DESIGN OF CONTROL INSTRUMENTATION OF TWO IN-VACUUM UNDULATORS IVU25S

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Abstract

This paper summarizes the primary controller that is based on Siemens S7 PLC for two in-vacuum undulators to be installed at SSRF shown in figure 1. The PLC controls a single gap stepper motor with a separate motor for taper control. Position feedback is derived from two SSI linear absolute encoders mounted across the gap at either end of the array to measure taper. All vacuum pump controls are provided along with cooling water control and a separate bake-out controller.

This system is designed for Shanghai Synchrotron Radiation Facility, SSRF, a third-generation synchrotron radiation light source, with the total power is 600 KW, energy 3.5 GeV, Circumference of 432 meter, and current of up to 300mA.

Figure 1: Shanghai Synchrotron Radiation Facility

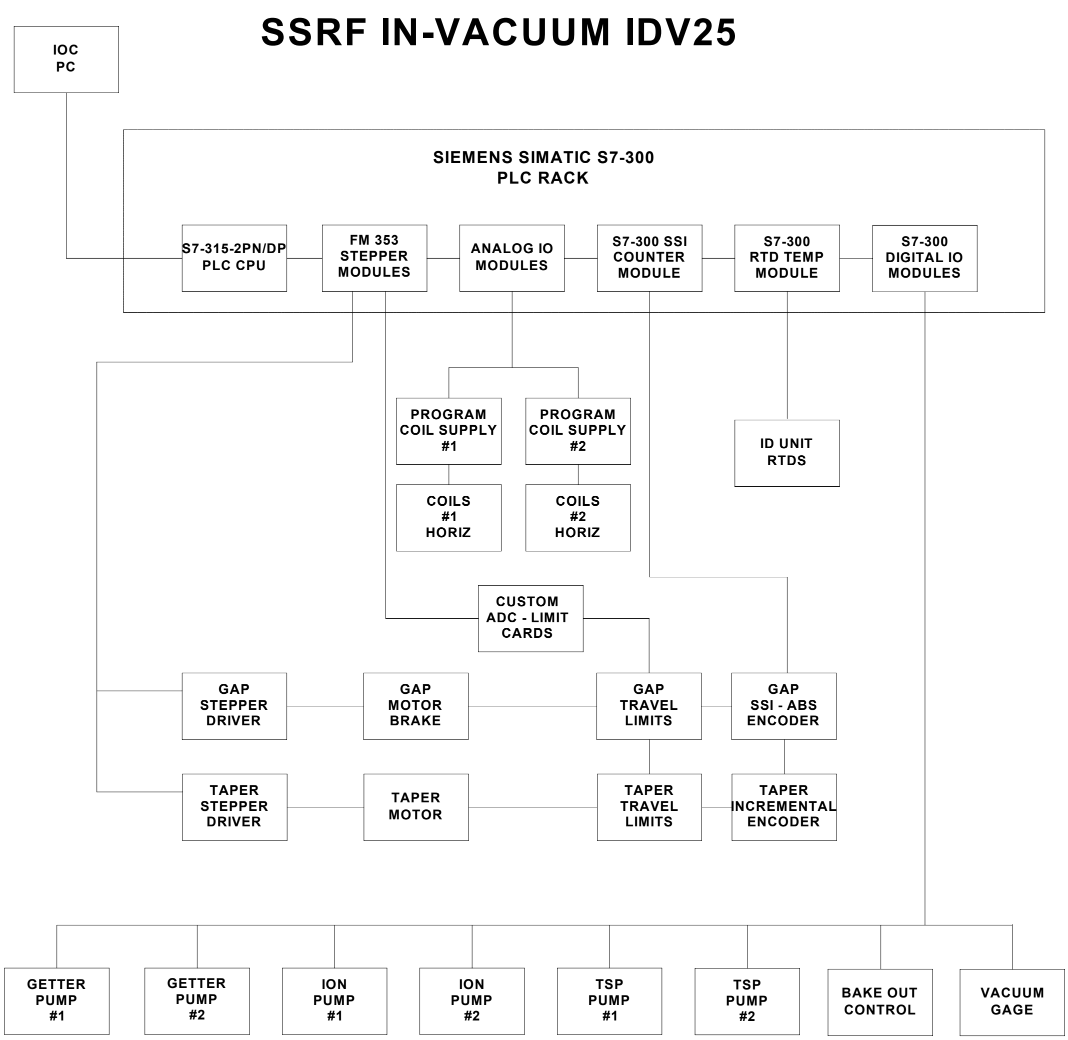

Figure 2: Control instrumentation architecture

ARCHITECTURE

The proposed controller is based on a single motor design for gap control with a separate motor for taper. The control architecture is presented in figure 2. The primary controller is a Siemens S7 PLC. This device is used widely at SSRF and is a very powerful PLC both in speed and programming features. The PLC controls stepper motor and driver both made by Parker-Hannifin. The gap motor is supplied with a brake that is normally on (applied with power off).

other direction (off the switch). The Kill switches remove power to the motor, however, these are defeated by a key switch to allow motion in the other direction.

The taper motor and driver also are Parker-Hannifin but the position feedback is derived from a rotary incremental encoder. This encoder is only used to close the position loop on relative moves, actual taper is measured at the linear encoders. The taper motor drives a large gear reducer that produces a taper by effectively altering the length of the screw-jack on one side of the gap drive motor. Figure 3 shows schematic of the device.

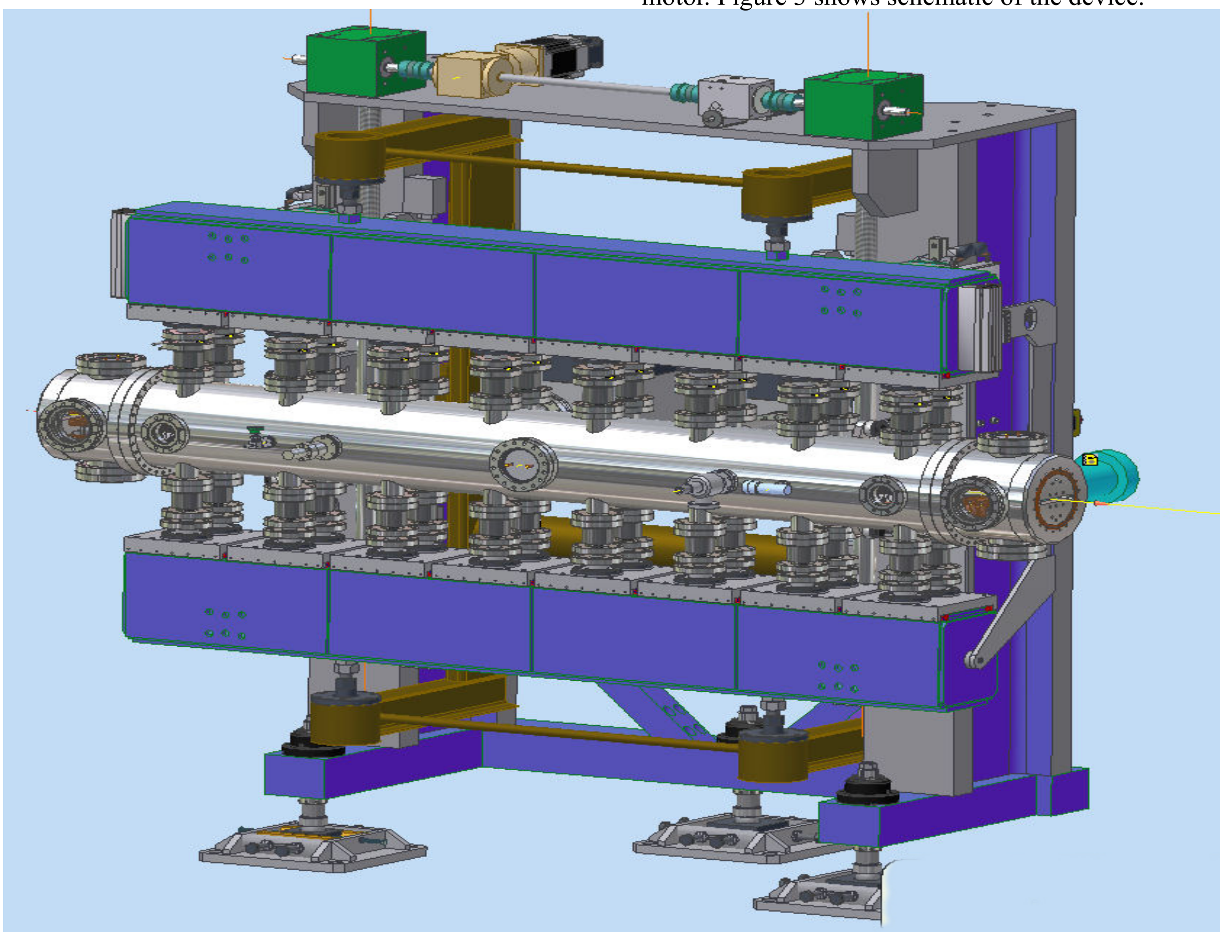

Figure 3: In-Vacuum undulator for SSRF

Position feedback is derived from two TR Electronics linear absolute LTS-240 encoders mounted across the gap on each end of the magnet array. The absolute encoder interface is SSI and the resolution is programmable down to .1 um per count. Since the encoder is absolute, there will be no need to home the gap axis and the taper is always known. The advantage of linear encoders is the measurement is more direct and is not subject to wind-up and deflection that a rotary encoder would see on the end of a ball screw. Four limits are provided as well as 4 kill switches.

The 4 switches (2 limits and 2 kills) at min gap are optical and the 4 outer switches (2 limits and 2 kills) are mechanical. The limits prevent further motion in the direction they protect but allow the axis to be driven in the

The controller layout is shown in figure 4. The major components are mounted on a vertical plate and which mounts easily in a 19 inch rack. Emergency Motor Off switches are provided on an operator panel and at the ID unit.

Four correction coils are planned for vertical and horizontal correction These coils are mounted outside the vacuum chamber. The power supplies are Kepco BOP (bipolar) supplies. These provide up to 400 watts of power in the full 19 inch rack package. Current control and tracking is accomplished using analog input and output. The water cooling unit and vacuum pumps are also monitored and controlled via analog IO.

There are 2 Ion pumps, 2 TSP pumps, and 2 Getter pumps with NEG filters. The controller monitors vacuum pressure and controls the vacuum pumps for operation and regeneration.

SOFTWARE

The PLC has two tasks that can run independently. The main task holds all the motion controls, error checking, and host interface. A separate high speed task updates the data to the correction coils using a 4 coil array – execution time is less than 5 ms.

Both the Main task and the high speed task are written in structured text. The programming environment is Step-7, which is a powerful tool for program development and debug. SSRF has supplied ADC with an EPICS driver for the Siemens PLC. ADC will verify EPICS communication with a Linux PC.

Communication is via Ethernet TCP/IP. The PLC acts as a server with the host the client. DHCP is not supported.

CONCLUSION

ADC is confident that the Siemens S7 PLC will provide all the functionality required to control the SSRF In-Vacuum undulators. The design is a near virtual copy of the ASP Wiggler controller. Details such as complete schematics, cable assemblies, Bills of Material, Spare Parts List, and software are all available on request.

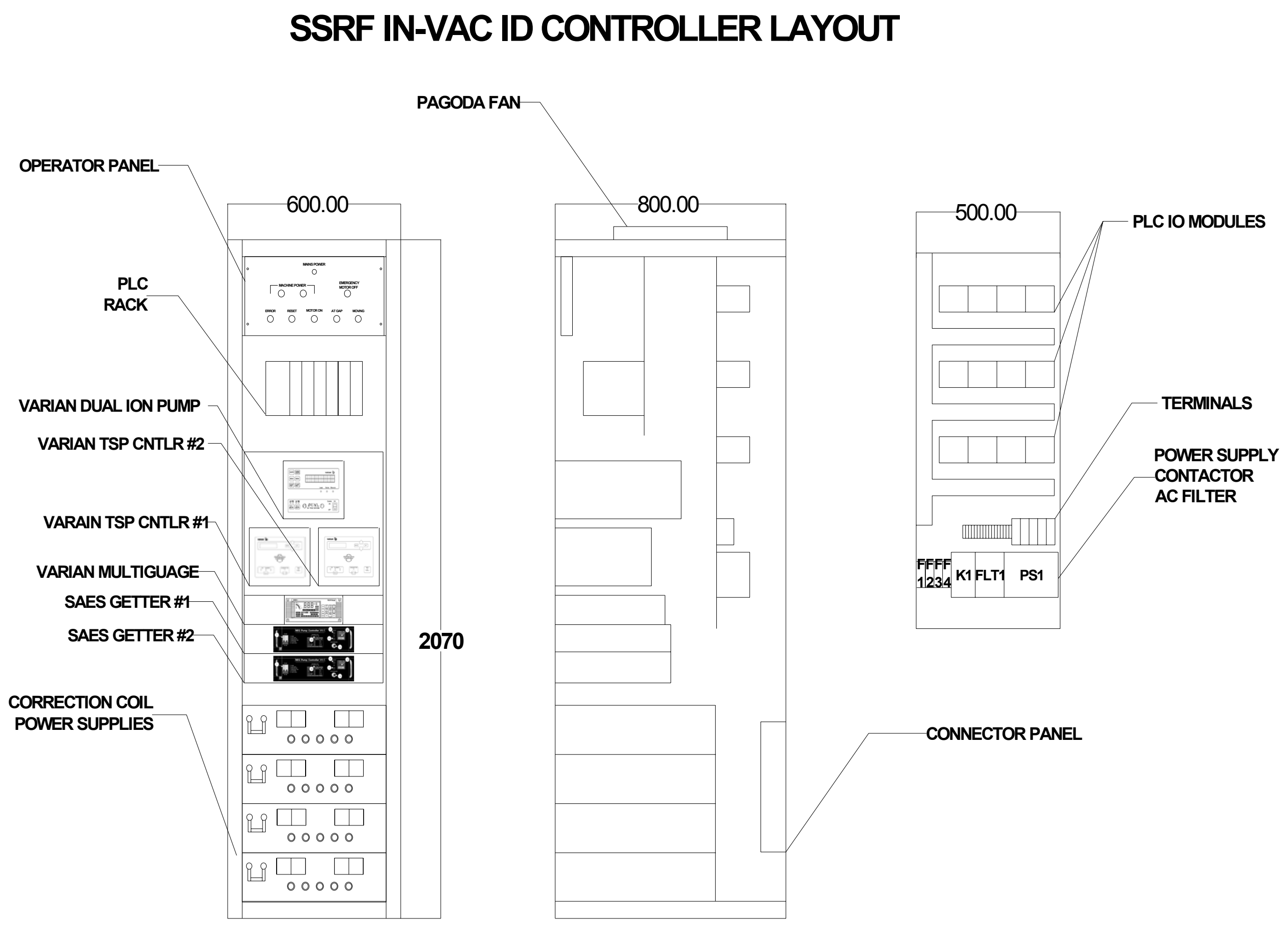

Figure 4: Controller layout