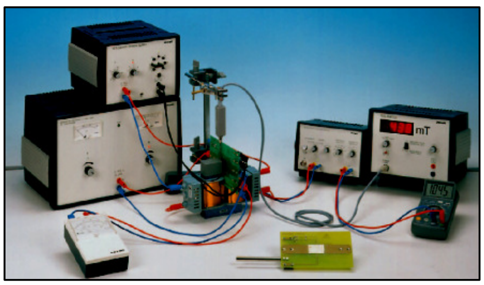
G.M.R. EFFECT DEVICE FABICATION & EXPERIMENTAL SET-UP

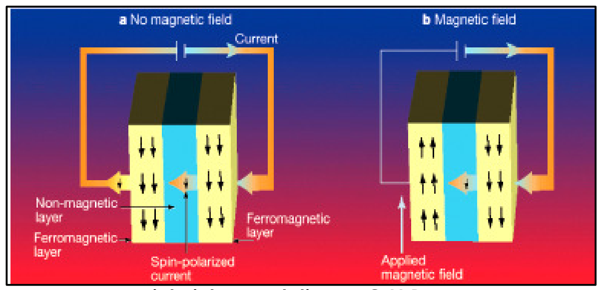
MGMRS-Series

Introduction: MGMRS series of G.M.R. experimemntal set-ups are available in five different models to examine and explore the effect of magnetic field on ferromagnetic alloys sandwiched around an ultrathin nonmagnetic conducting middle layer as shown in picture-01. on account re-alignment of magnetic moments. This effect is used in fabriucating magnetometer, position sensor, encoder; this tabletop set-up comprises Variable magnetic field electromagnet in various ranges from 5000 to 30,000 gauss, precision electrometer with constant current/voltage source. On account it's versatile feature this preferable choice for research and teaching institution, telecom, aerospace, railways, M.E.M.S, electrical/mechanical industries, sensors, and many uncountable defense/nuclear application. Company offers tailor made solution to custom requirement.

Operating Principle: The GMR sensors utilize the quantum nature of electrons that have two spin states. Conducting electrons with spin direction parallel to the sensor film's magnetic orientation move easily and thus produce low electrical resistance and the movement of electrons of opposite spin direction is impeded by frequent collisions with atoms in the film thereby producing higher resistance. A non magnetic film of copper of few atomin thickness is sandwitched between two oppositely magnetically oriented ferro-magnetic film of 5-6 atom thick ness to ease modulation of orientation magnetic grain on conduction electrons. Changes in the external magnetic field orientation cause magnetic rotation of the sensor film's orientation. This changing magnetic orientation alters the electrical resistance of the sensor array. Low resistance occurs when the ferro-films are magnetically orientated in the same direction because electrons with parallel spin direction move freely in both films. Higher resistance occurs when magnetic orientations ferro-film s are opposite and accordingly the electron movement of either spin direction is hampered by one or the other films. GMR sensitivity is twice as high as MR and is now used for the highest performance disks. Magnetically-sensitive resistors, called spin valves etc



MGMRS-05305



pictorial presentation on G.M.R.

Model	Electromagnet-field Gauss/pole dia/gap m.m. & magneti field resolution	Precision Power supply Volt/current range	GMR material	Voltage measurement range
MGMRS-05305	05000(25/25) Resolution : 1.0 micro gauss	50 Volt/10 amps	Not-disclosed	0.1/0.5 -99999.9MIV & 10.0 mV-10.0Volts
MGMRS-05305	10,000(40/25) Resolution : 1.0 micro gauss	50 Volt/20 amps	Not-disclosed	0.1/0.5 -99999.9MIV & 10.0 mV-10.0Volts
MGMRS-05305	10,000(40/40) Resolution : 1.0 micro gauss	50 Volt/30 amps	Not-disclosed	0.1/0.5 -99999.9MIV & 10.0 mV-10.0Volts
MGMRS-05305	15,000(40/40) Resolution : 1.0 micro gauss	50 Volt/40 amps	Not-disclosed	0.1/0.5 -99999.9MIV & 10.0 mV-10.0Volts
MGMRS-05305	20,000(50/50) Resolution : 1.0 micro gauss	75 Volt/50 amps	Not-disclosed	0.1/0.5 -99999.9MIV & 10.0 mV-10.0Volts
MGMRS-05305	30,000(65/50) Resolution : 1.0 micro gauss	100 Volt/100 amps	Not-disclosed	0.1/0.5 -99999.9MIV & 10.0 mV-10.0Volts

General electrical/mechanical specification of G.M.R. Effect analysis set-up:

Electromagnet: 5000-30,000 gauss
Power supply: 50 v/25 amps to 100 volt/100 amps operated at 220 Volts/50 amps A.C.
Electrometer: above with tare facility
Reference tesla meter: : $10^{-12}/10^{-6}/10^{+3}$Tesla e AC/DC (optional)
GMR sample: NO-DISCLOSED .
Contact paste: Silver/pt paste
Data logger: 100 to 1000 sample parsec at RS-232
Accessories: clapms/stands, chillar Zero magnetic field reference

MHPEM-050025

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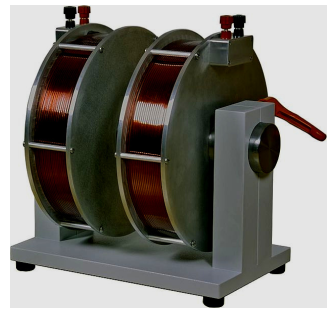
SPECIFICATIONs OF RESISTIVE ELECTROMAGNETS/ (D.C. & Ramp) **Power range<100.0 K.Watt**

Model	Pole dia m.m.	Pole gap m.m.	Frame size LxBxH	Bmax Tesla	Watts	Volts	Amps	Pulse / min	Cooling
MHPEM-025025	025	025	12X06x08	01.5	00500.0	25.0	010.00	80.0	Air
MHPEM-032050	032	050	12X06x08	01.5	00500.0	25.0	015.00	80.0	Air
MHPEM-050025	050	025	18X10X12	01`.5	0750.0	50.0	015.00	80.0	Air
MHPEM-050050	050	050	18X10X12	01.5	01250.0	50.0	025.0	80.0	Air
MHPEM-062062	062	062	24X18X08	01.5	02500.0	050.0	050.0	60.0	Air
MHPEM-075050	075	050	30X20X08	01.5	03750.0	075.0	050.0	60.0	Air
MHPEM-075050	075	050	24X18X08	03.0	05000.0	100.0	050.0	60.0	WATER
MHPEM-100050	100	050	32X20X08	03.0	10000.0	100.0	100.0	60.0	WATER

General Specifications of High Power Electromagnets:

Operating Voltage 220 Volts, 1/3 phase, 40-60 Hz
Pole Gap: 10-200 m.m.
Pole Diameter: 20-200 m.m.
Max magnetics field: 3.0 tesla
Pole material: COMPOSITE (detail not disclosed)
Pole material permeability@2.2T;
Pole Dimensional profile: 15-25% taper
Percentage surface irregularities: 0.001%
Oil O.D. 100 – 2000 m.m.
Oil Length: 75- 800 m.m.
Oil inductance: 100- 2000 mili-henry (MEASURE AT LOW FREQUENXY)
Oil time Constant: 10-100 mili-secs
Oil Voltage: 50-400 VOLT d.c
Oil Current: 50-500 amps d.c.
Duty cycle: 30 min on/30 min off
Frame size: 6x24 to 100x200"



low field electromagnet
MHPEM-025010

Specifications OF HIGH CURRENT/LOW VOLTAGE POWER SUPPLIES D.C./RAMP **Power range<100.0 K.Watts**

Model	Watts	Volts	Current	Pulse/seX x10	Cooling	Model	Watts	Volts	Current	Pulse rate in Xase of pulse/seX x 10	Cooling
MEMPS-200200	4000.0	20.0	200.0	1000	Air	MEMPS-100100	10000.0	100.0	100.0	400	Air
MEMPS-025025	625.0	25.0	25.0	1000	Air	MEMPS-100100	15000.0	100.0	150.0	400	Air
MEMPS-025050	1250.0	25.0	50.0	1000	Air	MEMPS-100300	30000.0	100.0	300.0	400	Air
MEMPS-025100	2500.0	25.0	100.0	800	Air	MEMPS-100400	40000.0	100.0	400.0	400	Air
MEMPS-025150	3750.0	25.0	150.0	800	Air	MEMPS-200400	10000.0	200.0	50.0	400	AIR
MEMPS-025200	5000.0	25.0	200.0	800	Air	MEMPS-200050	20,000.0	200.0	100.0	400	Air
MEMPS-050050	2500.0	50.0	50.0	800	Air	MEMPS-200100	20,000.0	200.0	200.0	400	Air
MEMPS-050100	5000.0	50.0	100.0	800	Air	MEMPS-400100	40,000.0	400.0	100.0	400	Air
MEMPS-050200	5000.0	50.0	200.0	800	Air	MEMPS-300100	30,000.0	600.0	750.0	400	Air
MEMPS-050400	5000.0	50.0	400.0	800	Air	MEMPS-600100	60,000.0	600.0	1500	400	Air

General Specifications of High Current/low voltage power supply:

Operating voltage 220 volts, 1/3 phase, 40-60 Hz
Output Current/voltage 0-400 volts/400 amps (max) (pulse/D.X)/multioutput mode
Voltage/Current Control accuracy 99.9% of set point
Output impedence: Compatible to load to ensure maximum possible power trasfer.
Resolution 0.1 volts/amps D.X.
Repeatability 100 percent
Response time 0.5 –1.1 mill-seconds
Voltage regulation: Line: ±0.05% (for ±10% of input Change)/ Load: 0.05% (for 10 to 100% of load Change)
Current regulation: Line: ±0.05% (For ±10% of input Change)/Load: 0.05% (for 10 to 100% of load Change)
Interface Signal 0.0-12.0 volts D.X. (proportional to process variable
Voltage Control range 0.0-400 volts
Step down ratio 0-100%
Control options 1. Reverse polarity Xontrol 2. 1. Cascade feedbaXk Xontrol with
Soft start 2.Ratio Xontrol (option) 2. Contant voltage/Current with
External adjustment
Display Voltage/Current/kilowatt/Jules in 3½ red glow LED display
Protection over voltage/short Ckt.
Additional: Local: Constant voltage mode, by 10-turn potentiometer
Constant Current mode, by 10-turn potentiometer
Remote: Constant voltage mode, by external voltage of 0 to 10VdX*
NOTE: These power supplies are also offered in pulse mode.

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Specification of High Current/Low voltage Pulse Power Supplies (D.C./RAMP) **Power range<100.0 K.Watts**

Model	Watt	Volts	Current	pulse/sec	Model	Watts	Volts	Current	pulse/sec x 10
MEMPSD-0202001	0400	020.0	200.0	10	MEMPSD-0602001	12000	060.0	200.0	5
MEMPSD-0300501	01500	030.0	050.0	10	MEMPSD-0600501	03000	060.0	050.0	5
MEMPSD-0301001	03000	030.0	100.0	10	MEMPSD-0601001	06000	060.0	100.0	5
MEMPSD-0400501	02000	040.0	050.0	10	MEMPSD-0602001	12000	060.0	200.0	5
MEMPSD-0401001	04000	040.0	100.0	10	MEMPSD-0601001	06000	060.0	100.0	5

Three numerals after MEMPSD indicates voltage of power supply and last three digit Indicates current. All dimensions are in inches

Specification of AC/DC GMR probe :

MHEMM-00000901 **MHEMM-09999902**

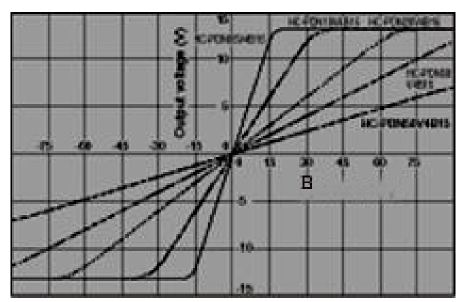
Model	GAUSS	Step-down ratio	k.hz	T_{max} °C	Model	GAUSS	Step-down ratio	k.hz	T_{max} °C
MHEMM-00000091	0.099999	1:1000000	0-50	90	MHEMM-00000092	0.099999	1:1000000	0-50	90
MHEMM-00000991	00.99999	1:1000000	0-50	90	MHEMM-00000992	00.99999	1:1000000	0-50	90
MHEMM-00009991	009.9999	1:1000000	0-50	90	MHEMM-00009992	009.9999	1:1000000	0-50	90
MHEMM-00099991	00999.99	1:1000000	0-50	90	MHEMM-00099992	00999.99	1:1000000	0-50	90
MHEMM-00999991	009999.9	1:1000000	0-50	90	MHEMM-00999992	009999.9	1:1000000	0-50	90
MHEMM-09999991	099999.9	1:1000000	0-50	90	MHEMM-09999992	099999.9	1:1000000	0-50	90

General Specification of ultra-precision magnetometer :

Operating Voltage: 220 Volt A.C. (50-20,000 Hz)/ 12 Volts D.C.
Measurement range (full scale): as aboVe in different model.
Tesla signal(measurement) : $10^{-3}/10^{-6}/10^{-9}$ Tesla e AC/DC (optional)
Input capacitance: 10 nF
Response time: 1000 sample/sec
Burden: less than 100 counts /full scales or better
Step down ratio: 1:100000
Accuracy: 0.5/1.0/2.0 % reading
Repeatability: 100 of reading
Resolution: 1/5 mili/ , 1/5 micro , 1/5 nano tesla and may be altered based on time behaViour of signal
Range (V/I -A.C./D.C): 10^{-09}-10^{-04} /10^{-4}-10^{+1} /10^{+1}-10^{+3} Volt least count- nano tesla
pto 100 nano Volt
Input imedence: ultra high (<1000 counts),
Filtering: low pass(adjustable)
MLCHVEM-9999990402
Offset: Variable upto 1000 counts (manual/auto)
CMMR: >80 db at 50-60 Hz
Isolation: > 100 giga ohm
Connector: BNC-9 pinx2 and BNC-25 pinx2
Size: 5X8X8 inches/rack mounted or portable
Interface: RS-232
Option : ADDITIONAL SOFTWARE to plot V/I OR ANY DESIRED INFERENTIAL PARAMETER.
THESE SPECIFICATIONS OR PART THERE OF MAY BE MODIFIED TO MEET ANY TAILOR MADE SOLUTIONS.
NOTES: The numeral after product code indicates the (ampere meter) range and last digit corresponds to size (5x5x8, 8x8x12)

Magneto-electric effect Monitor diemension:

MHEMM-00000091	08X06X06	MHEMM-00000092	08X06X06
MHEMM-00000991	08X06X06	MHEMM-00000992	08X06X06
MHEMM-00009991	08X06X06	MHEMM-00009992	08X06X06



Input/output characteristic of sensor

1. Five numerals after MHEMM indicates Voltage of Magneto-electric effect magnetic field and two numerals Indicates o/p Voltage. 2. All dimensions are in inch and may be altered to suit conVinience 3.These probes are available For multi-axial application.

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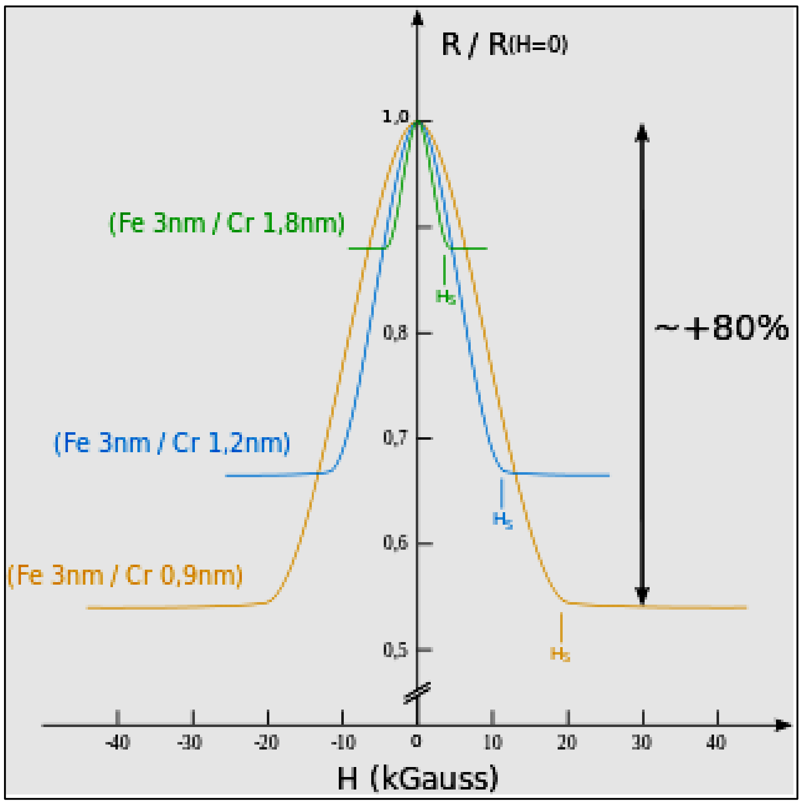

To understand how GMR works on the atomic level, consider the following analogies: If a person throws a ball (analogous to a conduction electron) between two sets of rollers turning the same direction (analogous to parallel spin-aligned magnetic layers), the ball tends to go through smoothly. But if the top and bottom rollers turn in opposite directions, the ball tends to bounce and scatter. Alternatively, the GMR effect may be compared to light passing through polarizers. When the polarizers are aligned, light passes through; when their optical axes are rotated with respect to each other, light is blocked.

The resistance of metals depends on the mean free path of their conduction electrons, which, in GMR devices, depends on the spin orientation. In ferromagnetic materials, conduction electrons either spin up when their spin is parallel to the magnetic moment of the ferromagnet, or spin down when they are antiparallel. In nonmagnetic conductors, there are equal numbers of spin-up and spin-down electrons in all energy bands. Because of the ferromagnetic exchange interaction, there is a difference between the number of spin-up and spin-down electrons in the conduction bands. Quantum mechanics dictates that the probability of an electron being scattered when it passes into a ferromagnetic conductor depends on the direction of its spin. In general, electrons with a spin aligned with the majority of spins in the ferromagnets will travel further without being scattered.

In a GMR spintronic device, the first magnetic layer polarizes the electron spins. The second layer scatters the spins strongly if its moment is not aligned with the polarizer's moment. If the second layer's moment is aligned, it allows the spins to pass. The resistance therefore changes depending on whether the moments of the magnetic layers are parallel (low resistance) or antiparallel (high resistance).

Optimal layer thicknesses enhance magnetic-layer antiparallel coupling, which is necessary to keep the sensor in the high-resistance state when no field is applied. When an external field overcomes the antiparallel coupling, the moments in the magnetic layers align and reduce the resistance. If the layers are not the proper thickness, however, the coupling mechanism can destroy the GMR effect by causing ferromagnetic coupling between the magnetic layers.

For spin-dependent scattering to be a significant part of the total resistance, the layers must be thinner (to a magnitude of several nanometers) than the mean free path of electrons in most spintronic materials. A typical GMR medical sensor has a conducting