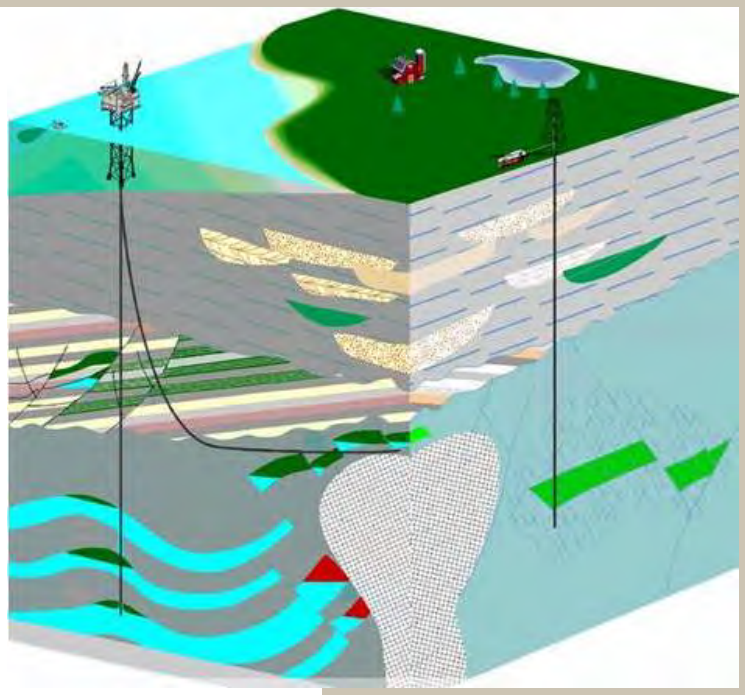
KMS Technologies

Innovating Solutions

KMS Company Overview




WORLDWIDE
KMS
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KMS CSEM Array System
KMS
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Innovating Solutions


KMS
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KMS-820 Quick-Reference

WELCOME

Dear Customer:

KMS Technologies is proud to outline of the past few years. The pandemic world is not easy, but we managed to deliver a 150/200 KVA CSEM system to a client in the Middle East and carry out a baseline CO_2 monitoring survey. Technically we are getting closer to a fully cloud-based system.

Our Mission is:

Provide exploration & reservoir monitoring technology to the energy industry for the energy transition by focusing on innovative sensors & integrated interpretation for exploration, appraisal & production monitoring of hydrocarbons/geothermal resources.

Our emphasis is on technology development and boutique services/training, we are delivering EM data acquisition systems worldwide and they have been used in well over 20 countries. We are proud to provide the best sensors in the market with our joint venture with Ukraine's LEMI LLC and acquisition services around the globe through our alliance with US/foreign seismic/microseismic companies. Our product lines cover land system with shallow borehole tools for magnetotellurics and controlled source electromagnetics. We also offer proprietary technology for borehole tools and marine electromagnetic system.

Using our training and Cloud support services recent customers were ble to acquire reliable CSEM/MT data from the first operational day.

Here is a **Quick Overview** of our company, followed by selected applications where our systems can add value. We then show some of our **New Products.** Note: We constantly update our products and data sheets (like all system are no qualitied for -20 to $+60^0$ C etc.) but it may not be fully reflected herein.

For more information, please go to www.kmstechologies.com or www.lemisensors.com.

Vision

To make electromagnetic methods (EM), specifically time domain-controlled source electromagnetics (tCSEM™), routine tools for exploration, production & monitoring for the energy transition. To use the technology for carbon footprint reduction and fully integrate it with seismic. Our all-in-one solutions include the most reliable sensors in the market manufacture though our joint venture with LEMI, excellence in acquisition services with the capability to operate all over the globe using local content, and the know-how for borehole, land and marine real-time applications. Our new cloud-based services/training make this possible.

Quick Overview

KMS Technologies focuses on advanced electromagnetic methods for the oil/geothermal industry to increase the discovery & recovery factors or carry out production monitoring and achieve ZERO carbon footprint faster. We support our technology via high-quality services, state-of-the-art R&D projects, and several unique hardware & software products.

Products

Microseismic & electromagnetics monitoring systems

- Low-cost options (LEMI-423 & LEMI-424)
- Wireless acquisition, true array functionality
- MT & CSEM: DC to 40 kHz, 24 & 32 bit
- Surface-to-borehole EM
- Custom marine systems
- Mud logging (porosity & permeability) with NMR

CSEM transmitters

- High-power options (≥ 500 kVA)
- Land 100 kVA or 150 kVA
- Transition zone
- Marine (custom)

LEMI sensors

- Drone fluxgate magnetometers
- Induction coil magnetometers (DC to 200 kHz)
- Electrodes (ultra-low noise, lead free)

Services

CO_2, water-flood, geothermal & heavy oil monitoring

- 3D feasibility studies
- Pilot demonstration
- Technology transfer

Cloud-based services

- MT processing & interpretation
  - 1D, 2D & 3D inversion
- CSEM QA/QC & processing

Volcanic eruptions & earthquake prediction

- 3D modeling
- Survey design
- Data acquisition

Custom projects & EM demonstration surveys

- EM training
- Prototyping
- Survey design

Hardware

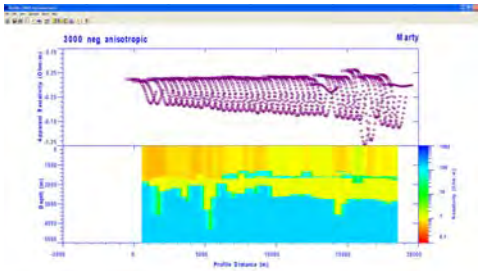
- KMS-820 - Array acquisition unit for MT, CSEM & microseismic
- KMS-831 - Channel expansion module
- KMS-5100 - High power CSEM transmitter (100, 150 & 500 kVA (custom), 10 kVA for CSAMT)
- KMS-888 - Seismic & EM shallow borehole tool
- EM sensors
    - Induction coils
    - Electrodes
    - Fluxgate magnetometers
    - Borehole tools

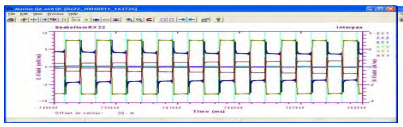
LEMI-423 MT system

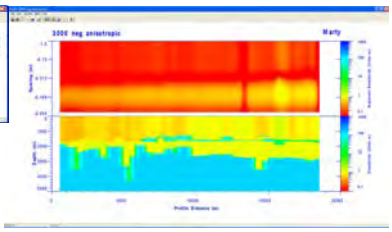
The new **LEMI-423** broadband MT system is ideal for geophysical exploration, volcanic eruptions monitoring, and deep crustal research. It is compact and low-cost. The bundle option, **KMS-423,** includes the LEMI-423 system, 4 x LEMI-701 electrodes, KMS-WAB (web access box) & KMS-200 software.

Software

- 3D modeling
- Survey design & acquisition QC
- Data processing
- 1D, 2D & 3D MT inversion
- Inversion delivered via Cloud







Applications

- Land and Marine Controlled Source EM (CSEM)
- Land and Marine Magnetotellurics (MT)
- EM & microseismic reservoir monitoring
- Geothermal

Services

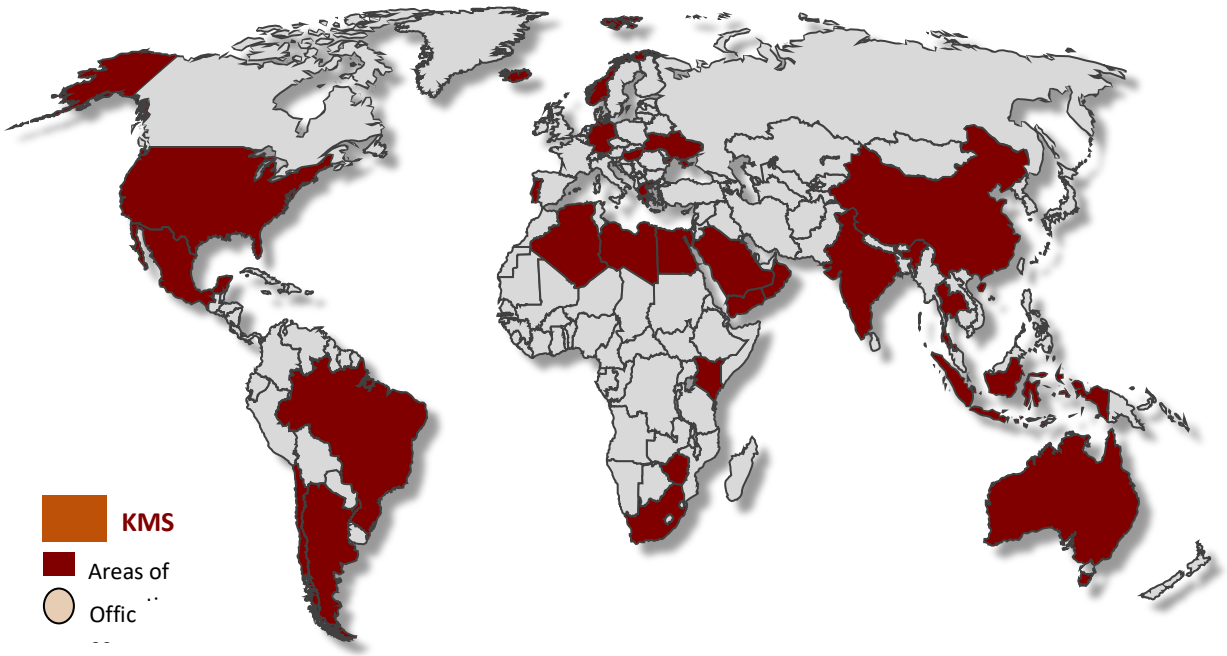
- Feasibility studies
- Data processing & interpretation
- Custom R&D projects
- Boutique acquisition services
- Product development & manufacture
    - Hardware
    - Software

Global services

We work with several seismic contractors using KMS Technologies know-how, with the ability to deliver KMS technical solutions with operational experience in over 28 countries utilizing over 90% local content.

Among the services we are:

- Renewables
  - Carbon Capture Utilization & Storage (CCUS) monitoring
  - Analysis, quantification, monitoring and certification of storage volumes
- Geothermal
  - Induced seismicity monitoring both seismic and EM response
  - Sweet spot identification optimized drilling
- Enhanced Oil Recovery (EOR+) solutions and monitoring
- Volcanic eruption prediction
  - Volcano monitoring and alert
- Multi-physics integrated solutions



Technology solutions

KMS Technologies thrives at providing solutions to our customers. We provide boutique products and services to adapt to each of our client's specific needs. Our years of experience in prototype development help us find alternative solutions and think outside the box.

Our current technology development focuses primarily on energy transition applications and for oil and gas enhanced production, however our products can be used for a large range of applications such as:

- Reservoir monitoring
- Carbon capture, utilization & storage (CCUS) reservoir characterization & monitoring
- Geothermal exploration & induced seismicity monitoring
- Oil and gas exploration (land & marine)
- Hydrocarbon reservoir dynamics
- Porosity mapping within carbonate reservoirs
- Volcanic eruptions monitoring
- Earthquake prediction research
- Metals and mineral exploration
- Engineering & environmental studies
- Deep crustal research
- Integration to reservoir via borehole (KMS-borehole system)

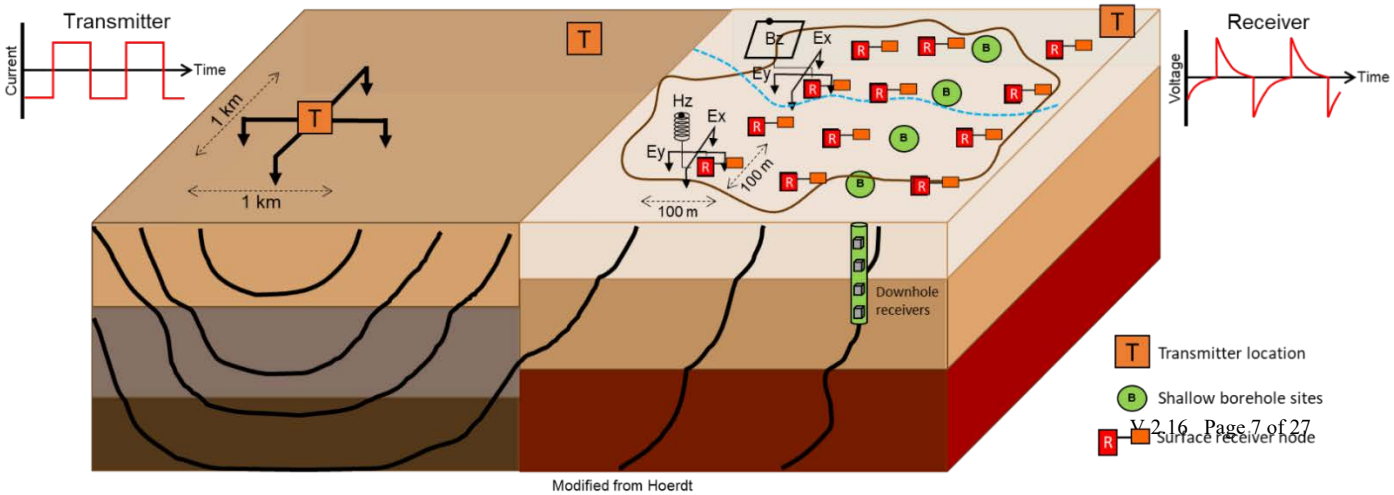
Following are some selective examples of applications.

Reservoir monitoring with CSEM

Reservoir monitoring is a key element in the management of geothermal, oil and gas production and CO_2 storage. This is often executed by combining borehole and surface measurements, either with permanent or semi-permanent sensors and time-lapse acquisition. Traditionally, microseismic has been used for such application, however, with KMS' array system, both microseismic and CSEM for surface and borehole measurements can easily be conducted. CSEM acquisition requires a transmitter, such as the KMS- 5100 with 150/200 KVA, to inject an electric current into the ground, for deep reservoirs KMS offers a high-power transmitter up to 500 KVA. An array of receivers at the surface and in shallow boreholes record the EM signal. Since the reservoir changes are 3-dimenssional, careful survey design with multiple transmitter locations is required to understand the 3D fluid movement. We suggest a minimum of two transmission sites. Prior to data acquisition, it is recommended to do a 3D feasibility modeling, including an on-site noise test which will define critical survey parameters such as receiver spacing and sensor selection. Below is an example of a typical CSEM survey configuration. (Colombo et al., 2010; Hu et al., 2008; Strack, 2010, Barajas-Olalde, 2021).

There is also a CSAMT/TFEM 10 KVA version (to 8 kHz) available upon request.

Survey layouts are usually designed as per specific objectives. The example figure shows a layout for **water-flood monitoring**. There are 3 transmitter locations and an array of receivers using the KMS-820 system, additional channels can be added to each receiver site by adding the KMS-831. Shallow borehole measurements are obtained with the KMS-888 tool which includes sensors with 3 components for seismic, magnetic and electric measurements.



Low-cost geothermal (AMT – MT)

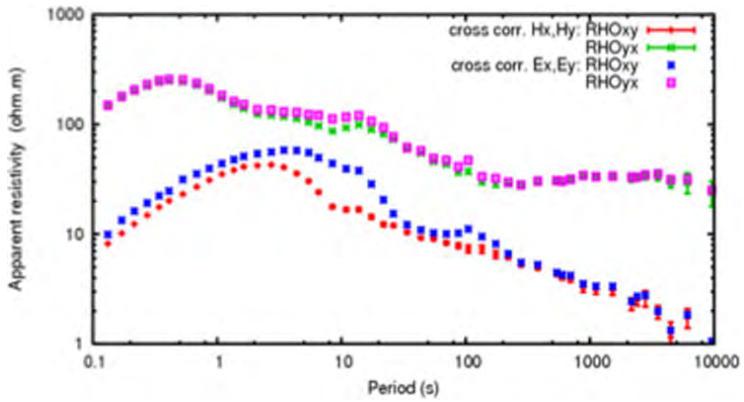
Magnetotellurics (MT) and Audio MT (AMT) target different depths of investigation, natural MT signals come from a variety of induced currents caused by thunderstorms and the ionosphere. The frequency ranges of MT data spans from 0.0001 Hz to 1,000 Hz and for AMT from 10 Hz to 20 kHz.

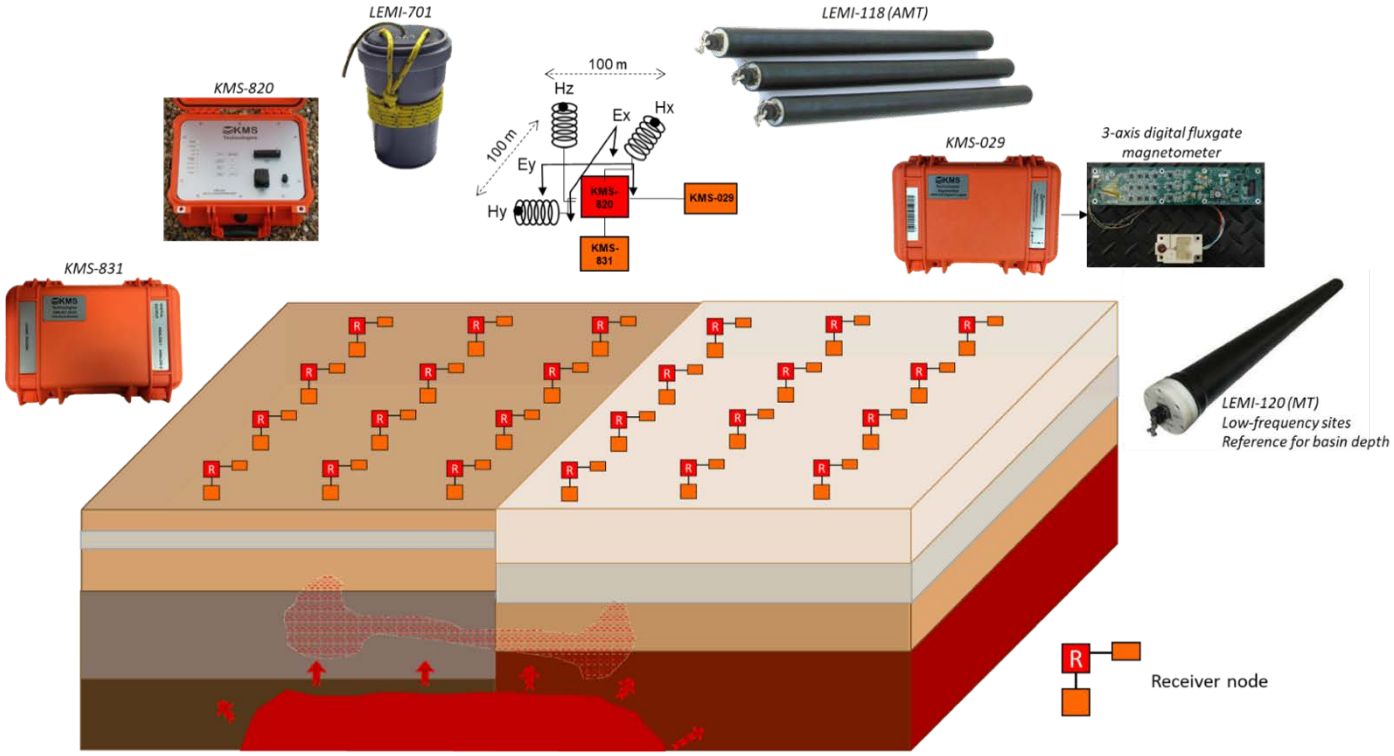
MT is usually used to map conductive zones such as geothermal zones or sediment packages. For geothermal application, one often requires the high frequencies and only limited low frequencies. For this we developed a combination between an array with sub-acquisition nodes and low frequency fluxgate receivers (KMS-820 MT-Mini package). We are adopting the concept of 3D bin-based MT acquisition which uses limited magnetic field but denser electric field data. With the new broadband sensor LEMI-152, we have sufficient overlap with the fluxgate-based site. Other MT systems are available, such as the LEMI-423, LEMI-424, the Super broadband and the Standard, to fulfill client's specific needs.

The AMT system includes an AMT or broadband coil. It records only for a few hours. The MT-Mini records for at least 6 hours or a full day. Magnetic fields from the fluxgate sensor and coil are matched (figure below). In this case, coil and fluxgate have been matched and shown the difference between the perpendicular components. A survey configuration for geothermal applications is shown below.

Advantages:

- Lower equipment cost
- Faster acquisition
- Consistent high-quality data
- Cloud-based QA, processing & interpretation (add-on)





Magnetotelluric (MT) systems

KMS Technologies provides variety of Magnetotelluric (MT) systems, these systems are customized, fit for purpose and lower cost. Most systems work with the NOISE-FREE web access box (KMS-WAB), which offers real-time data access from anywhere in the world, with fast onsite or remote QA/QC and the option to add-on KMS cloud services. Below are the different systems' features & specifications.

1. **LEMI-423 broadband MT system NEW!**
   - Lowest power consumption - <0.35 W
   - Frequency band – DC – 1,000 Hz
   - 3 LEMI-120 induction coils
   - Geophysical exploration, volcanic eruption & earthquake monitoring

2. **LEMI-424 MT system**
   - Lowest power consumption - <0.35 W
   - Frequency band – DC – 10 Hz
   - One 3 component fluxgate
   - Crustal investigations; used by US MT array

3. **Mini-MT system**
   - Low power consumption - <5 W
   - Frequency band – DC - 180 Hz
   - Crustal investigation; MT & CSEM
   - MT system in a suitcase < 30 Kg

4. **Super broadband MT system**
   - Low power - <5 W
   - One coil for MT & AMT
   - Frequency band - 0.00025 - 10,000 Hz
   - MT, AMT, CSEM
   - Industrial system for operational efficiency

5. **Standard MT system**
   - Low power - <5 W
   - Frequency band - 0.0001 - 1,000 Hz
   - Crustal investigation, MT, CSEM

6. **MT/AMT system**
   - Low power - <5 W
   - MT Frequency band - 0.0001 - 1,000 Hz
   - AMT Frequency band – 1 - 70,000 Hz
   - Lowest noise operation

7. **MT MAX system – 11 channels**
   - Low power - <5 W
   - MT, AMT, and Fluxgate sensor included

KMS Cloud-based acquisition, QA & interpretation

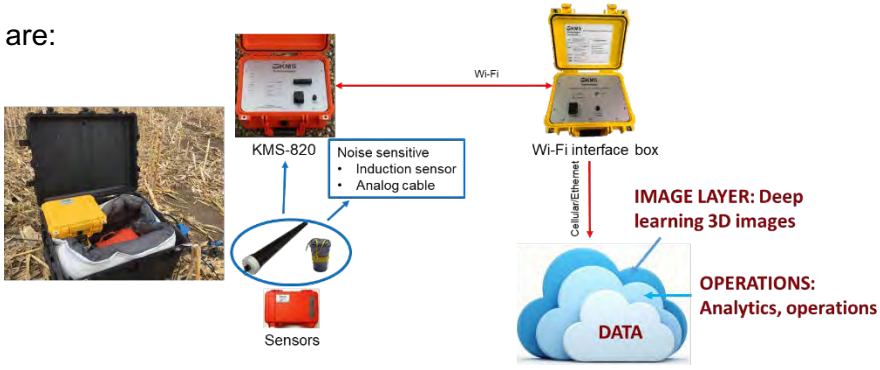
Electromagnetics is the preferred way to image reservoir fluids due to its strong coupling to the fluid resistivity. KMS Technologies is currently working towards accelerating the time it takes from acquisition to data interpretation resulting in a significant cost optimization of field operations. Using artificial intelligence and Cloud based data acquisition, we can reduce the operational feedback to near real time and even, for the interpretation, to close to 24 hours. This opens new doors for the utilization of this technology from exploration to production and monitoring.

The ultimate goal is to get real-time feedback of the noise conditions to optimized acquisition, utilized AI for Cloud-based processing and initial interpretation. Once all components are commercialized, the full implementation could become a real game changer by providing near real time 3-dimensional subsurface images in support of the energy transition.

KMS Technologies already provides high-level interpretation services via Cloud; tie to our Cloud-enable acquisition system and real-time processing.

Among some of the advantages of this services are:

- Fast turn-around time – 24 hrs. to 72 hrs.
- No experts needed within the company - you get ours!
- Expert reviewed results
- NO startup cost, get full results for your survey from A to Z
- CLIENT saves 95% training time to provide high-level services

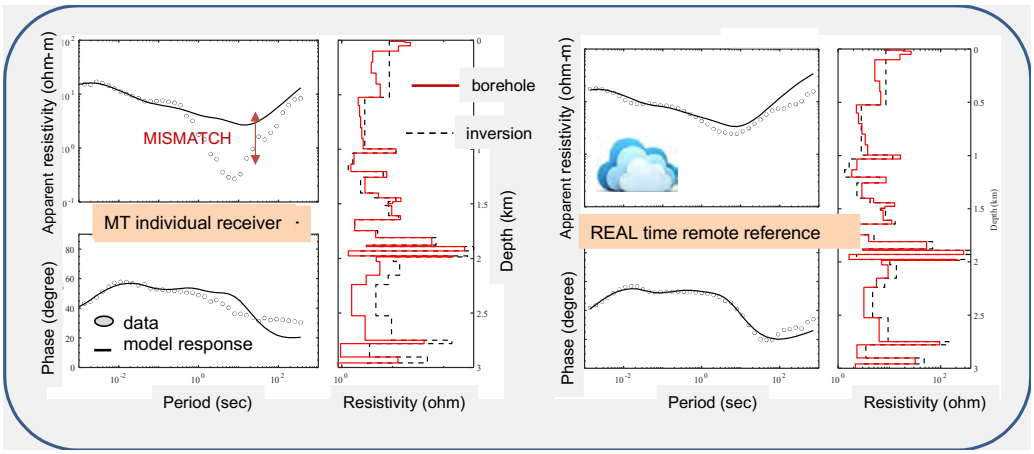


Cloud-based MT interpretation NEW!

We provide full Magnetotelluric (MT) data inversion via the cloud:

1. 1D inversion including robust processing
2. 2D inversion
3. 3D inversion

With years of combined expertise, our algorithms have been carefully developed to provide our clients high-level interpretation results, all done over KMS Cloud. Our services performs forward and inverse modeling of MT data including: any combination of impedance tensor components; frequency domain inline E and broadside E; isotropic or anisotropic resistivity models.



Inversion of MT data at single site and real-time remote reference (> 200 miles distance)

Main components

Land

- KMS-820 data acquisition unit
- KMS-831 32-bit interface module
- 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)
- LEMI-152 Super- broadband induction coil sensor (0.0001 – 10,000 Hz)
- KMS-029 fluxgate magnetic sensor
  32-bit, (DC – 180 Hz)
- Multicomponent geophones

Transmitter

- High-power land transmitter (500 kVA) – **NEW!**
- KMS-5100 land transmitter (100/150 kVA)
- KMS-500 transition zone transmitter

Borehole

- KMS-888 Shallow borehole data acquisition unit & sensors

Marine

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

3D software license & interpretation services **NEW Cloud services!**

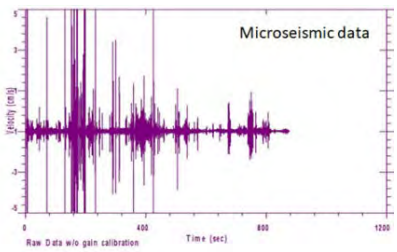
The KMS array data acquisition system is developed for EM (ElectroMagnetics) **and** microseismic applications to obtain subsurface resistivity and velocity structure for geothermal and oil and gas exploration. It also can be used in general purpose acquisition and long-term monitoring services.

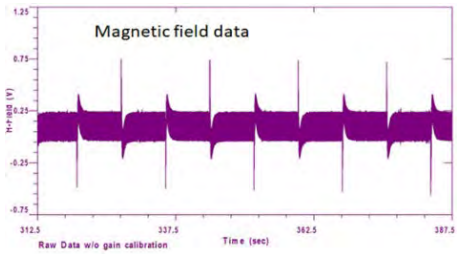
The system comes with various options to facilitate microseismic and EM reservoir monitoring. It also synchronizes and integrates with our borehole acquisition system and our marine MT acquisition node (KMS-870).

The core of the system is the KMS-820 Data Acquisition Unit which has six 24-bit low noise, low drift analogue channels and, through the digital port, and the KMS-831, unlimited channel expansion. Typically, the digital port is used to record 32-bit fluxgate magnetic fields, at the same time as acquiring coil data. The 24-bit architecture goes to 100 kHz sampling, and the 32-bit architecture to 4,000 Hz. All channels are sampled simultaneously and synchronized with GPS.

In addition, the KMS-820 can be used to control any of the transmitter such as the KMS-5100 for CSEM/CSAMT/TFEM. Multiple communication and data harvesting options exist: USB cable, SD card exchange, long range wireless, and CLOUD enable with the addition of KMS-WAB.

Our equipment is design as such, that crews without EM experience are capable to operate the system. A variety of survey configurations, from single recording station to 3D acquisition arrays are possible.





System highlights

- Acquire microseismic data independently or simultaneously with EM
- Combined CSEM & natural source EM (magnetotellurics – MT) acquisition in one receiver deployment
- Same layout can acquire different methods by adding optional transmitters or geophones
- 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 – 1,000 Hz), AMT band (LEMI-118: 1 – 50,000 Hz)
- Lightweight, portable, rugged, low power consumption
- Wireless network (long range), GPS synchronized, wide bandwidth & 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 with or without cables
- Each KMS-820 can be expanded to unlimited channels with multiple KMS-831 (32-bit)
- High sampling rate to adapt to various geophysical methods (24-bit to 80 kHz, 32-bit to 4 KHz)

Main components

1. KMS-820 digital acquisition system	2. KMS-831 sub-acquisition controller
3. KMS-029 (fluxgate magnetometer)	4. LEMI-120 (low frequency magnetometer)
5. LEMI-118 (low frequency magnetometer)	6. LEMI-701 electrode
7. S-20 (air coil magnetic sensor)	8. Multicomponent geophone
9. Misc. interconnect cables	10. Accessories (KMS-300, USB cable)
11. Laptop computer 11A. KMS-410 Lithium-ion batteries	12. KMS-5100 transmitter (not to scale)

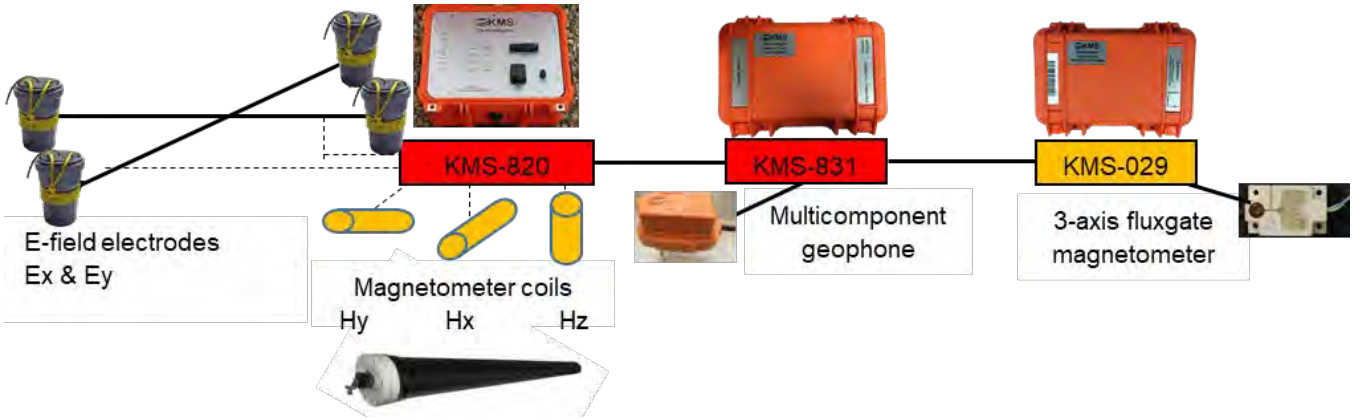
System configuration options

The various system configuration options for different surveys and applications are summarized in the following table. System components can be mixed and matched in a modular fashion. Seismic sensors can be added to each configuration. Each configuration is expandable by adding more KMS-831 sub-acquisition controller. The shallow borehole seismic/EM receiver KMS-888 can be added as needed. All of the LEMI sensors are compatible with the KMS-820 and/or KMS-831 units.

Survey	Receiver	Transmitter	Sensors	Applications / Depth
MT	KMS-820 & KMS-831	N/A	Electrodes: LEMI-701 Magnetometer: LEMI-120 LEMI-118 LEMI-152 KMS-029	Onshore / Deep targets & basin study
CSAMT	KMS-820	KMS-500	Electrodes: LEMI-701 Magnetometer: LEMI-118 LEMI-152	Onshore, transition zone / Shallow targets
TFEM	KMS-820 & KMS-831	KMS-500 KMS-5100	Electrodes: LEMI-701 Magnetometer: LEMI-140 LEMI-120 LEMI-118 LEMI-152 KMS-029	Onshore, transition zone / Shallow to mid-depth targets
LOTEM	KMS-820 & KMS-831	KMS-500 KMS-5100	Electrodes: LEMI-701 Magnetometer: LEMI-140 Air-coil cable: KMS S20	Onshore, transition zone / Shallow to mid-depth targets Sub-basalt, sub-salt
TFEM, IP	KMS-820 & KMS-831	KMS-500 KMS-5100	Electrodes: LEMI-701 Magnetometer: LEMI-140 LEMI-120 LEMI-118 LEMI-152	Onshore, transition zone / Shallow to mid-depth targets
CSEM	KMS-820 & KMS-831	KMS-500 KMS-5100	Electrodes: LEMI-701 Magnetometer: LEMI-120 Air-coil cable: LEMI-118 LEMI-152 KMS S20	Onshore, transition zone / Shallow to mid-depth targets
MMT & CSEM	KMS-870	On request	Seismic & EM included	Deep water ocean bottom imaging
Reservoir monitoring	KMS-820 & KMS-831	KMS-5100 100, 150 or 500 KVA	Seismic: 3C or borehole 3C Electrodes: LEMI-701 Magnetometer: LEMI-120 Air-coil cable: LEMI-118 LEMI-152 KMS-029 KMS S20 Shallow Borehole Tool: KMS-888	Water-flood monitoring Porosity mapping in carbonates Monitor induced seismicity CO_2 monitoring Depletion monitoring

Typical receiver station layout

The KMS array data acquisition system allows great flexibility in acquisition design adjusting with survey requirements, including that all receiver stations may not be identical. The acquisition scheduler allows the system to be used for different acquisitions and even methods in one drop. The figure below shows a sample layout, purely to illustrate how a receiver station might be configured.



MT systems advantages

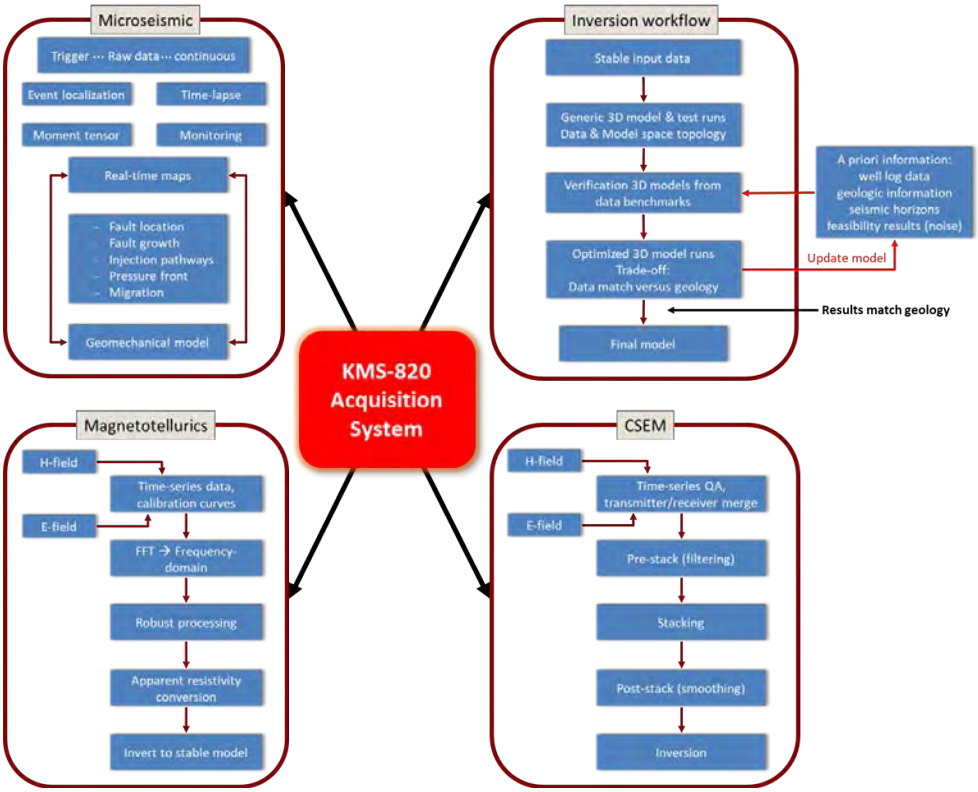
- Customized, fit-for-purpose saves cost
- Smooth, switch-free single time series (no band limited acquisition)
- Easy, windows-driven operation
- Real-time data access from anywhere using **noise-free web access box**
- Fast in field results
- Remote QA/QC and calibration
- On site automated data processing
- Autonomous recording MT/AMT via scheduler

Specifications

System	Frequency band	Noise	Components	Comments
LEMI-423	DC – 1,000 Hz	≤ 10 pT/ Hz @1 Hz	LEMI-423 & LEMI-120 Various options	Low cost, ideal for geophysical exploration
LEMI-424	DC - 10 Hz	≤ 10 pT/√Hz @1 Hz	LEMI-424 & Fluxgate Various options	Lowest cost, standard for research applications
Mini-MT	DC - 180 Hz	≤ 6 pT/√Hz @1 Hz	KMS-820 & Fluxgate	MT system in suitcase. ENTRY LEVEL system
Broadband MT	0.00025 - 10,000 Hz	≤ 0.3 pT/√Hz @1 Hz	KMS-820 & LEMI-152	Cost effective for industrial operational
Standard MT	0.0001 - 1,000 Hz	≤ 0.1 pT/√Hz @1 Hz	KMS-820 & LEMI-120	Lowest noise system
MT/AMT	0.0001 - 1,000 Hz (MT) 1 - 20,000 Hz (AMT)	≤ 0.1 pT/√Hz @1 Hz ≤ 5 pT/√Hz @1 Hz	KMS-820, LEMI-118, & LEMI-120	Standard system for many years
MT MAX	DC - 70,000 Hz	≤ 6 pT/√Hz @1 Hz ≤ 0.1 pT/√Hz @1 Hz ≤ 5 pT/√Hz @1 Hz	KMS-820, Fluxgate, LEMI-120 LEMI-118	All in one MT solution

Acquisition (QA/QC) & processing software

The KMS-200 is the most comprehensive acquisition & monitoring software with embedded processing to accompany the KMS-820, LEMI-423 and LEMI-42 systems. With some basic steps, the user can visualize data and response parameters (i.e., in MT: apparent resistivity & phase). For CSEM it can QA/QC, filter and stack the data. It can also do 1D inversions and generate the output for 3D inversion for MT and CSEM data. KMS-200 software helps users go from acquisition, data QA/QC to processing, all in one platform. KMS-200 is easy to use with default workflows and with our integrated services for 1D, 2D and 3D inversions, our group of experts will guide you step by step. KMS-200 is optimized for MacOS, with speeds 10x faster for systems with Apple M1 chip.



Software features

- Available for all operating systems: **Windows** 32 and 64-bit, **MacOS** (optimized for faster speeds in systems with Apple M1/2 chip), **Linux**
- Time series editing
- Data processing (single site and remote reference) and visualizing of MT parameters
- Calculate impedance, resistivity, phase and other MT parameters like skew, tipper, polar diagram, induction arrow etc. and plotting
- Real-time acquisition & monitoring software
- Quality assessment of CSEM data
- Export to numerous industry standard formats including: EDI, VTK, SEGY, miniSEED, ASCII, BIN
- 1D inversion: Ultra-fast transformation based, IX1D Interpex Ltd (included), SVD based Occam inversion with numerous regularization options (optional)
- CSEM data processing (Lotem, FSEM) - KMSPro

Options:

- TFEM & Induced polarization (time domain)
- KMS 1D & 2D inversion
- KMS 3D MT inversion (only through KMS cloud)
- Others upon request

Software products & bundles

- **Acquisition software: KMS-200-ACQ** — for KMS-820 only
  - Receiver acquisition control & monitor
  - Acquisition scheduler
  - Sensor calibration
- **Transmitter control & monitor software: KMS-200-TX** — for KMS-820 only
  - Transmitter control & monitor
  - Pre-defined & customized transmitter waveform
  - Special transmitter safety feature
- **Basic robust MT processing software: KMS-200-P** — for KMS-820 only
  - Robust MT processing
  - Standard MT processing workflow
- **Fast robust processing software: KMS-200-AP** — for KMS-820, LEMI-423 & 424
  - Fast robust processing
  - Adjustable processing parameter
  - Batch processing mode
  - Improved graphic display
- **1D MT inversion software: KMS-200-IX1D** — for KMS-820, LEMI-423 & 424
  - IX1D MT sounding inversion
  - Graphic display of apparent resistivity & impedance phase
- **2D MT inversion software: KMS-200-ZONDMT2D** — for KMS-820, LEMI-423 & 424
  - Zond 2D MT inversion
- **OPTION KMS** instead of 5 & 6 above: 1D & 2D Inversion for MT — for KMS-820, LEMI-423 & 424
- **3D EM inversion: KMSProInv3D** — for KMS-820, LEMI-423 & 424
  - For MT data
  - Only available through KMS cloud
- **TEM processing software: KMS-200-tCSEM™** — for KMS-820 only
  - KMSPro tCSEM™ processing (lease only)

Software bundles (collection of software product application/price optimized)

- **KMS-200 MT Bundle 1**: includes KMS-200-ACQ, KMS-200-P, KMS-200-AP, & KMS-200-IX1D
- **KMS-200 MT Bundle 2**: all in Bundle 1 plus KMS-200-ZONDMT2D
- **All bundles can be supplied with KMS Option: 1D, 2D, 3D inversion** (3D inversion provided through KMS cloud, includes first 100 sites for free)

Software products order information

Software bundles

- **KMS-200 MT Bundle 1**: includes KMS-200-ACQ, KMS-200-P, KMS-200-AP, & KMS-200-IX1D
- **KMS-200 MT Bundle 2**: all in Bundle 1 plus KMS-200-ZONDMT2D

Both above with KMS option:

- **KMS-200 MT Bundle 1 – KMS:** includes KMS 1D inversion)
- **KMS-200 MT Bundle 2 – KMS:** includes KMS 1D, 2D, 3D inversion (100 free sites via KMS cloud)
- All inversion can also be provided via KMS CLOUD

Individual software products

- KMS-200-ACQ: Acquisition software for KMS-820 only
- KMS-200-TX: Transmitter control & monitor software for KMS-820 only
- KMS-200-P: Basic robust MT processing software for KMS-820 only
- KMS-200-AP Fast robust processing software: for KMS-820 & LEMI-424
- KMS-200-IX1D: 1D MT inversion software for KMS-820 & LEMI-424
- KMS-200-ZONDMT2D: 2D MT inversion software for KMS-820 & LEMI-424
- KMS-200-tCSEM™ : TEM processing software for KMS-820 only

CSEMulator – 3D modeling software **NEW!**

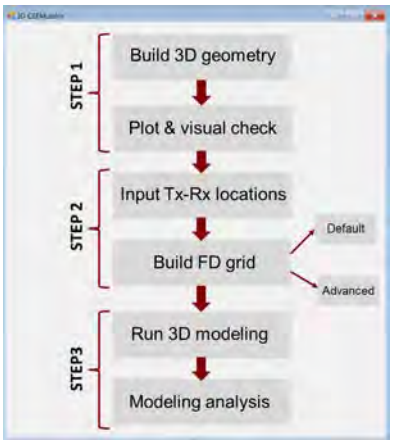
KMS Technologies provides 3D modeling software for Controlled-Source Electromagnetics (CSEM), for surface (land and marine), surface-to-borehole, and borehole environments.

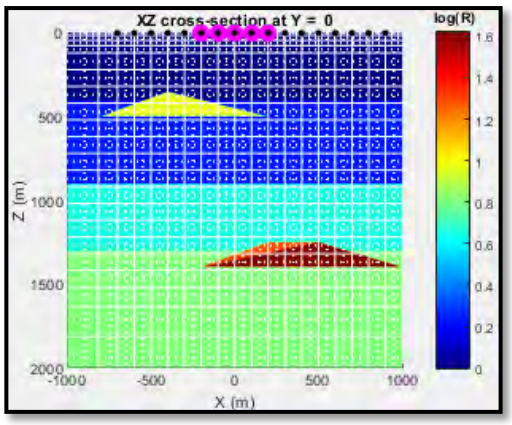
Electromagnetic methods are among the best to map changes in bulk resistivity influenced by reservoir fluids. CSEMulator is capable to simulate these changes in a 3-dimensional space within a complex geologic setting. Among some of the most common applications for simulation are:

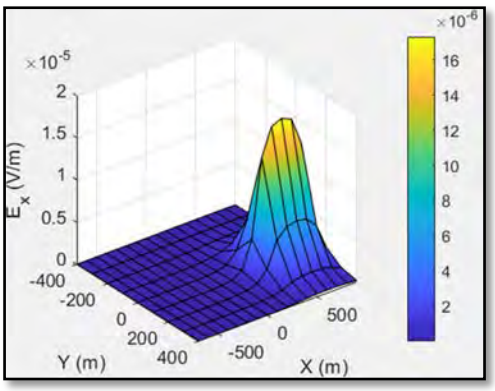
- Reservoir monitoring
  - Carbon sequestration
  - Enhanced Oil Recovery (EOR): Water/steam flooding
  - Fracture zone & plumes detection
- Geothermal exploration
  - Deep & shallow
- Carbon capture & storage
  - Time-lapse monitoring
  - Leakage
- Fracture mapping

Our 3D modeling software enables you to do the analysis you need. CSEMulator can simulate complex scenarios with outstanding computing performance. As we move into the energy transition era, is critical to select the right methods for traditional exploration and production, and upcoming clean energy applications.

CSEMulator has a user-friendly GUI and provides an easy workflow so even unexperienced users can execute complex 3D simulations in simple to follow steps.







CSEMulator is available for licensing, including technical support and training.

Array acquisition unit KMS-820

The next generation of array system units comprise a portable KMS-820 data acquisition unit: versatile, compact, and low cost.

Product features

- Low-power design for long recording time
- Long-range wireless
- Wi-Fi & add-on web access box
- Bandwidth: DC - 50 kHz
- Up to 80 kHz sampling rate (total 480 kHz)
- Six 24-bit GPS synchronized channels
- With 32-bit remote acquisition controller
- Unlimited digital channels expansion
- Low noise & low drift input amplifiers
- Portable & lightweight
- Ruggedized design for field application
- Acquisition & monitoring software included
- Processing software for MT & CSEM
- Low cost

New transportation case with web access box (left); KMS-WAB (right)

Benefits

- NOISE FREE data transfer
- during MT acquisition
- Real-time remote acquisition control
- Real-time remote data processing

Applications

Land ElectroMagnetics (EM)

- Acquisition: Magnetotellurics (MT), LOTEM, CSAMT, Induced Polarization
- EM transmitter controller
- System response recording (time domain)
- EM survey in array configuration
- Shallow borehole receiver

Marine EM

- Transition zone transmitter & monitor
- Source controller & environmental monitor (current & one field component)
- Marine EM version

Land seismic

- Special high bandwidth applications
- Passive microseismic monitoring for regional & local seismic activities
- Seismic security surveillance

General lab measurement

- General acquisition system
- Electrode long term stability
- Custom versions available

LEMI-423 NEW!

LEMI-423 system full set layout (left); LEMI-423 system in transportation case (center); Induction coil magnetometers in transportation case (right).

Wide band magnetotellurics station LEMI-423 is intended for the study of natural electromagnetic fluctuations in field conditions in wide temperature range. The station registers and digitizes automatically the data from 3 search-coil magnetometers and 2 electric channels and monitors the temperature of electronic unit. The electric channels include lightning protection unit, one of two its constructions differing by the way to connect electric lines (see photo) may be selected. The real time acquisition, recording and visualization of current and previously recorded data are executed in the external PC. The data logger (DL) is developed for the analog signals received both from the LEMI-120 magnetometers and from electric lines for telluric field measurements digitizing and storage. In order to realize the design of electric channels major attention was paid to thermal and temporal stability, high input impedance and low drift. High-pass filter-free technology of input stages was used in order to let super-long period signals (up to 100.000 second) to be measured. The lightning protection unit (at the photo, two models shown left and right, below) allows both the protection against nearby lightning discharges and easy connection of electric lines in the field. Specially developed very low noise LEMI-701 electrodes are recommended, electrodes are not included in the delivery set but can be added

Product features

- High resolution and accuracy
- Very low noise
- 4 electric & 4 magnetic channels
- Very low temporal & thermal drift
- Low power consumption
- 8 GB SD card
- Satellite synchronization
- Graphic display with touch screen
- USB output
- Waterproof plastic case
- Two models of lightning protection units to choose

Product specifications

Frequency band	DC – 1,000 Hz
Measured range	± 2,450 mV
Resolution of electric meter along each component (ADC 32-bit)	2 nV
Sample rate	1 per second
SD card	8 GB
Digital output & control	USB or Via KMS-WAB (optional)
GPS	GPS timing, coordinates & altitude determination (antenna cable length 3 m)
Operating temperature range	-20 to +60° C
Power supply	5-20 V
Power consumption	<0.35 W
Weight: Electronic unit	2.0 kg
Weight: Lighting protection unit	1.0 kg

LEMI sensors

The Laboratory of ElectroMagnetic Innovations (LEMI) was founded 2008 as a joint venture between KMS Technologies & the Lviv Centre of Institute for Space Research (LCISR) to focus on the development & production of high quality electromagnetic (EM) sensors. LEMI is located in Lviv, Ukraine.

Fluxgates	**LEMI-011**	**LEMI-018**	**LEMI-024**	**LEMI-029**	**LEMI-031**	**LEMI-036**	**LEMI-039**
Application	Super low power applications	Measurement of Earth's magnetic field	Cost-effective 3-channel fluxgate	Measurement of Earth's magnetic field	Low power designed to be embedded into a host system	Super sensitivity measurement of Earth's magnetic field	Precise measurement of Earth's magnetic field
Measurement Range	+/- 50,000 nT	+/- 68,000 nT	Unfiltered +/- 80,000 nT Filtered +/- 200 nT	Unfiltered +/- 78,000 nT	+/- 53,000 nT	+/- 4,000 nT	+/- 65,000 nT
Frequency Range	0-20 Hz	DC – 1 Hz	Unfiltered DC - 500 Hz Filtered 0.003 - 10 Hz	DC to 180 Hz	DC - 15 Hz	DC – 3.5 Hz	DC - 10 Hz
Sensitivity	45 mV/nT	2.4 mV/nT	Unfiltered 0.056 mV/nT Filtered 22.4 mV/nT	N/A	0.6 mV/nT	0.01 nT	25 mV/nT
Noise Level	0.1 nT / √Hz @ 5 Hz	≤15 pT / √Hz @ 0.03 – 0.3 Hz	≤6 pT / √Hz @ 1 Hz	≤6 pT / √Hz @ 1 Hz	<25 pT / √Hz @ 1 Hz	<0.01 nT √Hz @ 0.01 - 1 Hz	<10 pT / √Hz @ 1 Hz
Number of Axis	3	3	3	3	3	3	3
Orthogonality error of sensor axes, max	+/- 2°	N/A	N/A	N/A	<2°	<30”	<30”
Power	2.5-5.5 mA @ 5 V	<0.8 W	≤350 mW	425 mW	<10 mW	<4 W	<0.5 W
Dimension	Sensor: 50 x 16 x 16 mm Monoblock "tube": 160 x 20 x 7 mm Monoblock "box": 115 x 60 x 27 mm		Sensor w/o cable: 76 mm (L), 76 mm (D) Box 110 x 75 x 67 mm	Sensor: 62 mm (L), 38 mm (W), 38 mm (H)	Sensor: 70.5 mm (L), 32 mm (D) Electronics board: 84 mm (D), 22 mm (H)	Sensor: 160 mm (L), 360 mm (W) Electronic unit: 402 x 160 x 91 mm	Sensor: 350 mm (L), 110 mm (D)

Induction coils	**LEMI-118**	**LEMI-120**	**LEMI-121**	**LEMI-123**	**LEMI-142**	**LEMI-145**	**LEMI-152**
Application	Land	Land	Land/Marine	Marine	Land	Land	Land
Frequency Range	1 - 70,000 Hz	0.0001 - 1,000 Hz	0.001 – 500 Hz	1 - 1,000 Hz	1 – 500,000 Hz	0.04 – 30,000 Hz	0.0001 to10 000 Hz
Transformation Factor	Linear section: f * 1 mV/nT Flat section: 20 mV/nT	Linear section: f * 100 or 200 mV/nT Flat section: 100 or 200 mV/nT	Linear section: f * 200 mV/nT Flat section: 200 mV/nT	Linear section: f * 0.2 mV/nT Flat section: 20 mV/nT	Flat section: 25 mV/nT	f * 100 or 100 mV/nT	Linear section: f * 100 or 100 mV/nT
Noise Level	1 Hz ≤ 5 pT/√Hz 10 Hz ≤ 0.2 pT/√Hz 10,000 Hz ≤ 0.005 pT/√Hz 50,000 Hz ≤ 0.001 pT/√Hz	0.001 Hz ≤ 100 pT/√Hz 0.01 Hz ≤ 10 pT/√Hz 1 Hz ≤ 0.1 pT/√Hz 100 Hz ≤ 0.01 pT/√Hz	0.001 Hz ≤ 600 pT/√Hz 0.01 Hz ≤ 5 pT/√Hz 100 Hz ≤ 0.05 pT/√Hz	1 Hz ≤ 8 pT/√Hz 10 Hz ≤ 0.5 pT/√Hz 100 Hz ≤ 0.05 pT/√Hz 1000 Hz ≤ 0.02 pT/√Hz	1 Hz ≤ 0.005 pT/√Hz	1 Hz ≤ 1.6 pT/√Hz 1000 Hz ≤ 0.002 pT/√Hz 10000 Hz ≤ 0.001 pT/√Hz	0.01 Hz: ≤ 75 pT/√Hz 0.1 Hz: ≤ 7 pT/√Hz 1 Hz: ≤ 0.3 pT/√Hz 100 Hz: ≤ 0.05 pT/√Hz 1000 Hz: ≤ 0.03 pT/√Hz
Power	≤ 240 mW	225 mW	116 mW	65 mW	84 mW	84 mW	<225 mW
Dimension	800 mm (L) 42 mm (D)	1340 mm (L) 85 mm (D)	560 mm (L) 85 mm (D)	255 mm (L) 48 mm (D)	310 mm (L)	1340 mm (L) 65 mm (D)	1340 mm (L)

Fluxgate magnetometers:


LEMI-011


LEMI-018


LEMI-024

LEMI-029


LEMI-031

LEMI-036


LEMI-039

Induction coils:


LEMI-118


LEMI-120


LEMI-121


LEMI-123


LEMI-142


LEMI-145


LEMI-152

Electrodes:


LEMI-701

Applications:

- Land & marine CSEM
- Marine magnetotellurics
- Land magnetotellurics
- Permanent sensors
- Airborne sensors

Fluxgate magnetometers

LEMI-011
Low power 3-components fluxgate magnetometer. Frequency (DC-20 Hz)

LEMI-018
Vector magnetometer for the precise measurements of Earth magnetic field with several sensor options.

LEMI-024
Low power 3-components & highly sensitive analog fluxgate magnetometer. Frequency (0.003-10 Hz)

LEMI-029
Low noise fluxgate magnetometer with exceptional low-frequency stability. Frequency (DC-180 Hz)

LEMI-031
Super low-power consumption fluxgate. Low noise with exceptional low-frequency stability. Frequency (DC-15 Hz)

LEMI-036
3 component fluxgate for super sensitive measurement of the Earth magnetic field. Frequency (DC-3.5 Hz)

LEMI-039
Precise fluxgate magnetometer with exceptional frequency stability. Frequency (DC-10 Hz)

Induction coils

LEMI-118
High frequency induction coil (1-70 kHz)

LEMI-120
Broadband induction coil (0.0001- 1 kHz) with the lowest noise in class.

LEMI-121
Low power, very low noise & compact. Frequency (0.0001-500 Hz), marine EM

LEMI-123
Low noise, low power & compact. Frequency (1 Hz -1 kHz), high frequency marine EM

LEMI-142
Highly sensitive magnetometer with low noise Frequency (1 – 500 kHz)

LEMI-145
Extremely low noise, low power & lightweight. Frequency (0.004-10,000 Hz)

LEMI-152
Super broad band coil. Frequency (0.00025-10,000 Hz)

Electrodes

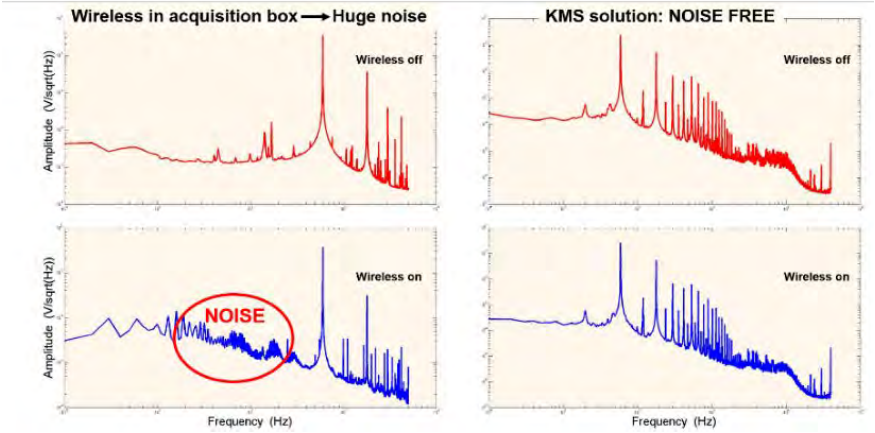
LEMI-701
Ultra-low noise non-polarizable electrodes (Cu-$CuSO_4$), matched pairs

KMS-WAB (Web access box)

The KMS-WAB is a micro-computer controller that allows FULL real time data streaming through wireless or wired connection. For MT applications we use a short Wi-Fi connection to this box that generates **little to no noise** in the MT sensors. Cell phone modem uses up to G4 where available.

The KMS-WAB works with the KMS-820 unit as well as with the LEMI-423 and LEMI-424.

Web access box



Web access box performance

Problem & solution

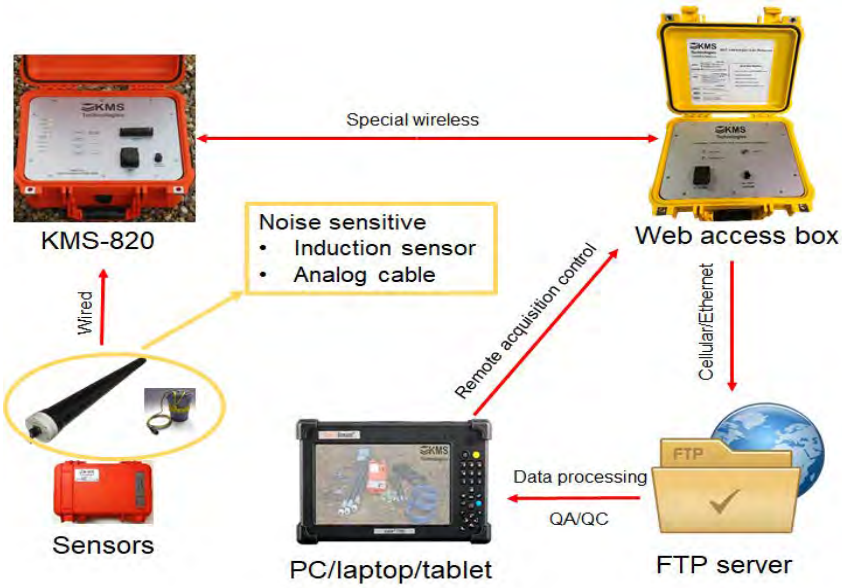
Problem:

- Wi-Fi transmission during EM acquisition generates noise
- Lack of real-time control of acquisition

KMS solution: Web access box

Solution benefits:

- NOISE FREE data transfer during MT acquisition
- Real-time remote acquisition control
- Real-time remote data processing
- Lower operational cost



Wi-Fi interface box configuration diagram

LEMI-026 DRONE fluxgate magnetometer

Fluxgate magnetometer (FG) LEMI-026 was developed for the super sensitive magnetic field measurements for the use in drones or other moving applications. The autonomous fluxgate magnetometer precisely measures the three components of the Earth's magnetic field both in motion and as a reference base. It includes a low power data logger.

It may be used for autonomous measurements with moving carriers (e.g., drones) or included as part of a sea/land station. Featuring two-component tilt-meters and GPS antenna, the sensor allows for precise measurement timing, magnetometer coordinates, altitude and attitude during movement. These data are stored in an SD memory card.

Product features

- Operation in movement
- High resolution and precision
- Low noise
- Low temperature drift
- Two tilt measurement channels
- Temperature measurement channel
- Low power consumption
- Shockproof housing

LEMI-026 system with and without housing cover

Product specifications

Magnetic field range	± 70,000 nT
Frequency band	DC – 100 Hz
Sampling	250 Hz
Noise level at 1 Hz	<0.1 nT/SQRT(Hz)
ADC	32-bits
Tilt-meter range	± 30°
Tilt-meter resolution	0.01°
Operating temperature range	-20 to +60° C
Power supply	5 + 0.25 V
Maximal power consumption	<1.2 W
Recording time with 1900 mAh internal battery	5 h

GPS Receiver	
Time accuracy	<100 ns
Maximal data rate	10 Hz
Auxiliary digital interface	USB
SD card	8 GB
Weight (with internal battery)	1.25 kg
Dimensions	96 x 96x 270 mm

KMS-5100 CSEM transmitter

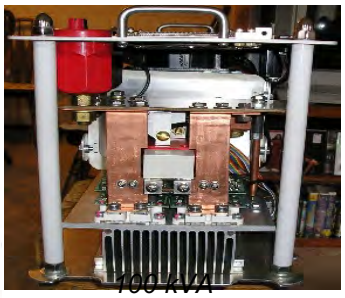
Product features

- Maximum output: 100, 150 or 200 kVA; for CSAMT – 10 kVA
- GPS synchronized timing control
- Long-range wireless for remote control & monitoring
- Linear ramp better than 5 µs turn off characteristic
- Bi-polar reversing ramp time < 20 µs
- Suitable for time domain EM (TDEM or LOTEM), induced polarization (IP), TFEM, CSAMT, FSEM, etc.
- Target depth of 600 m or deeper (shallower for 10 kVA or custom)
- Ideal for deep EM geophysical applications 2-4 km
- Grounded dipole or loop source
- Integrated in KMS array system via KMS-820-T
- Controller has 6 analog (3 unassigned) & (unlimited) digital channels
- Ruggedized design for field operations
- Data is saved to SD card (16-32 GB) and send to CLOUD (optional)

150 kVA

Product specifications

Current waveform	**Reversing polarity square (100 % duty cycle) or bipolar with off-time (firmware selectable from 0.001 Hz to 1000 Hz, CSAMT – 8 KHZ). Other waveform can be generated by controller**
Transmitter type	**Dipole source or loop source**
Maximum output current	**Limited to 40 A unipolar, 80 A bi-polar (10 kVA version) Limited to 125 A unipolar, 250 A bi-polar (100 kVA version) Limited to 175 A unipolar, 350 A bi-polar (150 kVA version) Limited to 240 A unipolar, 480 A bi-polar (200 kVA version)**
Maximum output voltage	**Following input voltage**
Input voltage	**480 – 600 VAC at 50/60 Hz**
Frequency range	**0.001 – 1 kHz (CSAMT to 8 kHz)**
Current recording sampling rate	**< 80 kHz, same as receiver acquisition sampling rate**
Maximum power output	**10, 40, 100/150/200 kVA at 25° C**



100 kVA

Output measurement	**24-bit KMS-820 with KMS-831 up to 32-bit**
Dimensions	**KMS-5100-100: 0.7 m x 0.9 m x 1.01 m (W x H x D)**
Operating environment	**-20° - 60° C**
Weight	**KMS-5100: 30 kg (switchbox only), for 150 kVA = 90 kg and 200 kVA = 120 kg**
Duty cycle	**100 %, 50 %, 33 %, 25 %, variable**
User interface	**Long range wireless, 802.11, USB or cable**
Standard packaging	**Unit in field container shipped in ruggedized large transport container**

Application history - references

Since 2010, the KMS-820 array data acquisition system has been used in: Argentina, Azerbaijan, China, Germany, Kenya, India, Indonesia, Israel, Italy, Saudi Arabia, Slovakia, Thailand, and Ukraine, USA (CA, CO, HI, NV, and TX).

Please check our website for an updated list of publications: http://www.kmstechnologies.com/KMS_flyer_archive.html

The system and methods are covered by various patents – see our website for the latest list. KMS provides their clients a license to the respective patents.

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Past clients

Summary Client List:

Anadarko – Texas, Apache—Texas, Aramco – Saudi Arabia, Baker Hughes (US & Europe), British Geological Survey - UK, BP – Texas, CGG – Mexico, Chevron – California, CNPC – China, ConocoPhillips- Texas, EMGS- Norway, EMI – California, GDC – Kenya, Geokinetics, Geoelec –Mexico, Halliburton – Houston, ENI – Italy, Geosystems – Italy, ION, Mannvit – Iceland, Minnkota – North Dakota, ORMAT – Nevada, PDO – Oman, PTTEP—Thailand, OMV – Austria, Petroalliance – Russia, Oyo-Geospace – Texas, Philips – Oklahoma, Proingo, Argentina, RXT – Norway, RWE-DEA – Germany, Schlumberger Technology Corporation - Texas, Shell – Texas, Sinopec - China, Welldynamics – Texas, WINS ASA—Norway, Wintershall (Germany & Libya)

Hardware sales in > 30 countries: Argentina, Australia, Brazil, Canada, China, Chile, Czech Republic, Germany, Greece, Hungary, Iceland, India, Indonesia, Iraq, Israel, Italy, Malaysia, Mexico, Mozambique, Norway, Oman, Portugal, Russia, Saudi Arabia, Singapore, Slovenia, Spain, Sweden, Thailand, Turkey, UAE, UK, Ukraine, USA

Research organizations in: Australia, Brazil, Canada, Chile, China, Germany, Greece, India, Indonesia, Malaysia, Mexico, Saudi Arabia, Thailand, Ukraine, USA (TX, CA, CO, FL, LA, OK, MA, ND, NH, NM, NV), IRIS, Laser Interferometer Gravitational-Wave Observatory (**LIGO**)

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