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sales@geomatrix.co.uk
Tel: 01525 383438

MetalMapper 2x2 Data Sheet

MetalMapper 2x2 is the most advanced Transient Electromagnetic (TEM) instrument available for Unexploded Ordinance (UXO) detection. Through analysing the 3D EM decay curves of buried metallic targets the instrument permits an operator to differentiate between intact UXO, fragmented shrapnel and metallic debris. This is achieved through illuminating a buried object from different locations and recording the three-axis electromagnetic decay.

The instrument consists of four 35cmx35cm transmitter loops, producing 30A-m2 magnetic moment, positioned in a two by two array. Located in the centre of each transmitter coil is a three-axis receiver. Each transmitter is sequentially triggered and the decay curves from each receiver coil recorded, producing in total 48 decay curves.



MetalMapper 2x2 being used to locate UXO on a US DoD test range. Image Courtesy of Geometrics Inc.

By inverting the recorded x, y and z decay curves it is possible to determine the local (X,Y,Z) location of the target beneath the array, the orientation of its principal axes, and the principal axis polarizability with high degrees of accuracy. From which the following discriminating factors can be can be derived for each anomaly;

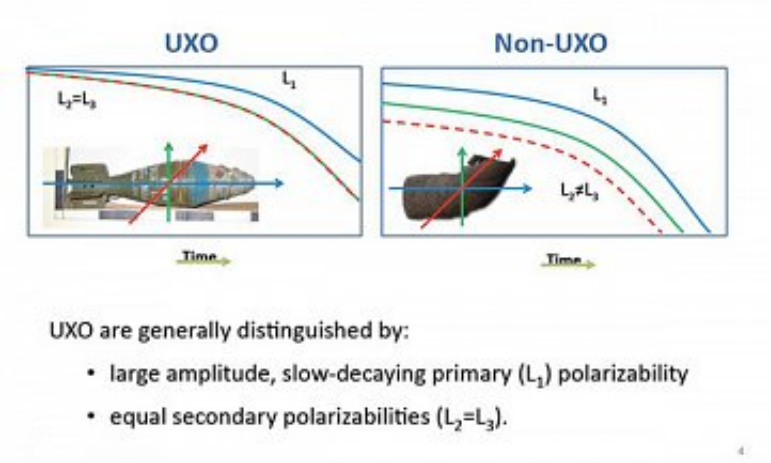
- Location
- Measure of size
- Depth of burial

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- Symmetry of object (i.e. cylindrical, spherical, plate like or asymmetrical)
- 3 polarizability decays indicating target shape

Target classification is based on a library matching procedure. Intact UXO are fundamentally a cylinder of metal, therefore if the UXO target is intact two of the decay curves should present the same gradient.



Principle behind UXO discrimination from metallic clutter.Image Courtesy of Geometrics Inc.

However if the all three decay curves are dissimilar then the object has an irregular shape and the object is more likely to be fragmented shrapnel and metallic debris. Recorded decay curves are statically matched against the object library to determine the nature of the target. This procedure takes on average thirty seconds to complete.

The system exploits external GNSS positioning and an Inertial Measurement Unit (IMU) to pin point each discovered anomaly.

By analysing the decay curves in such a way it is possible to discriminate multiple targets located within the footprint of the system.

Post-processing and inversion of the decay curves is undertaken using the UX-Analyses module developed by Geosoft as part of their Oasis Montaj. Classification is the process of analyzing data to decide whether the source of an anomaly is a hazardous target of interest (TOI), and in some cases, even deciding which specific type of munition may be present. During munition clean-up projects, most of the items excavated are harmless scrap metal (or ‘clutter’). If geophysical targets can be determined to be non-hazardous without digging, they can be left unexcavated.

For UXO projects using advanced electromagnetic (EM) geophysical data such as that from the MetalMapper, UX-Analyze provides a software solution for data processing, modelling and target classification. UX-Analyze allows you to select target signatures of interest, model the data and classify the results from static (cued over known targets) or dynamic surveys. These capabilities are incorporated into a complete workflow with easy to use tools for the following main functions:

- Prepare Data for Analysis - Import data, quality checks, apply data corrections
- Find Targets - Automated and manual target picking including “Informed source selection”
- Analyze- Inversions (solvers), target libraries
- Classify and Rank - Find targets matching signature library and find unexpected TOI, classify and rank targets for excavation or for follow-up static survey.

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UX-Analyze includes modelling tools developed in partnership with Acorn Science & Innovation. UX-Analyze is an extension of Oasis montaj and requires Oasis montaj and the UXO Land extension as prerequisites.

Product Dimensions

Physical	Dimensions (L x W x H)	Weight
(instrument only)	1.4cm x 110cm x 120cm	50kg

Technical Specifications

Configuration:	Four transmitter loops, four 3-component MetalMapper receiver cubes/loops, field modifiable configuration for cart-mounted wheeled transport or skid-steer mounted sled.
A/D Conversion:	Up to 24, 16-bit A/D channels simultaneously sampled and operation at 250kHz.
Bandwidth:	DC to 50kHz for purposes of anti-aliasing. Effective bandwidth is independent of data collection parameters.
Noise Floor:	4nT/s/?Hz at 1000Hz.
Stacking Trigger Accuracy:	All timing accurate to one sample interval (4 ?s).
Maximum Input Signal:	Receivers withstand any transient capable of being produced by the transmitter.
Effective area of each receiving loop / preamplifier:	100m²
Transmitter loops:	Four loops oriented in a 2x2 horizontal array , each 35cm x 35cm.
Transmitter loop moment:	30 A-m² typical.
Receiver loops:	Each receiver cube contains three 10cm x 10cm orthogonally-oriented, co-located loops.
Data acquisition time blocks:	33.33 ms, 100 ms, 300 ms, 900 ms, 2.7s
Data point acquisition and storage rate:	30, 10, 3.33, 1, 0.37 data points/s.
Cycles of time-domain signal in each data-acquisition block:	1, 3, 9, 27, 81, 243.
Transient-decay length:	Selectable based on data-acquisition block time and cycles within that block. Useful decay lengths can vary from 103 ?s to 675ms long.
Data acquisition modes:	- Full wave (stores all data samples for each channel, i.e. 4 ?s samples). - Decays (stores data samples in one decay curve after stacking multiple decays from a data-acquisition block). - Decimated decays (stores decays after stacking time gated decays and

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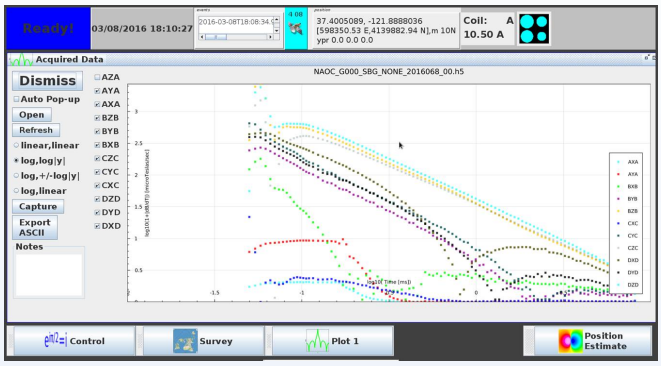
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	computing average amplitude in each time gate).
Transmitter turn-off and primary die-away time including receivers' response:	100 ?s maximum after initiating transmitter turn-off. After background subtraction, secondary decay transients can typically be observed at 50 ms. Transmitter turn-off to 1% is on the order of 10 ms.
Decimation time gates:	The gate widths are determined by applying an (operator selectable) fraction of the delay time at each gate , with a one sample minimum. Gating begins after a selectable hold-off time.
Transmit Current Monitoring channel::	One digital channel records digitized transmitter current to same sampling specifications as receiver channels.
Console:	Rugged Tablet PC running Debian (Linux-based).
Power::	Three 12 A-h Li-Ion batteries. Requires +12V supply for data acquisition and ±12V supplies for the transmitter.
Operating time on full battery charge::	Up to 8 hours.
Environmental:	0 to 50 degrees C.
Personnel:	2 operators required.

Gallery

Code	Measurement type	Description
SAM	Static Anomaly Measurement	Static measurements over an identified location with an unknown anomaly source
DAM	Dynamic Anomaly Measurements	Dynamic survey for detection and classification of potential MEC
SBG	Background Measurement	Static measurement over a non-anomalous location
DBG	Background Measurement	Dynamic measurement over a non-anomalous location
SQC	Quality Control (static IVS)	Static survey of emplaced IVS targets for QC purposes
DQC	Dynamic QC (IVS line)	Dynamic survey of an IVS used for QC purposes
SFT	Function Test	A direct test of all sensor component responses to a standard object placed at a precisely know location (relative to the sensor).
DFT	Function Test	A direct test of all sensor component responses to a standard object placed at a precisely know location (relative to the sensor).
SXM	Miscellaneous	Static all other
DXM	Miscellaneous	Dynamic all other

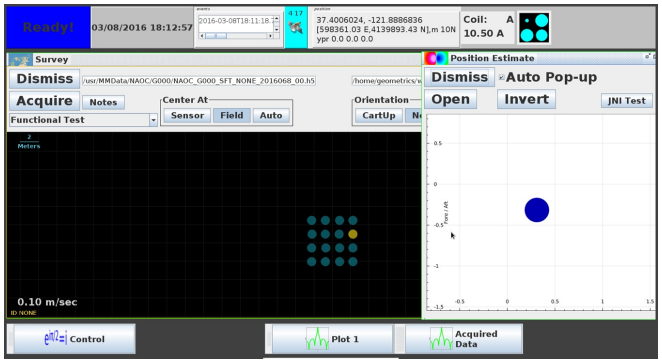
Table outlining the different measurement routines offered by the MetalMapper 2x2.



Decay curves can be reviewed in real time for quality control purposes. Records can be dismissed, or additional measurements stacked to the record. In this example the decay curves have poor correlation.

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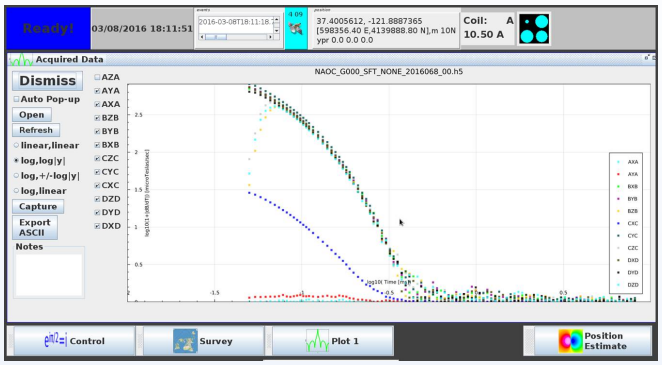
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Conducting Static Measurements requires prior knowledge of anomaly locations, either from the results of a dynamic MetalMapper 2x2 survey or through third party sources. These can be uploaded to the data acquisition software which will guide the operator to position and align the MetalMapper 2x2 over the target in preparation for a static measurement.



The MetalMapper 2x2 includes multiple quality assurance tools which are designed to validate the performance of the system. these function tests can be performed at any point during the survey.



Example of strong decay curve correlation.

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MetalMapper2x2 undertaking a prove-out at Ft. Ord, in Seaside, CA. Ordnance Detection and Discrimination System (ODDS) plot.

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Picture of the MetalMapper2x2 in action at the NSGG test site locating buried mock UXO targets.

Videos

20170503 MetalMapper2x2 video
https://www.youtube.com/watch?v=dY5TpEYoWLQ

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