iSentek Magnetometer

Application Note

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1 Introduction

This document introduces the types of magnetic interferences and layout/system considerations for iSentek magnetometers in real applications. We recommend users to follow this application note with layout considerations to achieve our best performance.

In general, the geomagnetic field density is around 0.2 Gauss (20uTesla) to 0.5Gauss (50uTesla); since the sensor is used to detect the geomagnetic field, it is better to keep a distance to other magnetic or magnetizable components to reduce the interference to geomagnetic field and allows the magnetometer to measure the azimuth accurately. Those components, which may interfere with the magnetometer's performance, contain ferro- or ferri-magnetic materials (for example ferrum, cobalt, nickel, etc…). Critical distances between some typical interference sources to the magnetometer are provided in this document (Table 1); however, since the materials' compositions of those components vary from system to system, the numbers are only for reference, please contact us for more detailed analyses.

iSentek magnetometers are implemented with iSentek AMR technology, which has ultra-low hysteresis, excellent offset temperature drift performance and good sensitivity, which make it a perfect candidate for high accuracy applications. iSentek not only provide you the best magnetometer solutions but also provide best customer services, including PCB layout/placement consulting and magnetic field scan for minimizing magnetic interference consideration (with high accuracy gauss meter, made of iSentek magnetometer and iSentek PCB magnetic field scanner). **It is highly recommended that customers should co-work with iSentek during the PCB design to allow us to characterize the magnetic interferences in your system for you, therefore achieves our magnetometers' best performance.**

*Unit conversion

1 tesla= 10^4 gauss

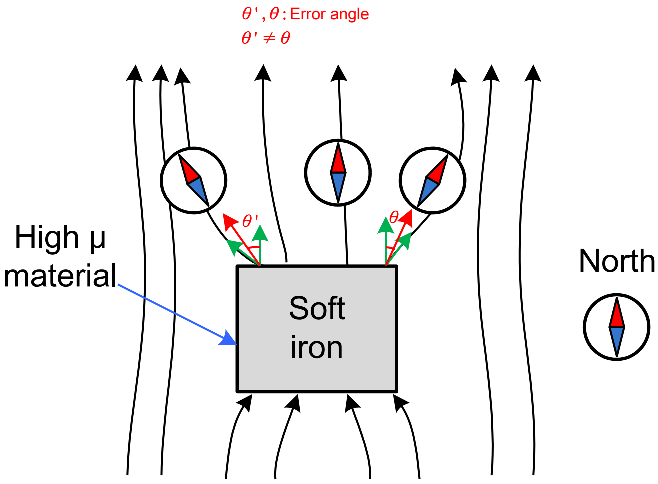
1 gauss=10^{-4} tesla=1 oersted (Oe)

2 Magnetic Interferences

Although our magnetometers have high dynamic rang (+/-1600uT), the placement and layout of the magnetometer should still be optimized to reduce interferences. Optimized placement and layout can reduce the possibility of calibration and achieve more accurate compass heading performance. Two common types of interferences as「soft iron」and「hard iron」are introduced below.

2.1 Soft iron interference

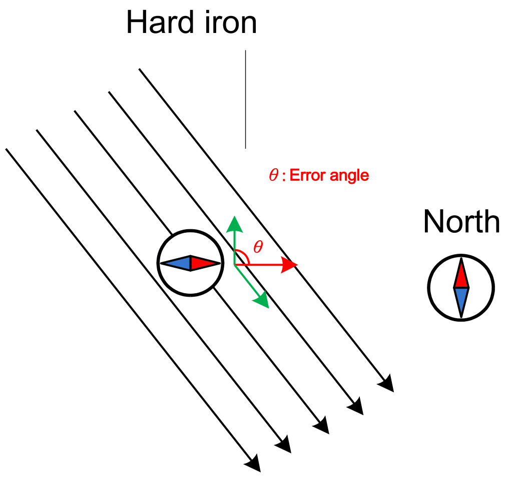
Soft iron interference is induced by high permeability materials in the vicinity of the sensor which bends the geomagnetic field and lead to an error in local field direction, as shown in the figure below. In a system, components contains high permeability materials are usually in-avoidable, such as screws, radiator, shield case, batteries, antenna, wireless charger, etc. In order to minimize soft iron interference, components contain high permeability materials should be placed in a clearance to the magnetometer, as shown in Table 1.



2.2 Hard iron interference

Hard iron interference is a magnetic field bias within a certain area in the system, it is generated by the components having magnetic pole (such as speaker, vibrator, camera and motor). This type of interference causes an offset at magnetometer's output. The strength of hard iron interference is the sum of the magnetic fields generated by all hard iron sources in a system. This sum should not be larger than the dynamic range of the magnetometer; otherwise the sensor will be failed to detect the geomagnetic field. Therefore, maximize the clearance from hard iron sources to the magnetometer is the most efficient way to ensure the accuracy.

The critical distance for sensor placement are shown in Table 1.



2.3 Safety Distance

Table 1 shows the safety distance from the interference sources to the magnetometer on PCB. Users are suggested to follow this rule for better accuracy. However, the sizes and materials of those interference sources vary from case to case; thus **it is highly recommended that user should co-work with iSentek while designing the PCB for the purpose of optimizing the magnetometer performance.**

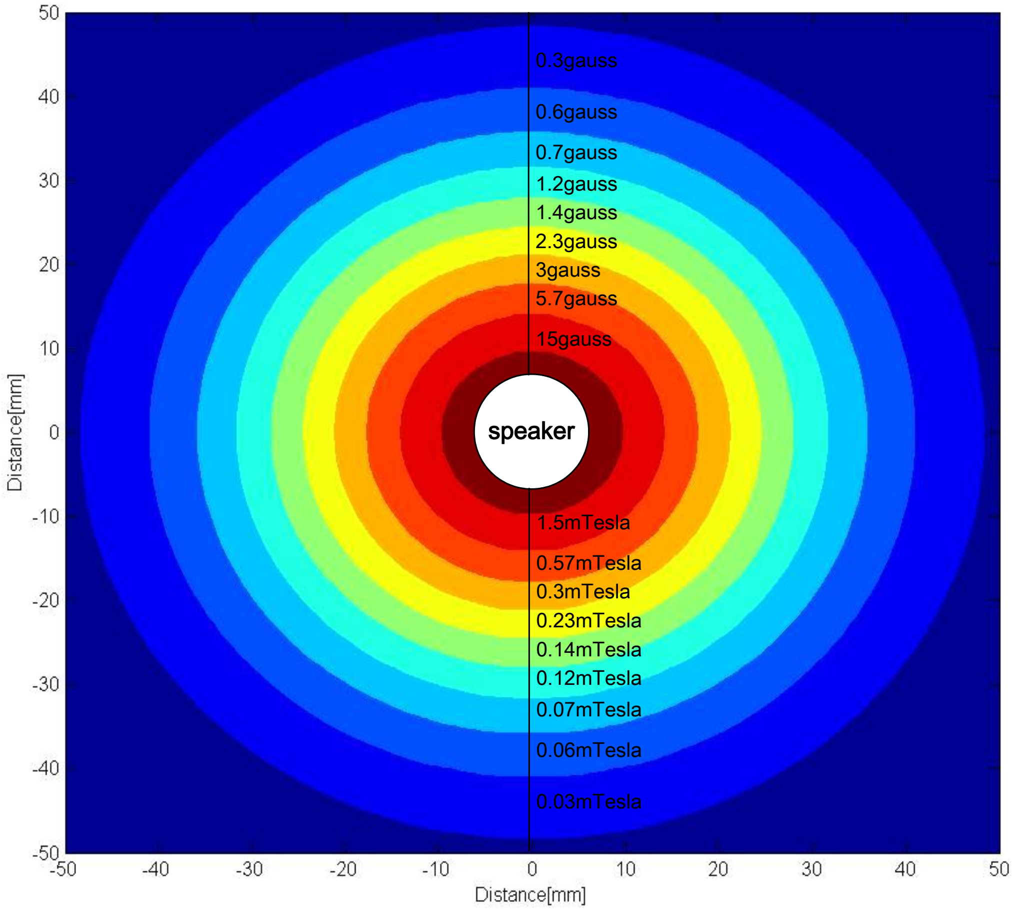
Table 1

Interference Sources	*Critical Distance (mm)
Speaker	>25mm
Voice Receiver	>15mm
Vibrator	>15mm
Camera	>10mm
Shield Case	>5mm
SIM Card Holder	>5mm
NFC	>40mm
Brushless Motor	>40mm

*For reference only, numbers varies from system to system.

2.4 Interference example: Speaker

As an example, following picture indicates the magnetic density at various distances from a speaker. It is recommended to put the magnetometer as far as possible from the speaker.



2.5 Power Line Analysis

Current flows (high current traces) will also generate magnetic fields, it will become a hard iron interference (if it is not time-variant). Although it may be reduced by calibration, it should still be to carefully dealt with. Designers should place high current traces (for example power line) as far as possible from the magnetometer in PCB layout. Relation between current and magnetic field strength are shown below:

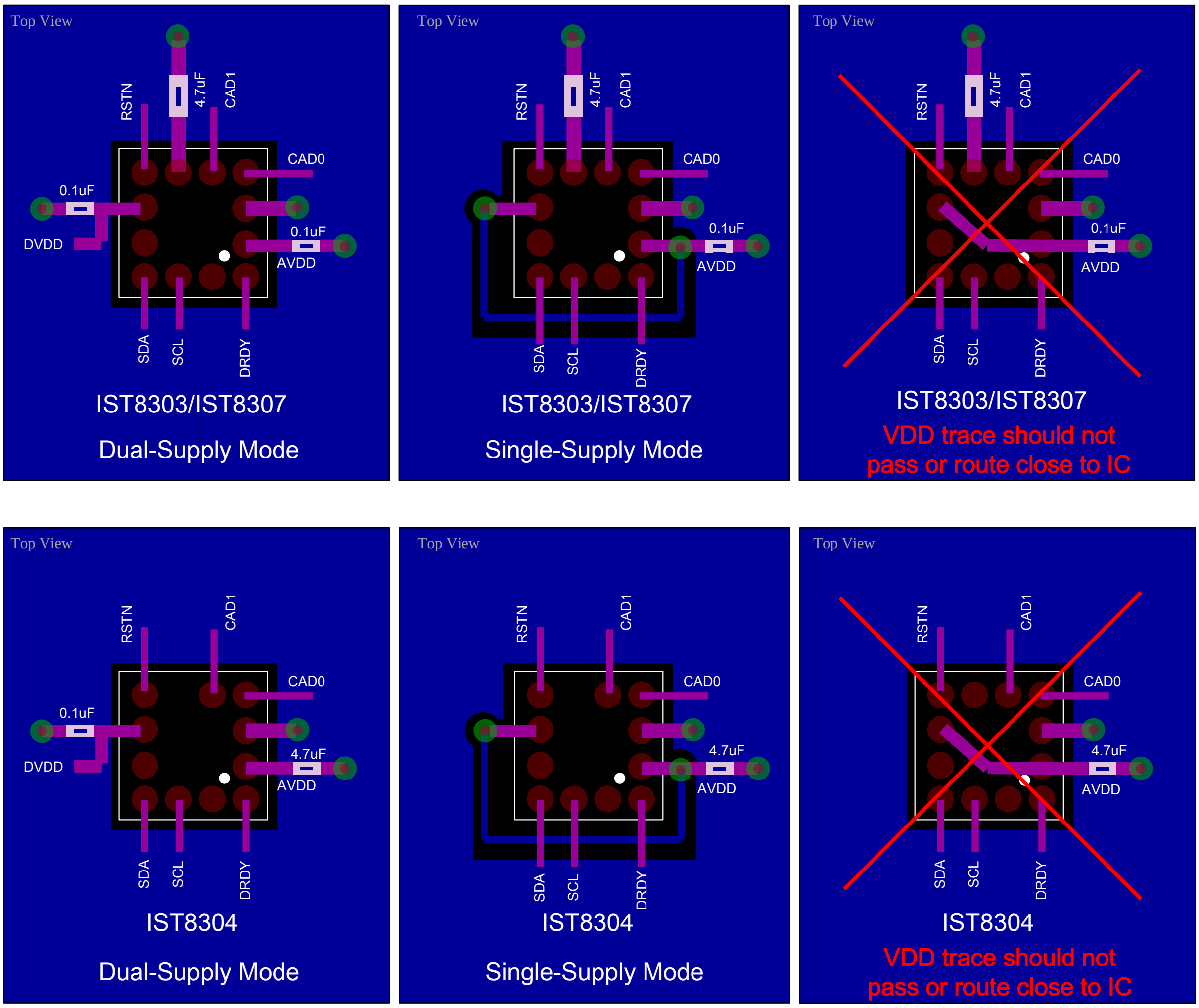
$$\mu_0 = 4\pi \times 10^{-7} \frac{N}{A^2} \left(= \frac{H}{m} \right)$$

$$H = \frac{\mu_0 I}{2\pi r_0} = \frac{0.2 \times 10^{-6} I}{r_0}$$

μ_0 is the permeability of free space

Table 2 shows the safety distance from high current traces, which is under the assumption of 1uTesla interference is okay for the system, however this value varies in each application.

2.6 Layout Example & Note



2.7 Summary of General Design Considerations

- ✧ Put the magnetometer as far as possible from hard iron, soft iron interference sources, safety distances for reference are shown in Table 1.
- ✧ Don't put the magnetometer too close to current traces especially time-varying current traces and high current traces, safety distance for reference are shown in Table 2.
- ✧ Don't shield the magnetometer.
- ✧ The best locations for a magnetometer are normally on the edges of a PCB.

Table 2

current[A] / distance[mm]	0.05	0.01	0.02	0.03	0.06	0.1	0.12	0.15	0.2	unit
1	0.01	0.02	0.04	0.06	0.12	0.20	0.24	0.30	0.40	gauss
2	0.01	0.01	0.02	0.03	0.06	0.10	0.12	0.15	0.20	gauss
3	0.00	0.01	0.01	0.02	0.04	0.07	0.08	0.10	0.13	gauss
4	0.00	0.01	0.01	0.02	0.03	0.05	0.06	0.08	0.10	gauss
5	0.00	0.00	0.01	0.01	0.02	0.04	0.05	0.06	0.08	gauss
6	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.07	gauss
7	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.06	gauss
8	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.05	gauss
9	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	gauss
10	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	gauss
11	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	gauss
12	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	gauss
13	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	gauss
14	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	gauss
15	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	gauss
16	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	gauss
17	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	gauss
18	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	gauss
19	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	gauss
20	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	gauss
21	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	gauss
22	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	gauss
23	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	gauss
24	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	gauss
25	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	gauss
26	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	gauss
27	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	gauss
28	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	gauss
29	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	gauss
30	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	gauss

Appendix. iSentek Customer Service: Magnetic Field Scan

iSentek provides customer services of magnetic field scan for customers to find the optimum place of their PCB design and also for troubleshooting. Two tools are provided: high accuracy gauss meter (made of iSentek magnetometer)and iSentek PCB magnetic field scanner. Please contact iSentek for the services.