

Helmholtz Coil Systems



Bartington®
Instruments



HC1®, HC2, HC9 & HC16

Helmholtz Coil Systems

These Helmholtz Coils are used in the calibration of magnetic field sensors, or for conducting any test or experiment requiring a known magnetic environment.

The coils are available with diameters of 350mm (HC9 & HC16), 500mm (HC1®) or 1m (HC2). They can be supplied on their own, or together with our Power Amplifier (PA1) and Control Unit (CU1).

The CU2 Module allows for closed-loop compensation to take place for improved field stability.

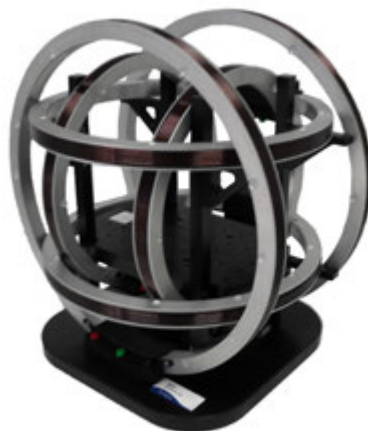
A compatible National Instruments acquisition card or PXI system enabling software control is also available. Please refer to the Helmholtz Coil Control System brochure.

Also available is a range of 1.3m (BH1300) and 2m (BHC2000) Ferronato™ Helmholtz coils compatible with this control system. Further information is available in the Ferronato™ coils datasheet.

HC1



HC9



HC2



Bartington® is a registered trade mark of Bartington Instruments Limited in the following countries: United Kingdom, Australia, Brazil, Canada, China, European Union, India, Japan, New Zealand, Norway and the United States of America.

HC1® is a registered trade mark of Bartington Instruments Limited in the United Kingdom.

Features

- HC9 and HC16 350mm diameter, HC1® 500mm coil diameter or HC2 1m coil diameter
- Option of 1, 2 or 3 axes for HC1®
- Mounting table available
- HC2 coils provided in flat-pack assembly to facilitate freight and installation
- PA1 Power Amplifier provides power and offers DC offset compensation
- CU2 provides closed-loop control for cancellation of DC and AC field variations
- PA1-1, 2 or 3 axis versions for operation with HC1®
- CU1 interfaces the PA1 to a National Instruments™ acquisition card or PXI system

Typical Applications

- Calibration of three-axis magnetic field sensors
- Creation of a known magnetic environment

Product Identification

Product name	Code	Item
HC1®	-1X , -1Y, -1Z	Single axis Helmholtz Coil 500mm nominal diameter: 1 pair of coils Available in X-axis, Y-axis, or Z-axis versions
	-2XY, -2XZ, -2YZ	Two-axis Helmholtz Coil 500mm nominal diameter: 2 pairs of coils Available in 3 different axis combinations. X and Y, X and Z, or Y and Z axes
	-3	Three-axis Helmholtz Coil 500mm nominal diameter: 3 pairs of coils
HC2	n/a	Three-axis Helmholtz Coil 1m nominal diameter: 3 pairs of coils
HC9	n/a	Three-axis Helmholtz Coil 350mm nominal diameter: 3 pairs of coils on aluminium coil formers
HC16	n/a	Three-axis Helmholtz Coil 350mm nominal diameter: 3 pairs of coils on plastic coil formers
PA1	-1X, -1Y, -1Z	Power Amplifier for HC1®-1 Available in X-axis, Y-axis, or Z-axis versions. To be used with corresponding Helmholtz coil.
	-2XY, -2XZ, -2YZ	Power Amplifier for HC1®-2 Available in 3 different axis combinations. X and Y, X and Z, or Y and Z axes. To be used with corresponding Helmholtz coil.
	-3	Power Amplifier for HC1®-3, HC2, HC9 or HC16
CU1	n/a	Control Unit for HC1®, HC2, HC9 or HC16
CU2	n/a	Closed-Loop Module supplied with CU2 Reference Magnetometer

HC1®, HC2, HC9 and HC16 Helmholtz Coils

Each pair of coils generates a homogeneous magnetic field in one specific axis: X, Y or Z. The coils can be calibrated to add or subtract from distortions in the Earth's magnetic field.

For the HC1® customers may specify the number of axes, and hence pairs of coils, required. The two-axis version is available in any combination (X+Y, X+Z or Y+Z) which needs to be specified when placing an order. The HC2 coils are provided in flat-pack form for assembly at the customer's convenience.

Specifications

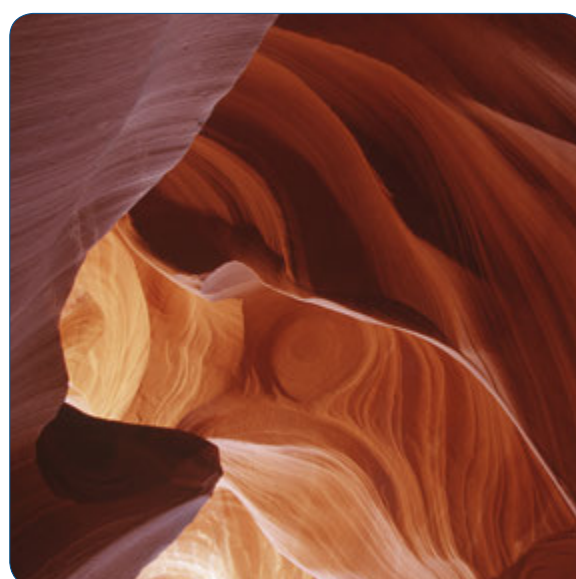
Performance:	HC1®-1	HC1®-2	HC1®-3	HC2	HC9	HC16
Number of axes	1	2	3	3	3	3
Parallelism	±1°					
Mounting to datum	±1° (electronic adjustment possible to <0.1° ¹)					
Orthogonality error	<0.1° (electronic adjustment possible to <0.05° ¹)					
Field performance ²	>25μT per amp per axis			>15μT per amp per axis	>120μT per amp per axis TBC	>120μT per amp per axis TBC
Coil homogeneous volume (<0.1% error)	260cm ³ (~4cm radius sphere)			2515cm ³ (13.6cm cube)	175cm ³ (~3.5cm radius sphere)	175cm ³ (~3.5cm radius sphere)
Coil homogeneous volume (<1% error)	1700cm ³ (~7.5cm radius sphere)			13824cm ³ (24cm cube)	1150cm ³ (6.5cm radius sphere)	1150cm ³ (6.5cm radius sphere)
Coil homogeneous volume (<5% error)					4100cm ³ (~10cm radius sphere)	4100cm ³ (~10cm radius sphere)

¹ When used with Bartington Instruments PA1 Power Amplifier. ² Axis dependent, stated for largest coil. Smaller coils may generate larger fields than the largest coil.

Environmental	HC1® and HC2	HC9 and HC16
Operating temperature range	+15°C to +30°C	+15°C to +50°C
Storage temperature	+10°C to +40°C	0°C to +50°C
Operating humidity	Up to 90% RH non-condensing	

Mechanical	HC1®	HC2	HC9	HC16
Coil dimensions (nominal diameter)	X Coil: 61.8cm Y Coil: 56.0cm Z Coil: 50.7cm	X Coil: 103cm Y Coil: 114cm Z Coil: 125cm	X Coil: 274mm Y Coil: 322mm Z Coil: 370mm	X Coil: 274mm Y Coil: 322mm Z Coil: 370mm
Assembly overall dimensions	Height: 67.5cm Width: 68.4cm Depth: 64.2cm	Height: 130cm Width: 120cm Depth: 130cm	Height: 405mm Width: 380mm Depth: 340mm	Height: 405mm Width: 380mm Depth: 340mm
Maximum aperture	28x22cm	62x55cm	13.5x14.1cm	13.5x14.1cm
Coil gross weight	1-axis: 37kg 2-axis: 41kg 3-axis: 43kg	3-axis: 130kg	3-axis: 15kg	3-axis: 15kg
Coil construction material	Plastic coil former	Polyester glass matt former	Aluminium coil former	Plastic coil former
Optional Accessories	Bartington sensor mounting adaptors			

Electrical	HC1®	HC2	HC9	HC16
Maximum DC resistance per axis	0.2Ω	0.6Ω	0.16Ω	0.16Ω
Maximum inductance per axis	340μH	2200μH	0.9mH	0.9mH
Maximum allowed current (per axis)	20A	20A at 20°C	20A	20A
Connector	Neutrik Speakon 8 poles			



PA1 Power Amplifier

This unit supplies the necessary current to the Helmholtz coil assemblies in order to generate the required magnetic field. It also applies a DC offset current to the coils, typically used to cancel the ambient magnetic field.

Additional electronic adjustment of the scaling and orthogonality enables the generation of high precision magnetic field with excellent orthogonality accuracy.

The PA1 runs from a standard mains AC supply. The amplifier is fan-cooled with a self-resetting thermal shut-down mechanism to prevent damage through overheating.



Specifications

Environmental	
Operating temperature range	+15°C to +30°C
Storage temperature	+10°C to +40°C
Operating humidity	Up to 90% RH non-condensing

Mechanical	PA1-1	PA1-2	PA1-3
Enclosure dimensions	6U 19in rack mount box Height: 27cm Width: 51cm Depth: 60cm		
Enclosure gross weight*	40kg	45kg	50kg

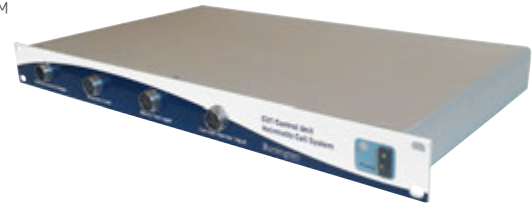
*Weight varies as the PA1 contains one fan and amplifier channel per pair of coils in use.

Electrical	
Input connector	Hirose RM15TRD-10S
Coils output connector	Neutrik Speakon 8 poles
Current monitor output connector	Hirose RM15TRD-10P
Power requirement	100V-230V AC, 50/60Hz permanent installation
Maximum power consumed	1.5kW
Control input (maximum voltage)	±10V
Current monitor output (maximum voltage)	±15V
Coil drive output (minimum voltage)	±25V (no load)
Maximum total output current to Helmholtz coils	29A (maximum 20A per axis)
Output impedance per individual axis	1.35Ω

CU1 Control Unit

This unit is an interface between the PA1 and a National Instruments™ based control system. The signal required to generate the field is routed through the CU1.

The CU1 also provides power to two sensors, with signals from these and the current monitor, filtered and sent to the National Instruments™ system.



Specifications

Functionality		
Magnetometer / auxiliary sensing	Description	Two separate inputs compatible with most Bartington magnetometers with up to 3 axes, differential or single-ended output, dual or single rail
	Analogue input	Up to $\pm 10V$ differential or single-ended
	Input filter	Type Butterworth 2-pole 12dB per octave low pass Frequencies (software selectable): 10kHz, 1kHz, 100Hz & 10Hz
	Supply output: Magnetometer Auxiliary	0 to $\pm 20V$ programmable, limited to 100mA (compatible with single or dual supply devices) $\pm 15V$ limited to 50mA per sensor channel. Power output protected by self-resetting semiconductor fuses
	Connector	Hirose RM15TRD-10P (front panel)
	Mating connector	Hirose RM15TRD-10S (supplied on request)
	Maximum cable length	10m ¹
Current sense	Description	Up to three axes connected to current sense output on Helmholtz drive amplifier
	Analogue input	Up to $\pm 10V$ differential
	Input filter	Type Butterworth 2-pole 12dB per octave low pass Frequencies (software selectable): 10kHz, 1kHz, 100Hz & 10Hz
	Connector	Hirose RM15TRD-10P (front panel)
	Mating connector	Hirose RM15TRD-10S (supplied on request)
	Maximum cable length	3m ¹

Output to PA1 Power Amplifier	Description	Up to three axes connected to Helmholtz drive amplifier
	Analogue output	±10V differential
	Connector	Hirose RM15TRD-10S (front panel)
	Mating connector	Hirose RM15TRD-10P (supplied on request)
	Maximum cable length	3m*
NI DAQ interface	Description	Two separate interfaces for NI DAQ card
	Connector	2 x 68-way Harting 6001 068 5232
	Mating cable	NI cable SHC68-68EPM
	Maximum cable length	3m ¹

* This is to ensure compliance with FCC and CE regulatory approvals.

Environmental

Operating temperature range	+10°C to +50°C
Operating humidity	0 to 50% RH non-condensing
Storage temperature	-40°C to +85°C

Mechanical

Dimensions	The CU1 conforms to the standard 19-inch rack mount specification and is 1U high
Weight	2.4kg

Electrical

Power supply voltage	100–250V AC 50/60Hz
Power supply current	1100mA (115V) / 640mA (230V) type*
Power input (rear panel)	3-way IEC 320 with integral filter (mains cable provided)
Working common mode input voltage	±10V
Absolute maximum input voltage	±15V on any input pin
ESD Protection	±15V on any input pin Comprehensive ESD surge protection on input and output channels for ESD and lightning protection

* A 1A slow blow fuse is fitted internally to limit mains supply current to the power supply module

CU2 Closed-Loop Module

The CU2 Closed-Loop Module, supplied with a dedicated Reference Magnetometer, provides active compensation for external DC and AC magnetic field variations.

When using the CU2, the Helmholtz Coil system setup is greatly simplified, with orthogonality, scaling and DC offset adjustment on the PA1 no longer required.



Specifications

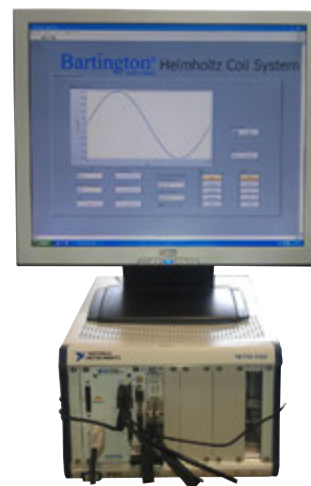
Functionality when used with CU1 and PA1				
DC accuracy with disturbance up to 100μT	<±1% with CU” Reference Magnetometer offsets removed			
AC disturbance field attenuation @ 50Hz	>45 [~33dB]			
AC disturbance field attenuation @ 60Hz	>35 [~30dB]			
Orthogonality error	<0.1°			
Reference magnetometer range	±500μT			
Reference magnetometer scaling	20mV/μT (±10V full scale)			
Environmental				
Operating temperature range	+10°C to +50°C			
Operating humidity	0 to 50% RH non-condensing			
Storage temperature	-40°C to +85°C			
Mechanical	CU2 Module	CU2 Reference Magnetometer		
Dimensions (W x H x L)	106 x 58 x 144mm	32 x 32 x 122mm (excluding cable)		
Weight	445g	210g (approximate)		
Mounting	N/A	4 x M2.5 tapped holes, centres are 113.5 x 24mm		
Electrical				
Power supply voltage	±15V DC from the CU1 Auxialiary Connection			
Power supply current	50mA max			
Working common mode input voltage	±10V			
Absolute maximum input voltage	±15V on any input pin			
Connections	Reference Magnetometer	Auxiliary Connection	Current Control Input	Current Control Output
Analogue Input/output	±10V single-ended input	±10V single-ended output	±10V differential input	±10V differential output
Connector	Hirose RM15TRD-10P		Hirose RM15TRD-10S	
Maximum cable length	10m	3m	3m	3m
Input filter	One pole LPF [~10Hz]	N/A		
Supply voltage output	±15V DC	N/A		

Control System Components

In order to control the Helmholtz Coil system from a PC, a suitable National Instruments™ acquisition card or PXI system can be supplied. This connects to the CU1, and enable a user to control the field generated using the supplied control software.

Signals from the Device Under Test and Auxiliary sensor are also digitised by the acquisition card.

The recommended PXI system is detailed below. Standalone suitable acquisition cards include the PCIe-6353 or USB-6363.



Recommended National Instruments components	
Cardframe	PXI-1042*
Processor	PXI-8108*
DAQ module	PXI-6289*

* See the National Instruments website at www.ni.com for specifications of these products.



Compatibility

Combination	HC1® with PA1	HC2 with PA1	HC9 or HC16 with PA1
Maximum field DC single axis*	>±500μT	>±250μT	>±1mT
Corner frequency	100Hz	20Hz	>100Hz
Maximum field at AC (single axis)*	>±100μT at 3kHz	>±100μT at 300Hz	>±100μT at 5kHz
DC field compensation	>±80μT	>±45μT	>±80μT

* Axis dependent, stated for larger coil. Smaller coils can achieve approximately 20% higher fields.

HC9 and HC16: additional PA1 compatibility information	
Max DC Field (all axes simultaneously driven)	1mT (target)
Max AC Field (all axes simultaneously driven)	1mT Peak <440 Hz (target)
Maximum frequency	5kHz
Field at maximum frequency (per axis, all axes simultaneously driven – value for largest diameter axis, other axes are higher)	110 μT Peak

Accessories

Sensor for Helmholtz Coil Setup and recalibration

A sensor is required to complete the setup procedure of the Helmholtz Coil at the customer location. Bartington recommends the use of the Mag-13MS and associated mounting accessories. This equipment will allow for final checks and adjustments after installation of the coils, together with periodical calibration. This will not be required when using the CU2 Module.

Sensor Mounting Accessories

Bartington offers a range of mounting accessories for positioning of Bartington sensors within the centre of the homogeneous volume.

Helmholtz Coil Breakout Box

A Helmholtz Coil Breakout box can be supplied for monitoring the voltage and current between the HC1®, HC2, HC9 or HC16 and a PA1 on each axis.

The box enables straightforward testing and real-time monitoring of the system.





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The specifications of the products described in this brochure are subject to change without prior notice.