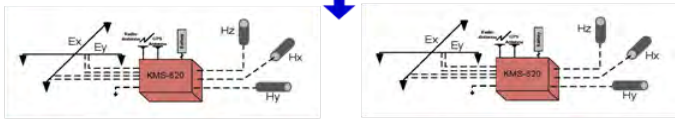


2D EM inversion result



Remote reference site

10 km to 100 km



Single or multiple recording sites with remote reference

EM methods & microseismics

- MT, AMT: Magnetotellurics and Audio MT are used for basin reconnaissance and structure studies including near surface applications, mostly oil &gas and geothermal applications.
- CSAMT: Controlled Source Audio MT uses a transmitter to get better Signal-to-Noise (S/N) ratios for detailed structure investigations of the upper 2 km.
- TFEM, IP: Time-Frequency Domain ElectroMagnetics and Induced Polarization combine time and frequency domain electromagnetics for hydrocarbon and mineral exploration.
- LOTEM: Long Offset Transient ElectroMagnetics is applied to detailed structural investigations of the upper 5 km for hydrocarbon and geothermal Exploration & Production. Focused TEM is also possible.
- All EM methods can be combined with simultaneous microseismic acquisition, The KMS-870 includes broadband microseismic and marine MT acquisition in one unit.

Applications

- Oil and gas exploration (land & marine)
- Hydrocarbon reservoir dynamics and CO_2 storage monitoring
- Geothermal exploration
- Engineering and environmental studies
- Earthquake prediction research
- Deep crustal research
- Metals and mineral exploration
- Linkage to KMS-borehole system
- Reservoir monitoring

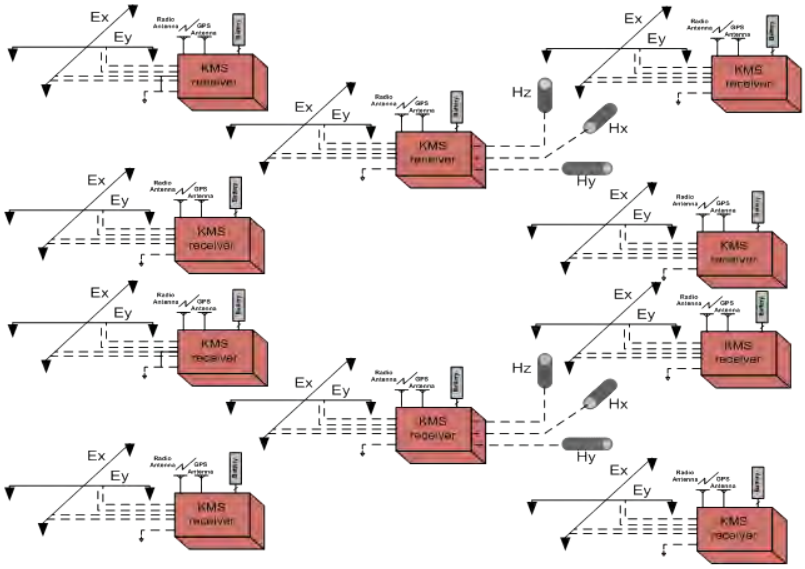
3D EM/seismic array layouts

KMS acquisition systems can be used for large scope 3D EM survey with densely spaced electric sensors and sparsely installed magnetometers. The system's wireless network feature makes field operations very efficient when conducting massive 3D EM survey. Depending upon distance between sites, KMS-820 or KMS-831 with digital interconnect (≈100 m) can be used. KMS-831 is about 5 times less expensive than the KMS-820 and connects to a KMS-820.

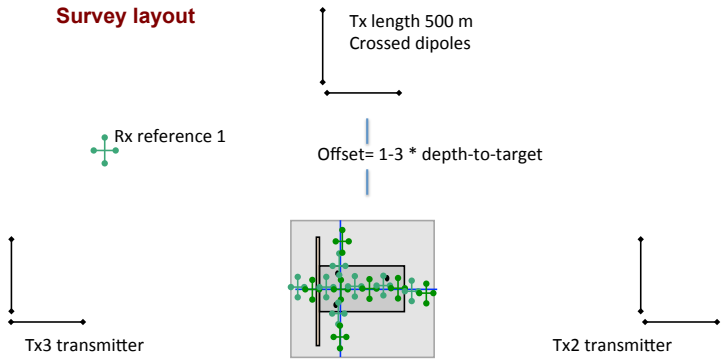
Handheld

KMS-5100 transmitter

OPTIONS



Reservoir monitoring layout



MT applications

Magnetotellurics (MT) and Audio MT (AMT) target different depth of investigation in hydrocarbon and geothermal exploration. For hydrocarbon exploration, high resistivity lithology such as salt, basalt, and overthrusting often mask underlying sediments. They are difficult to image with seismic data due to high velocities and diffuse scattering. But they can be easily imaged by MT or Lotem method because of their associated large resistivity contrasts.

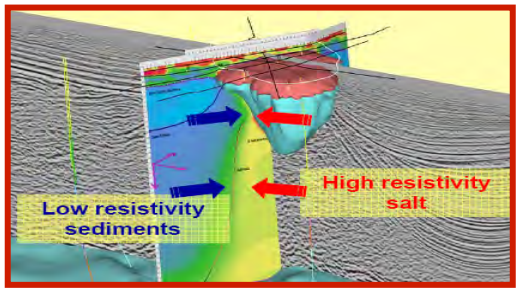
MT utilizes natural variations in the Earth's magnetic field as a source. Natural MT signals come from a variety of induced currents caused by thunderstorms and the ionosphere. The frequency range of MT data spans from 0.0001 Hz to 1000 Hz and for AMT from 10 Hz to 20 kHz.

2D or 3D MT survey configurations

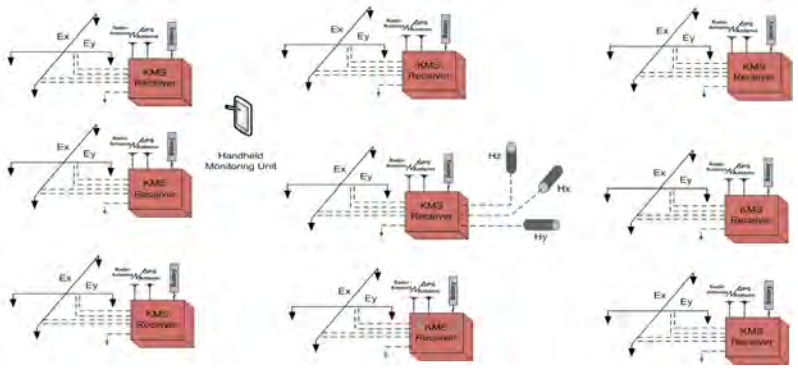
For large site count 2D and 3D MT or AMT surveys, the array configuration is more cost effective. The central control unit of the array is capable of controlling several thousand recording units wirelessly. Standard distances are 5 miles without and- principally-unlimited with wireless relays.

Commercial benefits:

- Low cost for 2D or 3D MT and AMT surveys
- High speed sampling rate allow acquiring MT and AMT data with the same unit
- Fast and easy operation and deployment of multiple recording units
- Customized wireless system for remote system monitoring
- Designed for dense acquisition spacing for data redundancy and high resolution data recording



After Zerilli et al., 2002



Array recording configuration for 3D MT/AMT data acquisition

System configuration table

Following table shows the various system configuration options for different surveys and applications. System components can be mixed and matched in a modular fashion. Seismic sensors can always be added.

Survey	Receiver	Transmitter	Sensors	Applications / Depth
MT	*KMS-820*	*N/A*	*Electrode: LEMI-701* *Magnetometer: LEMI-120* *LEMI-118* *KMS-029*	*Onshore /* *Deep targets & basin study*
CSAMT	*KMS-820*	*KMS-5100*	*Electrode: LEMI-701* *Magnetometer: LEMI-118*	*Onshore, transition zone /Shallow targets*
TFEM	*KMS-820*	*KMS-500* *KMS-5100*	*Electrode: LEMI-701* *Magnetometer: LEMI-140* *LEMI-120* *LEMI-118* *KMS-029*	*Onshore, transition zone /Shallow to mid-depth targets*
LOTEM	*KMS-820*	*KMS-500* *KMS-5100*	*Electrode: LEMI-701* *Magnetometer: LEMI-140* *KMS-air coil*	*Onshore, transition zone /Shallow to mid-depth targets*
TFEM, IP	*KMS-820*	*KMS-500* *KMS-5100*	*Electrode: LEMI-701* *Magnetometer: LEMI-140* *LEMI-120* *LEMI-118*	*Onshore, transition zone /Shallow to mid-depth targets*
CSEM	*KMS-820*	*KMS-500* *KMS-5100*	*Electrode: LEMI-701* *Magnetometer: LEMI-120* *LEMI-118*	*Onshore, transition zone /Shallow to mid-depth targets*
MMT & CSEM	KMS-870	on request	*Seismic & EM included*	*Deep water ocean bottom imaging*

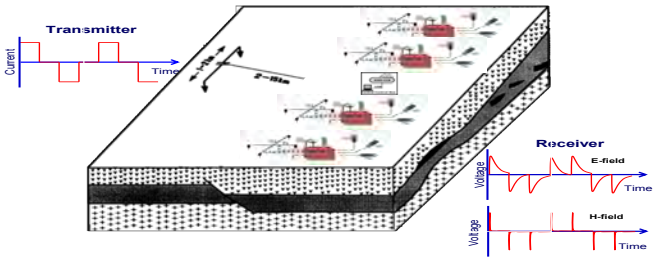
TFEM method

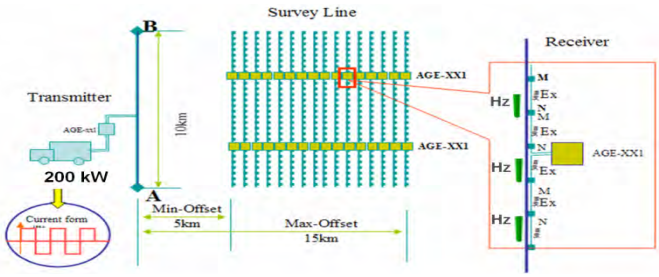
Time-Frequency ElectroMagnetics (TFEM) applies the Transient ElectroMagnetic (TEM) and Spectral Induced Polarization (SIP) techniques. It records broad-band frequency and time domain following a scheduled process.

An anomaly with the combination of high resistivity and high Induced Polarization (IP) can indicate an oil or gas reservoir. The high power transmitter signal can penetrate the overlying formations to detect this oil and gas anomaly directly.

The layout comprises of a transmitter synchronized with the receivers. A frequency optimized high power square-wave current is injected into the ground by an electric dipole, allowing Ex (horizontal electric field) and Hz (vertical magnetic field) to be recorded.

The KMS array system includes scheduler and synchronization with transmitter to be able to follow any pre-defined transmission and acquisition sequence.





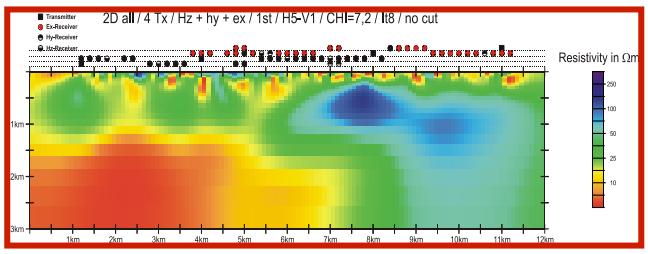
LOTEM method

The Long Offset Transient ElectroMagnetics (LOTEM) method is a Transient ElectroMagnetic (TEM) method in which a primary field is generated by a grounded current dipole. The signal transmitted by the dipole consists of a series of alternating step functions that create a collapsing field that in turn induces electric and magnetic fields in the conducting subsurface. Subsurface properties and features at great depth can be deduced by recording these fields at greater and greater distances from the transmitter during the off times.

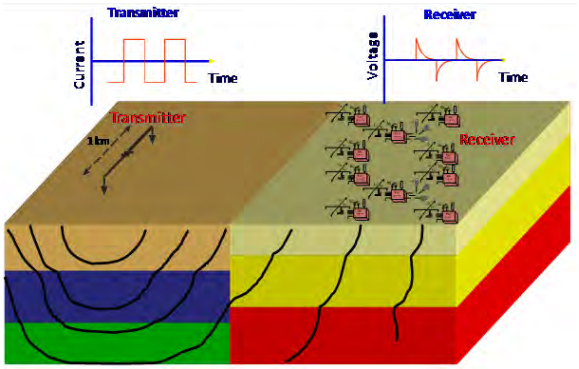
Using the KMS array system scheduling function and synchronization with multiple transmitters, the system can realize focused TEM applications, which give better volume focusing.

The LOTEM method can be applied to any of the following targets:

- Mapping of thin resistive layers, like hydrocarbons (electric fields)
- Determining conductive structures, like geothermal anomalies (magnetic fields, MT combined)



after Martin et al., 2005



Application history:

Since 2010, the system has ben used in: Argentina, Azerbajan, China, Germany, Kenya, India, Indonesia, Israel, Italy, Saudi Arabia, Slovakia, Thailand, Ukraine, USA (CA, CO, HI, NV, TX). Applications include magnetotellurics, Audi-magnetotellurics, Lotem, microseismics (intrusion monitoring), bottom hole to surface communication, marine CSEM.