APPLICATION NOTE
QuickStick 100 Magnetic Field Measurement

Purpose

This application note provides information on the magnetic field levels surrounding a QuickStick 100 magnet array.

Introduction

The QuickStick 100 magnet array consists of alternating polarity magnets on a steel back plate that cancels the field to near zero on the top of the array. Figure 1 shows a diagram of the field surrounding the magnet array. Some materials being transported with a QuickStick 100 system are sensitive to magnetic fields, therefore it is important to characterize these magnetic fields and to reduce the magnetic fields for those applications if necessary.

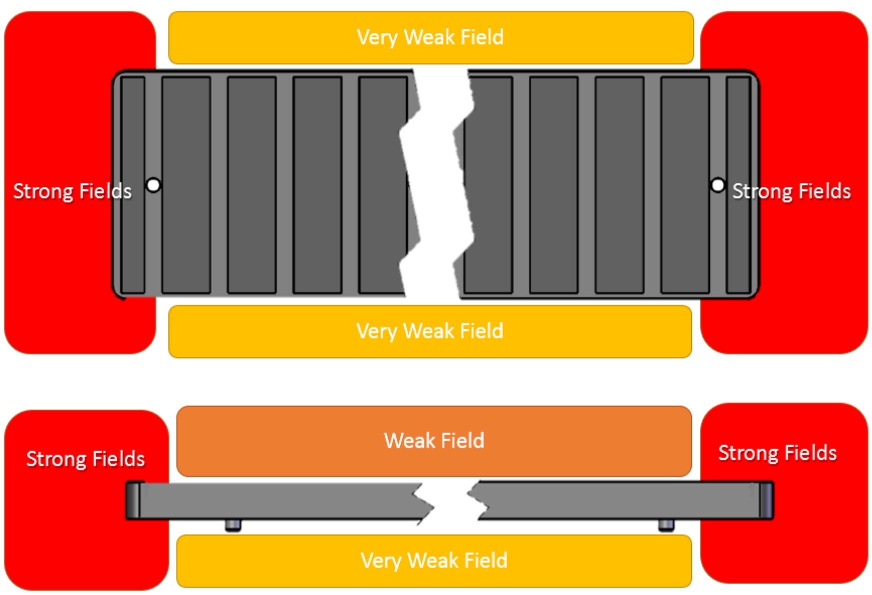

Figure 1: Strength of the magnetic field magnitude for QS100 magnet array. Diagram for illustration purposes only.

Methods

Magnetic field measurements were taken with an AlphaLab Inc. Vector/Magnitude Gaussmeter, which uses a tri-axial probe measuring between 0G to 799G in magnitude, and a F. W. Bell Vector Gaussmeter, used to measure fields above 800G near the surface of the magnet array. After the probe is zeroed at the ambient magnetic field, it is used to measure the magnitude of the field at a given point. The magnetic field is described in terms of its magnitude: $|B| = \sqrt{B_x^2 + B_y^2 + B_z^2}$.

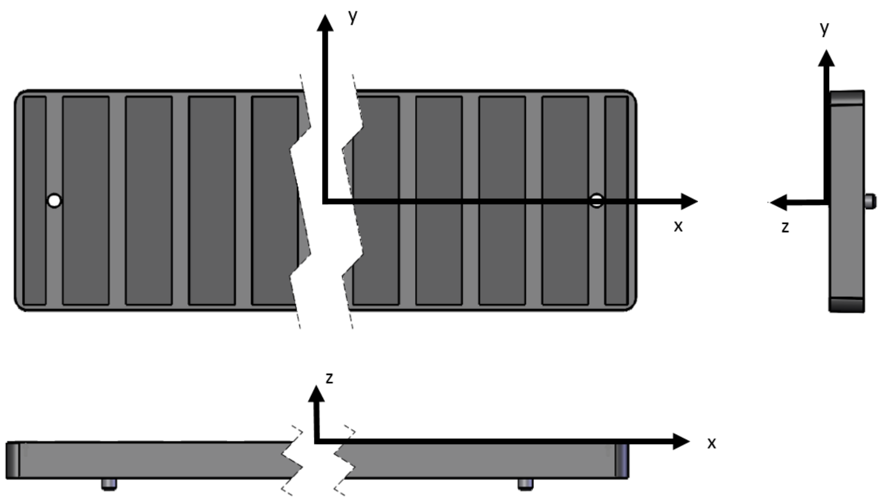

Figure 2: Axis direction and location of origin with respect to the magnet array.

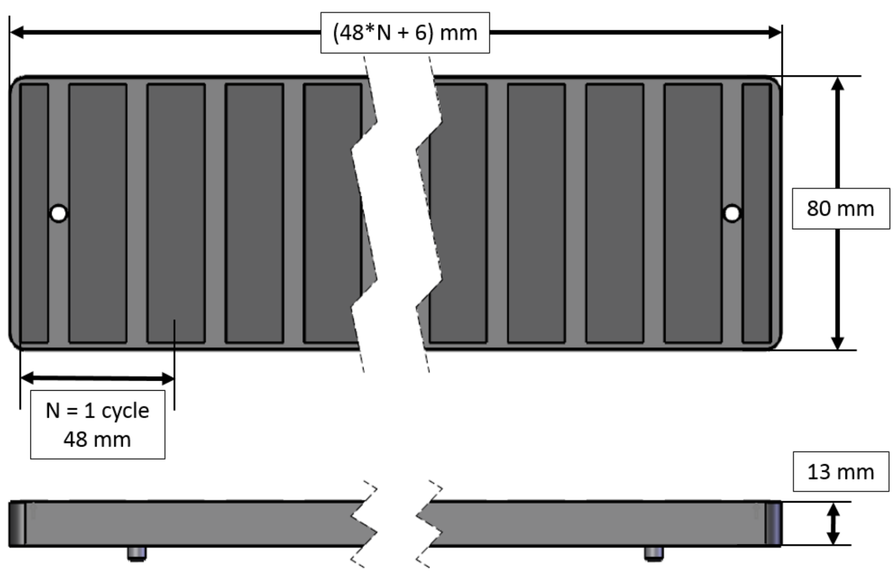

Figure 3: Overall magnet array dimensions.

Figure 2 shows the axis direction and origin location with respect to the magnet array for our measurements. Figure 3 shows the basic dimensions for a magnet array, where N denotes one cycle of a magnet array. A cycle is described as a half north magnet, a full south magnet, and a half north magnet. The magnet array is described by the number of these cycles placed end to end. There is a 3 mm potting material at each end of the magnet array.

It is important to note that due to the design of the magnet array, the x-axis and y-axis measurements are symmetric, but the z-axis is not. Magnetic field magnitude measurements are taken at the following heights:

- Z = 0 mm (front face of magnet array)
- Z = -13 mm (back face of magnet array)
- 50 mm interval above and below face of the magnet array

for the following conditions while the puck is not on a motor:

1. Measurements taken along direction of travel (along x-axis) and Y = 0.

Due to the nature of a multi-cycle magnet array, where the magnetic field will alternate between cycles, measurements were taken for peak magnetic field magnitudes at a distance above the array. This measurement will be the worst case magnetic field for a QS100 magnet array.

Results

Earth's magnetic field is between 0.3 to 0.6 Gauss. At the test location, the ambient magnetic field is 0.5 Gauss. The following graphs show how the magnetic field falls off to approximately the ambient field as the measurement probe is moved further from the magnet array.

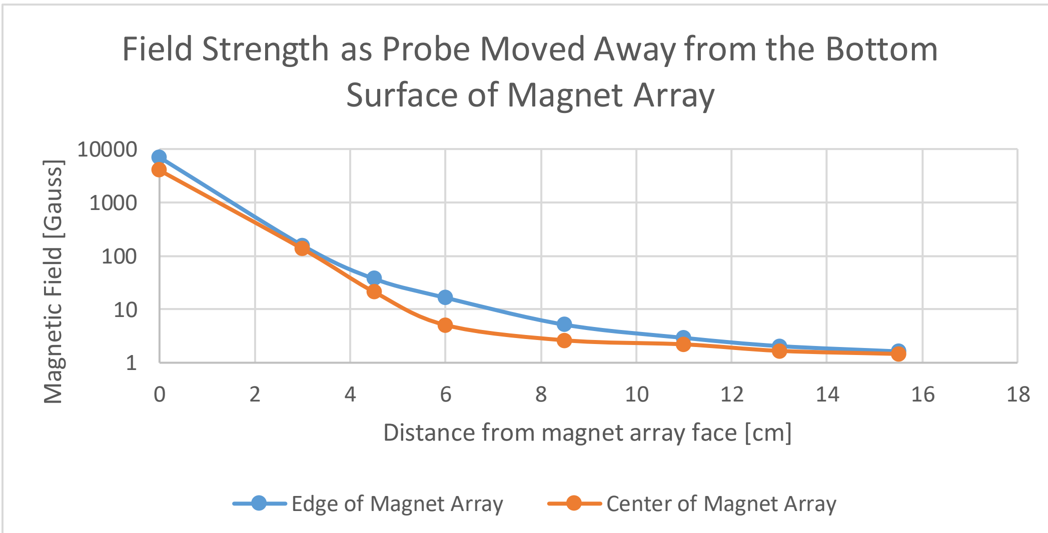

Figure 4: Magnetic field magnitude below magnet array near the edge and center of the magnet array at different heights. Measurements were taken at a given Z, along the X-Axis, and Y = 0

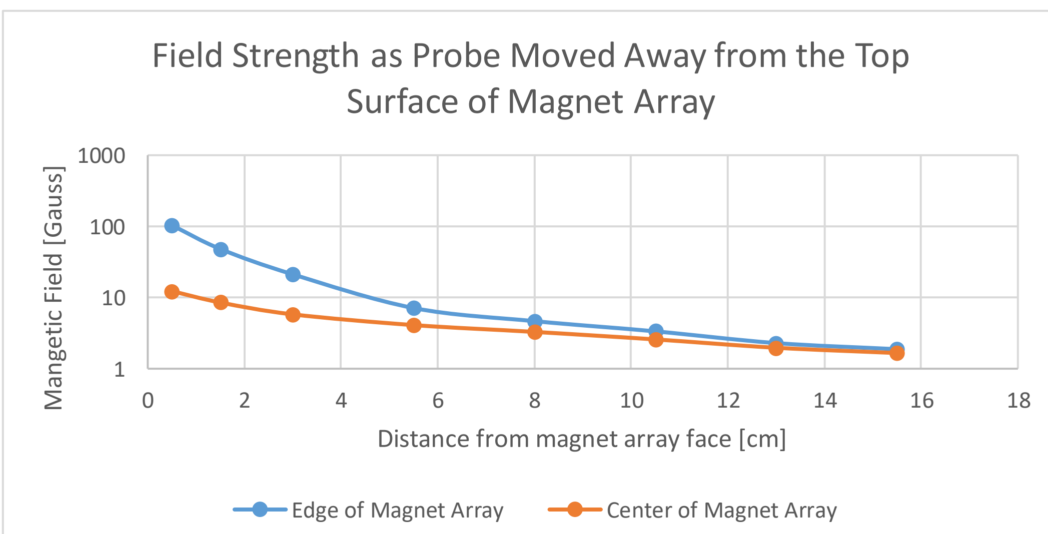

Figure 5: Magnetic field magnitude above magnet array near the edge and center of the magnet array at different heights. Measurements were taken at a given Z, along the X-Axis, and Y = 0

Figure 4 show the magnetic field below the magnet array, where the field is the strongest. As the magnetic field magnitude drops to close to 1G, it is considered to reach ambient fields.

As some materials being transported by a puck might be sensitive to magnetic fields, Figure 5 show the field strength above the magnet array.

Shielding

The puck's magnetic field can be shielded by the addition of ferromagnetic metal. Metals such as iron, nickel or cobalt can work as a shield.

Permeability is the ability to re-direct magnetic flux, in effect providing a short circuit path to steer the flux away from the area one is trying to shield. Higher permeability materials are better than lower permeability materials. But one must also consider the saturation point of the material – the point at which the material loses the ability to steer additional magnetic flux – as well as the thickness of the material. Thinner materials will saturate at a lower flux density than thicker ones. Once the material saturates, the shielding effect diminishes. If saturation is an issue, multiple layers of material can be used.

Steel is commonly used because it is inexpensive and widely available. It saturates around 22 kG, and has a permeability between 1000 and 3000 times μ_0 (the permeability of free space). Steel is a good shielding material for applications involving large, powerful neodymium magnets due to the higher saturation point of steel. In these cases, steel provides good attenuation and a much higher saturation threshold.

Summary

The magnetic field is largest below the face of the magnet array, where it interacts with the motor for propulsion. Due to the orientation of the magnet array, the longitudinal direction fields are stronger than the lateral direction. Table 1 shows a summary of the distance required to reduce magnetic fields to approximately 1G in the different scenarios.

Table 1: Distance to Reduce Magnetic Field to 1G

Orientation	Distance [cm]
Above puck (x = 31, z = 0)	15
Below puck (x = 0, z = 0)	15

Adding shielding material, such as a steel sheet, reduces the distance at which the magnetic field dissipates to ambient levels. Factors that affect shield performance are the shape, size, and thickness of the shield and distance from the shield to the array.

More Information

MagneMotion Website: www.magnemotion.com

Questions & Comments: www.magnemotion.com/about-magnemotion/contact.cfm

Revision History

Rev.	Change Description
A	Initial release