MACS/D FOR ELECTRON MICROSCOPY

- **High Performance DSP Architecture Applies Advanced Signal Processing Algorithms to Achieve Superior Environmental EMI Shielding Specifically for Charged-Beam Instrumentation and Manufacturing Operations**
- **Superior Magnetic Field Shielding for High-resolution Electron Microscopy, Scanning Electron Microscopy, Scanning Tunneling Electron Microscopy and Nuclear Magnetic Resonance InstrumentationProduct Features**
- **Three-axis High Power Compensation Corrects for EMI in Extreme Environments**
- **Cancellation of Environmental AC/DC EMI Interference Over Wide Frequency Range**
- **Effective Protection Against Fluctuations in EMI Fields Caused by Subways, Elevators, Moving Vehicles, Magnetic Navigation Systems and Electrical Distribution Equipment**
- **Wide Range of Permissible Compensation Coil Geometries**
- **Probe Positional Offset Achieved Electronically Via ACR Option**
- **Remote Access for All Monitor, Setup, Diagnostic and Parametric Adjustment Capabilities**
- **HTML Trace Page Permits Scrolling Display of Any Subset, or All, of 35 Parameters**
- **Data Logging Screen Provides Detailed Output of System Status and Status History when Required**
- **Secure VPN-protected Remote Access; Critical Adjustments are Password Protected**

ETS-Lindgren's EMF-compensating (EMFC) MACS/D systems provide cost-effective, maintenance-free high performance attenuation of dynamic environmental magnetic fields for maximum performance of high resolution electron microscopy instrumentation and other sensitive charged-beam scientific and production apparatus. The ETS-Lindgren MACS/D system features high resolution, ultra low latency digital signal processing with characteristically low intrinsic noise floor and negligible drift, permitting wide dynamic range and inherent stability. For special applications requiring ultra low system noise or extended high- or low-frequency response, specialized probes and complementary signal processing options are available.

ACR technology (U.S. patent 9,692,391 B2) incorporated in the MACS/D digital architecture typically provides a higher interference attenuation factor than other active compensation systems or passive shielding systems in sites subject to high interfering field gradients. This feature permits, when significant interfering signal gradients are encountered, location of the MACS/D sensor probe away from sources of high extraneous magnetic fields such as ion pumps without significant attenuation loss at the protected instrument location.

MACS/D capabilities are based on fast, high-resolution DSP based signal processing and a unique control/computing architecture that provides maximum software and firmware flexibility. In addition to performance and operational advantages, the MACS/D system can be either locally or remotely updated with software and DSP firmware upgrades, maximizing long-term utility. Signal processing within the MACS/D system is accomplished entirely in the digital domain by a high-performance DSP engine that facilitates an overall system latency on the order of microseconds.

The MACS/D system's negative feedback closed loop configuration provides high attenuation over a dynamic range extending from 0.2 nT (20 mG) to at least 45 mT (450 mG) with standard compensation coil sets. MACS/D standard compensation coil are comprised of a set of 0.5 inch (13 mm) diameter cables which define the endplanes of the Operational Volume (OV) for each of the three axes. Additionally, an efficient, high-power multichannel coil driver amplifier provides extraordinary system capability and reliability in compensation of high interfering fields. Large dynamic range and enhanced long-term system reliability for sites subject to high-level interfering fields are significant MACS/D advantages over currently available competing active magnetic field compensation systems.

The MACS/D system controller front panel screen provides three-axis scrolling displays of the residual magnetic fields, with concurrent numeric readouts of instantaneous axial field values, the MACS/D system configuration, system state, time and date, and LAN IP. An embedded machine control computer (MCC) provides full LAN-based capability for site setup and remote diagnostic viewing. This capability includes a real-time HTML-based monitoring display in which up to 35 parameters may be selected for simultaneous viewing. Fully implemented VPN client support is available for secure remote diagnostics and remote data capturing; the VPN support ensemble also includes provision for downloading of software upgrades.

From a reputation as industry leader with over 200 high performance MACS EMFC installations worldwide, introduction of the MACS/D system advances ETS-Lindgren to the preeminent position of currently sourcing the world's premier active compensation system for electron microscopy and other sensitive charged-beam instrumentation and manufacturing operations.

Features

Autonomous Operation

Even absent remote monitoring or control, the MACS/D will resume normal operation in compensation mode with most recent parametric settings after a.c. power interruptions. At start-up, the system performs comprehensive self-tests under MCC control to confirm hardware and software integrity.

MCC (Linux-based Machine Control Computer)

Remote Internet access via VPN client provides maximum network security. The VPN client provides the ability to remotely and securely monitor, troubleshoot, repair, diagnose, and update firmware/software from any Internet access point.

Increased Power

The MACS/D system employs significantly more powerful and efficient coil drivers than previous MACS versions or any known competing active compensation system, resulting in at least 100% greater field compensation ability in each of the 3 axes, typically >15uT (150mG) for coils utilizing a single turn per axis of MACS/D standard gauge multiconductor cable installed in accordance with typical room geometry.

Comprehensive Monitoring

The front panel LCD displays real-time field level monitoring, system status, time and date, local IP address, system configuration, and warning/error messages.

MACS/D-EMFC-ACR (MEA) Controller front panel display: (1a) Field Level Monitor, provides readouts and 1 minute, 1 sample/second scrolling record of averaged magnetic field absolute magnitude; (1b) System Status, displays system machine state, "OPERATE" indicates normal operative condition; (1c) Time and Date, automatically updated when accessing VPN server, maintained by local reference clock when external lookup not available; (1d) Local IP Address, DHCP or fixed, displays "No IP Address" if LAN is not connected or is inoperative; (1e) System Configuration, displays configuration in format "MxA", where "x" indicates the application, for EMFC sites the configuration is "MEA" as shown. LAN/ Remote monitoring includes independent selection of all or any subset of system readable variables (see specifications, below), updated on a 1 reading/second chart or charts.

Straightforward Setup

Setup calibration requires only straightforward adjustment of the axial output gain settings, which are room geometry and probe location dependent, and a subsequent adjustment of the ACR level parameter for each axis, if probe offset is desired in the presence of significant protected volume interfering signal gradients. These setup parameter values are stored in nonvolatile memory and are reloaded at each power-up occurrence. then product information.

Technical Specifications

Electrical	
Input Voltage	95 to 125V or 210 to 240 AC (50/60Hz), 15A Maximum
Maximum Compensating Field	>15 mT (150 mG), Standard Cable Installation; >45 mT (450 mG) Augmented Cable Installation
Magnetic Field Sensor	0.1 mT/1 G Fuxgate Probe, Tri-axial, Plug-compatible with and Powered by System Controller
Noise Floor	<0.4 nT (4.0 mG) rms, Determined Primarily by Sensor Noise Contribution
Baseline Acquisition Range	900 T (Maximum Permissible Environmental Static Field for System with Above Probe)
Operational Range	Baseline 99.99 mT
Front Panel Field Display Range	99.99 mT (Averaged, Weighted Peak Absolute Magnitude)
Frequency Range	0.8 mHz to 100 Hz (-3 dB); 0.5 mHz to 180 Hz (-12 dB); ACR .01 to 10 Hz
Magnetic Field Attenuation	Factor of 70 (38 dB) Minimum, Location of Maximum Attenuation Point with Respect to Probe can be Modified by ACR, in Presence of Field Gradients
Remote Monitoring	Residual Main X, Y, Z Axial Fields, Absolute Magnitude, 99.99 T Maximum Residual Main X, Y, Z Axial Fields, Raw Data, 99.99 T Aux (Optional Probe) X, Y, Z Axial Fields, Absolute Magnitude, 99.99 T Maximum Aux (Optional Probe) X, Y, Z Axial Fields, Raw Data, 99.99 T PEM (Parameter Extraction Module) X, Y, Z Coil Currents, 7A Maximum Drive (Signal to CDA/Coil Drive Amplifier) X, Y, Z, 10V f.s. AMP CURRENT (CDA a.c. Mains Input Current), 10A rms, Maximum ACR Signal Nodes Through DSP Processing Chain (Development Aid) Utility I/O Channel Values (Reserved, not Currently Active) 65 dBc
Physical	
Dimensions	53.34 cm x 22.9 cm x 43.18 cm (21 in x 9 in x 17 in)
Weight	27.22 kg (60 lb)

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