Southern African Large Telescope
Prime Focus Imaging Spectrograph

Electronics Design Description

SALT-3140AE0021

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Modification Record

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Introduction

This note serves as a roadmap to the detailed wiring diagrams for the PFIS control system.

System Overview

Here is the PFIS block diagram.
PFIS is run from a control computer in the operator’s area. It uses a fiber link to the payload. The main box contains a PCI-like backplane with commercial motion control, digital and analog I/O boards. Wires fan out to two satellite control boxes, one primarily controlling the collimator mechanisms, and the other controlling the camera mechanisms. These 3 boxes are cooled with facility glycol.
The PFIS etalons are controlled from a pair of rack-mounted Queensgate CS-100 controllers. These sit in a glycol-cooled box on the top hex. Their AC inputs come from PFIS, so that we can interlock the high voltage outputs. The CS-100 control outputs go from the top hex through the cable wrap, into PFIS.

The SAAO CCD subsystem is controlled from the computer room via another fiber connection. The only electronic connection between the CCD subsystem and the PFIS electronics is a fiber shutter control so the CCD control computer (PDET) can open and close the PFIS shutter with high time precision.

**Control Computer**

The PFIS control computer is a Windows PC running LabVIEW. Linux cannot be used here because National Instruments does not support motion control under Linux (or Mac OS). There is just one PCI card in its backplane, the MXI fiber interface card from National Instruments. The MXI fiber system is a backplane extender. The other end is up in PFIS, in the main control box.

**Main Control Box**

The main control box contains a National Instruments PXI chassis with 8 slots. One slot is taken up by the other end of the fiber backplane extender. 2 contain National Instruments 7334 stepper motor motion control cards. These are 4-axis, closed loop motion control cards. The 7334 cards also offer 32 bits of digital I/O. Another slot uses a 96-bit digital input card, and another has an analog input card.

In addition to the PXI chassis, the main box contains high efficiency power supplies for PFIS actuators and sensors. They provide +5V, +/-15V, and +24V.

This is a glycol-cooled box.

We divided the motor driver boards, pneumatic manifolds, relays, interlock logic, and signal conditioning electronics into two satellite boxes. There were many reasons to do this:

- Lessen the heat load in any one box
- Small voids in the PFIS truss are more plentiful that large ones
- Locate electronics in the vicinity of the mechanism being controlled

**Satellite Box 1**

Satellite Box 1 contains the driver boards, pneumatic valves, and control electronics for the slitmask
This is a glycol-cooled box.

**Satellite Box 2**

Satellite Box 2 contains the driver boards, pneumatic valves, and control electronics for the

- etalons
- grating
- filter
- articulation

This is a glycol-cooled box.

**Hardware Interlocks**

PFIS protects itself with hardware interlock implemented in programmable logic devices (PLD). The interlocks are specified in the PFIS Interlock Specification and Design Document (SALT-3140AE0015). Each pneumatic control line, and the forward and reverse stepper command lines, pass through a PLD. The PLDs monitor the required sensors, and suppress the actuator command when the interlock condition is present.

Each PLD provides a set of output bits, one for each interlocked actuator. These bits indicate when an interlock condition is present, and which one it is.

Satellite Box 1 implements interlocks that involve single mechanisms. That is, the slit mask mechanism has interlocks that depend on slit mask sensors, but which do not depend on any other mechanism.

Satellite Box 2 has interlocks that depend on more than one mechanism. In particular, the grating and etalon mechanisms create the danger of physical damage to heavy and expensive optics. The hardware interlock system prevents any spectrographic operation when the etalons are in the beam, and prevent any etalon use until all spectrographic actuators are in their home positions.

**Electro-mechanical Prototype**

We proved all the basic control system concepts by building a prototype "generic" mechanism. This mechanism is specified in the Generic Mechanism Specification (SALT-3140AS0014) and is pictured [here](http://www.sal.wisc.edu/PFIS/docs/archive/protected/pfis/3140/3140AE0021-edd.html).

This prototype proved our design choices in the following areas:
• LabVIEW client/server control
• Fiber link to PXI chassis
• Control box/Satellite Box wire harness
• NI Motion control with 3rd party motor driver boards
• Fail-open limit switches (broken wires assert the condition)
• Quadrature incremental encoder for closed-loop control
• Analog absolute position sensor
• Temperature sensor
• Pneumatic switching
• High-precision station indicator using 2 phased-lagged Hall effect vane sensors
• Slitmask-style station-seeking procedure