Innovation in Magnetic Measuring Instruments

Operation Manual for

Mag648 and Mag649
Low Power Three-Axis Magnetic Field Sensors

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Bartington® Instruments

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1. Legal notices

1.1. Copyright

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2. How to Use this Manual

This document describes the installation, operation and maintenance of the Mag648 and Mag649 magnetic field sensors.

Take the time to get well acquainted with your instrument by reading this manual. Knowing and understanding your sensor will ensure you experience the most reliable operation.

When service or maintenance is required, contact the Bartington Instruments helpdesk.

All the information you need about your sensor, including technical specifications and service information, can be found in the appropriate datasheet on the Bartington website.

2.1. Symbols Glossary

The following symbols used within this manual call your attention to specific types of information:

WARNING: Indicates a situation in which serious bodily injury or death could result if the warning is ignored.

Caution: Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.

Identifies items that must be disposed of safely to prevent unnecessary damage to the environment.

Note: A note provides useful supporting information and sometimes suggests how to make better use of your purchase.

3. Safe Use

WARNING: These products are not qualified for use in explosive atmospheres or life support systems. Consult Bartington Instruments for advice.

4. Introduction to the Mag648 & Mag649 Series

Both the Mag648 and Mag649 are magnetometers consisting of a cluster of three, feedback stabilised, fluxgate sensors arranged along X, Y and Z axes. Each axis provides a highly linear magnetic response with low hysteresis and low crosstalk between axes. These characteristics, combined with the compact design and very low power consumption, make these magnetometers ideally suited for perimeter surveillance with a multi-sensor network. Regulating the power supply internally ensures the Mag64x series is suitable for battery powered operation, over both long and short cables.

The Mag649 offers a wider bandwidth than the standard Mag648.

High stability circuitry ensures that a minimum of ten years' service should be expected.

4.1. Vector Measurements and Conventions

Each magnetometer produces three independent analogue output voltages in response to the magnitude and direction of the orthogonal components of a magnetic field. A "right-hand" co-ordinate system is adopted (see figure 1). In this system the X, Y and Z axis correspond to the thumb, first and second finger respectively of the right hand. By convention, the magnetometer should be installed so that the X axis is arranged to point North, the Y axis to point East and the Z axis to point down.

The centres of the three vector sensors are superimposed; each orientation is denoted on the magnetometer's label. The point of each vector arrow indicates the positive direction of each axis.

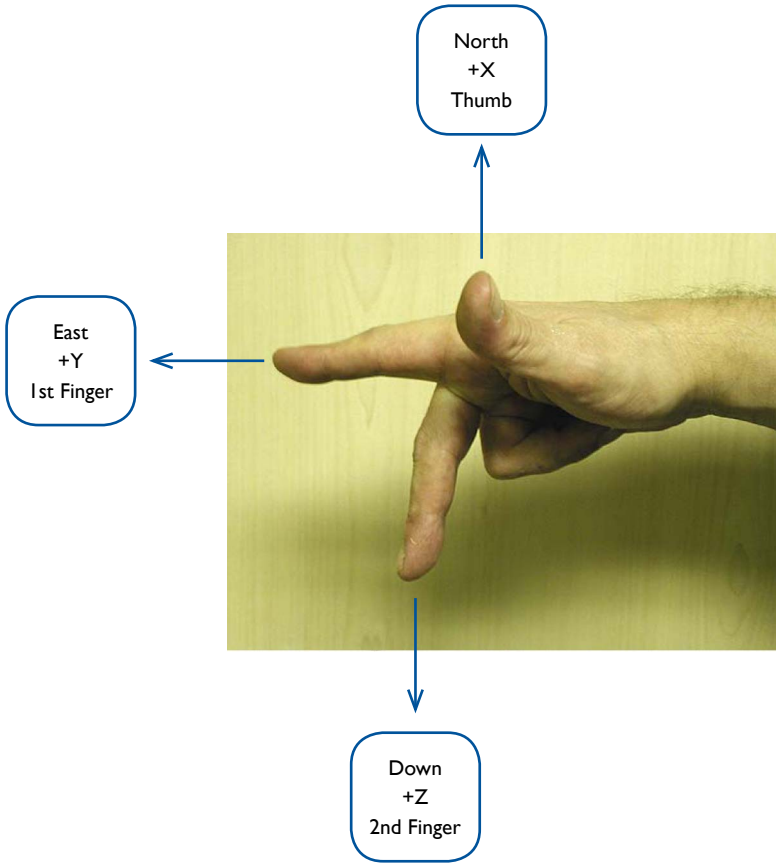

Figure 1. The 'right hand' rule.

5. Installing the Mag648 or Mag649

5.1. Siting the Magnetometer (Environment Recommendations)

- The magnetometer should be sited several metres from any magnetic base rock to avoid compromising measurements.
- Site the magnetometer several tens of metres from very large ferromagnetic objects that could become magnetised and create fields exceeding the measuring range of the sensor.
- Avoid siting the sensor near any ferromagnetic objects that may be subjected to the effects of magnetic hysteresis, which would affect the sensor in an unpredictable manner.

For these reasons, a magnetic evaluation of any proposed installation site should be conducted to establish that it is free from magnetic contaminants. It is recommended that such an evaluation be carried out using total field or resonance magnetometers.

5.2. Cable Recommendations

The standard magnetometer provides differential output lines for analogue signal transmission. The advantages of this differential arrangement are very high common-mode noise rejection and the suitability of readily available cable types. Each of the two anti-phase output lines has low output impedance at the signal source, damping the lines and preventing ringing. Cable inductance and capacitance considerations require the cable to be terminated with a differential amplifier having a circa 50kΩ input impedance. This arrangement will provide some damping to high frequencies but will attenuate the signals above the frequency range of the sensor.

Due to these effects:

- The cable pair loop resistance should not exceed 0.1 ohms per metre.
- The pair loop inductance should not exceed 0.5 micro-Henry per metre.
- The capacitance between should not exceed 52pF per metre.
- The capacitance between conductors and shield should not exceed 120pF per metre.

To optimise operational life of underwater cables and avoid physical damage to the joint during handling:

1. Use a water-blocked cable.
2. Reduce the risk of stress on the soldering by ensuring there is adequate slack in the wire between the cable and the wire terminations.
3. Brace the slack with epoxy resin before moulding the cable to the connector.
4. Fit additional protection in the form of a plastic hose, or sleeve, around the cable(s) at the emergence point.

Note: Cables are particularly prone to wear and damage at the point where they emerge at the surface of the ground, or sea.

5.3. Pre-Installation Tests

Prior to the installation of the system, the magnetometer, cable and power supply must be fully tested to ensure correct function as follows:

Caution: Take care to avoid bending, or otherwise damaging the contacts whilst conducting the tests.

1. Test the cables for continuity (using an electrical continuity tester or ohmmeter).

a. Test the cables end to end at the connectors to ensure the correct pins have been allocated to the conductors and there are no open, or high resistance circuits.

Note: Cable resistance will vary: refer to the appropriate datasheet for the expected values.

b. Test the cables at the connectors to ensure there are no short circuits between the conductors.

2. Check the power supply output voltage using a voltmeter. Refer to the appropriate datasheet for the required values.

Caution: Ensure the polarity is correct. Incorrect polarity is likely to irreparably damage the sensor.

Note: Bartington recommends the use of a current-limited power supply.

3. Connect the magnetometer to the cable connector.
4. Connect the power supply to the other cable connector.
5. Switch on the power supply and wait until the magnetometer has stabilised. Refer to the appropriate datasheet for warm-up times.
6. Confirm no magnetic objects are moving in the vicinity.
7. For each of the three (X, Y and Z) axes in turn:

a. Connect a voltmeter to the axis sensor outputs.

b. Whilst monitoring the voltmeter readings, align the magnetometer with the terrestrial field until the maximum voltage value is determined.

c. Confirm the measured readings approach the local geomagnetic field value.

Note: Geomagnetic field values can be provided by your local magnetic observatory. A margin of error due to local disturbance should be taken into account.

5.4. Mounting Recommendations

Each magnetometer has a set of mounting holes to allow attachment to a stable base or fixture. Refer to the appropriate datasheet for further information as shown in the mechanical drawings.

Caution: For the Mag648S and Mag649S only - Take care to avoid damage to the connector or magnetometer by correctly aligning the cable to the connector. When aligned correctly, hand tighten the connector. Refer to the appropriate datasheet for detailed information.

Note: Other versions of the Mag648 and Mag649 have plug-in type connectors.

The sensor can also mounted on the Bartington Instruments Mag-03-TA Tripod Adaptor using the Mag-03-TA Product Adaptor mounting plate. See datasheet DS3140 for instructions on how to do this.

5.5. Post Installation Testing

1. Site the magnetometer, and install the power supply and cabling.
2. Switch on the power supply and wait until the magnetometer has stabilised. Refer to the appropriate datasheet for warm-up times.
3. Confirm no magnetic objects are moving in the vicinity.
4. Monitor the sensor outputs.
5. Confirm that the vector sum of the measured magnetic field vectors is similar to the expected local earth field.

   Note: The outputs from the sensor should remain stable to within the quoted noise limits. Refer to the appropriate datasheet for the expected values.

6. Using the Mag648 and Mag649

6.1. Magnetic Hysteresis

Both the Mag648 and Mag649 are designed to have an extremely low magnetic hysteresis. However, Bartington Instruments recommends your magnetometer is not subjected to magnetic fields greater than their stated measuring range for extended periods as this could alter the DC offset. If this occurs, the offset will exhibit drift as it returns to its original offset specification.

Caution: Subjecting the magnetometer to fields in excess of 2 x the nominal range may cause inaccuracy in future measurements. Degaussing the magnetometer can reverse such an effect.

6.2. Environmental Precautions

Refer to the datasheet for maximum environmental electrical and mechanical ratings.

Caution: Exceeding the maximum environmental ratings may cause irreparable damage to your sensor.

7. Troubleshooting

Your magnetometer is unlikely to suffer any defects in normal use: no internal components are serviceable. The most likely causes of failure, and their solutions, are detailed in the following table:

Causes of failure	Solution
Power supply	Check the power supply as detailed in Pre-Installation Tests.
Cables	Check the cables as detailed in Pre-Installation Tests. In some cases damaged connectors can be replaced. Contact the Bartington Instruments helpdesk for further advice.
Power input	If no fault can be found in the power supply or cables, ensure the cable length is not too long, causing excessive voltage drop between the power supply and magnetometer. Refer to the specifications defined in the datasheet
Magnetometer (packaged)	Physical damage or damage to the electronics of these types of Mag648 or Mag649 magnetometers is irreparable. Replace with a new unit. For information about disposal of the damaged unit, refer to End of Life Disposal.
Magnetometer (unpackaged)	Physical damage or damage to the electronics of these types of Mag648 and Mag649 can sometimes be repaired. Contact the Bartington Instruments helpdesk for further advice. If repair is not advised, replace with a new unit. For information about disposal of the damaged unit, refer to End of Life Disposal.

8. Care and Maintenance

Unpackaged versions of the Mag648 and Mag649 magnetometers and damaged end connectors may be repairable: no other repair or servicing is possible. For further details refer to the section on Troubleshooting.

8.1. Cleaning Mag648 and Mag649 Magnetometers

Use water and mild soap to remove grime only on packaged versions of the magnetometers.

Caution: Never use chemicals, such as solvents, when cleaning a Mag648 or Mag649.

Caution: Take particular care when cleaning around electrical connections. Bent or damaged pins may cause the magnetometer to malfunction.

8.2. Calibration

Return the Mag648 or Mag649 to Bartington Instruments for calibration at the recommended intervals. Refer to the Calibration Certificate for further details.

9. End of Life Disposal

For details of when to dispose of your magnetometer refer to the section on Troubleshooting.

9.1. Waste Electrical and Electronic Equipment (WEEE) Regulations

This product (electrical and electronic equipment) should not be placed in municipal waste. Check local regulations for disposal of electronic products.

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