SNS EXTRACTION KICKER POWER SUPPLY CONTROL*

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Abstract

Fourteen PFN power supplies and four control racks will make up the SNS Extraction Kicker PS System. This paper will discuss the fourteen charging power supplies for the PFNs, as well as the arrangement and function of the extraction kicker system control devices. These control instruments and boards are installed into four standard racks. Some of the control board functions will be described in this paper. Photographs of the equipment are also included.

INTRODUCTION

Fourteen PFN power supplies will be installed in the SNS Extraction Kicker System. Each PFN power supply will energize one magnet, which will be located in the accumulate ring tunnel. Each PFN power supply consists of a PFN modulator tank and a charging power supply rack.

PFN modulators will be installed in PFN gallery. Charging power supply racks and four control racks will be installed in extraction kicker charging power supply room in the service building.

The PFN modulator consists of a lumped element Blumlein pulsed forming network (BPFN). The BPFN modulator main operation parameter is as fallows:

Operation voltage:	35	kV
Operation current (peak):	2.4	kA
Maximum Pulse repetition:	60	Hz
Pulse flat top time:	700	nsec
PFN charging time:	~13.5	msec

The charging power supply rack contains a capacitor charging power supply, filament and reservoir power supply, and PLC controller. A 50 kV capacitor charging power supply, model ALE 802 manufactured by Lambda, EMI, is rated for a 9kJ/sec peak charging rate.

Four control racks consists of timing, charging finished interlock and beam kick perform status monitor three ports.

EXTRACTION KICKER POWER SUPPLY OPERATION TIMING ORDER

Figure 1 shows the SNS Accumulator Ring Extraction Kicker System pulse timing relationships. The maximum kicker operation pulse repetition is 60 PPS. Based on the PFN capacitance and the capacitor charging power supply capability, the PFN needs 13.5 milliseconds to charge to the operating voltage of 35 kV. After the PFN charging voltage reaches the operating voltage, a charging finished pulse will be sent out to main control system as one of the signals that permit the Linac to inject proton beam into the accumulator ring. The PFN will hold the voltage for around one millisecond until a trigger pulse to the thyratron discharges the PFN energy into magnet. This kicks the proton beam from the accumulator ring into the Ring to Target Beam Transport line (RTBT). After the proton beam is kicked out, the kicker power supply system will check that each single PFN modulator functioned properly.

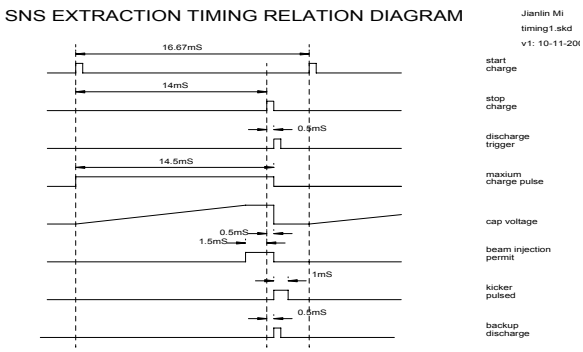

Figure 1: SNS Accumulate Ring Extraction Kicker System pulses timing relation

CHARGING POWER SUPPLY RACK FUNCTION AND CONTROL

The charging power supply racks are shown in Figure 2. Each rack contains a capacitor charging power supply (208VAC, 3 phase), a filament and reservoir power supply, a PLC controller (made by Allen- Bradley) with a Panel View operator interface and PLC power supply, a voltage and pulse monitor 3U sub-rack, and a PSI interface 1U sub-rack and a circuit break panel. A blower and a group of four fans are installed at the bottom and top of the rack to vent the rack. There is a Solar AC constant voltage regulator, which is installed in the rack to regulate the one phase 120V AC power input to the rack.

The circuit break panel controls the all AC power into the rack. A RED push bottom is used to turn off rack power in emergency. The PLC section controls all the status of power supplies in the charging power supply rack. A PSI interface is connected to PLC input terminals in order to performance a remote control function to the charging power supply rack.

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Figure 2: Charging Power Supply Racks picture

The charging power supply rack control is sorted in four levels; PS off, Standby, HV on and HV pulsing. Some of four control level functions are listed as follows:

Level 1, PS off:

- Turn local breaker on and Turn PLC on

Level 2, Standby:

- Fan and blower on
- DG535 on
- Scope on
- AC meter on, Filament PS and Reservoir PS on

Level 3, HV on:

- Shorting relay on (open)
- ALE 802 power supply HV on
- E2V Trigger generator on
- Oil pump on

Level 4, HV pulsing:

- Start charging
- Charging completed
- Stop charging
- Discharging
- Kicker kicked

And some interlocks

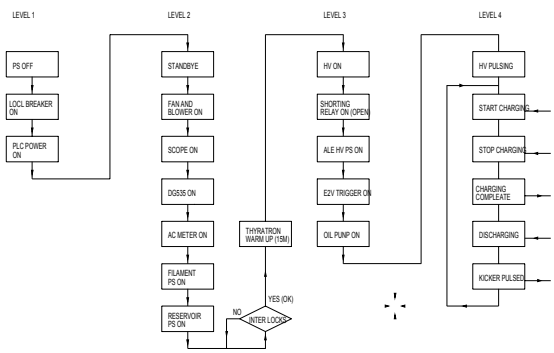

Figure 3: four function control level diagram

FOUR CONTROL RACK FUNCTION AND CONTROL

Figure 3 shows the wire diagram of the four control racks. The four control rack operation functions are described as follows:

Eight LeCroy Scopes will be installed in the four racks, which are used to line up fourteen kicker magnet current waveforms. As well, these scopes will monitor each magnet current and all PFN charge voltage waveforms.

In Rack 1, a start charging trigger pulse from accelerator timing system is sent to PG9, a DG535 pulse delay generator to generate a 13.5 millisecond width pulse. This pulse is sent to four Pulse Fan out PCB boards (PF1-1 to PF1-4) to fan out fourteen charging inhibit pulses. Then, these fourteen charging inhibit pulses are sent to each HV capacitor charging power supply in the charging power supply rack to control the power supply charging time. A discharging trigger pulse from FAN2-1 in Rack 2 is sent to PG10 (another DG535) in rack 1. PG10 will send a synchronal discharge pulse out to PG1 to PG 8 (8 DG535) in rack 3. PG9 exports a inhibit pulse to PG10, to inhibit the synchronal discharge pulse output when the charging power supplies are charging the PFN.

In Rack 2, a discharging trigger pulse from accelerator timing system is sent to FAN2-1, a pulse fun out circuit. Four pulses from FAN2-1 will be sent out, one output will be sent to PG10 in rack 1, as mentioned above. Two outputs are sent to FAN3-1 to FAN3-4, as the drawing shows. All fourteen output will sent to fourteen 3U pulse monitor boards in fourteen charging power supply racks. These fourteen pulses will synchronize the pulse monitor board to detect the load current. Another output will be sent to SUMM11-1. There are fourteen thyratron current signals, which will be sent to SUM10-1 and SUM10-2 than summing to SUM11-1. SUM11-1 will check if there is a thyratron pre-fired. If so, SUM11-1 will send a pulse to FAN2-1 to dump the beam from the accumulator ring. At same time SUM11-1 will send out a warn signal to accelerator system.

Figure 4: four Control Racks pictures

In rack 3, eight DG535 (PG1 to PG8) pulse delay generators are installed in. These eight generators are triggered by a synchronal pulse sent from DG10 in rack 1.

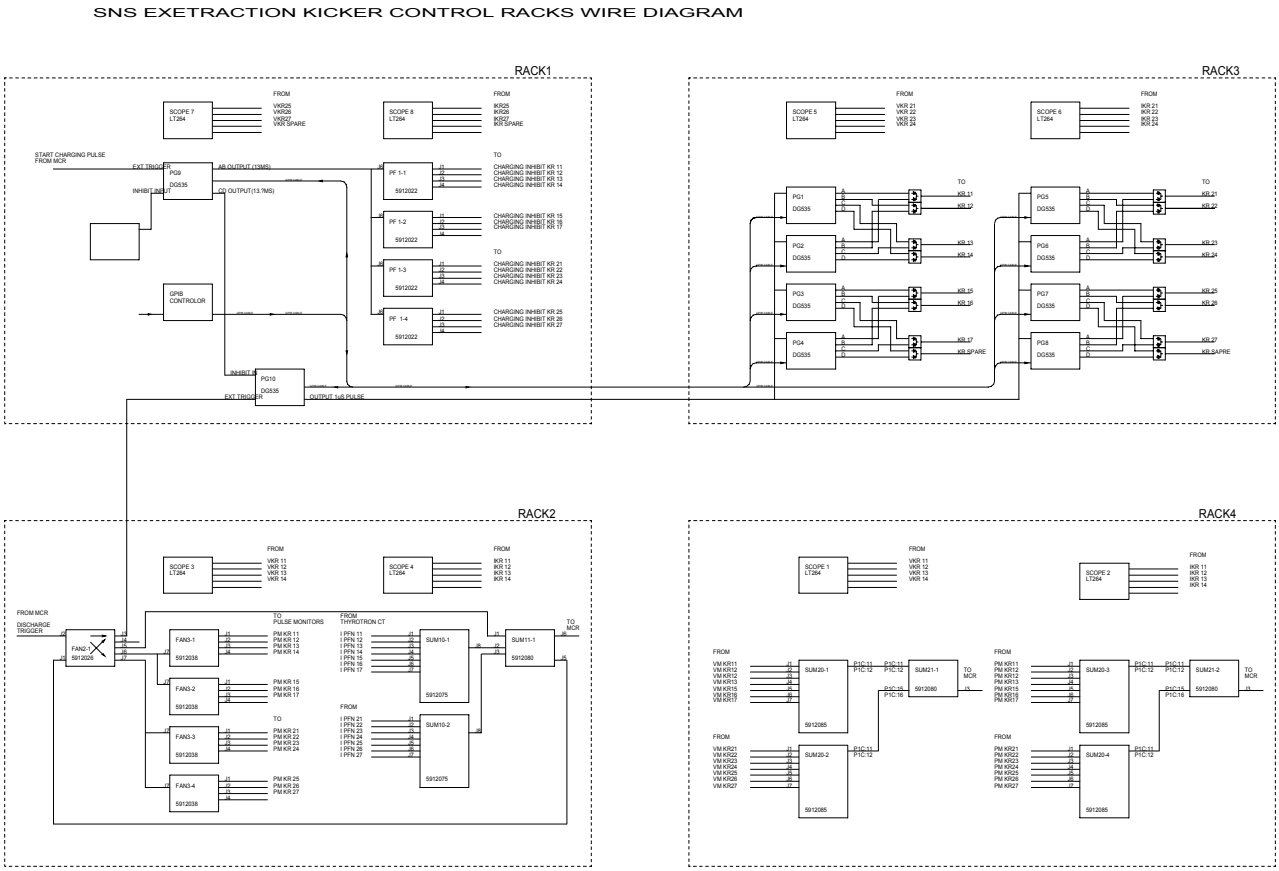

Figure 5: four control racks wire diagram

Each two output pulse from the 8 DG535 pulse delay generators are combined to one trigger pulse to fire one E2V trigger generator located on the top of the PFN modulator tank. Each pulse delay generator output delay time can be adjusted manually at local or remotely by GPIB. And it can line up all fourteen kicker load current.

In rack 4, fourteen PFN charging finished signal transferred from fourteen voltage monitors, which are installed in the charging power supply racks will be send to SUM20-1 to SUM20-4, and than summing to SUM11-1 and SUM11-2. Two output signals from SUM11-1 and SUM11-2 will be sent out to accelerator system to report that kicker system is ready for beam injection.

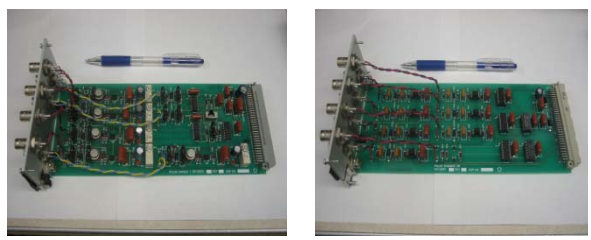

Figure 6: fan out board and summing board pictures

CONCLUSION

All four control racks have been assembled. Most of the 3U sub-rack and PCB boards have been tested. Five PFN modulators, five charging power supply racks and four control racks have been shipped to Oak Ridge National Laboratory. The kicker system will soon be tested as a complete system.

ACKNOWLEDGEMENT

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