Mauna Kea Infrared
NICI Mechanism Utility Box Specification

Rev 0.3
Last Modified 10/26/2004

PRELIMINARY

ABSTRACT: This document is the functional specification of the Mechanism Utility Box of the NICI instrument. It provides a functional overview of the Utility Box. It also provides detailed technical information on the components within the Utility Box and internal and external cabling.

This document is intended for engineers and technicians working with NICI's mechanisms.

Revision History

Revision	Author	Summary of revisions	Date
0.3 PRELIM	Mike Thompson	Prepared for initial customer release.	10/26/04

Table of Contents

Table of Figures

1 Mechanism Utility Box Overview

The Mechanism Utility Box (UBox) is mounted in NICI's Instrument Control (IC) Rack, Rack1. It's purpose is to provide a clean interface from the Instrument Control Electronics to the mechanisms, calibration sources, and cryostat Temperature Monitor.

The UBox contains the Sixnet I/O electronics that control the AO Field Steering Mirror, IR Calibration Source, and Laser Calibration Source. The Utility Box also houses the Hall Effect Power Supply and the Lakeshore Temperature Monitor.

The UBox houses custom wiring from the IC Electronics interfaces to connectors for components external to the IC enclosure.

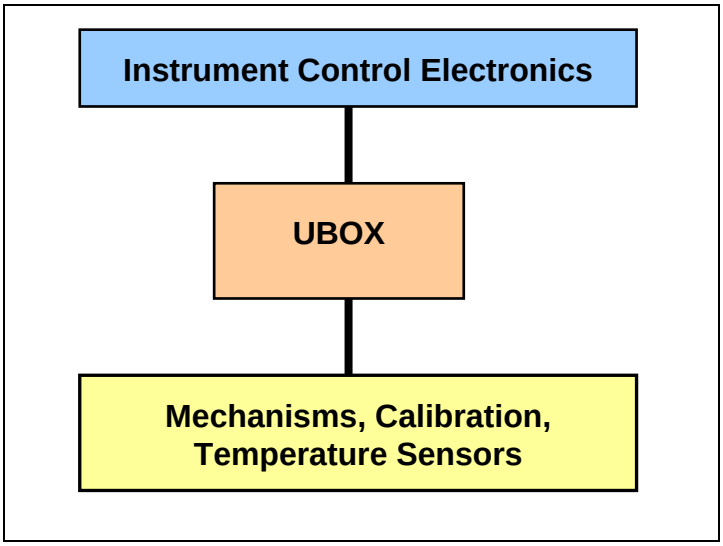

Figure 1 UBox Functional Diagram

1.1 Purpose

This document is the functional specification of the Mechanism Utility Box in the NICI instrument. It provides a functional description of the Utility Box. It also provides detailed technical information on the electronic components within the Utility Box and internal and external cabling.

This document is intended for engineers and technicians working with NICI's mechanisms.

1.2 Reference Documents

This specification is part of the NICI Service and Calibration Manual's Mechanism Control Subsystem Electronics Specification.

Readers may also reference the NICI User Manual for instrument usage information.

Detailed wiring implementations and pinouts can be found in the Mechanism Wiring Spreadsheet in the collection of system spreadsheets.

1.3 Functional Overview

The UBox houses various electronics components and provides an interface between the Instrument Control Electronics and external components.

- **Electronics**: The UBox houses the following electronics.
  - Sixnet I/O Electronics
    - Controls the AO FSM.
    - Powers the Laser Calibration Source and IR Driver Card.
    - Ethernet IC electronics interface.
  - IR Driver Card:
    - Controls the intensity of the IR emitter.
    - Serial IC electronics control interface.
  - Hall Effect Power Supply
  - Lakeshore Temperature Monitor.

- **IC Electronics Cabling Interface**: box mount receptacles for:
  - Animatics Mechanism Power
  - Serial control lines from the IC Rack's Terminal Server.
  - An Ethernet connection to the IC Rack's Ethernet Switch.

- **External Cabling Interface**: Box mount cable receptacles for:
  - Mechanism Utility Cable:
    - For the cryostat mechanisms.
  - AO Calibration Cable
    - 2 Fiber IR Calibration Source (array registration)
    - Laser Calibration Source
  - AO Mechanisms Cable
    - AO ND Filter Wheel
    - Fiber Calibration Slide
  - AO FSM Cables

2 Technical Specifications

This section provides a quick overview of the technical features and components of the Mechanism Utility Box. For additional details see Section 3 Functional Description.

- **Sixnet I/O Electronics**
  - **Ethernet Gateway**: ET-GT-ST-2.
    - Provides an Ethernet interface to the proprietary SixTRAK bus to control the Analog Output, Analog Input, and Discrete Output Sixnet I/O modules.
    - Ethernet Protocol: Modbus/TCP (Open Modbus) and SIXNET (I/O for Windows). 10BaseT at 10Mbps
    - RS-232 and RS-485 interfaces.
    - Typ. power: 1.6W.
    - Manufacturer Specification: http://sixnetio.com/htmlhelps/catalog/5cecb70.htm
  - **Analog Output Module**: ST-AO-10V-08F.
    - Provides analog output voltage to the Steering Mirror Controller.
    - 8 analog output channels, 14 bit D/A resolution, 1.5mV output voltage resolution 5 mA / channel.
    - Configurable output voltage ranges (per channel): 0 – 10 V, 0 – 5 V, +/- 5 V, +/- 10 V.
    - Max ST-Bus power consumption: 2200 mW.
    - Manufacturer Specification: http://sixnetio.com/htmlhelps/catalog/5a6c17b.htm
  - **Analog Input Module**: ST-AI-10V-08F
    - Provides a means for monitoring the position of the Steering Mirror.
    - 8 analog input channels, 12 bit A/D resolution, 0.6 mV voltage input resolution, 200 KOhm input impedance.
    - Scan rate: 5 ms / 8 channels.
    - Configurable input voltage ranges (per channel): +/- 1.0V, +/- 2.0V, +/- 5.0V, +/- 10V
    - Max ST-Bus power consumption: 950 mW.
    - Manufacturer Specification: http://sixnetio.com/htmlhelps/catalog/5a6ba6d.htm
  - **Discrete Output Module**: ST-DO-DC1-O8F
    - Provides discrete (on/off) voltage supply to the IR Calibration Source's Ion Optics IP500 Driver Board (5 VDC, 600mA) and Laser Calibration Source.
    - 8 discrete output channels, 0 – 60 VDC.
    - Load current: 0.1 mA/channel min., 2 A/channel max., 10 A max for all channels.
    - Inrush current (100 ms surge): 10 A.
    - Sixnet system watchdog capable.
    - Manufacturer Specification: http://sixnetio.com/htmlhelps/catalog/5a7b7e4.htm
  - **Sixnet Power Supply**: SOLA SCP 30S-DN, not a Sixnet product.
    - Provides +24 VDC power to all Sixnet modules.
    - Power: at 50 degC, 48 W at 2 A max.
    - Terminal Block interface.
- **IR Calibration Source Driver Board**
  - Ion Optics pulsIR driver board.
  - 12 VDC @ 1.25 A max Power
  - Serial Control
- **Field Steering Mirror Driver** (mounted external to the IC enclosure):
  - Ball Aerospace model TT 20 control electronics.
  - Command and Readout interface: +/- 10 V.
  - Peak operating power: 5 W.
  - Power supply: +/- 15VDC, +/- 1 A.
- **Hall Effect Power Supply**: SOLA SCP30T512-DN
  - Provides power to the Hall Effect Preamplifier Board over the Motor Control Utility Cable.
  - 30 Watts
  - 5V @ 3A, -12V @ 0.6A, 12V @ 0.6A

3 Functional Description

The Mechanism Utility Box is a rack-mounted enclosure that centralizes the electronics and wiring for controlling NICI's mechanisms and calibration sources and houses the Cryostat Temperature Monitor. A block diagram of the Mechanism Utility Box components is provided in Figure 2.

For controlling mechanisms the UBox combines IC Server driven serial control lines from the Terminal Server and combines them with power from the Animatics Power Supply in a custom designed 55-pin Mechanism Utility Cable. The Mechanism Utility Cable contains all of the power and control signals for driving the Cryostat Motors. Power and control for two mechanisms in the AO Bench are also driven from the UBox over two AO Mechanism Cables to the AO Bench.

The UBox also drives the Calibration Cable to the AO Bench for controlling the IR and Laser Calibration Sources. IC Software controls the IR Calibration Source via a serial line from the Terminal Server.

The command and readout lines for the Field Steering Mirror in the AO Bench are driven over the FSM cable. Software can control the command lines and monitor the readout lines via the Ethernet LAN.

A Lakeshore 318S Temperature Monitor is mounted the UBox with interfaces to the Cryostat's temperature sensors and serially to the Lakeshore 332S Temperature Controllers in the IC Rack. For more information on the Temperature Control Subsystem, see the Temperature Control Subsystem Specification.

The following sections provide functional and technical details about the UBox components.

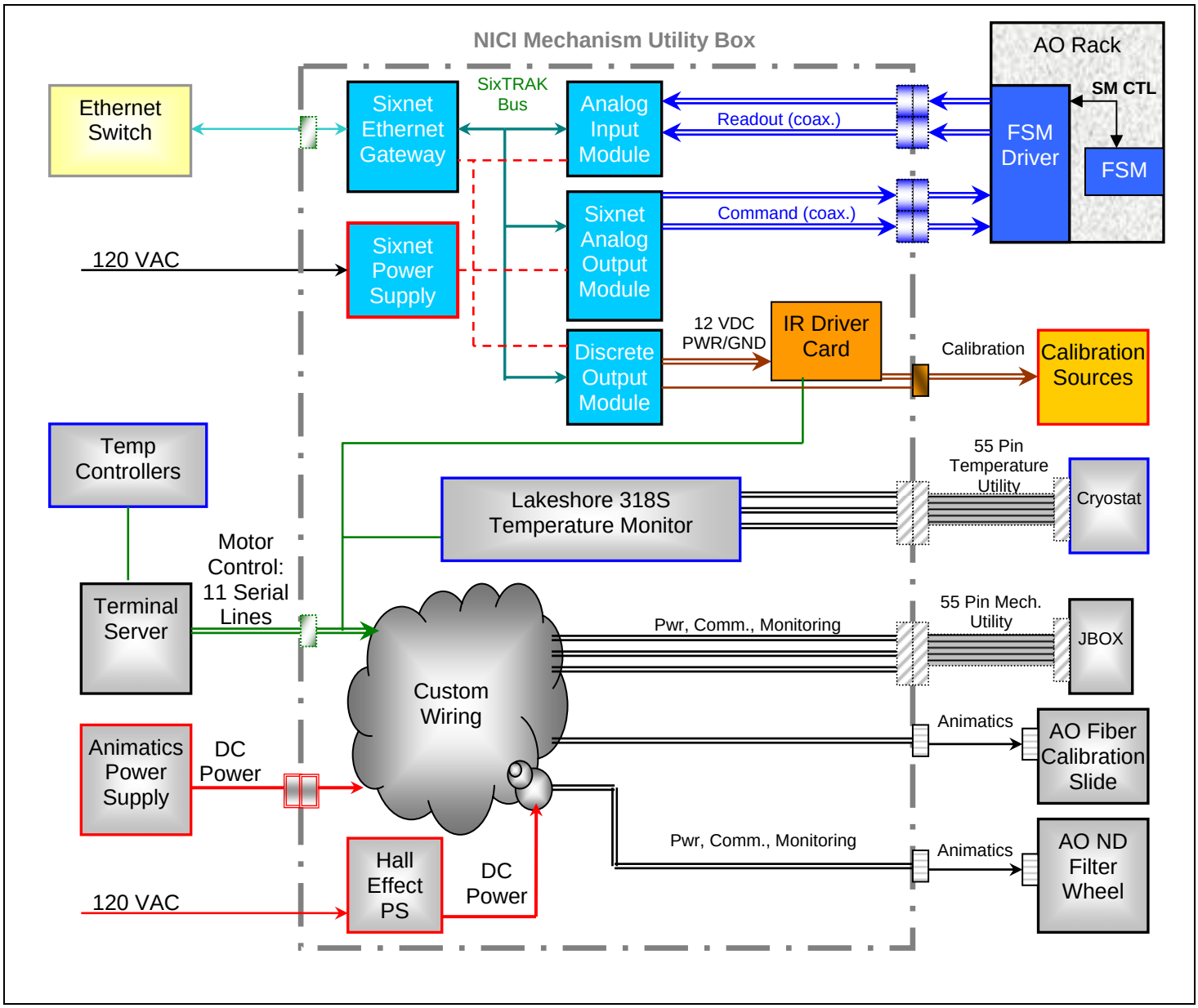

Figure 2 Block Diagram of Utility Box Components and Interfaces

Note that this diagram is representative. It does not show the method of penetrating the IC Thermal Enclosure. Refer to the System Wiring Spreadsheets for implementation details.

3.1 Sixnet Electronics

The Sixnet Electronics are a collection of modules that provide discrete and analog I/O control for driving calibration light sources and the AO Steering Mirror. The Sixnet modules are the Ethernet Gateway, Analog Output Module, Analog Input Module, Discrete Output Module, and Sixnet Power Supply. An overview of the Sixnet modules' specifications can be found in Section 2. Greater detail on the modules can be found in the manufacturer's technical specifications.

The front end of the Sixnet Electronics is an **Ethernet Gateway** which provides a 10BaseT Ethernet interface to the IC Rack's LAN for control of the Sixnet I/O modules. The Gateway is a transparent bridge between the instrument's LAN to the SixTRAK Bus, Sixnet's communication bus. All of the Sixnet I/O modules hang off of the SixTRAK Bus. System software sends commands to the Gateway to change the I/O state of the I/O modules.

The Sixnet **Analog Output Module** is used to drive two analog +/- 10V command signals to the Steering Mirror's Control Electronics.

The Sixnet **Analog Input Module** is used to monitor the position of the Steering Mirror. It samples the two Readout outputs from the Steering Mirror Controller upon software's prompting. Logically this provides an analog to digital conversion that is communicated to system software over the LAN.

The Sixnet **Discrete Output Module** provides a discrete (on/off) 12 VDC, 1A supply to the IR Calibration Source driver board and power to the Laser Calibration Source. Software controls the on/off state of these sources.

All of the I/O modules and the Ethernet Gateway are supplied with +24 VDC by the Sixnet Power Supply.

3.2 Custom Wiring

The Custom Wiring in the Mechanism Utility Box creates an interface from IC rack electronics to NICI mechanisms, calibration sources, and temperature monitoring components outside the IC enclosure.

On the IC Rack side, the UBox has interfaces with the cryostat Temperature Controllers, Terminal Server, and Animatics (motor) Power Supply. The serial lines from the Terminal Server are mechanism, Temperature Monitor, and driver board control and communication lines.

The Animatics Power Supply provides power to the mechanisms. The Hall Effect Power Supply in the Utility Box provides power to the Hall Effect Sensor circuitry in the JBOX. These lines are custom wired to the receptacles to external components.

The wiring for the Motor Control Cable takes 7 serial lines from the Terminal Server, power from the Animatics Power Supply and Hall Effect Power Supply, and bundles them into a connector for the 55 Pin Motor Control Cable. Two more serial lines from the Terminal Server along with power from the Animatics PS are wired into AO Mechanism Cables that are routed to the AO Fiber Calibration Slide and AO ND Filter Wheel.

4 Connections and Cabling

This section defines the internal cabling and external connectors for NICI's Mechanism Utility Box. External cables, such as the Utility Cables, are described in the Mechanism Control Subsystem Electronics Specification and in the Mechanism Wiring Spreadsheets. The reader may refer to the block diagram in Figure 2 for the connections defined in this section.

4.1 Internal UBox Connections List

- Mechanism Utility
- Sixnet SixTRAK Bus
- Sixnet Power
- Sixnet Ethernet
- AO FSM Command and Readout
- IR Driver Card Power
- Calibration
- Serial Lines
- AO Mechanisms
- Temp Monitoring
- Animatics Motor Power
- Hall Effect Power

4.2 Connection Descriptions

This section provides general descriptions and some implementation details for each of the Utility Box's internal connections.

4.2.1 Mechanism Utility

The connection to Mechanism Utility Cable receptacle bundles many power, I/O, and control lines for NICI's cryostat mechanisms.

Signals from 7 of the serial inputs, the Animatics Power Supply, and Hall Effect Power Supply are wired to a 55 pin box mount receptacle on the Utility Box, part number PT02A-22-55P. The Mechanism Utility Cable is plugged in to this receptacle.

The Mechanism Utility Cable is routed from the Utility Box through a cable clamp out of the IC Rack to the JBOX mounted on the vacuum jacket/cryostat assembly.

4.2.2 SixTRAK Bus

The SixTRAK Bus is a proprietary I/O bus for communications between the Sixnet Ethernet Gateway and Sixnet I/O modules. The Gateway drives this bus to control the I/O modules. All of the SixTRAK modules use field wiring connectors (screw clamp).

List of maximum power on SixTRAK Bus
AO module: 2.20 W (STBus Pwr)
DO module: 0.60 W (STBus Pwr)
AI module: 0.95 W (STBus Pwr)
Gateway: 1.60 W
TOTAL = 5.35 W

4.2.3 Sixnet Power

The Sixnet Power Supply, a SOLA SCP30S-DN, is mounted in the Utility Box for providing power to the Sixnet modules. A 120 VAC cable is routed to the Sixnet PS. Power is routed to the other Sixnet modules from field wiring clamps on the supply over power cables.

4.2.4 Sixnet Ethernet Connection

An Ethernet connection is routed from the IC Rack's Ethernet Switch to an RJ-45 coupler on the Utility Box. It connects to the Sixnet Ethernet Gateway's RJ-45 port inside the UBox. Software uses this port for controlling the Sixnet I/O modules to drive various devices.

4.2.5 AO FSM Command and Readout

The **Command Cables** are wired from a Sixnet Analog Output module to the Steering Mirror Control Electronics (SM Controller) via coaxial BNC couplers. These analog signals drive the X and Y position inputs on the SM Controller. For each command input (X, Y) there is a pair of signals, the input and its return line.

The user manual for the SM defines some requirements for these cables and connections (Ball Aerospace & Technologies Corp., Tip-Tilt Commercial Mirrors Model TT User Manual, 14-Jul-99). These requirements are:

- The interconnect cables between the SM Controller and NICI electronics should use twisted pair cables with shields terminated at the user interface for each signal pair. (ibid. p. 9)
- "[T]he user should receive the position signals differentially to isolate grounds." (ibid. p. 9)

The **Readout Cables** are wired from the SM Controller to the Sixnet Analog Input module via coaxial BNC couplers. They are connected to the X and Y position monitors on the SM Controller, which provide analog monitoring of the position of the SM.

For each monitor output (X, Y) from the SM Controller there is a pair of signals, the monitor and its return line.

4.2.6 IR Driver Card Power

The Sixnet Pwr/Gnd cables are driven by the Discrete Output modules to the IonOptics Driver Card which drives the IR Calibration Source. This connection provides 12 VDC at up to 2 A to the card.

4.2.7 Calibration

The Calibration connection bundles the IR Emitter drive signals from the IR Driver Card and Laser Calibration Source power from the Discrete Output Module in a box mount cable receptacle.

4.2.8 Serial Inputs

The 11 serial inputs are routed from the Terminal Server to RJ-45 receptacles on the Utility Box. Custom Wiring connects these signals to the receptacles for the Mechanism Utility and AO Mechanism Cables which are described in Sections 4.2.1 and 4.2.9. One of the serial connections is routed to a Sub-D9 connector on the IonOptics Driver Card and another is routed to a connector on the Temperature Monitor.

4.2.9 AO Mechanism

The AO Mechanism Cables provide power, control, and monitoring of the AO Fiber Calibration Slide and AO ND Filter Wheel mechanisms. RS-232 signals from the serial inputs and the Animatics Power Supply are routed to cylindrical cable receptacles on the Utility Box. This provides power and serial control/monitoring of the AO mechanisms. From these receptacles on the Ubox

4.2.10 Temperature Monitoring

Temperature Monitoring signals from the Temperature Utility Cable are wired from a 55-pin fanout board to a D connector on the Temperature Monitor.

4.2.11 Animatics Motor Power

The Animatics DC Power Supply mounted in the IC Rack provides DC Power for the Animatics mechanisms. The power is routed into the Utility Box by a 120 VAC EMI power receptacle.

4.2.12 Hall Effect Power

The Hall Effect Power Supply is mounted inside the Utility Box. The power is routed into the Utility Box by a 120 VAC EMI power receptacle. Custom Wiring provides over the Mechanism Utility Cable to the Hall Effect Sensor Board in the JBox.

4.3 Cable Specifications

This section provides technical details on UBox internal cabling. The table below provides details on each type of cable used in the Utility Box. Refer to the UBox Block Diagram in Figure 2 for a graphical depiction of these connections.

Implementation details of the cabling and connectors can be found in the Mechanism Wiring Spreadsheet.

Cable Name	Manuf./Part/Length	Conductors	Signal Type	Connectors
Motor Control	Glenair ABC55495, Neoprene Jacket, 92''' length.	55 x 22 AWG	Low level/noise, 48 VDC	PT06A22-55S molded connectors.
SixTRAK Bus	Off the shelf power rated for component.	1 per bus signal	-	Field Wiring screw clamps.
Sixnet Power	Off shelf power cables rated at least 10 A for Discrete module. Various lengths.	1 Pwr 1 Gnd	Power.	Field Wiring screw clamps.
Sixnet Pwr/Gnd	Off shelf power cables rated at least 2 A.	1 Pwr 1 Gnd	Power.	Field Wiring screw clamp on Sixnet.
Sixnet Ethernet	Off shelf RJ-45 cables.	Standard	CAT5 or greater	RJ-45 both ends.
AO FSM	Coax or TP, +/- 10V, 5W, 1A	differential	Low noise, shield terminated in Ubox, differential reception.	Various options.
IR Driver Pwr/Gnd	Off shelf power cables rated at least 2A. 12VDC.	1 Pwr 1 Gnd	Power.	Field Wiring screw clamp on Sixnet.
Calibration	Off shelf power cables rated at least 2 A	2 Pwr/Gnd	Power.	PT02E-10-5P receptacle
Serial Inputs	Standard RJ-45 serial cables. Optimize length.	standard serial	CAT5 or greater	RJ-45 both ends.
AO Mechanism	Custom.	PWR 14 AWG Comm <26 AWG	Various, see cable spec.	PT02E-10-12P box mount cable receptacle.
Temp Monitoring	Custom.	20	Low level/noise	DB25
Animatics DC Pwr	Off shelf power cables rated at least 30 W.	PWR	Power.	
Hall Effect Power	Off shelf power cables rated at least 30 W.	PWR	Power.	Custom Wiring from Hall Effect PS to Mechanism Utility Cable.

4.4 Pinouts

Pinouts can be found in the Mechanism Wiring Spreadsheet.

5 Mechanical Specifications

- Dimensions of utility box.
- Weight of UBox: 40 lbs, 18Kg approx.

6 System Grounding

This section is intended to provide a general description of the grounding concerns with the Ubox. The box itself should be grounded to PWR Neutral (the green wire). The Steering Mirror control lines and Calibration Source lines float.

7 Acronyms and Definitions

AO	Adaptive Optics
FSM	Field Steering Mirror
Gnd	Electrical ground
IC	Instrument Control
JBOX	Junction Box for interfacing with NICI's mechanisms.
MKIR	Mauna Kea Infrared
SixTRAK	A control and communications bus for Sixnet modules.
SM	Steering Mirror
TT	Tip-Tilt
UBox	The Mechanism Utility Box.