Approximating Magnetic Field When Using Everspin MRAM

INTRODUCTION

Everspin MRAM products are designed to be highly immune to magnetic fields normally found in commercial, industrial or AEC-Q100 Grade 1 applications. However, if there is concern that an MRAM device is expected to be in close proximity to a magnetic field, it may be prudent for the designer to verify that a magnetic field does not exceed the magnetic immunity specifications of the MRAM.

CALCULATING THE FIELD DENSITY AT A GIVEN DISTANCE FROM A MAGNET

In general, magnetic fields to consider when using MRAM devices are terrestrial and man-made resulting from current flowing through wires and from production magnets. Accurately calculating magnetic field intensity generated by motors, high-current conductors and magnets can be a complex exercise and is beyond the scope of this tutorial. This tutorial serves to determine a close approximation within the order-of-magnitude of such fields.

In general, the magnetic field strength a given distance from a magnet is the result of several factors:

- The shape of the magnet
- The length, width and thickness of the magnet
- Magnetic Material
- Pull strength
- Relative distance and direction from the magnet

There are many online resources available to compute the strength of a magnetic field a given distance from the magnet. Below are a few such resources:

http://www.dextermag.com/

http://www.kjmagnetics.com/calculator.asp

http://www.arnoldmagnetics.com/

http://www.ab-archive.net/search.html?q=magnetic+field+strength

MAGNETIC FIELDS RESULTING FROM CURRENT FLOWING THROUGH A WIRE

Table 1 (below) offers approximate Magnetic Field Density a given distance from wires carrying 200 and 50 Amperes of current. A graphical representation of the data is provided in Figure 1. As both table and chart indicate, the magnetic field drops significantly as the distance from the wire increases. This is in accordance with Ampere's Law. As data in Table 1 indicates, the field density between currents in a wire is linear and by interpolation can be used to estimate the field at a given distance from the wire for a particular wire carrying current of between 50 Amps and 200 Amps.

	Magnetic Field Density (A/m)	
Distance from Wire (cm)	Wire Current (A)	
	200	50
1	3,200	800
2	1,600	400
3	1,064	264
4	800	200
5	640	160
6	536	136
7	456	112
8	400	104
9	352	88
10	320	80

Table 1 Approximate Magnetic Field Intensity at various distances from 200 and 50 Amp current carrying wires

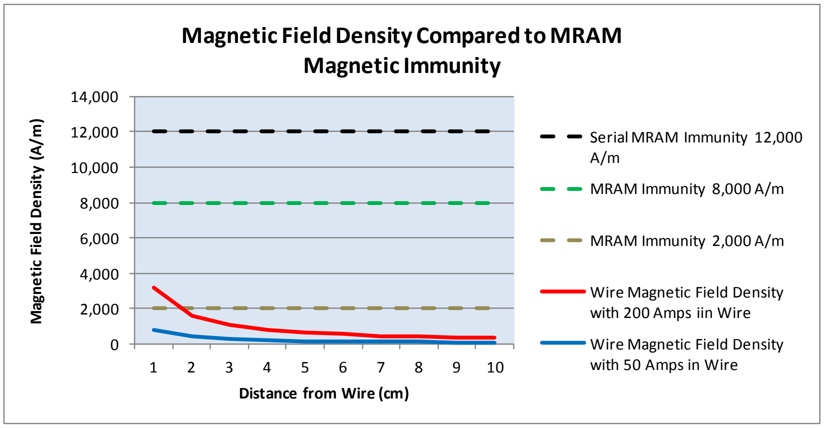

Figure 1: Magnetic field Intensity vs. Magnetic Field Immunity for Three Types of MRAM

MAGNETIC FIELD DENSITY vs. MAGNETIC IMMUNITY FOR MRAM DEVICES

Because the MRAM is magnetic in nature, *significant external* magnetic fields can have an effect on the MRAM device. Although the MRAM is quite stable and less susceptible to external magnetic fields over time and temperature while in a static state, MRAM data bits have greater sensitivity to magnetic fields during WRITE operations. This increased sensitivity necessitates independent absolute maximum field specifications for each operation.

During a WRITE cycle, the MRAM data cell changes state due to a localized magnetic field generated by current pulses flowing in conductors above and below each data bit. During a WRITE cycle an MRAM bit cell exposed to a significant external magnetic field (One that exceeds the maximum specification for write operations: H_{max_write}) can interfere with the localized switching field and create the potential for incorrect bit programming.

Conversely, during a READ operation there are no internal magnetic fields being applied. The static bits can tolerate a much higher magnetic field without being disturbed and the Absolute Maximum Spec is increased. The H_{max_read} specification applies during both read and standby operations.

Everspin MRAM devices maintain a maximum magnetic field immunity during write cycles specified to 2,000 A/m (H_{max_write}), for parallel memory densities up to 4Mb, 8,000 A/m for 16Mb parallel memory and 12,000 A/m for all serial MRAM's. **Figure 1** provides the approximate magnetic field density at various distances from wires carrying 200 Amps and 50 Amps of current.

SUMMARY

Everspin MRAM products are designed to be immune to most ambient magnetic fields found in commercial, industrial or AEC-Q100 Grade 1 applications. However, if products are intended to be used in applications where very high magnetic fields may be found, the prudent designer will consider such high ambient magnetic fields and ensure the MRAM device has been placed an adequate distance from either magnet or current carrying wire to minimize the magnetic influence on the MRAM.

How to Reach Us:
Home Page:
www.everspin.com

E-Mail:
support@everspin.com
orders@everspin.com
sales@everspin.com

USA/Canada/South and Central America
Everspin Technologies
1347 N. Alma School Road, Suite 220
Chandler, Arizona 85224
+1-877-347-MRAM (6726)
+1-480-347-1111

Europe, Middle East and Africa
support.europe@everspin.com

Japan
support.japan@everspin.com

Asia Pacific
support.asia@everspin.com

Approximating Magnetic Field Density

Author: Chuck Bohac, Manager Applications Engineering, Everspin Technologies chuck.bohac@everspin.com, 480-347-1161