Recommendations for BEPC-II Superconducting Magnet Electrical Systems

These recommendations are of a general nature. There is a large amount of details that would have to be developed before a successful design of this electrical system could be finished.

Quench Detector

- Recommend a DSP based quench detection system. System flexibility and data logging are its main advantages.
- All signals should be logged continuously at a slow sampling rate and fast sampling rate transient data recorded upon a quench.
- All analog input voltages and currents should be isolated to ±2.5 KV.
- Two types of detection schemes can be used. A fast coil difference schemes where the voltage of one coil is compared to another and if the difference exceeds a set limit a quench is detected. Another scheme is a current derivative, where the power supply current is used to calculate the di/dt voltage of the magnet coil and this is compared to the measured coil voltage and if the difference exceeds a set limit a quench is detected.
- For this quench detection system there would be 28 magnet coil signals, 24 superconducting bus signals, 24 gas cooled lead signals and 15 power supply current signals.
- All gas cooled leads would be monitored for an over-voltage condition by the quench detector.
- For all nested (shunt) power supplies the quench detection system will open an IGBT switches at the same time (within 100 usec.). This is to prevent excessive currents from flowing into the nested power supplies upon a quench.

Quench Protection

- The scheme of using an IGBT switch with energy extraction resistors across it and a SCR crowbar across the power supply output terminals is designed the remove current from the magnet circuit without creating dangerously high voltage transients.
- A ground connection in the center of the energy extraction resistors is used to balance voltage transients to ground during a quench. For nested power supplies this connection would not be used.

Power supplies

- All power supplies should be designed so they can operate (or float) 1 KV off ground.
Voltage Taps
- All voltage tap locations should have redundant taps. Two voltage taps for each location. Each tap should also have a 200 ohm resistor in series with it. These resistors should be placed as close as possible to the high current tap point. This will prevent damage to circuits in the event that a voltage tap gets shorted to ground.
Simplified Block Diagram For Bipolar Power Supply with Quench Protection

Diagram includes:
- Current Regulator
- Isolation Amplifiers
- Floating Bipolar Power Amplifier
- Shunt
- DCCT
- Ground Current Monitor & Interlock
- IGBT Gate Drive Board
- Blocking FUSE
- Blocking DIODE
- IGBT
- Energy Extraction Resistors
- Analog Signal Buffers & Power Supply Interlocks
- Power Converter
- Quench Protection Control & Status Signals
- Power Supply Control & Status Signals

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Simplified Block Diagram For Unipolar Power Supply with Quench Protection

- Floating Unipolar Power Supply
- IGBT Gate Drive Board
- IGBT Blocking Diode
- Energy Extraction Resistors
- Micro-Controller for Power Supply & Quench Protection Control
- Quench Protection Control & Status Signals
- Power Supply Control & Status Signals
- Ground Current Monitor & Interlock
- DCCT Shunt
- Crowbar Resistor
- IGBT Gate Drive Board
- Jumper
- Analog Signal Buffers & Power Supply Interlocks
- Current Regulator
- Isolation Amplifiers
- Power Converter
- AC Power
- Current Setpoint
- Energy Extraction Resistors
- Blocking Diode
- Fuse
- IGBT
RHIC TYPE QUENCH DETECTION SYSTEM BLOCK DIAGRAM

VXI SIZE FORM "C" CARD CAGE - 8 SLOTS

DUAL GAIN MUX CARD

- OPEN LEAD CKT
- GAIN CONTROL

SINGLE GAIN MUX CARD

- OPEN LEAD CKT
- ISOLATION AMPLIFIER

DIGITAL OUTPUT/INPUT CARD

- ADDRESS DECODER & DATA LATCH
- WATCHDOG TIMER
- OPTICAL ISOLATORS

EXTENSION CARD CAGE - 13 SLOTS

SINGLE GAIN MUX CARD

- ANALOG INPUTS

4 to 20 ma CARD

MAGNET
- VOLTAGE TAPS
- 8 ch per card

SC BUS
- VOLTAGE TAPS
- 8 ch per card

16 BITS
- QP C&S

GAS COOLED LEADS
- ANALOG INPUTS

8 ch per card

LOCAL BUS

ADC TIMING/CONTROL CARD

- 40 to 1 ANALOG MUX
- S/H

16-BIT ADC

40X8 FIFO BUFFER

STATUS & ERROR REG

ADDRESS DECODER BUFFER

COMMAND DECODER BUFFER

HEARTBEAT MONITOR

CRATE CONTROLLER COMMUNICATION COMPUTER

PHASE LOCK LOOP & TIMMING CARD

ETHERNET

60 Hz REF

720 Hz

PENTEK C40 DSP CARD

VME BUS

720 HZ

720 HZ

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