

EZ Vibrating Sample Magnetometers



EZ9 VSM

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 30 years. The latest generation VSMs, the new Easy (EZ) VSM systems, are the most sensitive and versatile resistive magnet VSM systems available today. The EZ VSMs are extremely sensitive, fast and easy to use.

Virtually any type of magnetic material can be characterized on the Easy (EZ) VSM systems. The sensitivity and exceptional low and high field performance make the system ideal for thin films, solids, liquids, powders, rocks etc. are all common applications for the EZ VSM systems.

CHOICE OF MODELS

The 4 VSM models differ only in the size of the electromagnet used and the maximum field that can be reached.

Sample Space	EZ 7	EZ8	EZ 9	EZ 11
4 mm	2.3 T	2.65 T	2.8 T	3.2 T
With single stage temperature option	1.8 T	2.05 T	2.2 T	2.7 T

GREAT LOW AND HIGH FIELD CAPABILITIES

Due to a proprietary real-time field control system with exceptionally low field noise, the EZ VSMs are suited for measuring samples with very low coercivities without the need to switch to a Helmholtz coil based system. At the same time, the EZ 9 VSM is the most compact electromagnet based VSM that can reach a maximum field of 2.25T with the temperature option or vector coil option in place.

BENEFITS OF THE EZ VSM systems

- Lowest noise of any resistive magnet VSM at any gap and especially when used with temperature or vector.
- Highest Maximum field of up to 3.2 Tesla (EZ11)
- Highest magnetic field of 2.7 T with temperature chamber in place of any similarly sized electromagnet based system
- 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
- **NEW Kerr Magnetometer option**
- **NEW Magneto Electric Option**
- **NEW DC & AC Magneto-resistance option**
- True Torque Magnetometer option
- Safe, efficient and reliable air-cooled magnet power supply
- Single cabinet providing a small footprint

HIGHEST SENSITIVITY

The EZ VSM systems have the lowest noise of any similar VSM at any gap. The sensitivity advantage is even larger with the temperature and vector options, which have 2.5x to 10x lower noise than other similar systems. Furthermore, due to the large ID of the temperature chamber, larger samples can be used. The 2.5 to 4 times larger sample volume (for a thin film sample) combined with the substantially lower noise leads to a Signal to Noise Ratio advantage of 6x or more.

Similarly, when the system is used with the vector option the noise is approximately 10 times lower than the noise in competing systems.

VERSATILITY

The EZ VSMs support 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, as well as Angular and AC Remanence Loops, 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, using the flexible EasyVSM software.

The ability to add Magneto-resistance, Torque, Kerr and Magneto-Electric options to the VSM, adds further to their versatility.

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, while at the same time facilitating measurements on soft magnetic samples with a 24 bit field resolution (better than 1 mOe).

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. Also, because the power supply is air cooled, the system can run many types of measurements without the need to turn on the water chiller.

The system is controlled by a large touch screen computer 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 enabled by the compact magnet power supply.

FLEXIBLE OPTIONS: 4 SYSTEMS IN ONE

ALL EZ VSMs can be equipped with or field upgraded with a range of options to offer a unique combination system including Torque, Kerr, and/or Magneto-Resistance options. 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 Kerr option offers the ability to do very fast longitudinal or perpendicular Kerr measurements.

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.

FAST AND EASY TO USE

A unique sample vibrating mechanism makes sample mounting and alignment fast and convenient. Samples can be quickly and easily aligned properly to maximize the measurement accuracy and repeatability. Thanks to the direct real-time field control and high sensitivity the EZ VSMs are

typically 3 times faster than competing systems (in field step mode).

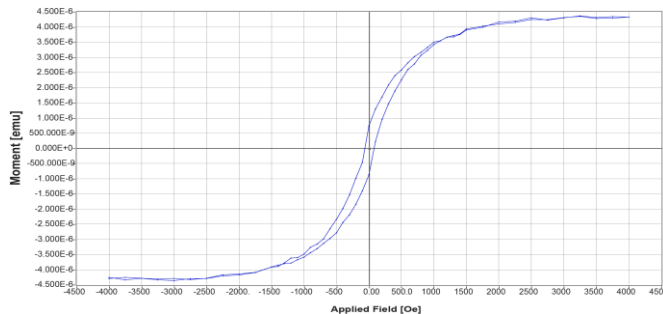
The temperature option (if it is included with the system) remains installed on the system and can be moved in and out of place using a simple lever-slide mechanism. This allows very fast changes between room temperature and low or high temperature measurements. Typically your measurement is already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



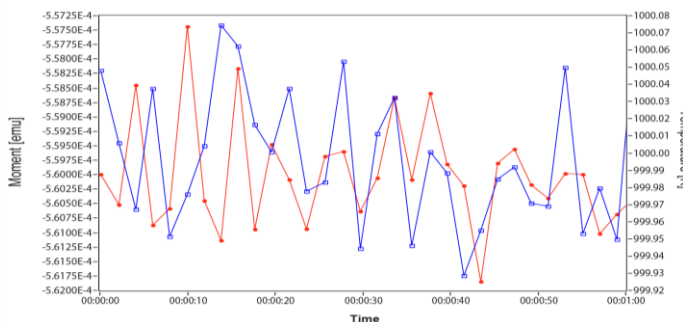
Temperature chamber in down position for room temperature measurements

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

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



Graph 1: Measurement on a 4.2 micro-emu sample



Graph 2: Example of measured Noise level WITHOUT Signal averaging at 1000 K, 1.18 μ emu RMS Noise (4.33 μ emu peak to peak noise). The red plot shows the temperature, the blue plot the moment.

EZ VSM Series – Specifications

MAGNETIC MOMENT

Magnetic moment noise (step mode measurement)

Range	Noise [$\mu\text{emu RMS}$]
Room temperature	
4 mm 0.1s TC, No Averaging	0.4
4 mm 0.1s TC, 1 s/pt	0.175
4 mm 0.1s TC, 10 s/Pt	0.075
10 mm 0.1s TC, No Averaging	0.8
10 mm 0.1s TC, 10 s/Pt	0.3
With single stage temperature option (No Averaging)	2.5 (1.25 typical for EZ9)
10 s/point	0.5
With standard vector option	2.5
10 s/point	0.5
With large space Vector option	3
10 s/point	0.75
With Helium Temperature option	5
10 s/point	1.5

Accuracy $\pm 1\%$ + noise if sample and calibration standard are equal in shape and size.

Repeatability $\pm 0.5\%$ + noise (Typical: 0.1%) at constant room temperature

Stability/Drift 0.05% RMS of full scale (Measured over 48 hours at constant field and room temperature with calibration standard at gap big enough to fit the EZ1-LNA temperature option)

MAGNETIC FIELD

Maximum Field (with 50 mm pole face)

Sample Space	EZ 7	EZ8	EZ 9	EZ 11
4 mm	2.3 T	2.65 T	2.8 T	3.2 T
10 mm	2.1 T	2.2 T	2.4 T	2.9 T
16 mm	1.8 T	2.1 T	2.3 T	2.75 T
With single stage temperature and/or vector option (s)	1.8 T	2.05 T	2.2 T	2.7 T
With High Temperature Oven	1.6 T	1.8 T	2.0 T	2.5 T
With Helium Cryostat	1.6 T	1.8 T	2.0 T	2.5 T
W/ large space vector option	1.6 T	1.8 T	2.0 T	2.5 T
With Torque option (with VSM coils in place)	2.1 T	2.2 T	2.4 T	2.9 T
With Torque Option (with VSM coils removed)	2.4T	2.75 T	3.0 T	3.4 T

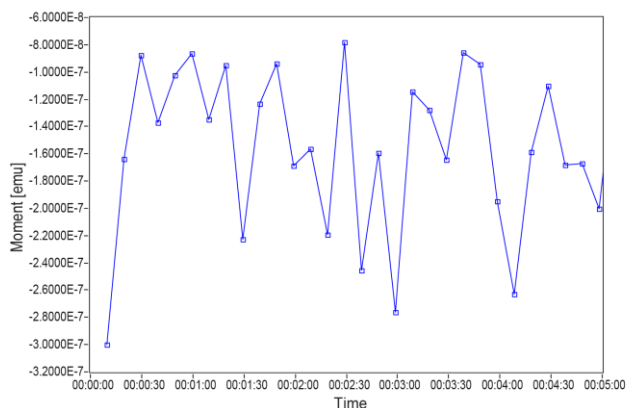
High Field option (EZ9 and EZ11)

This option raises the 4 mm max field of the EZ9 to 2.9T and 2.35 with temperature and/or Vector. For the EZ11 the maximum field is increased by 3-7% depending on the gap (more at larger gaps)

Field Resolution and Field Noise

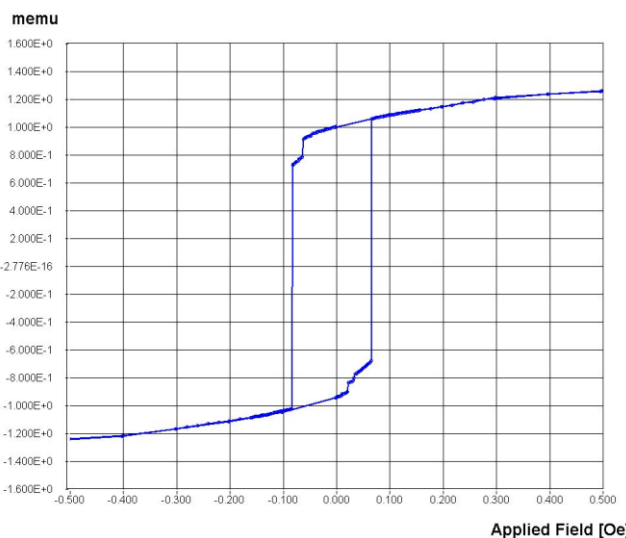
The system has 20 bit field programming and 24 bit field reading resolution.

Range	Program Resolution	Noise [RMS]
100 Gs	0.0002 Gs	5 mGs
200 GS	0.0004 Gs	5 mGs
400 Gs	0.001 Gs	10 mGs
1 kGs	0.002 Gs	10 mGs
2 kGs	0.004 Gs	15 mGs
4 kGs	0.01Gs	15 mGs
10 kGs	0.02 Gs	20 mGs
20 kGs	0.04 Gs	20 mGs
40 kGs	0.1 Gs	50 mGs
100 kGs	0.2 Gs	100 mGs



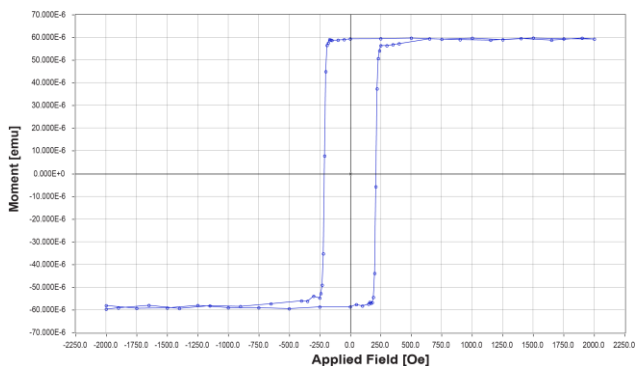
Graph 3: Measured noise at 10s per point averaging at a sample space of 4 mm. Observed noise 60 nemu RMS and 222 nemu PP.

Please note that the spec is 75 nemu RMS.



Graph 4: Measurement on microwire with 0.07 Oe coercivity. In the critical region 2 mOe field steps were used. The steps shown are Barkhausen jumps.

The low field resolution of the EZ VSMs exceeds the field resolution in dedicated low field only Helmholtz coil based VSM systems, without the need to switch between magnets for low field measurements.



Graph 5: 6:24 minute measurement on a 60 micro-emu sample. Measured at a 5 mm gap with 0.75 second/pt averaging.

EZ VSM Series – System Options

EZ1 – VAR AUTOMATIC ROTATION (typically included)

Range: $\pm 400^\circ$
Resolution: 0.002°
Accuracy: $\pm 0.2^\circ$

EZ1 – VSC VECTOR COILS

For simultaneous detection of X and Y Vector components of the magnetic signal.

Maximum field of vector option (standard coils):

EZ7	EZ8	EZ9	EZ11
1.8 T	2.05T	2.2 T	2.7 T

EZ1 – LNA Temperature Control Option

Temperature option offering a continuous temperature range from liquid nitrogen to 1000K, without any changes in VSM hardware over this range. Switching measurements from room temperature to low or high temperature occurs within seconds thanks to the slide mounted temperature chamber. The non-magnetic quartz temperature chamber with a large ID provides noise that is more than 2 times lower than the noise of any competing system while the achievable signal to Noise Ratio (SNR) is more than 6 times better (compared to competing systems) due to the large available sample space.

Range: 77 K, 100 K to 1000 K control
Resolution: 0.01 K
Inside diameter: 10 mm
Ramp rate: 60K per minute
Noise: 2.5 μemu (0.1s/pt) 0.5 μemu (10 s/pt)

EZ1-LHE Temperature Control Option

Liquid Helium temperature control system, can be used with liquid nitrogen with optional N2DEW system. Due to the low noise and large ID, the SNR with this option is at least 3 times better than the SNR of similar competing systems.

Range: 4.2 K, 8 K to 450 K control
Resolution: 0.01 K
Inside diameter: 9 mm

EZ1- SWP Sweeping Field Measurement Option

The standard measurement mode in the VSM uses field stepping; the field comes to a complete stop before a measurement point is taken. This gives the most accurate measurement of many of the magnetic parameters. Adding the Sweep field measurement option enables the system to measure data continuously while the field is being swept. This provides up to 60 data points per second, allowing for even faster measurement times and more data points per measurement. This option is most useful for high signal samples.

New: EZ1- MOKE Magneto Optic Kerr Effect option

The Kerr effect measurement system offers very high speed Magneto-Optic measurements on low signal samples both with the field in the plane and with the field perpendicular to the sample.

EZ1-TRQ Torque Magnetometer Option

Unique add on option for very accurate and sensitive real torque measurements.

The torque transducer and vibrator head are mounted on a slide for quick and easy switching between torque and VSM measurements. A true torque magnetometer is much more accurate and more than 5x more sensitive than a vector coil based torque system.

Range: 1 to 400 dyne-cm full-scale
Resolution: 0.0025% of full scale range
Accuracy: 1% when calibrated with pure Ni standard
Noise: 0.05 dyne-cm RMS (without averaging)
0.005 dyne-cm RMS (5s/pt averaging)

(For optimal torque noise performance a vibration free environment is required)

Maximum field of vector option:

	EZ 7	EZ8	EZ 9	EZ 11
w/ VSM coils & 10 mm gap	2.1 T	2.2 T	2.4 T	2.9 T
w/ VSM coils removed	2.4 T	2.6 T	2.8 T	3.4 T

EZ1- MR Magneto Resistance Option

Allows the fast and easy measurement of the resistance as a function of field, temperature, field angle, sample current and time. The MR probe uses 4 in-line spring loaded pins for a solder-less connection to the sample. The MR option can be used in combination with the EZ1-LNA option for measurements at low and high temperatures. The relatively large pin spacing increases resistance measurement accuracy.

Typical measurement time: 1 or 2 minutes with 3000-3600 data points per minute

Temperature range: 77K +100K to 673K
Max sample width: 3.5 mm (0.138")
Min. sample length: 8.1 mm (0.32")
Spacing between (outer) current pins: 7.77 mm (0.306")
Spacing between (inner) voltage pins: 4.978 mm (0.196")

DC MR option

Current ranges ± 2 mA, ± 20 mA
or optionally 2 nA, 20 nA, 200 nA ... 100 mA
Current resolution: < 0.1 μA or optionally 100 fA
Ohms range: $< 1\text{mOhm}$ to $> 1\text{MOhm}$
Resolution: 16 bit

New AC MR Option

Frequency range: 1 Hz - 100 kHz (optimal range depends on sample)
Current ranges: 2 nA, 20 nA, 200 nA ... 100 mA
Voltage ranges: 2nV – 1V in 1-2-5 sequence.
Current resolution: 100 fA in lowest range

New: EZ1- ME Magneto Electric Option

The Magneto Electric option allows measurement of the magnetic properties while an electrical voltage is applied to the sample.