Advanced Design Consulting USA, Inc

Portable Magnetic Field Measurement System

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Abstract. This portable magnetic field measurement system is a very sophisticated and sensitive machine for the measurement of magnetic fields in undulators (Planer, EPU, and Apple II), wigglers, and in-vacuum ID units. The magnetic fields are measured using 3 axis hall-effect probes, mounted orthogonally to a thin wand. The wand is mounted to a carriage that rides on vacuum air bearings. The measurement system base is a solid piece of granite. A flip coil is provided on two vertical towers with X, Y, and Theta axes. Special software is provided to assist in homing, movement, and data collection. A similar system to this was constructed for use at APS [1].

mechanical description

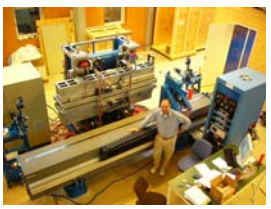
The magnetic field measurement system is based on a granite beam for accuracy and stability. Special mounts are provided with vibration dampening characteristics. Levelers are provided on the mounts for 3 point leveling. The front edge of the granite beam is the precise surface on which the carriage is guided. This is the right hand side facing the laser mount end.

The long axis is driven by a rotary servo motor on a traction drive. This is located ona hinged plate at the back of the carriage.

The carriage is supported on NewWay Precision vacuum air bearings, 3 on the top and 2 on the front side. Vacuum provides mass-less preload for the bearings while air provides friction free bearing for the carriage. The carriage is additionally preloaded by the slider due to the attractive force between the slider and magnet track.

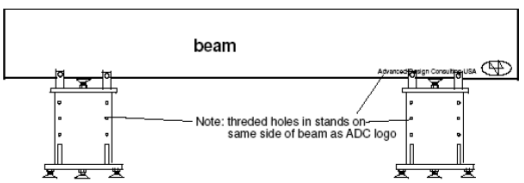
The vertical and horizontal axes are supported and guided on steel cross roller bearing rails. Total travel is 250 mm less limit region. Preloaded ball-screws have 10 turns per inch and are servo motor driven. All servo motors have rotary encoders with 8000 counts per revolution. The vertical axis is provided with a brake that is applied with Servo Off and disengaged with Servo On.

Cables for encoders, motors, and limits, and hoses for air and vacuum are fed thru an Igus flexible wire-way for low friction and cable life. An aluminum "I" beam is glued to the back of the granite to support the cable wire-way.



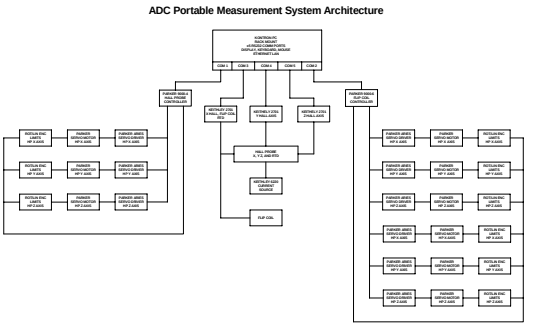
Granite leveling

Precise leveling of the granite is important for accurate alignment with ID units as well as proper operation of the long axis motor and stability as shown in figure 3. The granite beam is supported on 3 points equally spaced on the fifths of the length, these are marked on the underside of the granite. The beam supports have three threaded jack screws located in the bottom. These are used to level the supports and provide clearance for epoxy grout underneath for permanent installations.



control architecture

A block diagram of the control architecture is shown below in Figure 1. The architecture is based on a Kontron rack mount PC running Windows XP Office. The PC provides a means to communicate with the various components of the system while providing an operator graphical interface and connection to host or internet via Ethernet LAN. The PC runs a program called IGOR which provides the graphical interface as well as communication to system components



Controller

The controller consists of AC/DC power conversion and distribution, nine Parker Aries servo drives, 3 Kiethley 2701 DVM meters, one Keithley 6220 constant current source, a Konton rack-mount PC, two Parker ACR 9000 servo controllers, connector panels, and an operator panel. The controller shown below does not include the motor drivers or ACR 9000-6 for the flip coil.

electrical description

The motion controls are based on two Parker ACR 9000 servo controllers. These reside in the control cabinet. The ACR 9000-4 supports the Hall Probe carriage long axis servo (Z), the vertical servo (Y), and the horizontal servo (X). This controller also produces the triggers for the Hall Probe measurements. The ACR 9000-6 supports 6 servo axes for the Flip Coil, 2 each of X, Y and Theta. One set of 3 axes (X, Y, Theta) forms the master and the other 3 form the slave. Hall Probe and Flip Coil can function independently. All servo motors are driven by Parker Aries servo drives located in the control cabinet.

flip coil

The flip coil consists of two towers each with 3 degrees of freedom, X, Y and Theta shown in figure 4. They are named left and right and identified as you face the granite beam. The Master is on the right the Slave on the left. The master is identified by the manual tensioner and cable connection to the flip coil.

The cables attach to the controller at the connector panel and at the connector panel on each tower. The cables are labeled with the connector identifier. The flip coil towers are roughly aligned with the beam line of an undulator by manual positioning of the towers but then fine adjustment is provided in the software.

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