Application Bulletin AB-7
GMR in Isolation

The discovery in 1988 of the giant magnetoresistive (GMR) effect has provided us with a new technology that offers many advantages over the traditional methods used for isolation such as the optocoupler or capacitive barrier. In awarding the 2007 Nobel Prize in Physics for GMR the Nobel Committee said, "GMR can be considered one of the first real applications of the promising field of nanotechnology."

GMR offers two significant advantages over competitive methods of isolation. First, the giant change in resistance of GMR provides a larger signal. Second, and perhaps more important, the technology is compatible with integrated circuit technology, allowing GMR devices to be included as part of the chip package. This results in smaller, faster, and more precise devices such as digital isolators and sensors.

GMR is a large change in electrical resistance observed in artificial thin-film materials composed of alternating ferromagnetic and non-magnetic layers as a function of applied magnetic field. The electrical resistivity is dependent on the direction of the electron spin in relation to the magnetic moment of the films. Thus GMR is a type of spintronics, harnessing the spin of electrons rather than their charge. If the magnetic moments of the ferromagnetic layers are aligned (parallel), electron scattering is minimized and resistance is lowest. If the magnetic moments of the ferromagnetic layers are in opposing directions (antiparallel), electron scattering is at maximum and resistance is highest. The resistance of the structure is proportional to the cosine of the angle between the magnetic moments in adjacent magnetic layers.

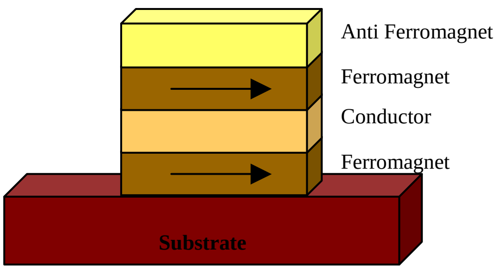


Figure 1. Parallel Moments
(low resistance)

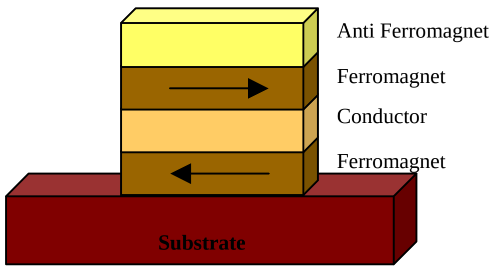


Figure 2. Antiparallel Moments
(high resistance)

A *spin valve*, which is the basic structure in IsoLoop® Isolators, is shown in Figure 3:

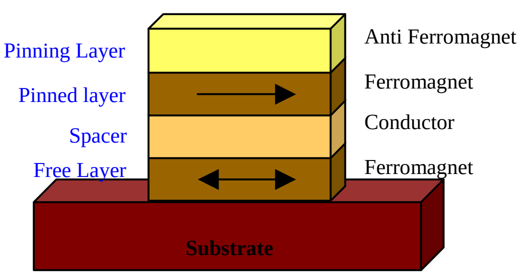


Figure 3. Spin Valve

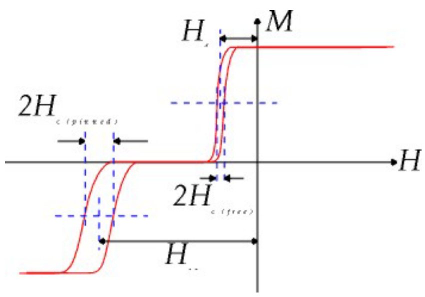


Figure 4. Hysteresis Loop

A spin valve is generally three-layer GMR structure incorporating a magnetically “soft” free layer. As shown in Figure 4, this layer is sensitive to lower magnetic fields (10 – 30 Oersteds) than the “pinned” layer, which is immune to switching due to exchange bias with the antiferromagnet. This basic spin valve structure is constructed as a serpentine resistor element and is used in a Wheatstone bridge configuration as the heart of IsoLoop Isolators. This electrical configuration is shown in Figure 5:

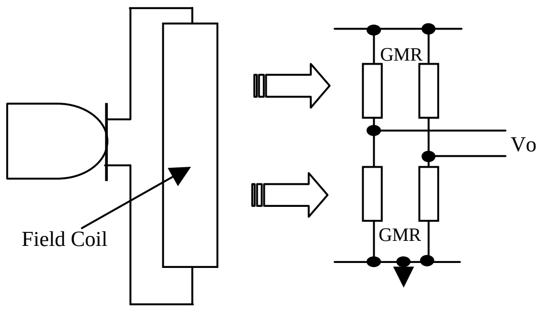


Figure 5. Basic GMR Wheatstone Bridge

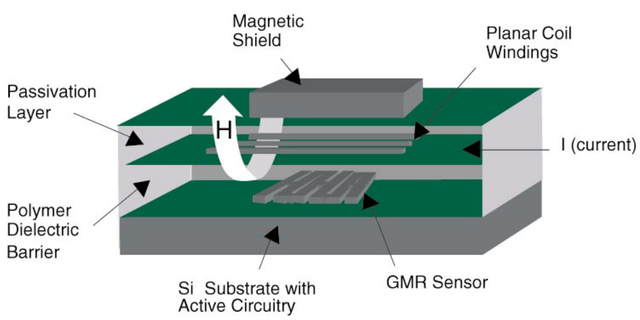
The directional current in the field coil creates the magnetic field required to switch the GMR Wheatstone bridge. This gives the corresponding directional V_o.

IsoLoop products based on this patented spintronic process provide the most advanced and versatile isolation devices available, especially compared to traditional optocouplers:

- Small packages: up to two channels in an MSOP-8
- High data rates: to 150 Mbps
- Very low Pulse Width Distortion: to 300 ps
- Very low propagation delay skew: 4 ns (device-to-device); 2 ns channel-to-channel
- Wide temperature range: −40ºC to +125ºCwith no derating

Devices include isolated one, two, four, and five-channel configurations; passive or digital inputs; CMOS or open-drain outputs; isolated RS-485 (including Profibus compliant); and isolated RS-422. Devices are available in standard MSOP, SOIC, and PDIP packages and are UL and IEC approved.

For more information, contact your local NVE distributor or refer to our Website at www.nve.com or www.IsoLoop.com.



Basic IsoLoop Isolator Structure