Gemini Near Infrared Coronagraphic Imager

Electronics System Document

GEMINI SDN3001

MKIR# NICI –900-200-01

Rev 0.6
(PRELIMINARY)

Last Modified 11/04/2004

ABSTRACT: This document is the top level electronics specification for the NICI IC and AO electronics and is part of the NICI Service & Calibration Manual. This document provides an overview of NICI's electronics and high level implementation details. It is intended for engineers and technicians working with NICI's electronics.

WARNING: **The Array Control Chassis and boards are not compatible with the VME standard**, though they may appear to be. Inserting the boards in a standard VME chassis will likely cause a **catastrophic failure**. Likewise inserting standard VME cards into the chassis is prohibited and extremely risky.

Prepared by Mauna Kea Infrared

Revision History

Revision	Author	Summary of revisions	Date
0.6 PRELIM	Mike Thompson	Prepared for Preliminary (80%) customer release.	11/04/04

Table of Contents

Table of Figures and Photos

1 NICI Electronics System Overview

1.1 Purpose

This document describes the System Level electronics of the Gemini Near Infrared Coronagraphic Imager (NICI) instrument. It is the highest level document for information regarding all electronics subsystems in NICI.

1.2 Major Assemblies

The major subsystems for NICI are physically located in Rack1, Rack2, the AO assembly, AO APD chassis, cryostat, and cryostat mounted motor assemblies. Rack1 and Rack2 are standard Gemini 1.3 meter Thermal Electronics Enclosures. These assemblies are illustrated in Figure 1.

The major functions of Rack1, the Instrument Control Rack, are NICI camera control and motor control. Two essentially identical Aladdin type III 1024 X 1024 infrared arrays are housed in the Cryostat, the Red Array and Blue Array. Rack2 contains the electronics that control the Adaptive Optics housed in the AO Assembly and the AO APD Chassis.

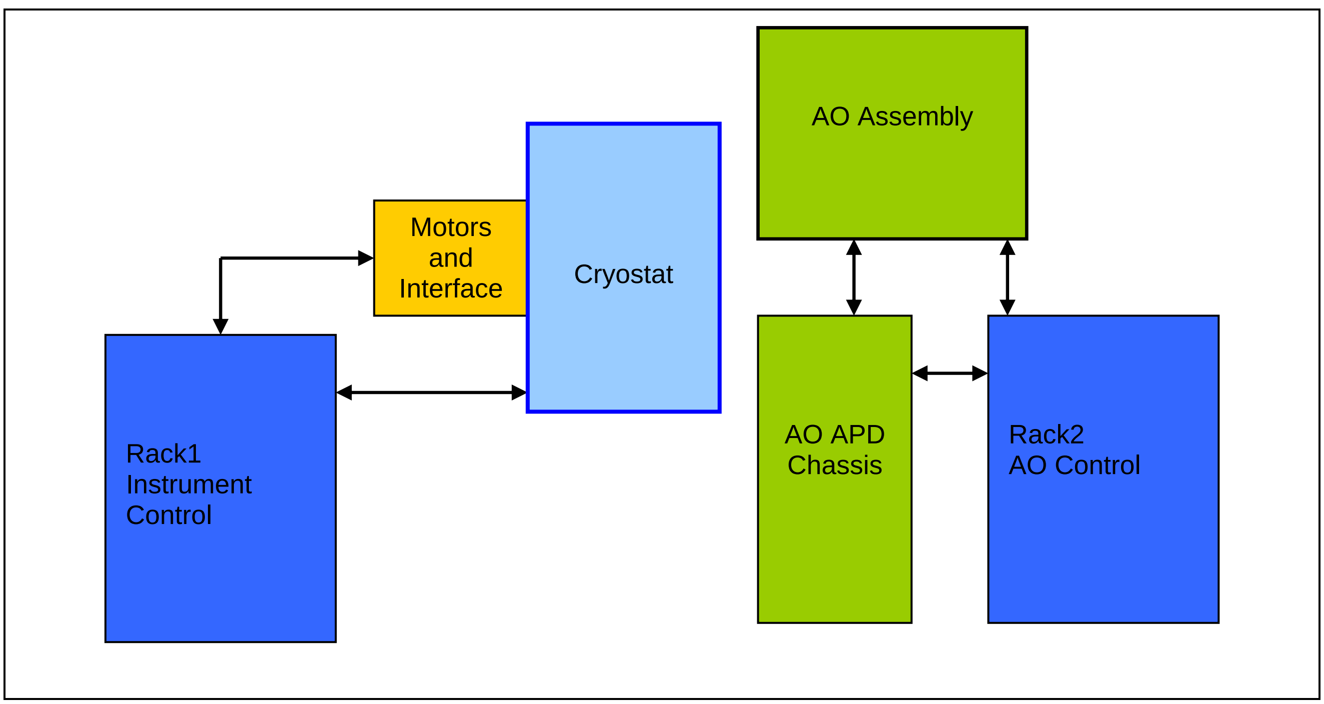
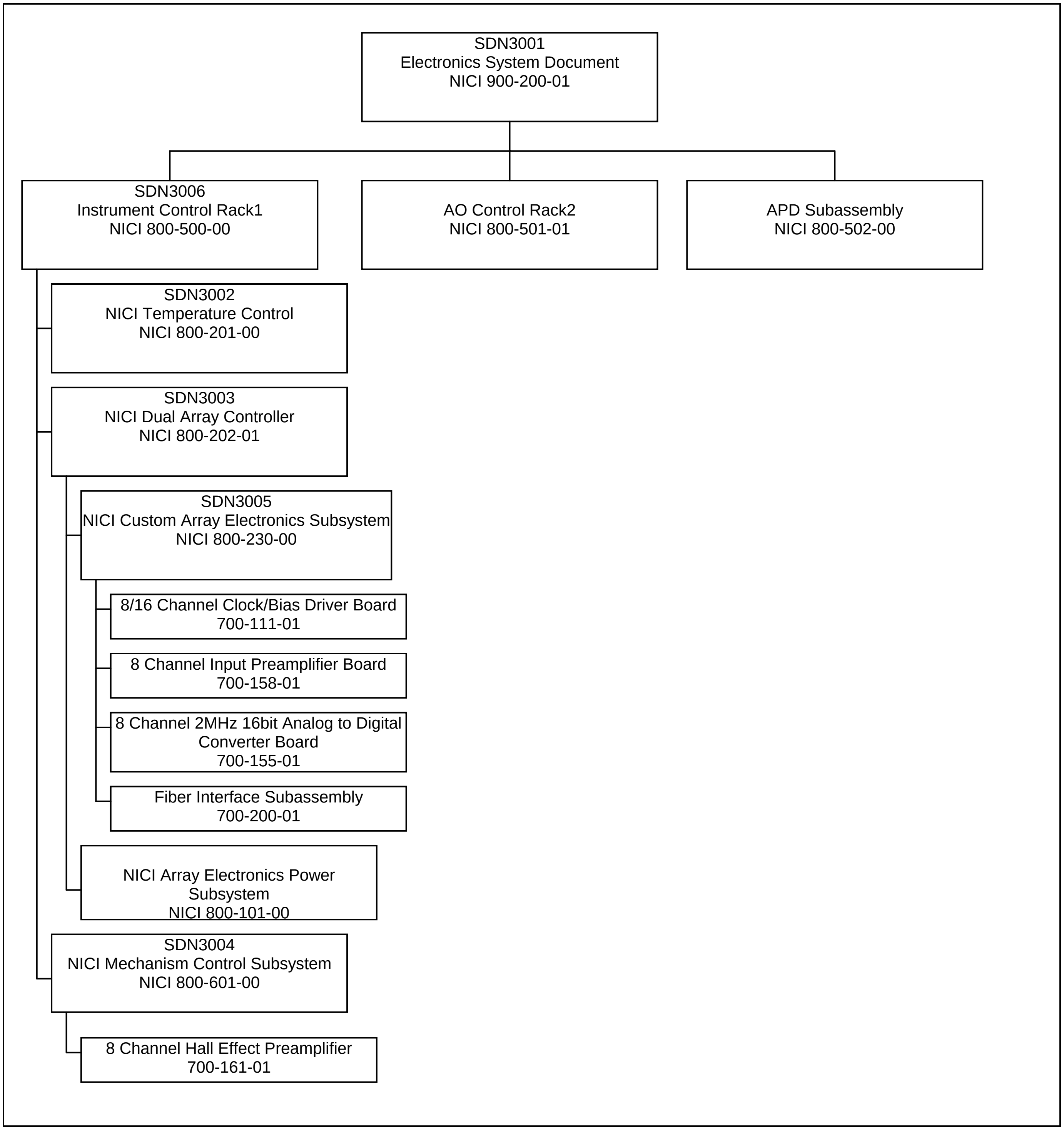


Figure 1 Block Diagram of Major NICI Assemblies

1.3 Subsystem Document Tree

This section provides a tree of the documentation associated with the NICI instrument.



1.4 System Layout Diagram

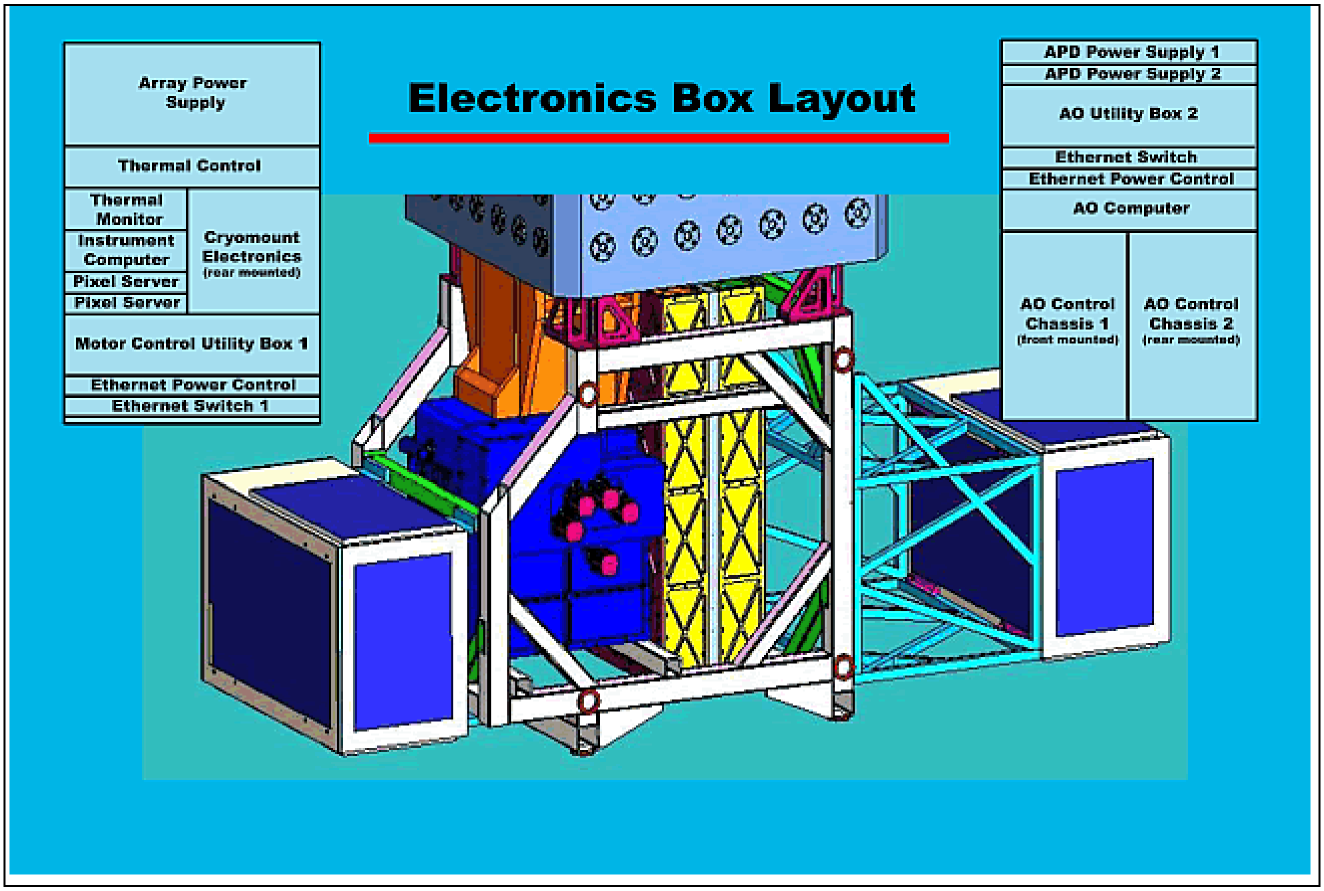


Figure 2 NICI System Electronics Box Layout

1.5 System Power Totals

The estimated electronics system total power dissipation is 2889 Watts.

Note: System power totals are subject to change through the integration phase.

2 Instrument Control, Rack1

This section discusses the NICI subsystems and hardware components that are contained in or have direct connections with the Instrument Control Rack, Rack1. The major functions of Instrument Control are NICI camera control and motor control. This includes array control, mechanism control, and cryogenic thermal control of the cryostat. Rack1 and Instrument Control are used interchangeably to refer to this component of NICI.

Major interfaces are to the Cryostat and cryostat mounted motor systems.

2.1 Instrument Control Functional and Performance Requirements

This section provides bullet lists of the functional and performance requirements for subsystems associated with Rack1, the IC Rack. This set of requirements specifies the Instrument Control electronics functionality and capabilities of the NICI instrument.

2.1.1 Array Control System Functional Requirements

- Must operate two 4 quadrant Aladdin type III style arrays
  - o *Reference Document*: SDN 3003 NICI Dual Array Controller
- Must allow synchronization of readouts of the two arrays to 1 millisecond.
  - o *'Quick Answer'*: The Clocking FPGA circuitry located on the FCRYO2 board will start exposures when in an ARM state and after receiving an optocoupled TTL level TRIGGER signal. Clocking will be synchronized to within 140nsec.
  - o *Reference Document*: FCRYO2 Fiber Interface Subassembly, 700-200-01
- Single subarray mode minimum size 8x16 placed anywhere in the array and reflected to all four quadrants.
- Global reset.
- Single sampled readout mode.
- Double correlated sampling readout mode.
- Multiple NDR noise reduction sampling mode.
  - o *'Quick Answer'*: The Clocking FPGA circuitry located on the FCRYO2 board allows for flexible clocking encompassing these requirements.
  - o *Reference Document*: FCRYO2 Fiber Interface Subassembly, 700-200-01
- Connect to Gemini through a Socket for remote control.
  - o *Reference Document*: NICI Software Array Control and Image Acquisition.
- State set and state read commands.
- Populate the FITS header and ship the data to the DHS.
  - o *Reference Document*: NICI Software Array Control and Image Acquisition.
- Must operate in a standalone mode or under Gemini control in a remote mode.
- Must provide an image display in standalone mode.
  - o *Reference Document*: NICI Software Array Control and Image Acquisition.
- Must provide local storage for standalone mode
  - o *Reference Document*: SDN 3003 NICI Dual Array Controller, NICI-800-202-01
- Must time stamp frames using Gemini supplied time board.
  - o *'Quick Answer'*: NICI will use a MKIR supplied time board located in the Pixel Servers
  - o *Reference Document*: SDN 3003 NICI Dual Array Controller, NICI-800-202-01
  - o *This requirement has been changed to a Gemini responsibility*.
- Must have macro capability in stand alone mode.
  - o *Reference Document*: SDN 3003 NICI Dual Array Controller, NICI-800-202-01

2.1.2 Array Control System Performance Requirements

- Read noise - the controller should not increase the device noise by more than 10%.
  - *'Quick Answer'*: 'The gain is fixed at X5 and the bandwidth is limited to ~2.9Mhz with resulting calculated noise (with a 1K source impedance) equal to 53.2uV. For the +/-2.5V input range of the ADCs' one bit (LSB) is equal to 76uV so the preamplifier contributes less than 1 LSB.'
    - *Reference Document*: PREAMP8 8 Channel Differential Input, Array Optimized Low Noise Preamplifier Board, 700-158-01.
  - *'Quick Answer'*: The previous generation array controllers using the same analog and ADC circuitry has been able to achieve the read noise requirement on 6 different Aladdin arrays on 3 different telescopes (SUBARU, IRTF, NRL/NO Flagstaff).
- A/D resolution – adequate to get two bits on the noise
  - *'Quick Answer'*: The gain is fixed at X5. From experience, the e/ADU ratio averages ~10e/ADU at this setting, leaving ~ 4bits of resolution on the noise from single Fowler pair readout of the Aladdin III.
    - *Reference Document*: PREAMP8 8 Channel Differential Input, Array Optimized Low Noise Preamplifier Board, 700-158-01
- Full frame co-add rate – 2 Hz required (10 Hz goal).
- Full frame to disk rate – 2 Hz required (10 Hz goal).
  - *'Quick Answer'*: As of 3/15/2002, testing has that shown data processing and storage rates have achieved the 2 Hz requirement and 10Hz goal for both coaddition and storage.
- Display frame rate stand in alone mode – 0.5 sec to display frame desired.
  - *'Quick Answer'*: As of 3/15/2002, no testing has been performed.

2.1.3 Temperature Controller System Functional Requirements

- Independently control the temperature of each array to a user settable temperature of approximately 30 – 35 degrees Kelvin +/- 0.1 degrees Kelvin.
- The temperature controller shall be serially controlled and allow for readout of the temperature and modification of the set point, the servo loop PID parameters and the heater output power.
- Temperature sensors positions will be in the following locations:
  - Red Array mount
  - Blue Array mount
  - Cold Structure Closed Cycle Cooler first stage
  - Cold Structure Closed Cycle Cooler second stage
  - Camera cold structure (farthest point from closed cycle cooler attachment)
  - Radiation shield (farthest point from closed cycle cooler attachment)
  - Radiation Shield cooler first stage
  - Avalanche Photo Diode (APD) Chassis

2.1.4 Temperature Controller System Performance Requirements

- The temperature may not vary by more than 0.1 degrees K over periods of 10 minutes. Gradual drifts of not more than 1 degree K are allowed as long as the change in temperature does not exceed 0.1 degrees K/10 minute period.

2.1.5 Mechanism Control System Functional Requirements

Additional functional and performance requirements for Mechanism Control can be found in the NICI Operational Concepts Definition Document, the NICI Functional and Performance Requirements Document, and SDN1001 NICI Mechanism Top Level Functional and Performance Requirements documents.

- The NICI mechanisms must be capable of operation while the telescope is slewing and under the maximum instrument rotation when transiting near zenith.

2.1.6 Mechanism Control System Performance Requirements

- Mechanisms have a goal of changing from any position to any other position in under 60 seconds, with an ideal goal of 30 seconds.

2.2 Descriptions of Rack1 Instrument Control Components

2.2.1 Overview of Instrument Control Components

The Instrument Control, Rack1, portion of NICI is contains several subsystems. The subsystems often encompass several subassemblies. Listed below are the subsystems and the subassemblies they contain. A system level diagram of the subassemblies is provided in Figure 3. There are 2 interfaces to assemblies associated with Rack2, the AO Assembly and the AO APD Chassis.

- Dual Array Control
  - Array Control Chassis (Red and Blue)
  - Pixel Servers (Red and Blue)
  - Array Power Supply Subsystem
- Instrument Controller (server)
- Temperature Control
  - Temperature Controllers (Red and Blue)
  - Temperature Monitor
- Mechanism Control
  - Terminal Server
  - Mechanism Utility Box
  - JBOX (external to Rack1)
  - Motors (external to Rack1 mounted on the Cryostat)
  - Field Steering Mirror controller
  - Animatics Power Supply

Additionally there are two subassemblies that support the general operation of Rack1, the Ethernet Power Control module and the Ethernet Switch.

Functional descriptions of Instrument Control subsystems are provided in the following sections.

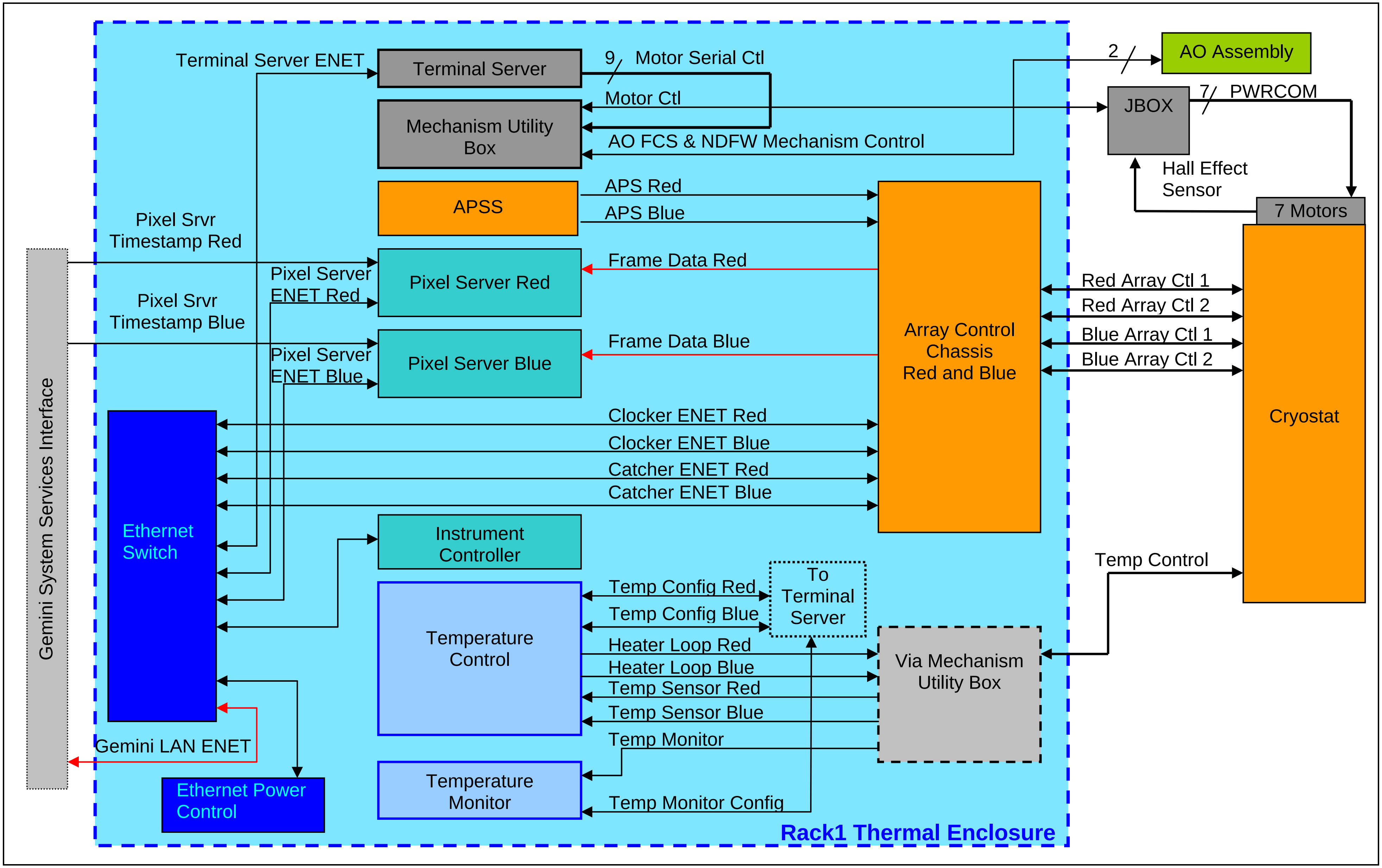


Figure 3   Rack1 System Level Block Diagram

2.2.2 Dual Array Controller Description

The Dual Array Controller is dual implementation of MKIR's Redstar3 Array Controller. The Redstar3 provides control of and data acquisition from a four quadrant Aladdin type III 1024x1024 array. By using both array channels one can observe in a differential mode and high fidelity frame differencing is possible. The Dual Array Controller contains several major subassemblies: the Array Control Chassis, an Array Power Supply Subsystem, an Instrument Control server, and two Pixel Servers.

For a detailed description of the Dual Array Controller, see the document Gemini SDN3003, Dual Array Controller, MKIR# NICI-800-202-01.

2.2.2.1 Array Control Chassis

The Array Control Chassis is a VME-style enclosure that contain Dual Array Control subsystem electronics. Each is a chassis that contains various boards and system cable connectors used to implement the Dual Array Controller functionality. Note that the Array Control Chassis is not implemented as a standard VME chassis. The Array Control Chassis are mounted inside Rack1.

WARNING: **The Array Control Chassis and boards are not compatible with the VME standard**, though they may appear to be. Inserting the boards in a standard VME chassis will likely cause a **catastrophic failure**. Likewise inserting standard VME cards into the chassis is prohibited and extremely risky.

Note that previous implementations of the Array Controller had this chassis mounted on the Cryostat. So, some documentation may refer to this subsystem as the Cryomount Electronics or the Cryostat Mounted Electronics.

2.2.2.2 Array Power Supply Subsystem

The Array Power Supply Subsystem (APSS) provides low noise power to the Array Control Chassis components and hence the arrays. The APSS is implemented with a specially modified Hewlit Packard (Agilent) 66000 Modular Power System. The APSS is mounted inside Rack1.

2.2.2.3 Pixel Servers

The Red and Blue Pixel Servers are NICI's data processing engines. They collect and assemble array data and perform some image processing. The Pixel Servers are implemented with Thinservers and are mounted in Rack1.

Most of the functionality of the Pixel Servers is implemented with software. For more information see the NICI Software Array Control and Image Acquisition document.

2.2.3 Temperature Control

The Temperature Control subsystem is a dual array temperature control and monitoring subsystem based on two Lakeshore Cryotonics 332 temperature controllers and one Model 218 Temperature Monitor. They are used to monitor and control the temperatures of the arrays in the cryostat.

For more details on the Temperature Control subsystem, see the Gemini SDN3002, TEMP2 Redstar3 Dual Array Temperature Controller document, MKIR# NICI-800-220-00.

2.2.3.1 Temperature Controllers

The Temperature Controllers are two Lakeshore Model 332S Temperature Controllers which are used to control the Red Array and Blue Array temperatures. The controllers' function can be controlled via a serial interface. The Temperature Controllers are mounted inside Rack1.

2.2.3.2 Temperature Monitor

The Temperature Monitor is a Lakeshore Model 218 Temperature Monitor. The Temperature Monitor monitors the temperatures of both arrays and the APD Chassis. The monitor is mounted inside Rack1.

2.2.4 Instrument Controller
The Instrument Controller (IC) is the primary controller of the NICI instrument. It is implemented in a Thinserver. The Instrument Controller provides configuration information and run-time control to the Array Controller subsystem and provides motor control to the Motor Control subsystem. The Instrument Controller also provides configuration information to the Pixel Servers for data acquisition. The Instrument Controller is mounted inside Rack1.

Most of the functionality of the IC is implemented with software. For more information see the NICI Software Array Control and Image Acquisition document.

The Instrument Controller may also be referred to as the Instrument Workstation.

2.2.5 Cryostat
The Cryostat is a thermal enclosure that houses NICI's Aladdin III arrays. The Cryostat interfaces with the Temperature Control and Dual Array Control subsystems in the Instrument Controller.

2.2.6 Mechanism Control
The Mechanism Control subsystem controls nine mechanisms in the NICI instrument. The Mechanism Control subsystem consists of the Terminal Server, Mechanism Utility Box, Motors, and JBOX. These subassemblies are described in the following sections.

2.2.6.1 Terminal Server
The Terminal Server provides an Ethernet to serial interface for controlling the NICI mechanisms. It is mounted in Rack1.

2.2.6.2 Mechanism Utility Box
The mechanism utility box gathers the serial control lines for NICI's mechanisms into one cable for routing to the motors and provides power to the mechanisms. It is mounted in Rack1.

2.2.6.3 Motors
There are seven motors mounted on the Cryostat, the Pupil Mask, Dichroic, Red Channel Filter, Blue Channel Filter, Pupil Imager, and Spider Mask motors. There are also two mechanisms in the AO side of NICI that the Mechanism Control subsystem controls, one motor for the Neutral Density Filter wheel and one translator for the Fiber Optic Calibration Source mounted in the AO Assembly. The motors are controlled via serial ports.

2.2.6.4 JBOX
The JBOX, or Junction Box, is a custom component that provides fanout of the power and serial signals from the Motor Control subsystem to the motors mounted on the cryostat. The JBOX also contains motor control sensors (Hall effect). The JBOX is mounted outside of Rack1 on the Cryostat.

2.2.7 Ethernet Switch
The Rack1 Ethernet Switch is just that, an ethernet switch. It provides the means for Instrument Control components to communicate with each other and a connection to the Gemini LAN.

2.2.8 Ethernet Power Control
The Rack1 Ethernet Power Control modules provides a means for remotely controlling power to the subassemblies in Rack1. It provides a telnet interface for turning power to Rack1's subassemblies on and off and for monitoring power consumption.

2.3 Instrument Control Rack1 Mechanical Details

This section provides mechanical details on Rack1 and its components. Information is provided for mechanical dimensions, weight, layout, and power dissipation estimates.

2.3.1 Instrument Control Rack1 Thermal Electronics Enclosure Mechanical Dimensions

The 1300 mm Gemini Thermal Electronics Enclosure is used for the Instrument Control electronics Rack1. According to the Gemini document “ICD 1.9/3.7 Science Instruments to Facility Thermal Electronics Enclosures (9/23/97)” the Thermal Enclosure (BlueBox) contains a standard 19” rack with 22U of available height and 22.0” of available depth. Some custom rework on the enclosure was necessary to obtain maximum rack space. Some of NICI's components are mounted with custom hardware and rail modifications. An additional 4.3” of depth is available by using custom mounting hardware for a total of 28.3” of rack depth.

External Height		External Width		External Depth	
Inches	mm	Inches	mm	Inches	mm
51.2”	1300 mm	22.0"	559 mm	31.375"	796 mm

Figure 4 Rack1 Thermal Electronics Enclosure External Dimensions

Available Rack Space			Available Internal Width			Available Internal Depth	
U	Inches	mm	HP	Inches	mm	Inches	mm
22.5U	31.5”	800.1 mm	84	**18.0**	457 mm	28.3”	622.6 mm

Figure 5 Rack1 Thermal Electronics Enclosure Internal Dimensions

2.3.2 Rack1 Subassembly Mechanical Dimensions

This section provides the mechanical dimensions of the subassemblies in Rack1.

Subassembly	Part	H(in)	H(mm)	U	W(in)	W(mm)	D(in)	D(mm)
Terminal Server	Perle Terminal Server CS9024	1.77	45.0	1 U	16.93	430.0	9.01	228.9
Mech. Utility Box	Elma Type 14 3U chassis	4.95	125	3 U	16.75	425.45	20.96	532.38
APS	HP 66000	7.50	190.5	5 U	16.75	425.45	26.70*****	678.18*****
Pixel Server Red	HP DL360 G3	1.7	43.2	1 U	16.78	426.2	27.25*	692.2*****
Pixel Server Blue	HP DL360 G3	1.7	43.2	1 U	16.78	426.2	27.25*	692.2*****
Instrument Controller	HP DL360 G2	1.7	43.2	1 U	16.78	426.2	27.25*	692.2*****
2 Temp Controllers	Lakeshore 332S **2 mounted side by side**	3.5	90	2 U	17.0	434	14.5	368
2 CCC PS	CTI Custom **2 mounted side by side**	3.5	90	2 U	17.0	434	14.5	368
Temperature Monitor	Lakeshore 218	3.5	90	2 U	8.5	217	12.5	317.5
Ethernet Power Control	Baytech RPC3-20	1.72	43.7	1 U	16.73	424.9	5.25	133.4
Ethernet Switch*	Cisco 2950C-24 WS-C2950C-24	1.72	43.7	1 U	17.5	444.5	9.52	241.8*****
Array Control Chassis	Elma	9.90	251	6 U	16.75	425.45	12.0	304.8
Animatics Power Supply*	Animatics PS42V20A-OF	4.75	121	-	10.0	254	7.0	178
				26 U Total			*** Requires custom mounting hardware**	

Dimensions: **1U = 1.75"**

Figure 6 Table of Electronics Components' Dimensions in Rack 1

2.3.3 Rack1 Weight

This section lists the weights of the subassemblies in Rack1 including the Thermal Enclosure. It provides an estimate of the total weight of Rack1.

Assembly	Part	Weight (lbs)	Weight (Kg)
Blue Box	Gemini Electronics Thermal Enclosure	353	160
Terminal Server	Perle Terminal Server CS9024	4.4	2.0
Mech. Utility Box	Elma Type 14 3U chassis	30.0	13.6
APS	HP 66000	69.0	31.4
Pixel Server Red	HP DL360 G3	37.0	16.8
Pixel Server Blue	HP DL360 G3	37.0	16.8
Instrument Controller	HP DL360 G2	39.0	17.7
2 Temp Controllers	Lakeshore 332S	10.5	4.77
Temperature Monitor	Lakeshore 218	6.6	3.0
Ethernet Power Control	Baytech RPC3-20	3.0	1.4
Ethernet Switch	Cisco 2950C-24 WS-C2950C-24	6.5	3.0
2 CCC PS	CTI Custom	20	9.2
Array Control Chassis	Elma	25.0	11.4
Animatics PS	Animatics PS42V20A-OF	16.5	7.5
TOTAL		**657.5 lbs**	**298.6 Kg**

Figure 7 Table of Weights of NICI Rack1 Subassemblies

2.3.4 Rack1 Subassembly Layout

This section details the layout, that is, the physical locations of the subassemblies in Rack1. In the table below each 1U of vertical rack space is assigned a slot number from 1 to 22 from top to bottom. Electronics components can be mounted in the front side or in the rear side of the BlueBox. The rear side of the BlueBox is the side with the instrument connection breakout panel, often referred to as the Patch Panel. The Array Control Chassis has been placed to minimize the cable length of the Array Control cables. **Note that it is assumed that the Ethernet Power Control module(s) can be mounted *in* the enclosure *outside* of the rack.**

Slot	Rear Mounted Components	Front Mounted Components	Total Consumed Depth (inches)
1		Mech. Utility Box: 20.96” D, 3U	20.96
2		Mech. Utility Box: 20.96” D, 3U	20.96
3		Mech. Utility Box: 20.96” D, 3U	20.96
4		Instrument Controller: 27.3" D, 1U	27.3*
5		Pixel Server Red: 27.3" D, 1U	27.3*
6		Pixel Server Blue: 27.3" D, 1U	27.3*
7		2 CCC PS: 12.5” D, 3U	12.5
8	Terminal Server: 9.0” D, 1U	2 CCC PS: 12.5” D, 3U	21.5
9	Ethernet Switch: 9.52” D, 1U	2 CCC PS: 12.5” D, 3U	22.0
10		APS: 26.70” D, 5U	26.7*
11		APS: 26.70” D, 5U	26.7*
12		APS: 26.70” D, 5U	26.7*
13		APS: 26.70” D, 5U	26.7*
14		APS: 26.70” D, 5U	26.7*
15	Rotated Array Control Chassis: 12.0” D, 6U		24.0 + *
16	Rotated Array Control Chassis: 12.0” D, 6U, Array Cables		24.0 + *
17	Rotated Array Control Chassis: 12.0” D, 6U, Array Cables		24.0 + *
18	Rotated Array Control Chassis: 12.0” D, 6U		24.0 + *
19	Rotated Array Control Chassis: 12.0” D, 6U		24.0 + *
20	Rotated Array Control Chassis: 12.0” D, 6U		24.0 + *
21		**2** Temp Controllers: 14.5” D, 2U	14.5
22		**2** Temp Controllers: 14.5” D, 2U	14.5
	Ethernet Power Control* (Side mounted in the enclosure outside the rack)		16.73 Wide
	Animatics Power Supply* (Mounted on floor)		7.0
	<——————————Total Depth 22” (poss. 24”) ——————————>		*** Requires custom mounting hardware**

Figure 8 Table: Layout of Subassemblies in Rack1 Thermal Electronics Enclosure

2.4 Rack1 Power Dissipation Estimates

This section provides a table of the power dissipation estimates for the subassemblies in Rack1. See the supporting subsystem documents for a more detailed breakdown.

Subassembly	Power	Voltage Input	Current Input
Pixel Server Red	361.0 W (max)	120 VAC	3.89 A
Pixel Server Blue	361.0 W (max)	120 VAC	3.89 A
Instrument Controller	331.0 W (max)	120 VAC	3.89 A
APSS	91.8 W	120 VAC	0.54 A
Temperature Control	339.4 W	120 VAC	2.00 A
Temperature Monitor	25.5 W	120 VAC	0.15 A
Mechanism Utility Box	72.0 W	120 VAC	0.85 A
Terminal Server	25 W	120 VAC	1.8 A
Ethernet Power Control	5.0 W	120 VAC	0.06 A
Ethernet Switch	5.0 W	120 VAC	0.06 A
2 CCC PS	TODO TBD	120 VAC	2.0 A (1.0 each)
Array Control Chassis	via APSS	120 VAC	via APSS
TOTAL	**1296.7 W**	**-**	**19.13 A**

Figure 9 Rack1 Subassembly Power Estimates

3 Adaptive Optics, Rack2

This section discusses the NICI subsystems and hardware components that are contained in or have direct connections with the AO Rack, Rack2. The major function of the AO Rack is controlling NICI's adaptive optics. This includes monitoring the Wavefront Sensor (WFS), controlling the AO's Deformable Mirror (DM), and providing a User Interface.

Major interfaces are to the APD Chassis and AO Assembly.

3.1 Adaptive Optics Functional and Performance Requirements

This section provides bullet lists of the functional and performance requirements for subsystems associated with Rack2, the AO Control Rack. This set of requirements specifies the AO Control electronics functionality and capabilities of the NICI instrument.

- Internal mechanisms have a goal of changing from any position to any other position in under 60 seconds, with an ideal goal of 30 seconds.
- AO Mechanisms have some positional reproducibility specifications.
  - AO Relay's Fiber optic calibration feed, a 2 position translator: +/- 0.5 mm.
  - WFS' Tip/tilt Field Steering Mirror, a 2 angle tilt mirror: (TODO TBD).
  - WFS' Membrane mirror focus drive, a continuous linear slide: +/- 0.1 mm.
  - WFS' Neutral density filter wheel, a discrete position wheel: +/- 0.25 mm.
  - WFS' Field of view aperture, a motorized iris: +/- 0.25 mm.
- These are the expected corrected image Strehl versus wavelength for a guide star < 12^{th} magnitude.
  - Wavelength J, Strehl 0.50.
  - Wavelength H, Strehl 0.67.
  - Wavelength K, Strehl 0.80.
  - Wavelength L', Strehl 0.93.
  - Wavelength M', Strehl 0.95.

3.2 Descriptions of Adaptive Optics Components

3.2.1 Overview of Adaptive Optics Components

The Adaptive Optics, Rack2, portion of NICI contains two major subsystems, the Adaptive Optics control and the AO User Interface. The AO Control subsystem contains several subassemblies. Listed below are the subsystems and the subassemblies they contain. There are two subassemblies that support the general operation of Rack2, two Ethernet Power Control modules and the Ethernet Switch. A diagram of the subassemblies is provided in Figure 10.

- Adaptive Optics Control
  - AO Assembly
    - Optical Path Components
    - Lenslet Array
    - Deformable Mirror
  - APD Chassis and APD Power
  - Counter Chassis
  - High Voltage Amplifier (HVA) Chassis and HVA Power
  - Real Time (RT) Server
  - Terminal Server
  - AO Utility Box
  - Tip/Tilt Control and TT Platform
- User Interface (UI) Server

Functional descriptions of the AO subsystems are provided in the following sections.

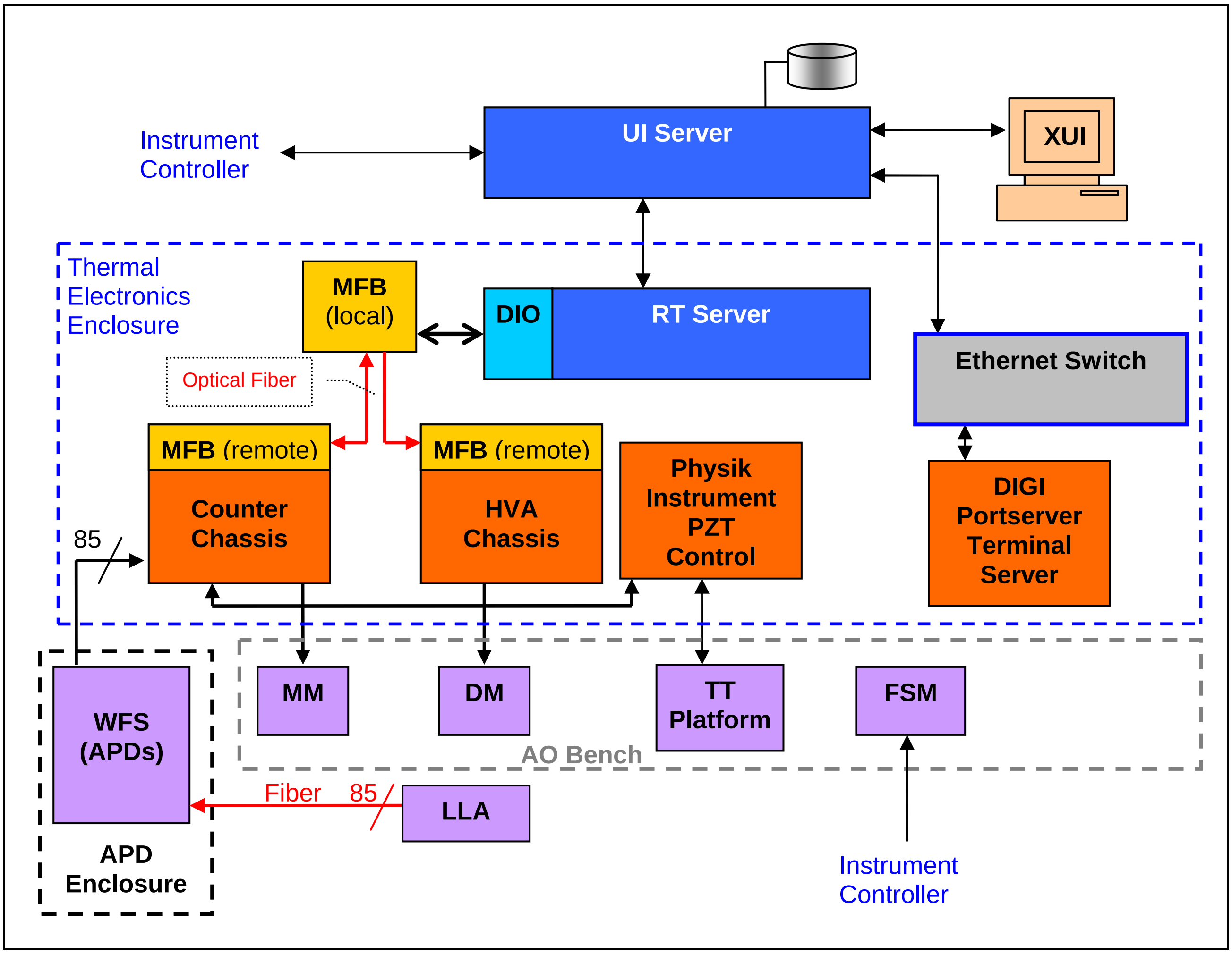


Figure 10 Rack2 System Level Block Diagram

3.2.2 AO Control Subsystem Description

The AO Control Subsystem provides real time control and monitoring of NICI's adaptive optics system. This section provides a description of the electronics components in NICI's AO Control subsystem.

The major electronics parts of the system are the Real Time (RT) Server, a High-Voltage Amplifier (HVA) Chassis, a Counter Chassis, a Tip/Tilt (TT) platform actuator controller, a terminal server (DIGI Portserver), and a pair of remote power control devices. All of these subsystems reside in the electronics thermal enclosure. The components that interface directly with the electronics are the WFS's APDs, the Membrane Mirror (MM), Deformable Mirror (DM), the DM tip/tilt platform, and Field Steering Mirror (FSM).

The AO Control subsystem implements a closed computational loop for controlling the adaptive optics function in NICI. The light from a guide star falls on the lenslet array which pipes the light into 85 fibers. These fibers are fed into the APD rack to 85 Avalanche Photo Diodes that provide photon counts to the Counter Chassis. The Counter Chassis accumulates these counts in 2 phases and sends them to the RT Server. The RT Server computes corrections to be sent to the HVA Chassis which drives high voltage to the Deformable Mirror in the AO Assembly.

The basic flow through the electrical system is as follows. First, photons passed by the Lenslet Array (LLA) are converted into TTL pulses by the APD modules. These pulses flow through 85 BNC cables from the APD enclosure to the Counter Chassis. Here the pulses are integrated and sent to the RT Server via a fiber optic cable. The RT Server calculates the wavefront errors and the DM and TT platform control signals. These signals are sent to the High-Voltage Amplifier Chassis via another fiber optic cable. The HVA Chassis converts the signals into high-voltage signals to drive the DM and TT platform. Auxiliary controls (such as mechanism controls) are done via the Instrument Control hardware and software.

3.2.2.1 AO Assembly

The electronics that the AO Assembly contains are the Lenslet Array, the Deformable Mirror, and Membrane Mirror. The Lenslet Array pipes light into fibers which are routed to the APDs. The APDs provide photon counts via electrical pulses to the Counter Chassis. The 85 element DM is controlled by the HVA chassis. The Membrane Mirror provides 2 out of focus images to the WFS and is controlled by the Counter Chassis.

3.2.2.2 APD Chassis and APD Power

The APD Chassis contains 85 Avalanche Photo Diodes. Light from the Lenslet Array in the AO Assembly is piped into 85 fibers which feed into the APDs. The APDs provide photon counts in the form of electrical pulses via coaxial cable to the counter chassis. A dedicated power supply, APD Power, is used to provide high current, low voltage, clean power to the APDs. Spare APD modules are also mounted in the APD Chassis for use in case of APD failures.

3.2.2.3 Counter Chassis

The Counter Chassis is a VME-style enclosure that contains AO Control boards, an amplifier for the Membrane Mirror, and various system cable connectors. The boards are Counter boards and a Multi-Function board. The function of the Counter Chassis is to accumulate photon counts from the APDs which are read by RT Server software. Note that the Counter Chassis is not implemented as a standard VME chassis. Do not insert standard VME cards into this chassis. Do not insert the Counter Chassis' boards into standard VME backplanes. The Counter Chassis is mounted inside Rack2.

3.2.2.4 HVA Chassis and HVA Power

The HVA Chassis is a VME-style enclosure that contains boards for driving the Deformable Mirror and system cable connectors. The boards are a Multi-Function board and High Voltage Amplifier boards. Note that the HVA Chassis is not implemented as a standard VME chassis. The HVA chassis is mounted in Rack2.

The High Voltage Electronics are designed to drive high voltage signals to the DM's actuators. There are two major components in the HV Electronics, the HVA Chassis and the High Voltage Power Supply (HVPS). The HVPS provides power to the HVA Chassis for driving the DM's actuators.

The HVA Power module provides high voltage power to the amplifiers in the HVA Chassis' HVA boards for driving the DM. The HVA Power module is also mounted in Rack2.

3.2.2.5 Real Time Server

The Real Time (RT) Server is the computational workhorse of the AO Control subsystem. It takes photon counts from the Counter boards in the Counter Chassis and computes corrections to send to the HVA boards in the HVA Chassis. As this computational loop is a critical step in the AO function of NICI the RT Server is wholly dedicated to these computations and is implemented in a Thin Server running Real Time Linux. The RT Server is implemented with an external Multi-Function board for interfacing with the HVA Chassis and Counter Chassis. The RT Server also communicates with the User Interface Server via the Ethernet Switch. This connection allows the RT Server to mount the hard drive of the UI Server, receive configuration and run time commands from the UI Server, and to provide status of operation. Both are mounted in Rack2.

3.2.2.6 Terminal Server

The Terminal Server provides the ability to permit serial communication connections to an APD temperature sensor and the AO Rack's Ethernet Power Controllers from NICI's Ethernet network.

3.2.3 User Interface Server Subsystem Description

The User Interface (UI) Server is used to implement all server functions of the AO Control subsystem not dedicated to the AO correction computational loop implemented in the RT Server. The UI Server's major task is to provide user interfaces for working with NICI. The UI Server is dedicated to non-real-time tasks such as serving the XUI for instrument control, driving NICI's mechanisms, and providing configuration and control commands to the RT Server. It provides an X User Interface (XUI) for control of the AO Control subsystem and provides the interface to the rest of the NICI instrument and the Gemini LAN. The UI Server is implemented in a Thin Server and is located remote from the instrument, probably in the Telescope Control Room.

The UI Server has a connection to NICI's Ethernet Switch. This connection serves the GUIs to external workstations and is the channel for sockets connecting to the AO Control system.

3.2.4 Ethernet Switch

The Rack2 Ethernet Switch is just that, an Ethernet switch. It provides the means for Adaptive Optics components to communicate with each other and a connection to the Gemini LAN.

3.2.5 Ethernet Power Control

The two Ethernet Power Control modules provide a means for remotely controlling power to the subassemblies in Rack2. Each provides a telnet interface for turning power to Rack2's subassemblies on and off and for monitoring power consumption.

The Remote Power Control modules provide the capability to remotely control and monitor power to NICI's electronics components via telnet. Each module has an Ethernet connection to NICI's local network (for users), a serial connection to the Digi Portserver (for software), and eight 120VAC outlets. A command list can be obtained in a telnet session to a unit with the 'help' command. Users may turn outlets on and off, query the status of the outlets, and monitor current consumption and internal RPC temperature.

3.3 Rack2 Mechanical Details

This section provides mechanical details on Rack2 and its components.

3.3.1 Rack2 Thermal Electronics Enclosure Mechanical Dimensions

Again, a 1300 mm Gemini Thermal Electronics Enclosure is used for Rack2. According to the Gemini document "ICD 1.9/3.7 Science Instruments to Facility Thermal Electronics Enclosures (9/23/97)" the Thermal Enclosure (BlueBox) contains a standard 19" rack with 22U of available height and 22.0" of available depth. The actual usable depth of the rack measured in the Thermal Enclosure that was delivered to MKIR is 24.0". An additional 4.3" of depth is available by using custom mounting hardware for a total of 28.3" of rack depth.

External Height		External Width		External Depth	
Inches	**mm**	**Inches**	**mm**	**Inches**	**mm**
51.2"	1300 mm	24.0"	609 mm	31.375"	796 mm

Figure 11 Rack2 Thermal Electronics Enclosure External Dimensions

Available Rack Space			Available Internal Width			Available Internal Depth	
U	**Inches**	**mm**	**HP**	**Inches**	**mm**	**Inches**	**mm**
22.5U	31.5"	800.1 mm	84	**18.0**	457 mm	28.3"	622.6 mm

Figure 12 Rack2 Thermal Electronics Enclosure Internal Dimensions

3.3.2 Rack2 Subassembly Mechanical Dimensions

Subassembly	Part	H(in)	H(mm)	U	W(in)	W(mm)	HP	D(in)	D(mm)
APD Power	Sorensen DCS8-125E DC Power Supply	1.75	44.5	1U	19.0	483	85	17.5	445
Counter Chassis	ELMA 6U VME Chassis	9.90	251.46	6U	16.75	425.45	84	12.0	304.8
HVA Chassis	ELMA 6U VME Chassis	9.90	251.46	6U	16.75	425.45	84	12.0	304.8
RT Server	SWT 2U Dual Athlon 2800+ (custom chassis)	3.5	88	2U	16.73	425.0	84	25.7*****	652*****
UI Server	SWT 2U Dual Athlon 2800+	3.5	88	2U	16.73	425.0	84	25.7*****	652*****
Ethernet Switch	Cisco 2950C-24 WS-C2950C-24	1.72	43.7	1U	17.5	444.5	86	9.52	241.8
Ethernet Power Control 1*	Baytech RPC3-20	1.72	43.7	-	16.73	424.9	84	5.25	133.4*
Ethernet Power Control 2*	Baytech RPC3-20	1.72	43.7	-	16.73	424.9	84	5.25	133.4*
HVA Power	Sorensen DCS600-1.7E DC Power Supply	1.75	44.5	1U	19.0	483	85	17.5	445
Terminal Server	Digi Portserver II	2.4	57	2U					
				21 U Total				*** Requires custom mounting hardware**	

Figure 13 Table of Electronics Components' Dimensions in Rack 2

3.3.3 Rack2 Weight

Assembly	Part	Weight (lbs)	Weight (Kg)
Blue Box	Gemini Electronics Thermal Enclosure	353	160
Counter Chassis	Elma 6U VME Chassis	25.0	11.4
HVA Chassis	Elma 6U VME Chassis	25.0	11.4
RT Server	SWT 2U Dual Athlon	51.8	23.5
UI Server	SWT 2U Dual Athlon	51.8	23.5
Ethernet Switch	Cisco 2950C-24 WS-C2950C-24	6.5	3.0
Ethernet Power Control 1	Baytech RPC3-20	3.0	1.4
Ethernet Power Control 2	Baytech RPC3-20	3.0	1.4
HVA Power	Sorensen DCS8-125E	19.0	8.62
AO Utility Box	Custom	30.0	13.6
Digi Portserver	Portserver II	2.3	1.0
Steering Mirror Control	Physik Instrumente	10	4.5
TOTAL		**580 lbs**	**263 Kg**

Figure 14 Table of Weights of AO Control Rack2 Subassemblies

3.3.4 Rack2 Subassembly Layout

This section details the layout, that is, the physical locations of the subassemblies in Rack2. In the table below each 1U of vertical rack space is assigned a slot number from 1 to 22 from top to bottom. Electronics components can be mounted in the front side or in the rear side of the BlueBox. The rear side of the BlueBox is the side with the instrument connection breakout panel, often referred to as the Patch Panel. **Note that it is assumed that the Ethernet Power Control and UPC module(s) can be mounted *in* the enclosure *outside* of the rack. It is also assumed that the UI Server is not mounted in Rack2.**

Note: This layout is subject to change through the integration phase.

Slot	Rear Mounted Components	Front Mounted Components	Total Consumed Depth (inches)
1		RT Server: 25.7” D, 2U	25.7*
2		RT Server: 25.7” D, 2U	25.7*
3		APD Power: 17.5” D, 1U	17.5
4		HVA Power: 17.5” D, 1U	17.5
5	Digiport:		
6	Ethernet Switch: 9.52” D, 1U		
7		HVA Chassis: 12.0” D, 6U	12.0”
8		HVA Chassis: 12.0” D, 6U	12.0”
9		HVA Chassis: 12.0” D, 6U	12.0
10		HVA Chassis: 12.0” D, 6U	12.0
11	APD Temp Monitor:	HVA Chassis: 12.0” D, 6U	16.0"
12		HVA Chassis: 12.0” D, 6U	12.0
13		COUNTER Chassis: 12.0” D, 6U	12.0
14		COUNTER Chassis: 12.0” D, 6U	12.0
15		COUNTER Chassis: 12.0” D, 6U	12.0
16		COUNTER Chassis: 12.0” D, 6U	12.0
17		COUNTER Chassis: 12.0” D, 6U	12.0
18		COUNTER Chassis: 12.0” D, 6U	12.0
19			
20			
21			
22			
	2 Ethernet Power Control (Side mounted in the enclosure outside the rack)		16.75 Wide*
	UPCs		
	<——————————Total Depth 28.3”————————————————>		*** Requires custom mounting hardware**

Figure 15 Table: Layout of Subassemblies in Rack2 Thermal Electronics Enclosure

3.4 Rack2 Power Dissipation Estimates

This section provides a table of the power dissipation estimates for the subassemblies in Rack2. See the supporting subsystem documents for a more detailed breakdown.

Subassembly	Power	Voltage Input	Current Input
APD Power	90 W	120 VAC	0.53 A
Counter Chassis	250 W	120 VAC	2.36 A
HVA Chassis	250 W	120 VAC	2.36 A
RT Server	400W	120 VAC	3.89 A
UI Server	400W	120 VAC	3.89 A
Ethernet Switch	5.0 W	120 VAC	0.06 A
Ethernet Power Control 1	5.0 W	120 VAC	0.06 A
Ethernet Power Control 2	5.0 W	120 VAC	0.06 A
HVA Power	90 W	120 VAC	0.53 A
AO Utility Box	72.0 W	120 VAC	0.85 A
Terminal Server	25 W	120 VAC	1.8 A
TOTAL	**1592.0 W**	**-**	**16.4 A**

Figure 16 Rack2 Subassembly Power Estimates

4 System Grounding

This section describes NICI's system grounding. Section 4.1 describes technical details of the grounding plan. Section 4.2 contains a diagram of the system grounding.

4.1 Plan Description

The grounding plan for the instrument is handled at five levels. The first is at the Array Control level. Separate analog and digital ground planes are used on all of the Array Control boards and the Array Control Chassis' backplane. A single point connection between them is unavoidably made at the analog to digital converters because the devices themselves are manufactured with an internal connection between the two potentials. The fact that there are multiple ADCs in the system places the best point for a single point ground at these connection points. This configuration dictates that the power supplies must have floating outputs. Previous experience has shown that there can also be substantial coupling capacitance between the power supply chassis and the outputs, so isolation is also often necessary.

The second level of grounding is accomplished with the fiber optic link between the Embedded Computers (IC and Pixel Servers) and the Array Control Chassis. This complete optical isolation is intended to keep the high current and high frequency power distortion generated by the computer systems away from the low noise Array Control electronics.

Each Array Control electronics subsystem will have its own independent ground (that can be alternatively shorted to the other). This third level of grounding is intended to minimize crosstalk between the readout of the two arrays. A dual independent power supply system supports this configuration.

Another area of concern is the fourth level of ground isolation that between the closed cycle cooler system and the cryostat mounted electronics. The closed cycle cooler will not be electrically isolated from the cryostat vacuum jacket, so the two array wiring inside will be isolated.

The fifth level of the system grounding plan is illustrated in the following figure. It is an attempt to identify all of the different ground potential points in the facility that may affect the performance of the instrument. The diagram provides a starting point to identify and fix grounding problems.

4.2 System Ground Diagram

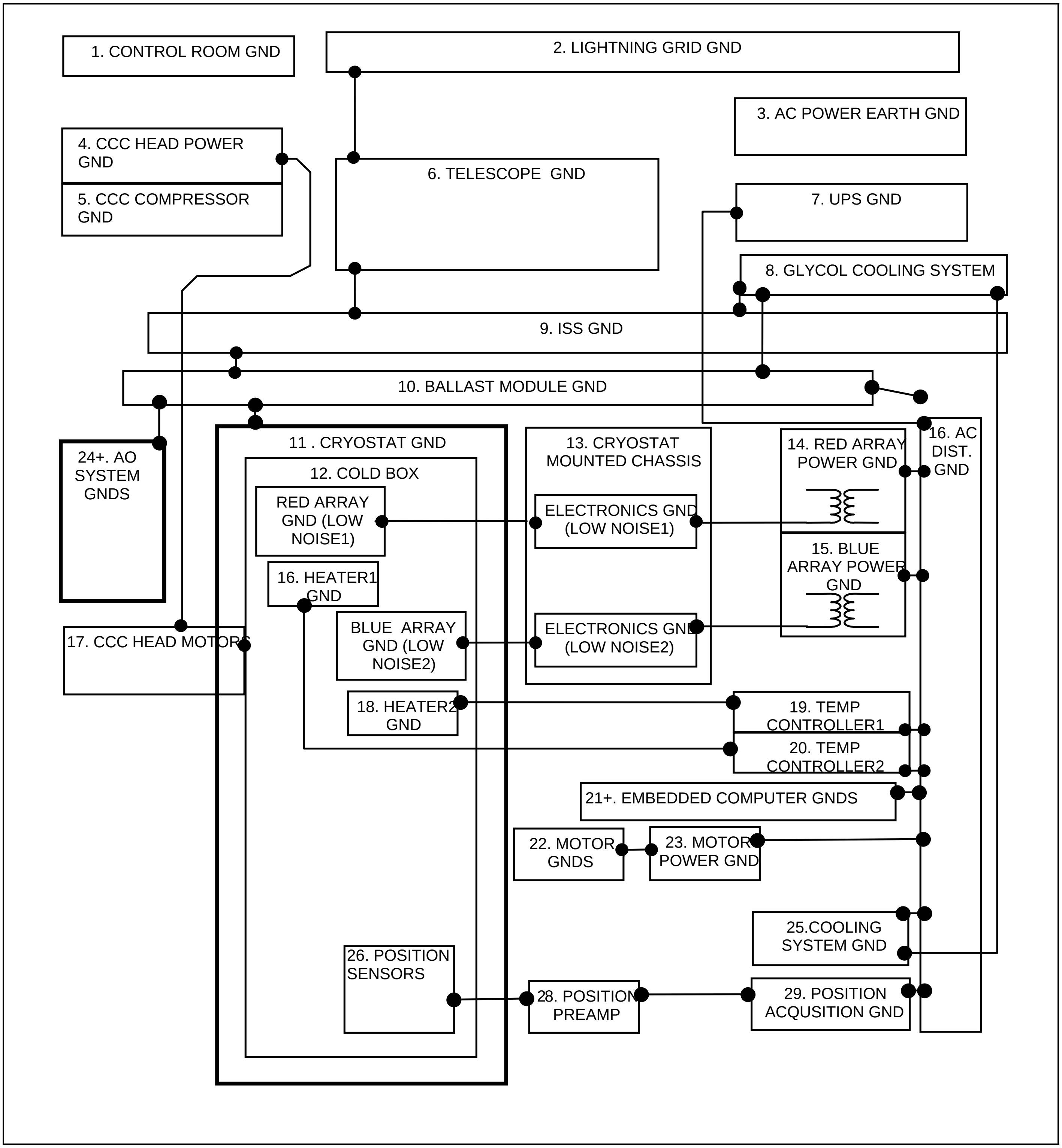


Figure 17 System Grounding Diagram

5 System Cabling

This section lists the System Level cables in the NICI instrument. System Level cabling is usually between subsystems, that is, between major components of NICI. Generally cabling and connections internal to a subsystem or subassembly are not considered to be at the System Level. For those connections see the corresponding Subsystem Level (800 Level) hardware document.

The cables are listed separately for Rack1 and Rack2. The cables are illustrated in the System Level Block Diagrams in Figure 3 on page 11 for Rack1 and Figure 10 on page 20 for Rack2. Power connections are not shown in the diagrams, but the power cables are listed here.

5.1 Rack1 System Cabling List

Rack1 Cable Name	Connections	Type, Description	Length
APS Red	Array Power Supply – Array Control Chassis Red	16-pin Glenair:	
APS Blue	Array Power Supply – Array Control Chassis Blue	16-pin Glenair:	
Frame Data Red	Array Control Chassis Red SL240 CMC –Pixel Server Red	2 Fiber Optic Multimode fibers. 50/125 μm (850nm) LC Connector	
Frame Data Blue	Array Control Chassis Blue SL240 CMC – Pixel Server Blue	2 Fiber Optic Multimode fibers. 50/125 μm (850nm) LC Connector	
Pixel Srvr ENET Red	Pixel Server Red – Ethernet Switch	RJ-45	
Pixel Srvr ENET Blue	Pixel Server Blue – Ethernet Switch	RJ-45	
Instrument Controller ENET	Instrument Controller – Ethernet Switch	RJ-45	
Gemini LAN ENET	Ethernet Switch – Patch Panel SC Fiber Coupler	Dual Fiber MT-RJ to SC	1 m
Clocker ENET Red	Ethernet Switch – Array Chassis	RJ-45	
Clocker ENET Blue	Ethernet Switch – Array Chassis	RJ-45	
Catcher ENET Red	Ethernet Switch – Array Chassis	RJ-45	
Catcher ENET Blue	Ethernet Switch – Array Chassis	RJ-45	
Heater Loop Red	Temperature Controller Red – 55 pin Temp Cable Fanout	Banana Cable	
Heater Loop Blue	Temperature Controller Blue – 55 pin Temp Cable Fanout	Banana Cable	
Temp Control	55 pin Temperature Cable Fanout – Cryostat	55 pin Glenair ABC 55495-5: Low level/noise and heater power	92"

Rack1 Cable Name	Connections	Type, Description	Length
Temp Sensor Red	Temperature Controller Red – 55 pin Temp Cable Fanout	DIN6	
Temp Sensor Blue	Temperature Controller Blue – 55 pin Temp Cable Fanout	DIN6	
Temp Config Red	Red Temperature Controller – Terminal Server	DB-9 to RJ-45	
Temp Config Blue	Blue Temperature Controller – Terminal Server	DB-9 to RJ-45	
Temp Monitor	Temperature Monitor – 55 pin Temp Cable Fanout	DB25	
Temp Monitor Config	Temperature Monitor – Terminal server	DB-9 to RJ-45	
Red Array Ctl 1	Array Control Chassis Red – Cryostat	61 pin Glenair: Critical low noise (similar to ABC56145 rA)	40"
Red Array Ctl 2	Array Control Chassis Red – Cryostat	61 pin Glenair: Critical low noise (similar to ABC56145 rA)	40"
Blue Array Ctl 1	Array Control Chassis Blue – Cryostat	61 pin Glenair: Critical low noise (similar to ABC56145 rA)	40"
Blue Array Ctl 2	Array Control Chassis Blue – Cryostat	61 pin Glenair: Critical low noise (similar to ABC56145 rA)	40"
ENET Power Ctl ENET	Ethernet Power Control – Ethernet Switch	RJ-45	
Motor Ctl	Mechanism Utility Box – JBOX	55-pin Glenair ABC 55495-5: low level/noise, 48 VDC	92"
Terminal Server ENET	Terminal Server – Ethernet Switch	RJ-45	
Pupil Mask Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
Dichroic Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
Red Filter Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
Blue Filter Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
Pupil Imager Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
Focal Plane Mask Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
Spider Mask Serial Ctl	Terminal Server – Mechanism Utility Box	RJ-45	
FCS Mech Ctl	Mechanism Utility Box – Fiber Calibration Slide	Custom, see spreadsheet	
NDFW Mech Ctl	Mechanism Utility Box – NDFW	Custom, see spreadsheet	

Rack1 Cable Name	Connections	Type, Description	Length
Pupil Mask PWRCOM	JBOX – Pupil Mask Motor	PT06A-10-12S to Animatics CBLPWRCOM	
Dichroic PWRCOM	JBOX – Dichroic motor	PT06A-10-12S TO Animatics CBLPWRCOM	
Red Filter PWRCOM	JBOX – Red Filter Motor	PT06A-10-12S TO Animatics CBLPWRCOM	
Blue Filter PWRCOM	JBOX – Blue Filter Motor	PT06A-10-12S TO Animatics CBLPWRCOM	
Pupil Imager PWRCOM	JBOX – Pupil Imager Motor	PT06A-10-12S TO Animatics CBLPWRCOM	
Focal Plane Mask PWRCOM	JBOX – Focal Plane Mask Motor	PT06A-10-12S TO Animatics CBLPWRCOM	
Spider Mask PWRCOM	JBOX – Spider Mask Motor	PT06A-10-12S TO Animatics CBLPWRCOM	
Hall Effect Sensor	JBOX – Cryostat	55 pin Glenair: ABC 55495-6	64"
POWER CABLES			
ENET Pwr Control Power	Ethernet Power Control – Facility UPS	NEMA 5-20P or L5-20P (twistlock) Included with Baytech RPC3-20	
Mechanism Power Strip	Plugs into ENET Power Control, serves Terminal Server, Mechanism Utility Box.	Power Strip with at least 2 sockets	
Mechanism Utility Power	Mechanism Power Strip – Mechanism Utility Box	3 prong 120 VAC	
Terminal Server Power	Mechanism Power Strip – Terminal Server	3 prong 120 VAC	
APS Power	Ethernet Power Control – Array Power Supply	3 prong 120 VAC	
Pixel Server Red Power	Ethernet Power Control – Pixel Server Red	3 prong 120 VAC	
Pixel Server Blue Power	Ethernet Power Control – Pixel Server Blue	3 prong 120 VAC	
Instrument Controller Power	Ethernet Power Control – Instrument Controller	3 prong 120 VAC	
Ethernet Switch Power	UPS – Ethernet Switch	3 prong 120 VAC	
Ethernet Power Control Power	Ethernet Power Control – UPS	3 prong 120 VAC	
Temp System Power	Ethernet Power Control – Temperature System Power Strip	3 prong 120 VAC	
Temp System Power Strip	Plugs into ENET Power Control, serves both Temperature Controllers and Temperature Monitor.	Power Strip with at least 3 sockets	
Temp Control Red Power	Temp System Power Strip – Temperature Controller Red	3 prong 120 VAC	
Temp Control Blue Power	Temp System Power Strip – Temperature Controller Blue	3 prong 120 VAC	

Rack1 Cable Name	Connections	Type, Description	Length
Temp Monitor Power	Temp System Power Strip – Temperature Monitor	3 prong 120 VAC	
JBOX Power	Ethernet Power Control – JBOX	3 prong 120 VAC	
Rack 1 UPS Power	UPS – Rack 1	Locking Dual 3 Prong 120 VAC	
Rack1 MAINS Power	MAINS - Rack 1	Locking Dual 3 Prong 120 VAC	

5.2 Rack2 System Cabling List

Rack2 Cable Name	Connections	Type, Description	Length
APD PWR 1	APD Power – APD Chassis	Custom,	
APD PWR 2	APD Power – APD Chassis	Custom	
APD Sensors	**85 X** APD Chassis – Counter Chassis (patched into BlueBox)	85 BNC Coax	Approx 8'
APD Sensor Jumpers	**85 X** APD Chassis – Counter Chassis (patched into BlueBox)	85 BNC Coax	Approx 2'
Count Fiber	Counter Chassis – Optical Switch	Fiber Optic:	
Count Config Fiber	Fiber Splitter – Counter Chassis	Fiber Optic:	
Correction Fiber	Fiber Splitter – HVA Chassis	Fiber Optic:	
RT Fiber	RT Server Local MFB Board – Fiber Splitter	Fiber Optic:	
DM Ctl 1	HVA Chassis – AO Assembly (DM)	High Voltage, > 44 conductors.	
DM Ctl 2	HVA Chassis – AO Assembly (DM)	High Voltage, > 44 conductors.	
RT Server ENET	RT Server – Ethernet Switch	RJ-45	
UI Server ENET	UI Server – Ethernet Switch	RJ-45	
Power Ctl ENET	Ethernet Power Control – Ethernet Switch	RJ-45	
Gemini LAN	Ethernet Switch – Gemini LAN	RJ-45	
WFS Sensors	**85 X** AO Assembly – APD Chassis	Fiber Optic:	
AO Mech Serial Ctl	Rack#1 Mechanism Utility Box – AO Assembly	Custom, see spreadsheet.	-
Power Cables			
APD Power	Ethernet Power Control – APD Power module	3 prong 120 VAC	-
Counter Chassis Power	Ethernet Power Control – Counter Chassis	3 prong 120 VAC	-
HVA Chassis Power	Ethernet Power Control – HVA Chassis	3 prong 120 VAC	-
RT Server Power	Ethernet Power Control – RT Server	3 prong 120 VAC	-
UI Server Power	Ethernet Power Control – UI Server	3 prong 120 VAC	-
Ethernet Switch	UPS – Ethernet Switch	3 prong 120 VAC	-
HVA Power	HVPS – HVA Chassis	3 prong 120 VAC	-

6 Acronyms and Definitions

ADC	Analog to Digital Converter
AO	Adaptive Optics
APD	Avalanche Photo Diode
APSS	Array Power Supply Subsystem
DHS	Gemini's Data Handling System
DM	Deformable Mirror
FCRYO2	Fiber Interface Board, an Array Controller subassembly.
FCS	Fiber Calibration Source or Fiber Calibration Slide
FITS	Flexible Image Transport System
FSM	Field Steering Mirror
GND	Electrical ground
HVA	High Voltage Amplifier
HVPS	High Voltage Power Supply
JBOX	Junction Box, part of the Mechanism Control subsystem.
LLA	Lenslet Array
LSB	Least Significant Bit
NDFW	Neutral Density Filter Wheel
MM	Membrane Mirror
NICI	Near Infrared Coronagraphic Imager
RT	Real Time
TBD	To Be Determined
Temp	Temperature
TT	Tip/Tilt
UPS	Uninterruptible Power Supply
UI	User Interface, usually referring to the UI Server
WFS	Wavefront Sensor