NIRSPEC

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NIRSPEC Electronics Application Note 01.00

NIRSPEC Electronics Overview

1 Introduction

This document gives an overview of the NIRSPEC electronics system, and is also a guide to the rest of the documentation. We have tried to put in as many cross-references to the other documents as we can. Wherever something is mentioned for the first time the name of a relevant document should be in brackets immediately following it. Electronics documents are numbered NEANxx (for instance this document would be referenced as NEAN01), and programming documents as NSPNxx.

The NIRSPEC electronics carry out the following functions:

• Supply power at appropriate voltages to the two IR array detectors, the PICNIC array in the slit-viewing camera (SCAM), and the Aladdin 2 detector in the spectrometer channel.

• Generate clock waveforms for the two detectors, and level-shift them to the appropriate voltages.

• Amplify, filter and digitize the analog signals from the two detectors.

• Read in the digital data from the detectors, do simple pre-processing (such as co-adding), and send it back to the host computer.

• Drive stepper motors to move the mechanisms in the dewar and the calibration/guider unit, and read back the status switch values from the mechanisms.

• Supply power and control of the arc lamps and quartz-halogen bulbs in the calibration/guider unit, and read sensors looking at the calibration unit lamps to make sure they work.

• Read cryogenic temperatures from the dewar, and control the temperature of the Aladdin detector in the spectrometer channel.

• Read the air temperature in the electronics cabinets, and if necessary shut down the electronics if temperatures get too high.

Some of these functions are performed by commercial units housed within the electronics cabinets, interfaced via RS232 to the rest of the system. The cabinets also house the controller for the Photometrics PXL guider camera.

2 Digital electronics

The intelligence and programmability in the system is provided by boards using the transputer processor, programmed in its own language, occam (NSPN22). There are 26 of these processors in the system. There are three types of transputer board; the DAQ17 (NEAN05) which has one transputer doing clock generation, motor control, and general digital I/O, the DAQ15 (NEAN04) with four transputers reading in data from the A-D converters, and the SIO232 (one transputer, two RS2323 channels) which talks to the cryogenic readout and temperature controller and the computer-controllable power strip.

All the DAQ15 boards and all but one of the DAQ17 boards are housed together in the main transputer crate, which is a 6U Eurocard crate with a VME backplane. The transputer boards don't interface to the VME bus, but are laid out in that format to make them easy to package. They pick up power and ground from the standard pins on the VME bus, and use uncommitted VME pins for wire wrapped links which run along the backplane to connect them together (NEAN13).

For each detector there is one DAQ17 board acting as the clock generator (NSPN18). The Aladdin detector in the spectrometer channel has four DAQ15 boards (for a total of 16 transputers), while the SCAM uses just two of the transputers on one DAQ15 board (NSPN19). These two types of board interact via clock signals as well as transputer messages to clock the arrays and take data (NSPN33).

The remaining DAQ17 board is packaged with the two SIO232 units in a 3U high rackmount enclosure, known as the “housekeeping crate” with its own power supply (NEAN18). The DAQ17 transputer acts as the “root” transputer of the transputer network, so it passes commands and data between the host computer and the rest of the transputers. This transputer also controls and monitors the arc lamps and quartz-halogen lamps in the calibration/guider unit, and reads Dallas Semiconductor DS1820 sensors monitoring the cabinet air temperature. The root transputer program is documented in NSPN17, and there is a data sheet for the DS1820 sensors in file 1820.pdf.

The SIO232 units (NSPN34) are packaged in the TRAM daughtercard format for transputers. Each TRAM has a transputer, some RAM and a 2-channel UART chip, so we have four RS232 channels in total. Three of the four RS232 channels talk to the LakeShore model 208 8-channel temperature readout, the LakeShore model 330 temperature controller, and the Pulizzi controllable power strip. The other channel is a spare.

3 Communicating with the host

The transputers have their own serial protocol which works fine over short distances. To connect to the host computer (a Sparcstation) that serial protocol in translated to and from SCSI using a small device called a MatchBox from Transtech. To span the distance between the instrument and the computer, we use Black Box Corp. SCSI - fiber extenders. One extender is next to the computer and its partner is in the central enclosure of the electronics cabinets, along with the MatchBox. Also in the same space is another extender which is used by the Photometrics PXL guide camera controller to talk to its host (the guider software doesn't run on the instrument computer). Additionally there is a SCSI-AIA converter box between the extender and an AIA interface card in the PXL controller.

4 Analog electronics

There are four different types of analog board in the system; twin-channel pre-amp/A-D board (NEAN06), bias board (NEAN08 & 09), interface board (NEAN07), and level shifter board (NEAN10). These are housed in Eurocard enclosures, except for the level shifters.

There are two analog crates, one for each detector array. The bus in these crates is not VME - at least not quite. There are two rows of connectors as in a VME bus, but they are two of the three rows from a Sun 3 backplane. The Sun 3 systems used a bus which had the same structure as VME but with a third row of connectors along the bottom, with mostly uncommitted pins. Our bus was made by cutting the top row of connectors off one of these Sun 3 backplanes, so we have the second and third rows only. In the spectrometer analog crate (a 6U crate) there are 16 pre-amp/A-D boards, one bias board, and one interface board. The level shifter board is in a separate box mounted right underneath the dewar. The SCAM analog system is smaller — bias board, interface board, and two pre-amp/A-D boards — so it is housed in a sub-frame in a 4U crate, with the boards horizontal. Again the level shifter is in its own box under the dewar.

The analog outputs from the detector arrays are fed to the pre-amp/A-D boards. Each of these boards has two channels of pre-amp, post-amp, filtering and A-D converter. The digital outputs from the two A-D converters are multiplexed onto a single output connector from which they are fed to the DAQ15 boards in the main transputer crate. Each pre-amp/A-D board has switchable gain (4 different values) and switchable filter bandwidth (4 values).

The bias boards (NEAN08 & 09) provide the necessary DC voltages required by each array. The voltages are set by pots on the board, with one exception. The detector bias for the Aladdin array in the spectrometer channel is supplied by a serial DAC controlled from the clock generator transputer. This takes 3 lines of digital input from the clock generator board, which are isolated using Burr-Brown ISO150 capacitive isolator chips (ISO150.pdf) to cut down cross-talk between the digital and analog section of the system.

The interface board in each analog crate handles interfacing between the digital and analog sections of the system. All control signals from the digital electronics (produced by the clock generator board in each channel) are isolated using Burr-Brown ISO150 capacitive isolator chips (ISO150.pdf). Once the signals are decoded they are passed along the backplane, using uncommitted bus lines, to the pre-amp/A-D boards.

The signals are:

- Two bits which select one of four different gain stages in the pre-amps.
- Two bits which select one of four filter stages in the pre-amps.
- The convert signal (a single line) for the A-D converters.
- The select signal (a single line) which switches between the output of the two A-Ds on each board.
- The signals controlling the serial DACs which provide the analog offset for each quadrant of each detector. There are 3 bits of input.

5 Power supplies

All power supplies in the system are linear, with the exception of the various commercial units such as temperature controllers. This was done to minimize noise. They are listed and described in NEAN03. The grounding scheme is described in NEAN02.

6 Motor driving

All the mechanisms use stepper motors, and every mechanism is constructed so that there is no need for holding current on the motor when the mechanism is static. This allows us to turn off motor power entirely between moves, so that we don't add heat to the cryogenic enclosure. The intelligence in the motor system is in transputer programs in three DAQ17 boards (NSPN20). Each motor has a number of logic signals produced under program control. There are steps, direction (CW/CCW), power on/off and high/low power. The driver units take these signals and produce the phased pulses at the right current level required by the motors.

All but one of the motors are driven by dual modules made by American Precision Industries (API). They are model 51 drivers (there is a manual). The exception is the motor of the image rotator which is driven by a low-noise single driver also made by API (model). This driver was chosen because the only motor that will move during integrations on the spectrometer detector is the image rotator, so we need to minimize the impact it might have on noise in the detector signal. All the drivers are housed in a 6U high crate.

7 Switch sensing

The digital I/O ports on the DAQ17 boards all provide a 5V line which is fed to microswitches in the mechanisms. These switches give the transputers status information such as whether a mechanism is at its home position.

8 Lamps control

There are two types of calibration lamps in the system, arc lamps and quartz-halogen bulbs. There are four arc lamps (neon, xenon, krypton and argon), driven from their own power supplies, which provide a starting spike followed by a steady DC current. There are four separate supplies, two each of two different types (models &). The four power supplies are in a 3U high box, with 4 LED indicators on the front. Four logic lines from the housekeeping box DAQ17 transputer control the AC power to the four power supplies. A board with Grayhill brand opto-isolated relays switches the 110V power. This board is mounted inside the crate with the four power supplies.

The power to the quartz-halogen lamps is switched using solid-state relays. Since the power for the lamps is DC, these are mounted inside one of the analog power supply crates.

9 Cryogenic temperature reading and control

We use two commercial units to read the crygenic temperatures inside the dewar and control the spectrometer detector temperature. There are 10 sensors inside the dewar, all silicon diode type ??? from LakeShore Cryotronics. Eight of them are read by a Model 208 readout. This device gives an LED display of the temperatures (visible through the window in the middle of the electronics), and communicates over an RS232 line with one of the SIO232 transputers, which sends the temperature data back to the host computer.

The other two sensors are connected to a LakeShore Cryotronics Model 330 controller (also visible through the window). This device reads and displays the temperature of the detector head for the Aladdin 2 detector in the spectrometer channel. It also drives a small heater resistor in the detector head so that it can control the detector temperature. It is also connected to one of the SIO232 transputers in the housekeeping crate. It reads back temperatures to the transputer, and can also have its control setpoint changed by a serial command.

10 Cabinet temperatures

The electronics cabinets are insulated to prevent heat loss into the dome spoiling the seeing, and cooled by Knurr heat exchanger units in the bottom of the cabinets. To make sure the air temperature doesn't creep up and cause damage to the electronics, there are sensors spread through the cabinets. The sensors are Dallas Semiconductor DS1820 standalone sensors. They daisy-chain on a 3-wire cable with 5V power, ground and a bi-directional signal line. They connect to one of the digital I/O ports on the DAQ17 board in the housekeeping crate. The DAQ17 transputer talks to the sensors and prompts them to send back temperature data, which it passes to the host computer.