

## EZ Vibrating Sample Magnetometers



MicroSense (formerly known as DMS and ADE Technologies and previously part of KLA-Tencor) has been manufacturing Vibrating Sample magnetometers and other magnetic measurement systems for more than 35 years. The latest generation VSMs, the Easy (EZ) VSM systems, are the most sensitive and versatile resistive magnet VSM systems available today. The ease of use, speed, sensitivity, versatility and expandability makes this the ideal system for magnetic research labs.

The sensitivity and exceptional low and high field performance make the system ideal for many types of magnetic materials, including thin films, solids, liquids, powders, rocks etc..

### CHOICE OF MODELS

The VSM models differ only in the size of the electromagnet used and the maximum field that can be reached.

Sample Space	EZ 7	EZ 9 HF	EZ 16
3.5 mm	2.6 T	3.2 T	3.65T*
With temperature option	2.03 T	2.54 T	2.95 T
With Vector Option	2.03 T	2.54 T	2.8 T

See details on specification page. HF version is optional.  
\*Depending on configuration

### GREAT LOW AND HIGH FIELD CAPABILITIES

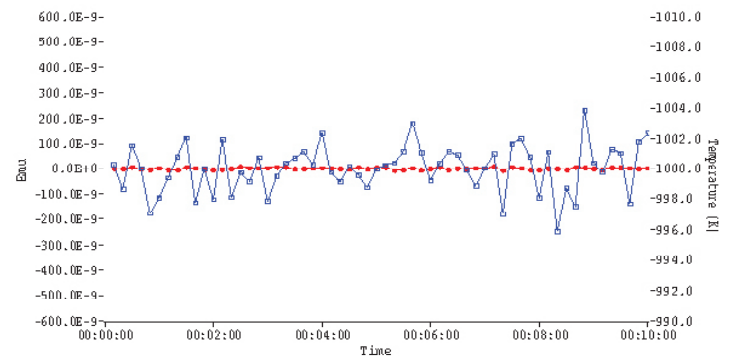
Due to a proprietary real-time field control system with exceptionally low field noise and 24 bit field resolution, the EZ VSMs are ideal for measuring samples with very low coercivities as well as for samples with a high saturation field.

### BENEFITS OF THE EZ VSM SYSTEMS

- **New: Higher Maximum Field**
- **New: Higher Sensitivity**
- **NEW High sensitivity MOKE (Kerr Effect Measurement) Option** with measurement time < 1 minute for a full loop
- **New: Automation Option** available for automatic sample changes. See <https://youtu.be/1-p7nGmT75g>
- Sweep option, up to 1 T/s, 1000 points/sec
- Highest Maximum field of up to 3.6 Tesla (EZ16)
- Highest magnetic field of 3.0 T with temperature chamber in place of any similarly sized electromagnet based system
- Most versatile with Vector, True Torque, AC and DC magneto-resistance, Kerr Effect (MOKE), Magneto-Electric and FMR options as well as automatic sample loading option.
- No hardware change between cooling and heating from 77 K to 1000 K
- Slide mounted oven/cryostat for quick change between room temperature and low/high temperatures
- Largest sample space (10 mm) with single stage temperature option allows for higher SNR.
- True Torque Magnetometer option
- Safe, efficient and reliable air-cooled magnet power supply
- Single cabinet proves a small footprint

### HIGHEST SIGNAL TO NOISE RATIO

The EZ VSM system sensitivity advantage is largest with the temperature and/or vector options. Due to the large ID of the temperature chamber, larger samples can be used, producing higher signals and a higher Signal to Noise Ratio.



Example of measured noise level at 10s/pt at 1000K, 95 nemu RMS noise (480 nemu peak to peak noise). The red plot shows the temperature, the blue plot the moment.

### HIGH ACCURACY

The high precision real time, direct field control used in conjunction with high performance signal acquisition and processing, leads to increased accuracy of the measured graphs and measured parameters.

## SMALL FOOTPRINT, SAFE AND EFFICIENT AIR COOLED POWER SUPPLY

All EZ VSM magnets are powered by a small and very energy efficient air cooled power supply. As a result the entire system fits in a single electronics cabinet taking up less space than systems that require a separate power supply cabinet. Because the power supply is air cooled, there is no risk of condensation inside the power supply and the system can run many moderate duty cycle measurements without the need to turn on the water chiller.

The system is controlled by a large touch screen computer and keyboard mounted on an arm on the cabinet. Because of the flexible arm, the computer can be used both standing and sitting. Alternatively, if so desired, the computer can be mounted on a desk. The software allows you to analyze completed measurements while continuing to run other measurements.



Even the high field EZ11 has a small footprint thanks to the single cabinet design.

## FLEXIBLE OPTIONS: 5 SYSTEMS IN ONE

All EZ VSMs can be equipped with or field upgraded with a range of options to offer a unique combination system. These options can be added to the VSM without increasing the system footprint and they reduce the cost compared to buying separate systems.

**The VSM** Measures the magnetic moment of materials as a function of field, angle, temperature, time and applied electric voltage (with the magneto-electric option)

**The MOKE option** offers the ability to do very fast longitudinal or perpendicular Kerr measurements. Typical measurement time for a hysteresis loop with thousands of points is less than 1 minute. Switching between VSM and MOKE options (and back) takes less than 1 minute and doesn't require gap changes or recalibration (when the VSM is set to the typical 17 mm gap for the EZ1-LNA option).

**The Torque option** measures the torque of materials as a function of rotation angle and applied field, resulting in Anisotropy data.

**The Magneto Resistance option** measures the resistance of thin film samples as a function of magnetic field, temperature, and angle. Magneto Resistance Measurements (with > 5000 points) take less than two minutes. In plane and perpendicular (room temperature only) options are available.

### The FMR Option

2-8, 2-18 GHz, 2-40 and soon 2-60 GHz options available. Switch between VSM and FMR in minutes. Extracts Ms, damping and gyromagnetic ratio. Ability to measure thin films down to 1.4 nm.

## Automatic Sample Loading Option

A unique automatic sample loading option allows for loading and exchanging cassettes of samples while other measurements are in progress for fully automatic 24/7 measurements.

## EASY TO USE TEMPERATURE OPTION

The temperature option (if it is included with the system) remains installed on the system and can be moved in and out of place using a simple lever-slide mechanism. This allows very fast changes between room temperature and low or high temperature measurements. Typically your measurement is already done in the time that it takes in some other systems to re-install and prepare the temperature chamber. See video at <http://youtu.be/69nnwSqPFjI>.



The single stage temperature chamber is always ready to use and does not require a vacuum pump.

Temperature chamber in down position for room temperature measurements

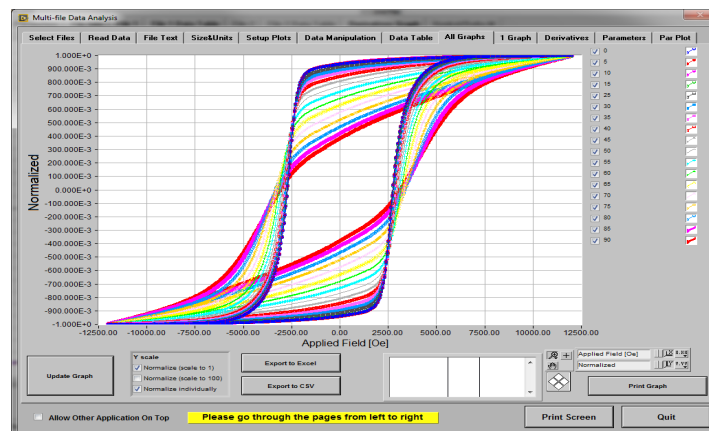
Temperature chamber in up position (for low and high temperature measurements)

## EASY TO USE AND POWERFUL SOFTWARE

The Powerful EasyVSM software allows quick setup of simple as well as complicated measurements and measurement sequences.

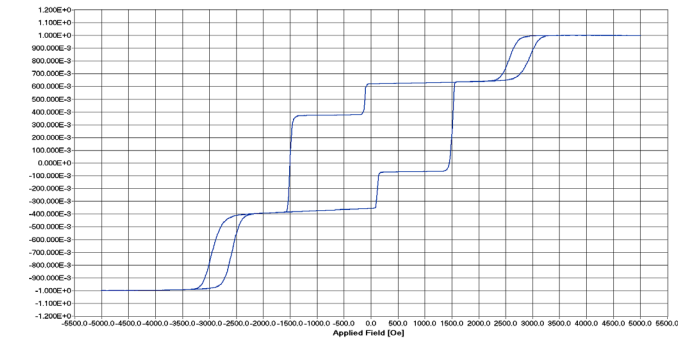
The software supports all known types of magnetic measurements such as Hysteresis and minor loops, IRM and DCD Remanence Loops, SFD, Delta M, delta H and Henkel Plots, FORC Measurements as well as Angular and AC Remanence, Temperature scans and Time decay measurements. Additionally, the user has the option to custom create measurements with full control over system functions. Any series of measurements can be run without user intervention

The powerful data analysis system allows the analysis and comparison of many measurements simultaneously and while the software itself produces virtually presentation ready graphs and tables, data exporting to other software packages is as easy as right clicking on a graph or table and selecting the export function. All data is saved in ASCII format.

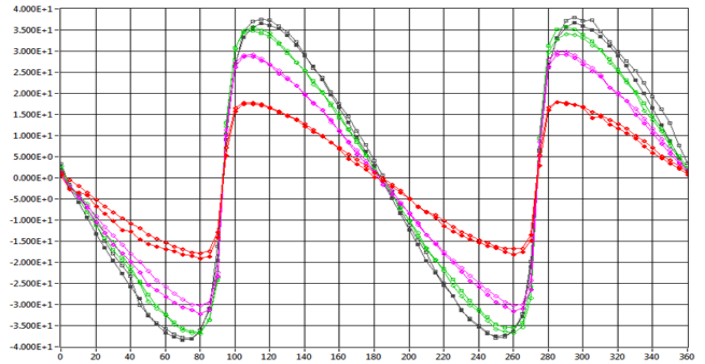


Screenshot of Multifile Data Analysis Menu showing the results of a series of VSM measurements as a function of the angle on a tape sample. The software will also automatically generate graphs of all the measurement parameters as a function of the angle (or temperature).

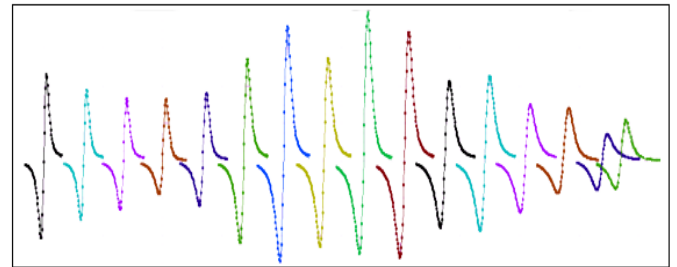
## Examples of VSM Data (all graphs shown were produced with the EasyVSM software)



MOKE measurement, 26 seconds measurement time. 1500 points

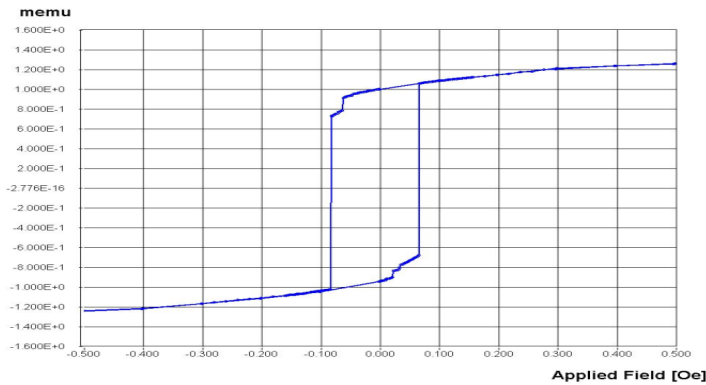


Torque Measurement.

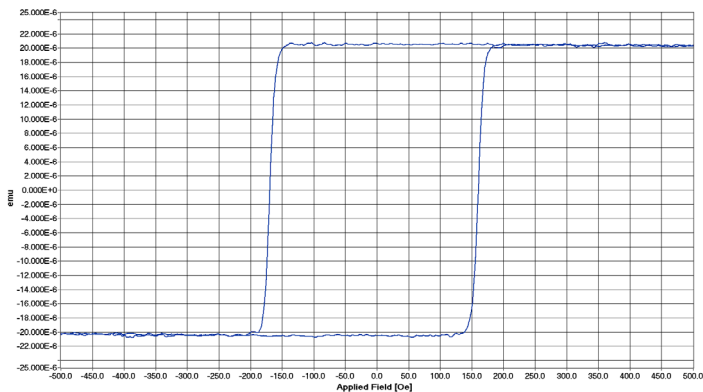


Magnetic Field

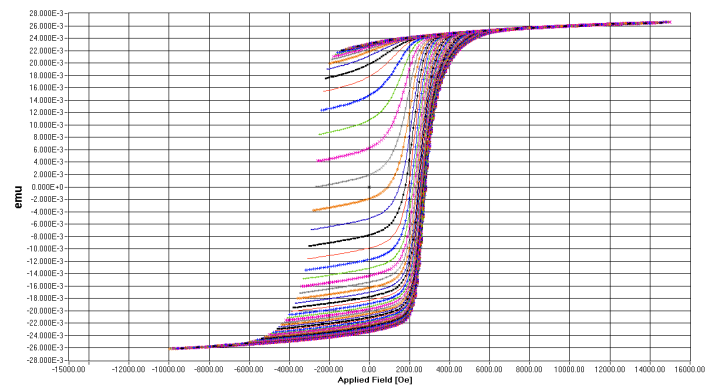
FMR test on MRAM type sample



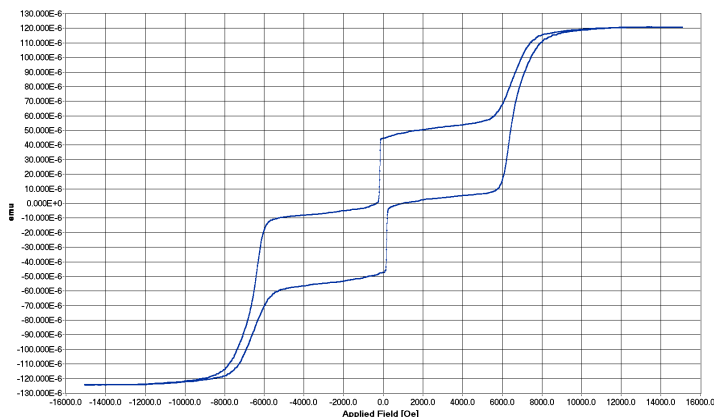
Measurement on microwire with 0.07 Oe coercivity.  
In the critical region 2 mOe field steps were used. The steps shown are Barkhausen jumps.



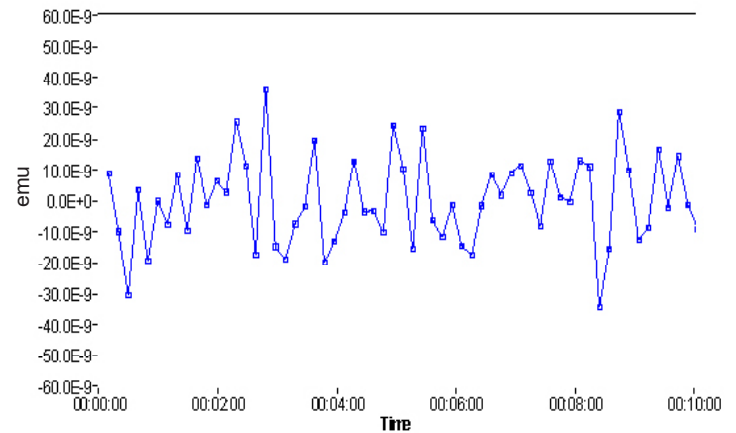
1:26 minute measurement on a 20 micro-emu sample, 820 points.  
3.5 mm gap with 0.1 s/pt averaging. Observed noise 113 nemu RMS.



FORC measurement on tape sample. 91 curves, 33,000 points, 36 minutes using sweep option



5 minute test, 0.05 s/pt averaging. Sweep mode. 6000 data points



Noise at 10s per point averaging at a 3.6 mm sample space. The observed noise is 14.2 nemu RMS and 70 nemu PP. (The spec is 20 nemu RMS)

# EZ VSM Series Specifications

## Magnetic Field - Maximum Fields [T] ( $\pm 1\%$ )

Sample Space	EZ7	EZ7 HF	EZ8	EZ9	EZ9 HF	EZ16
3.5 mm	2.6	2.76	2.8	3.0	3.2	3.5 (3.65*)
10 mm	2.32	2.45	2.53	2.75	2.85	3.3
16 mm	2.06	2.12	2.29	2.45	2.58	3.0
With Single Stage (77K-1000K) temperature option	2.03	2.1	2.25	2.4	2.54	2.9
With Cryostat or Oven option	1.6	1.7	1.9	2.15	2.3	2.7
With Vector Option	2.03	2.1	2.25	2.4	2.54	2.9
With Torque (VSM coils in place)	2.32	2.45	2.5	2.7	2.88	3.3
With Torque (VSM Coils removed)	2.4	2.55	2.6	2.8	3.0	3.6

Magnet at  $\leq 18^\circ\text{C}$ . HF is optional. \*With special pole tips

## Magnetic Field

Range		Resolution		Noise [RMS]	
Gauss	Tesla	Gauss	Tesla	Gauss	Tesla
100 - 200 Gs	10 - 20 mT	0.4 mGs	$\leq 40$ nT	1 mGs	100 nT
400 Gs	40 mT	1 mGs	100 nT	2 mGs	200 nT
1 kGs	0.1 T	2 mGs	200 nT	3 mGs	300 nT
2 kGs	0.2 T	4 mGs	400 nT	3 mGs	300 nT
4 kGs	0.4 T	10 mGs	1 $\mu\text{T}$	4 mGs	400 nT
10 kGs	1 T	20 mGs	2 $\mu\text{T}$	10 mGs	1 $\mu\text{T}$
20 kGs	2 T	40 mGs	4 $\mu\text{T}$	10 mGs	1 $\mu\text{T}$
40 kGs	4 T	0.1 Gs	10 $\mu\text{T}$	20 mGs	2 $\mu\text{T}$
Field Accuracy: 1% of reading or $\pm 0.05\%$ of full scale					
Field control stability: $< 0.05\%$ RMS full scale/h					

## Magnetic Moment Noise (Standard configuration, step field mode)

## RMS Noise in nemu or pAm<sup>2</sup>

Conditions	0.1s/pt	10s/pt
Room Temperature		
3.5 mm sample space	125	20
10 mm sample space	250	65
With Single Stage Temperature Option (77K-1000K)	500	120
With Vector Option	1000	300
With Oven or Cryostat Temperature Option	2500	500

## Moment Measurement

Accuracy	$\pm 1\%$ + noise if sample and calibration standard are equal in shape and size.
Repeatability	Stdev 0.5% + noise at constant room temperature Typical: $< 0.1\%$ when sample is undisturbed
Stability/Drift	0.05% RMS of full scale
Dynamic Range	$25 \times 10^{-9}$ to $10^3$ emu / $25 \times 10^{-12}$ to 1 Am <sup>2</sup> (with high moment option)
Sample Mass	0 - 10 g (depending on density and magnetization)

## Automatic Rotation - Standard Included

Range	$\pm 540^\circ$ or $-100^\circ$ to $900^\circ$
Resolution	0.002 $^\circ$
Accuracy	$\pm 0.2^\circ$

## Vector Option For max field specs: See table above

Noise in nemu or pAm <sup>2</sup>	1000 (0.1s/pt), 300 (10s/pt)
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## Automatic Sample Loading option (vertical and horizontal)

Number of cassettes/samples	6 Cassettes, 96 samples total
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## Temperature Control Options

	Single Stage	Cryostat	Oven
Range	77K fixed 100K-1000K Control	4.2K Fixed 8K-420K Control	300K- 1300K
Resolution	0.001K	0.001 K	0.001K
Stability	$\pm 0.5$ K	$\pm 0.5$ K	$\pm 0.5$ K
Inside Diameter	10 mm	9 mm	8 mm
Max Ramp Rate	100K/min	30K/min	100K/min (Up)
Noise 0.1 s/pt	600 nemu, pAm <sup>2</sup>	2.5 $\mu\text{emu}$ , nAm <sup>2</sup>	2.5 $\mu\text{emu}$ , nAm <sup>2</sup>
Noise 10 s/pt	120 nemu /pAm <sup>2</sup>	500 nemu, pAm <sup>2</sup>	500 nemu, pAm <sup>2</sup>
Gas/Liquid requirements	LN2 $< 300$ K N2 Gas 77K-573K Ar 300K-1000K	Liquid Helium and He Gas	Ar Gas
Note	Open flow design, gas cannot be recycled.		

## Torque Option

Range	1-400 dyn-cm
Noise	0.005 dyn cm (5s/pt averaging)

## Magneto Resistance Option

	DC MR	AC MR	AC&DC MR nV
Current Ranges	2, 20 mA	2 nA .. 100 mA	2 nA .. 100 mA
Current Resolution	0.1 $\mu\text{A}$	100 fA	100 fA
Voltage Range	60 $\mu\text{V}$ - 9 V	2nV – 1V	AC: 2nV – 1V DC: 100 nV- 100 V
Frequency Range	DC	1 Hz-100 kHz	DC, 1 Hz-100 kHz, DC w 12 Hz polarity reversal
Points per second	Up to 10,000 points/second		
Measurement Time	$> 10$ s, 1 min. typical		
Sample Size (in plane)	$< 3.5$ mm Wide, 8.1 - 9mm Long		
Sample Size (perp.)	8x8 mm - 10.5 x 10.5 mm		
Pin Spacing (in plane)	Current Pins: 7.77 mm, Voltage Pins: 4.978 mm		
Pin Spacing (perp.)	6x6 mm in square configuration		
Temperature Range	77K + 100K - 673K (with EZ1-LNA, in plane option only)		

## Magneto Electric Option

Voltage Range	-50V to + 50V, higher with optional amplifier.
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## Magneto Optic Kerr Effect (MOKE) Option (NEW)

Available Directions	Polar (perpendicular) and Longitudinal (in Plane)
Measurement Time	10s - 1 minute typical
Switch time VSM $\leftrightarrow$ MOKE	1 minute
Sample exchange time	$\sim 1$ minute
Spot Size	$\sim 1 \times 1.5$ mm

Specifications apply to new systems built after July 1, 2023. Specifications subject to change without notice.

For more information please visit <http://www.microsense.net/products-vsm.htm>