Hall C Expert Howto

Target Raster Maintenance Manual

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Abstract

A brief description of the electronic configuration of Hall A/C target raster systems and trouble shooting procedure are summarized for the use of professional maintenance staffs.

1 Driver Module Identification

ID	Owner	Frequency (kHz)	Status
#1	Hall C	24.96	in operation
#2	Hall C	25.08	in operation
#3	Hall C	24.96	spare
#4	Hall C	25.08	spare
#5	Hall A	24.96	spare
#6	Hall A	25.08	spare
#7	Hall A	24.96	in operation
#8	Hall A	25.08	in operation

2 Description of Front Panel

- AC switch
- AC power indicator (LED)
- Fuse - 120V, 10A
- AC line receptacle with EMI filter
- 9 pin D-sub socket, RS232 for EPICS
- 9 pin D-sub socket, for Manual controller
- BNC, FR sync TTL output
- BNC, Helicity (MPS) input
- 50A Supercon pin receptacles, FR magnet terminals
- BNC, Pearson 411 current monitor output
- BNC, LEM probe output

3 Module Internal Configuration

3.1 H-Bridge

The diagonal 2 by 2 power switch consists of 8 HEXAFETs (FA57SA50LS). Two of them are parallel. 4 snubber capacitors (MP88 2.5μF/800V, metalized polypropylene film) are connection between the common source and common drain of upper and lower HEXAFETs to eliminate spikes.

3.2 Energy Storage Capacitors

Two 165μF 600VDC Capacitors (Unlytic UL30, Electronic Concepts) are connected across upper-left common source and upper-right common drain. Other two are connected across lower-left common drain and lower-right common source. These four capacitors are used to store energy pumped from UltraVolt high voltage power supply to keep a stable HV level (1%) at 25 kHz raster frequency under full load.

3.3 H-Bridge Driver

Two driver boards directly connect upper and lower rows of HEXAFETs. Each driver board consists of 4 separated drivers (Max 4429MJA), and each driver drives a single HEXAFET. The input stage of driver is formed by opto-coupler (HCPL7710). A FLOATING 15V voltage generated by Polytron SWU0.75-5S DC/DC converter from 5V, powers the drivers.

3.4 H-Bridge Control Waveform Generator

An external trigger signal comes from J1 BNC. A Retriggerable one-shot 74HCT123 has a time constant 0.22 ms. If there is no external trigger signal during 0.22 ms, the circuit automatically switches to the internal crystal oscillator. If a trigger signal comes during 0.22 ms, the generator is controlled by external trigger.

From raster frequency input the 74HCT4046A phase-lock loop generates 8 f_0 synchronized signals. Control waveforms are produced by 161 counters and synthesis logic at OUTA and OUTB. A sync signal signal is also produced at line driver max4429.

3.5 HV Power Supply Input/Output Controller

The circuit receives analog voltage control and current signals from either PIC/ADIO EPICS interface or manual controller to generate HV control signal and voltage/current readback signals. The circuit gets PIC/ADIO and manual controller operating in parallel but only executes the larger value setting from them.

3.6 UltraVolt Switching HV Power Supply

The UltraVolt 1/2 C24 - P250 switching HV DC/DC converter (250 W, 500V) is used to power H-bridge. Its internal voltage reference is + 5 V. It needs a previous 24 V DC power supply. The 14 pin Molex connector gives following control signal connections:

- pin #3 - Output current monitoring
- pin #14 - Output voltage monitoring

- pin #4 - Enable/disable control
- pin #6 - Control voltage input
- pin #5 - Ground

The operational status of HV unit is displayed on FR EPICS control screen. For all 8 modules in normal operation, the average voltage reading and corresponding current reading are shown in the following table :

Voltage in V	50	100	150	200	250	300	350
Current in mA	54	82	108	133	160	187	215

The readout values on EPICS screen should be consistent with the display of manual controller.

3.7 HV Safety Protection

A Sumida mercury-wetted Reed relay with a 10W 10 kohm resistor are connected in series. The two terminals are connected to storage capacitors in parallel. The Reed relay is open in normal, as power interruption occurs Reed relay closed and HV discharges through 1 kohm resistor.

3.8 PIC/Adio Board

PIC/Adio board is provided by Fast Electronics Group as the interface between UltraVolt HV unit and EPICS control. It executes high voltage setting, voltage/current readback, logic control display. Parallel to manual controller, PIC/ADIO board gives EPICS control full information about the status of the module.

4 External Auxiliary Electronics

4.1 Field Pickup Integrator

Each target raster magnet is equipped with a pick-up coil at the center of magnet winding plane. The field pickup integrator converts the induced voltage signals into linear waveform and adjusts the amplitude of linear signals to the same amplitude of output of Pearson current probe.

4.2 Helicity Synchronization Unit

This optional NIM module unit is designed for the use of G_0 experiment. Hall A has already preserved such capability for future's application. The unit receives trigger signal from helicity reverse (MPS). A phase-lock circuit generates two correlated raster frequency signals. It enables the rastered beam starts at the exact same time of MPS. Therefore, the instant beam positions are always the same for each MPS.

4.3 On-line Raster Pattern Display ADC and Trigger Generator

A Jorgger 4-channel VME ADC has been shared by Hall C and Hall A two raster systems. The trigger generator produces 60 Hz synchronization signals from one raster frequency as the trigger of ADC. The 2D and 3D raster pattern display software was written by Chris Slominski. By pushing control button on EPICS control screen, users could observe raster 2D and 3D pattern on-line.

4.4 BRM/FSD system

It has the same function as of BRM/FSD system of old raster system. It takes analog magnet current signals to compare the calculated current amplitude value from beam energy and raster size. Fault warning signal will be given as soon as a discrepancy occurs.

5 In Site Trouble Shooting Procedure

5.1 Visual Diagnostics

- Verify the 2D FR pattern on the scope in Hall A/Hall C counting house
- Verify the 2D and 3D on-line pattern display on EPICS screen
- Verify voltage and current readback on front panel of manual controller
- Verify the module status on EPICS control screen

5.2 Check Cable Connection

Start from the scope cable in counting house, the signal channel waveform should be linear (triangular). If a distorted waveform observed, check the input analog cables. Bad cable connection could cause such distortion.

5.3 Module Quick Check

After the two steps previous check, if problem is still existing, ask for an entry to open the door of lead shielding cave. Use scope to look at LEM output. In case of either high level offset or asymmetric waveform observed, determine to replace the module because that indicates the core part of H-bridge is defect.

6 Maintenance in Laboratory

In most case if H-bridge failure was detected by diagnostics, it is impossible to fix on site because the complicated mechanical structure inside the power module. The defect module should be taken back to laboratory for necessary inspection and repair.

6.1 Assembly and Disassembly Procedure

- Dismount the rear panel (heatsink) from module by Hexascrew driver 1/8"
- Dismount the driver boards by using far-screw holes
- Unscrew the copper bus strips over the bridge
- Disconnect the short wire - first the gate, then the source
- Screw the copper bus strips again

6.2 HV I/O Controller Adjustment

6.2.1 Potentiometer Identification

- VR1 - HV output current adjustment

- VR3 - Current display adjustment
- VR2 - HV voltage limit adjustment
- VR4 - Voltage value display adjustment

6.2.2 Install the Maximum HV Value

Turn the multi-turn potentiometer on the front panel of manual controller to the right end to set the maximum voltage value of HV output.

6.2.3 Setup high voltage limit

Adjust VR2 to set the maximum voltage display on manual controller = 360 V

6.2.4 High Voltage Current adjustment

- Take P_2 connector away from Molex 4 position 90 degree socket on Control Waveform Generator board in order to switch the H-Bridge is off
- Connect 250 ohm 100 W resistor box (consists two parallel 500 ohm 50 W resistors) in series with multimeter and switch the multimeter to current measurement. Then, connect them to HV power supply output (copper bus strips), the only load of HV unit is the 250 ohm resistor.
- Measure voltage value at pin #8 of J6 of the HV I/O board (current monitoring readout) by the second multi-meter. For convenience, one can measure the terminal #41 on PIC/ADIO board. Adjust VR1 to make the second multi-meter readout being the same value with the first meter. 0pin #8 the same value with multi-meter readout.
- Adjust VR3 to make displayed current value of manual controller the same with multi-meter readout.

6.2.5 Voltage Calibration

- Use multimeter to measure HV directly
- Set multi-turn potentiometer a fixed position, for example 84.5

- Adjust VR2 to set the control voltage the same with multimeter
- Adjust VR4 to set the displayed voltage value on the manual controller front panel the same value with multimeter readout.

6.2.6 LEM Probe Offset Adjustment

In normal condition, a small DC offset appears on the zero-crossing line of H-Bridge output current waveform. It comes from tiny time difference of the diagonal shoulders. Adjust delay time by turning VR4 (2k ohm potentiometer) on Control Waveform Generator Board to minimize the DC offset at LEM output waveform.

6.3 Individual HEXAFET Inspection

After disassembly of H-bridge from heatsink, multi-meter can used to measure the resistance value between the drain and source. Normal value of resistance should be 1.5 - 2.2 M ohm. Less value indicates the HEXAFET was damaged.

6.4 Driver Board Inspection

Disconnect driver boards from H-Bridge. Keep input cables connected with control waveform generator. Use central needle of scope high impedance probe connecting output of each driver. The corresponding ground crocodile should connect each floating ground terminal.

The driver output should appear good leading edge and fall edge as well as top flatness. Both rise time and fall time should less than 10 ns at zero load. When driver is connected with capacitive load such as 10 nF (10,000 pF), both leading and fall edges become much slower like 50 ns at $\pm$ 15 V power supply voltage in the same amplitude. It is normal. If the slowdown of leading and fall edges is much larger than this value, it indicates defect of the driver.