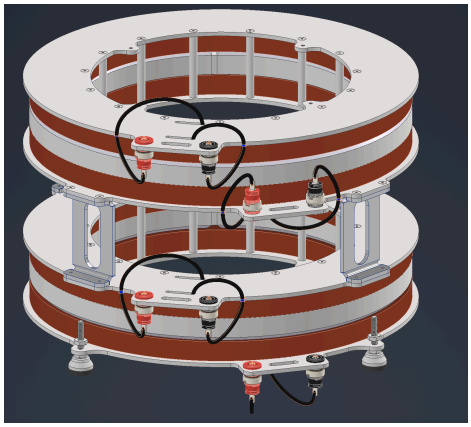
# Single-Axis Helmholtz Coil Systems

High-Field Laboratory Magnet Systems · Water-Cooled for Extended Operation · Custom Diameter Range 10mm–1000mm · Fields up to 200mT (2000 Gauss)

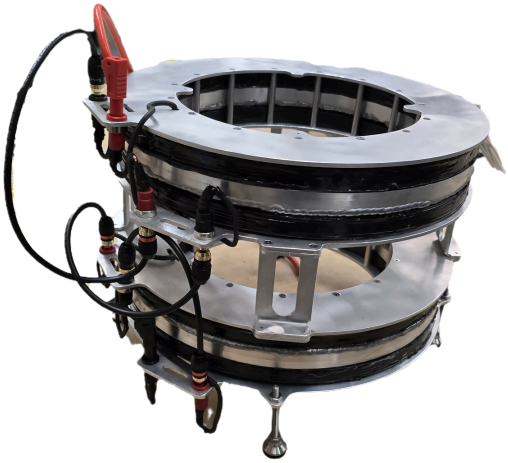
**CUSTOM BUILD** · Scalable geometry · Water-cooled thermal management · Precision field uniformity · Long-duration operation

Doc Ref: WE-HC-SINGLE-001 · Rev 01 · 2026-03-16

## Planar Vector Magnetic Field Control



Woodruff Engineering's Single-Axis Helmholtz Coil Systems provide uniform, well-characterized magnetic fields along a single axis using the classic Helmholtz coil pair geometry, delivering field strengths from 10mT to 1000mT for magnetic calibration, materials testing, sensor characterization, and fundamental physics research requiring precise one-dimensional field control. Constructed as two identical water-cooled circular coils separated by a distance equal to their radius, these systems generate highly uniform fields within a central working volume, serving metrology laboratories, university research groups, and industrial testing facilities requiring reliable and accurate magnetic field standards.



## Scalable Geometry and High-Field Capability

The single-axis geometry spans from compact benchtop units with 100mm diameter coils to large-scale installations exceeding 1000mm diameter, providing working volumes from 30mm to 250mm diameter spheres with field uniformity better than 0.5% throughout the measurement region. Each coil features precision-wound hollow copper conductors with continuous water cooling, enabling sustained operation at rated field strengths without thermal drift or degradation. Standard configurations deliver 100mT continuous fields for extended measurement campaigns, while high-field variants achieve 500mT to 1000mT in pulsed or duty-cycled operation for specialized applications requiring extreme magnetic environments.

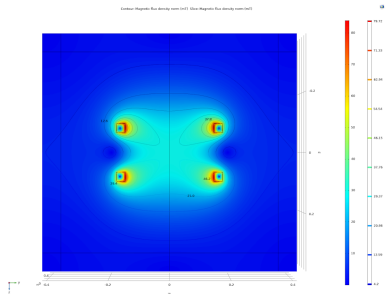
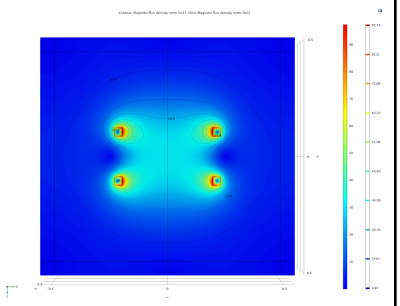
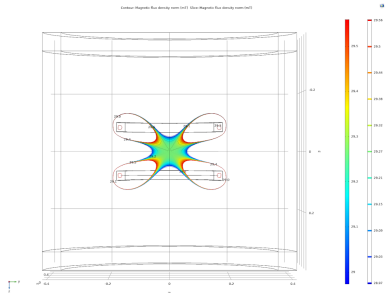
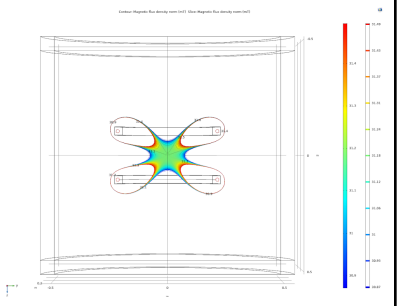
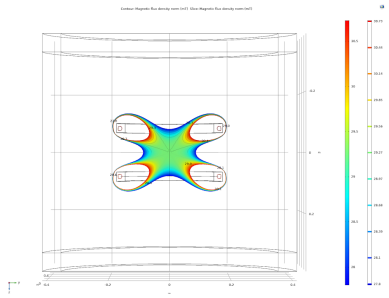
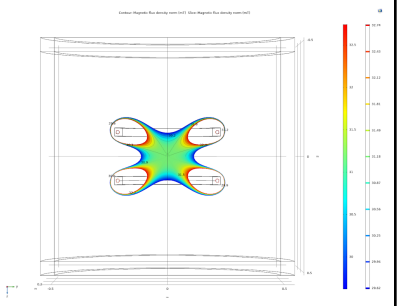
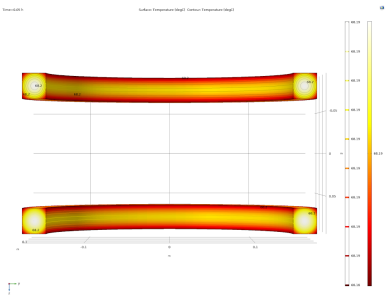
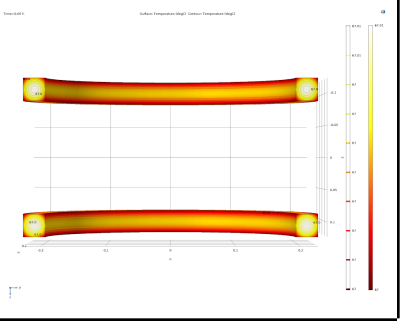
## Advanced Power Supply Integration and Field Stability

Woodruff Engineering provides matched DC power supplies with current regulation better than ±0.1%, active thermal compensation, and closed-loop Hall probe feedback ensuring long-term field stability within 0.05% over eight-hour measurement periods. Power supplies feature both manual control interfaces and digital communication protocols for automated testing sequences, with programmable current ramps supporting adiabatic magnetization studies and hysteresis loop measurements. Optional AC-capable configurations support frequencies up to 100Hz for dynamic magnetic testing, AC susceptibility measurements, and time-varying field applications, with synchronized triggering outputs for integration with data acquisition systems and measurement instrumentation.

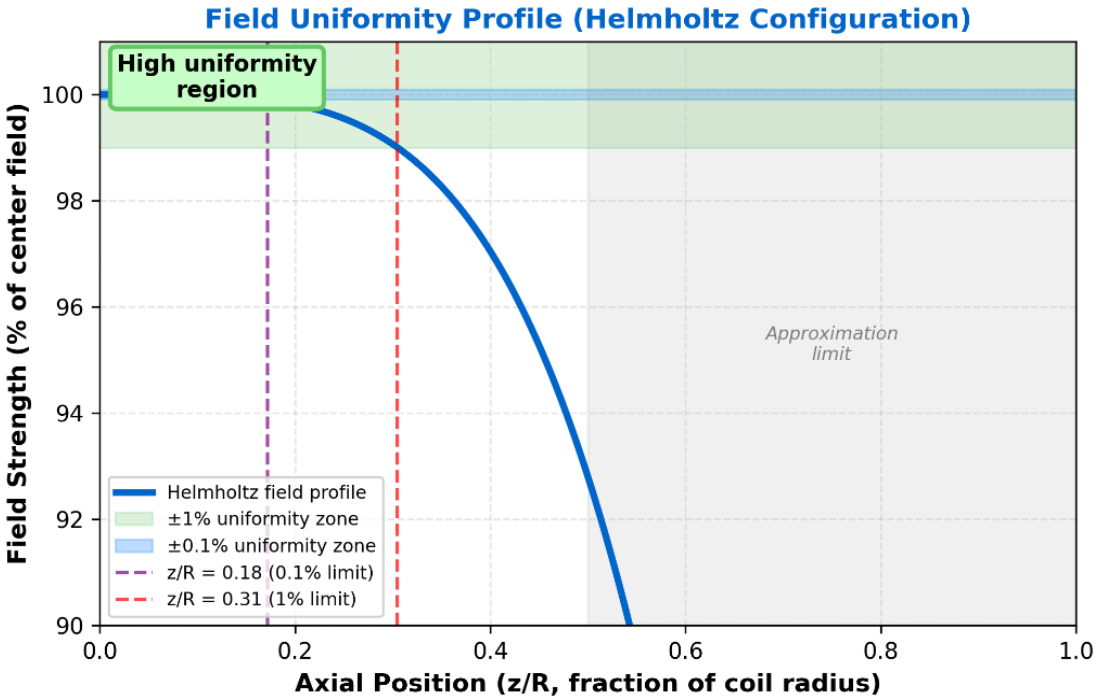
**Woodruff Engineering Inc.**
1003 Midtown Calle Central, Santa Fe, NM 87505, USA · woodruffeng.com

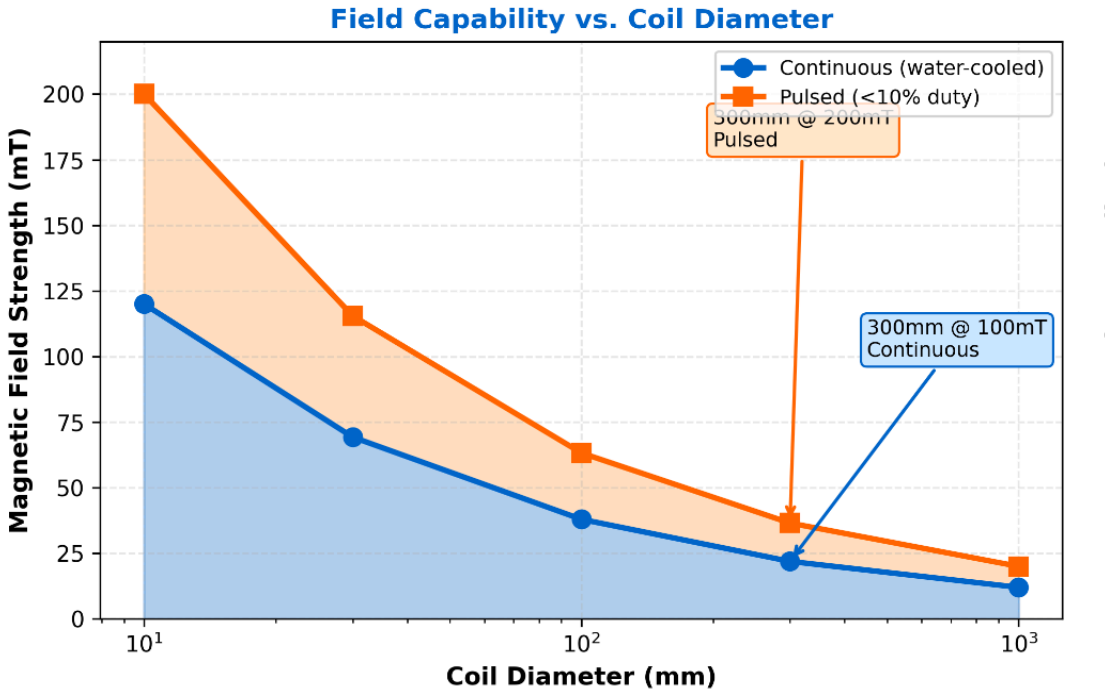
Production datasheet – specifications based on WE-OR-000035 reviewed & accepted requirements.

## COMSOL simulations of the single axis HH coil

| 22cm ID | 36cm ID | 50cm ID |
|---|---|---|
| **Field strength** |  |  |
| **1% uniformity** |  |  |
| **5% uniformity** |  |  |
| **Thermal** |  |  |

## Parameter space plots for the single axis coils



## SYSTEM SPECIFICATIONS

| | |
|---|---|
| **Field Strength Range** | 30–200 mT (300–2000 G)<br>*Continuous: 30–100mT; Pulsed: up to 200mT* |
| **Coil Diameter Range** | 200mm to 1000mm<br>*Typical: 300mm; Custom sizes available* |
| **Field Uniformity** | <1% variation over ~⅓ radius |
| **Coil Separation** | Equal to coil radius (Helmholtz condition)<br>*Optimized for maximum central uniformity* |
| **Orientation** | Horizontal or vertical mount<br>*Custom mounting options available* |

## THERMAL MANAGEMENT

| | |
|---|---|
| **Cooling Method** | Water-cooled windings<br>*Forced convection for extended duty* |
| **Coolant Flow Rate** | 1–10 L/min (size dependent)<br>*Temperature rise <20°C typical* |
| **Inlet Pressure** | 20–40 PSI (1.4–2.8 bar)<br>*Standard facility water compatible* |
| **Continuous Operation** | Up to 100mT with water cooling<br>*Field limited by thermal steady-state* |
| **Pulsed Operation** | Up to 200mT, 10% duty cycle<br>*Brief high-field pulses* |
| **Conductor Material** | Hollow copper tubing (water passage)<br>*High conductivity, integrated cooling* |

## ELECTRICAL MANAGEMENT

| | |
|---|---|
| **Power Requirements** | 1–20 kW (diameter/field dependent)<br>*Small coils ~1kW; Large coils 10–20kW* |
| **Operating Voltage** | Typically 24–120 VDC<br>*Varies with coil resistance* |
| **Operating Current** | 10–500 A (design dependent)<br>*Higher current for compact coils* |
| **Coil Resistance** | 0.05–2 Ω (size/turns dependent)<br>*Lower for larger coils* |
| **Inductance** | 0.1–50 mH (geometry dependent)<br>*Affects ramp time* |
| **Field Stability** | <10 ppm/hour with regulated PSU<br>*Requires precision current source* |

**Woodruff Engineering Inc.**
1003 Midtown Calle Central, Santa Fe, NM 87505, USA · woodruffeng.com

Production datasheet – specifications based on WE-OR-000035 reviewed & accepted requirements.

## MECHANICAL CONSTRUCTION

| | |
|---|---|
| **Coil Former** | G-10 fiberglass or aluminum<br>*Non-magnetic, thermally stable* |
| **Mounting Frame** | Aluminum or stainless steel<br>*Adjustable coil spacing* |
| **Winding Precision** | ±0.5mm typical<br>*CNC-wound for uniformity* |
| **Weight Range** | 1–500 kg (diameter dependent)<br>*Small coils benchtop; large floor-mount* |
| **Access Ports** | Clear bore for sample insertion<br>*Diameter ~60% of coil ID* |
| **Environmental** | Indoor lab environment, 15–30°C<br>*Humidity <80% RH non-condensing* |

## FIELD MEASUREMENT & CONTROL

| | |
|---|---|
| **Field Monitoring** | Optional Hall probe or NMR teslameter<br>*Real-time field readout* |
| **Current Sensing** | Precision shunt resistor<br>*±0.01% accuracy typical* |
| **Control Interface** | Analog 0–10V or digital (RS-232/Ethernet)<br>*Lab automation compatible* |
| **Ramp Rate** | Limited by L/R time constant<br>*Typically 10–100 mT/s* |
| **Feedback Control** | Optional closed-loop field regulation<br>*Improves long-term stability* |
| **Safety Interlocks** | Water flow, over-temperature, over-current<br>*Automatic shutdown protection* |

**Woodruff Engineering Inc.**
1003 Midtown Calle Central, Santa Fe, NM 87505, USA · woodruffeng.com

Production datasheet – specifications based on WE-OR-000035 reviewed & accepted requirements.

Standard and custom diameter configurations from 10mm to 1000mm · Water-cooled for fields 30–200mT · Continuous and pulsed operation

| MODEL | DIAMETER | MAX FIELD (CONT.) | MAX FIELD (PULSED) | WORKING VOL. | POWER | TYPICAL APPLICATIONS | LEAD |
|---|---|---|---|---|---|---|---|
| **WE-HC-50** | 50mm<br>*Small benchtop* | **100 mT**<br>*Water-cooled* | 180 mT<br>*10% duty* | ~20mm sphere<br>*<1% uniform* | 2–4 kW<br>*48–72 VDC* | Small sample, sensor cal, biology<br>*Compact lab* | 10 wks |
| **WE-HC-100** | 100mm<br>*Std benchtop* | **100 mT**<br>*Water-cooled* | 160 mT<br>*10% duty* | ~40mm sphere<br>*<1% uniform* | 3–6 kW<br>*60–90 VDC* | Materials testing, Hall probes, education<br>*Most versatile* | 10 wks |
| **WE-HC-200** | 200mm<br>*Medium lab* | **80 mT**<br>*Water-cooled* | 140 mT<br>*10% duty* | ~80mm sphere<br>*<1% uniform* | 5–9 kW<br>*72–120 VDC* | Larger samples, biological systems<br>*Good volume/field* | 12 wks |
| **WE-HC-300** | 300mm<br>*Most common* ⭐ | **100 mT**<br>*Water-cooled* | 200 mT<br>*10% duty* | ~120mm sphere<br>*<1% uniform* | 8–12 kW<br>*90–120 VDC* | Materials research, calibration, NMR/ESR<br>*Industry standard* | 12 wks |
| **WE-HC-500** | 500mm<br>*Large volume* | **70 mT**<br>*Water-cooled* | 120 mT<br>*10% duty* | ~200mm sphere<br>*<1% uniform* | 10–16 kW<br>*100–120 VDC* | Large sample characterization, assembly<br>*Significant access* | 14 wks |
| **WE-HC-1000** | 1000mm<br>*1 meter* | **50 mT**<br>*Water-cooled* | 80 mT<br>*10% duty* | ~400mm sphere<br>*<1% uniform* | 15–20 kW<br>*120 VDC* | Large-volume calibration, whole-body<br>*Facility-scale* | 16 wks |
| **WE-HC-CUSTOM** | Custom<br>*10–1000mm+* | **Custom**<br>*Optimized* | Custom<br>*To spec* | App-specific<br>*Optimized* | App-specific<br>*PSU sized* | Unique research requirements<br>*Full custom* | 14–20 wks |

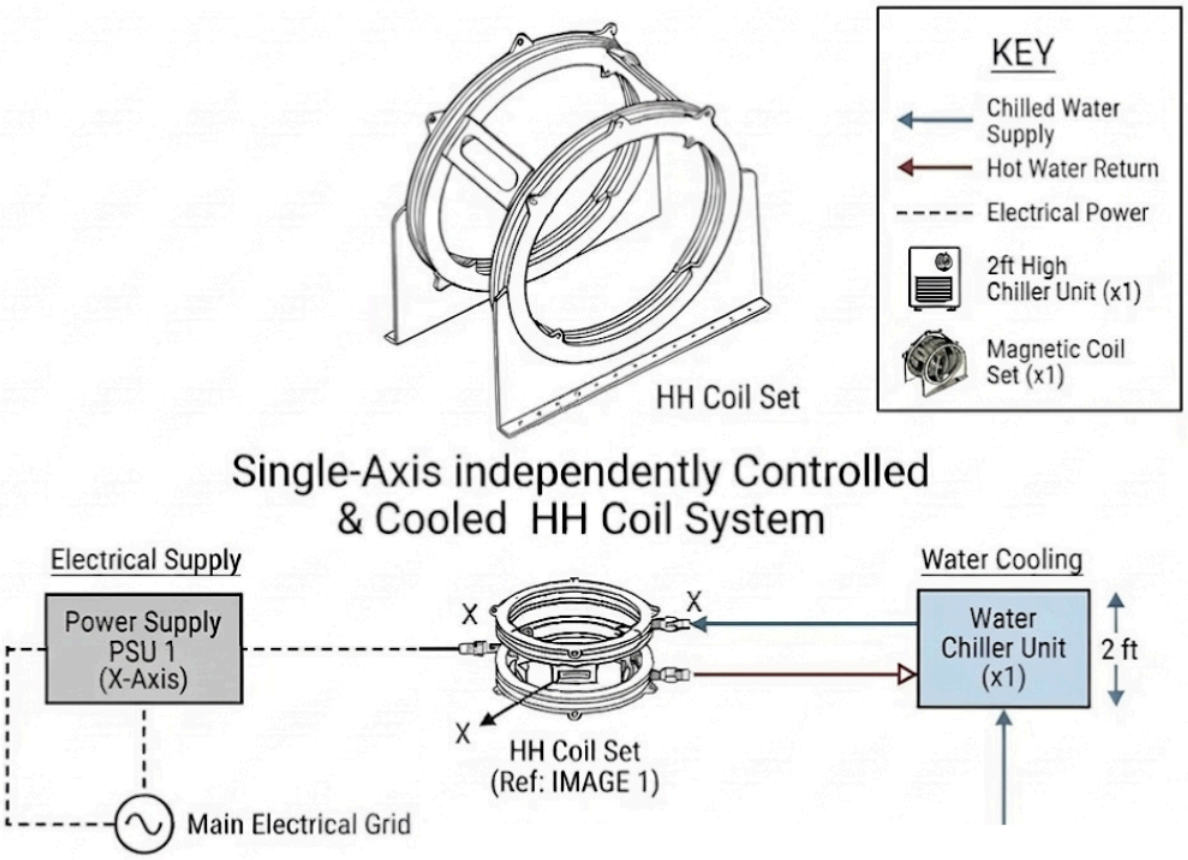
## NOTES:

- All systems include matched coil pair, mounting frame, water manifolds, and field uniformity certification
- Power supplies sold separately — contact WE for compatible PSU recommendations with required current stability
- Continuous field ratings assume water cooling at 2–8 L/min, ΔT <20°C, facility water 15–25°C inlet temperature
- Pulsed field ratings at 10% duty cycle (e.g., 6 min on, 54 min off per hour). Higher duty possible at reduced field
- Working volume = spherical region with <1% field uniformity. Central 20% diameter has <0.1% uniformity for precision calibration
- Optional accessories: Hall probe mount, NMR teslameter integration, programmable current controller, field mapping service

**Woodruff Engineering Inc.**
1003 Midtown Calle Central, Santa Fe, NM 87505, USA · woodruffeng.com

Production datasheet – specifications based on WE-OR-000035 reviewed & accepted requirements.

## Connection schematic of the single axis HH coil



# Helmholtz Coil System

Technical Specification Form

Please complete all sections below. This information will be used to prepare a detailed quotation and ensure the system meets your requirements. If you have questions about any specification, contact us at sales@woodruffeng.com

## CUSTOMER INFORMATION

| | |
|---|---|
| **Organization / Institution** | |
| **Contact Name** | |
| **Email Address** | |
| **Phone Number** | |
| **Shipping Address** | |

## SYSTEM CONFIGURATION

| | |
|---|---|
| **Number of Axes** | ☐ 1-axis (single coil pair) ☐ 2-axis (X-Y planar) ☐ 3-axis (X-Y-Z) |
| **Innermost Coil Diameter** | _____ mm (Typical range: 100–1000mm) |
| For multi-axis systems: | Outermost coil diameter: _____ mm |
| **Coil separation** | ☐ Standard Helmholtz (d = R) ☐ Custom (specify): _____ |

## FIELD REQUIREMENTS

| | |
|---|---|
| **Maximum Field Per Axis(Continuous Operation)** | _____ mT (Typical range: 10–200mT continuous) |
| **Peak Field Per Axis(Pulsed, if needed)** | _____ mT at _____ % duty cycle |
| **Maximum Vector Field(for multi-axis systems)** | _____ mT (2-axis: √2 × per-axis; 3-axis: √3 × per-axis) |

## WORKING VOLUME & UNIFORMITY

| | |
|---|---|
| **Required Uniform Volume(diameter or radius)** | _____ mm (Typically 30–50% of innermost coil diameter) |
| **Field Uniformity Specification** | ☐ <0.5% ☐ <1% ☐ <2% ☐ Other: _____% |
| Uniformity measured over: | ☐ Central sphere ☐ Central cylinder (1-axis) ☐ Other: |

**Woodruff Engineering Inc.**
1003 Midtown Calle Central, Santa Fe, NM 87505, USA · woodruffeng.com

Production datasheet – specifications based on WE-OR-000035 reviewed & accepted requirements.

## OPERATING FREQUENCY & POWER SUPPLY

| | |
|---|---|
| **Operating Mode** | ☐ DC only ☐ AC capable ☐ Both |
| If AC capable, frequency range: | DC to _____ Hz (Typical: DC–100Hz or DC–1000Hz) |
| **Waveform Requirements** | ☐ DC ☐ Sine ☐ Triangle ☐ Square ☐ Arbitrary |
| **For multi-axis, rotating fields?** | ☐ Not required ☐ Yes (specify rotation rate): _____ Hz |
| **Power Supply Preference** | ☐ Woodruff Engineering supply ☐ Customer-provided |
| If customer-provided: | Current capability: _____ A Voltage: _____ V |

## COOLING & INSTALLATION

| | |
|---|---|
| **Cooling Method** | ☐ Air-cooled ☐ Water-cooled ☐ Forced air |
| If water-cooled: | Available water flow: _____ L/min Pressure: _____ PSI |
| **Mounting Configuration** | ☐ Benchtop ☐ Floor-standing ☐ Custom frame |
| **Access requirements** | ☐ Horizontal bore ☐ Vertical bore ☐ Both (3-axis) |

## SPECIAL REQUIREMENTS & NOTES

| | |
|---|---|
| **Computer Control Interface** | ☐ Not required ☐ USB ☐ Ethernet ☐ RS-232 |
| **Control Software** | ☐ Standalone GUI ☐ LabVIEW compatible ☐ Python API |
| **Field Sensors / Feedback** | ☐ Open-loop ☐ Closed-loop (Hall probe feedback) |
| **Coordinate system control** | ☐ Cartesian (Bx, By, Bz) ☐ Spherical (B, θ, φ) |
| **Budget Range (optional)** | $ _____ to $ _____ |
| **Target Delivery Date** | _____ (Typical lead times vary between 8–26 weeks) |

**Additional Requirements or Notes:**

_____

_____

_____

_____

## SUBMISSION

**Please email this completed form to: sales@woodruffeng.com**

We will review your specifications and provide a detailed quotation within 3–5 business days. If clarification is needed on any requirements, we will contact you directly.

**Woodruff Engineering Inc.**
1003 Midtown Calle Central, Santa Fe, NM 87505, USA · woodruffeng.com

Production datasheet – specifications based on WE-OR-000035 reviewed & accepted requirements.