SGP / SPACE GEODESY PROJECT

Signal Chain Frontend Subsystem Interface Control Document

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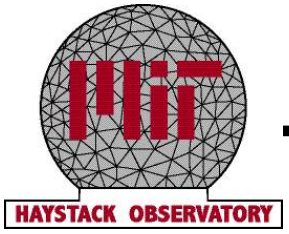

Massachusetts Institute of Technology
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Space Geodesy Project VLBI
Signal Chain Frontend Subsystem Interface Control Document

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Table of Contents

1 Introduction

1.1 Purpose

This Interface Control Document (ICD) covers all external interfaces of the Frontend Subsystem (FES) of the Signal Chain (SC) of the VGOS system to be installed at KPGO. The interface requirements to connect the FES to the KPGO infrastructure are presented. The site infrastructure is not the responsibility of this ICD. This ICD describes the mechanical, electrical, network, and software interfaces between the site and all FES hardware, software, support systems, and equipment. Figure 1 places the focus of this ICD in the context of the entire VGOS Signal Chain.

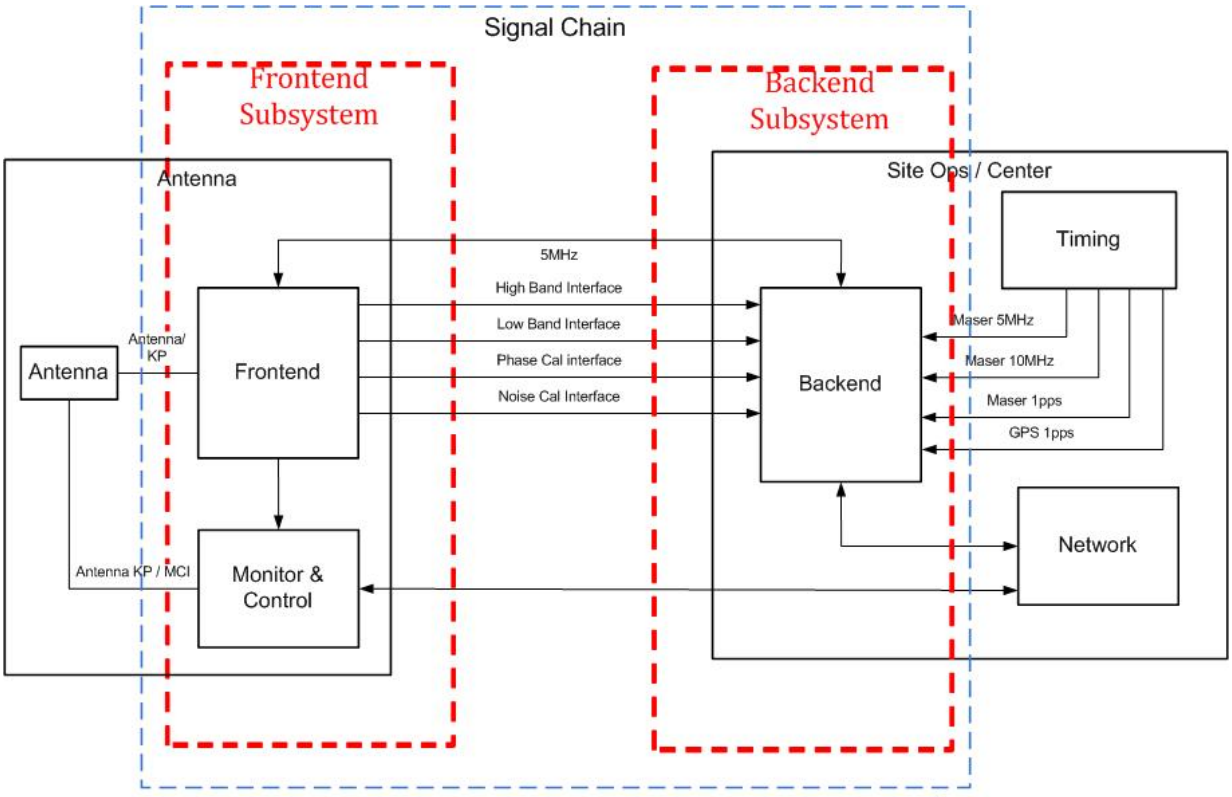

Figure 1: VLBI Signal Chain with (red) Frontend and the Backend subsystems outlined. The latter has a timing interface and a network interface with the Site Operations Center.

1.2 Applicability

This document is applicable to the VLBI component of the Space Geodesy Project (SGP), and to external organizations under direct contract to the SGP.

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1.3 Referenced and Applicable Documents

Ref.	Title	Version	Date
RD1	Design Aspects of the VLBI 2010 System, Progress Report of the IVS VLBI2010 Committee	N/A	June 2009
RD2	A Vision for Geodetic VLBI, Report of Working Group 3 to the IVS Directing Board	N/A	September 2005
AP1	Mechanical Interface Document 12 meter VLBI2010 Antenna for the US Naval Observatory at Kokee Park Geophysical Observatory Kauai, Hawaii	1301-017	August 2014
AP2	SGP-VLBI-ICD-0003 (MCI Command Set)	1.0	07/02/2015

2 Signal Chain Frontend Subsystem Interfaces

This section describes the external interfaces to the Signal Chain Frontend Subsystem in the VGOS system. The primary functions of the FES are to receive RF signals from the antenna and provide two high- and two low-band dual-polarization (vertical and horizontal) signals to the Backend Subsystem (BES), to provide calibration capabilities, and to monitor and control (MCI) the antenna. The FES interfaces to the antenna (see Interface 1 in Figure 2) include both mechanical and signal interfaces. The FES interface to the site infrastructure (see Interface 2 in Figure 2) includes mechanical, electrical, network, and signal interfaces. Each of these interfaces are described in the following sub-sections.

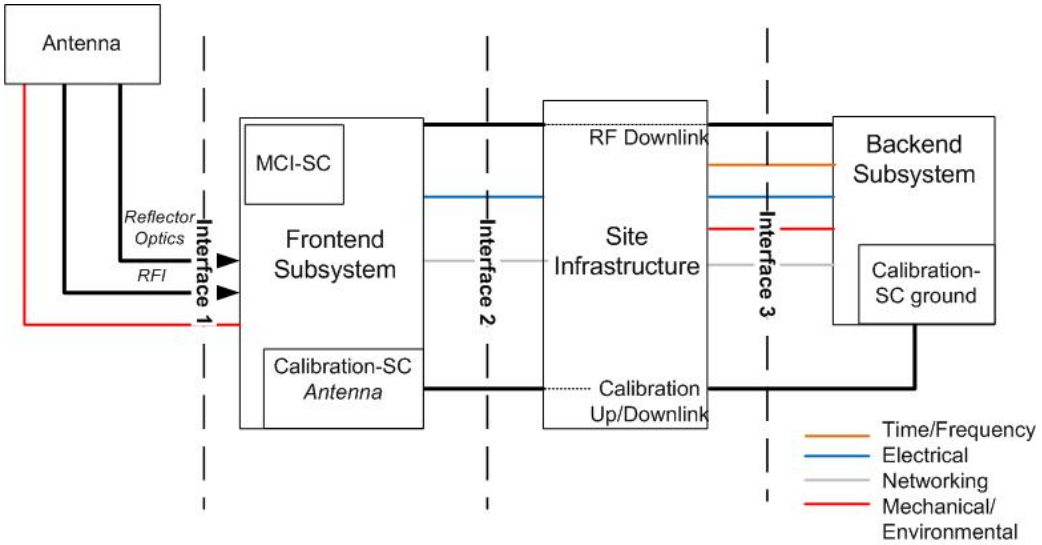

Figure 2: VGOS Signal Chain interfaces. This document describes "Interface 1" and "Interface 2."

2.1 Frontend Subsystem to Antenna Interface

The FES interface to the antenna, Interface 1 in Figure 2, includes a mechanical and a signal interface. The primary interface to be defined is the mechanical interface where the Dewar, positioner, and frontend are mounted. The signal interface includes the reflector optics interface. These interfaces are defined in turn.

2.1.1 Mechanical interface – Feed Interface

The antenna feed is situated in a cryogenically cooled Dewar that has a radio transparent window. The window allows electromagnetic waves, focused by the radio telescope antenna, to freely propagate to the cooled antenna feed. The feed assembly, or positioner, (Figure 3) has two mechanical interfaces. One between the positioner and the antenna feed cone, and the second between the base of the positioner and the antenna hub.

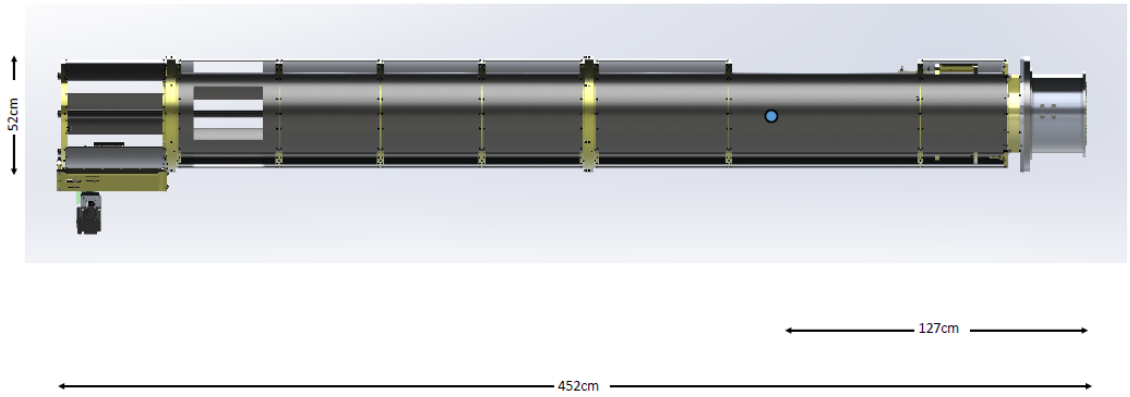

Figure 3: Positioner

The interface between the positioner and the antenna feed cone is an opening and bolt circle to match the upper interface plate of the positioner (Figure 4).

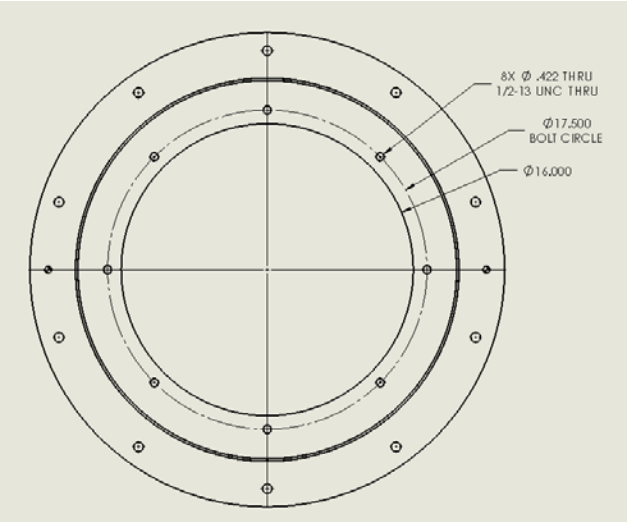

Figure 4: Bolt Plate Interface to Positioner.

The interface between the base of the positioner and the antenna hub is to connect two adjustable tie rods, at greater than 90 degrees offset to the internal ribs the antenna hub (Figure 5).

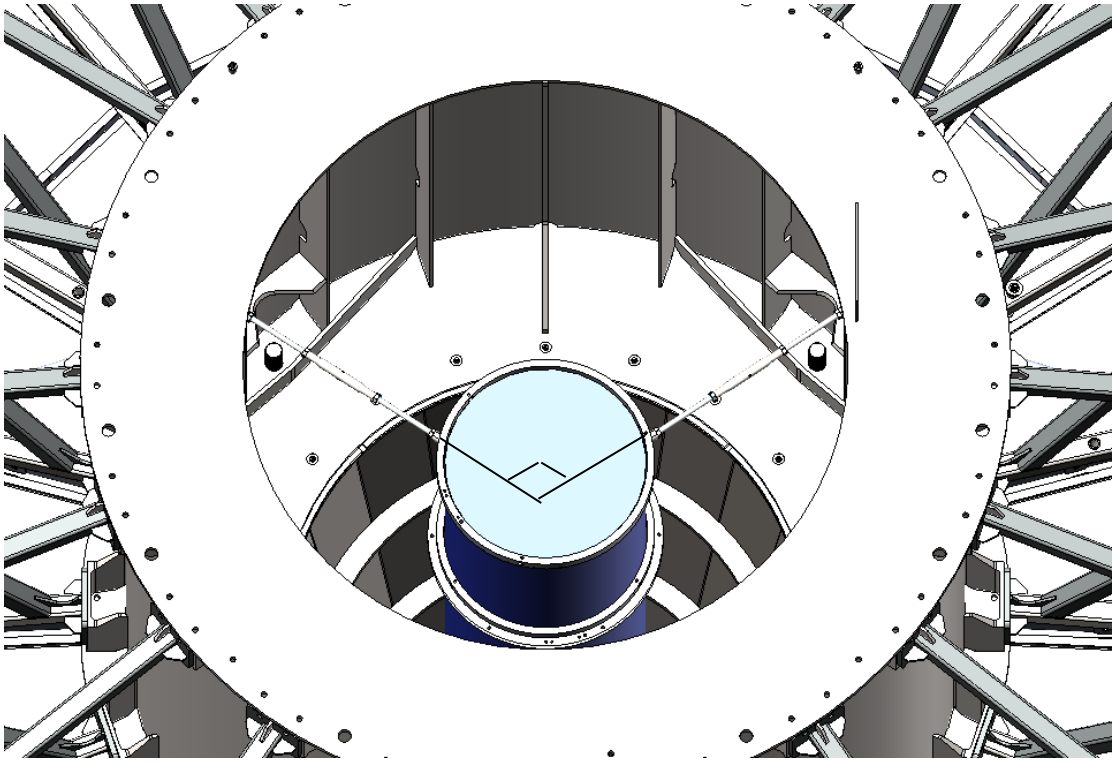

Figure 5: Interface between base of Positioner and Hub.

2.1.2 Antenna / MCI

The interface between the MCI system, located in the FE, and the Antenna contain four components:

1. Motor
2. Pedestal
    a. Hub Pressure
3. Reflector Subsystem
4. Ambient

Each of these components will contain an MCI node that can be queried from the MCI Computer. The software interface to the MCI nodes uses a TCP/IP protocol with text fields carriage return terminated and port 10,000. The MCI interface to the Antenna are via a RK45 Ethernet connection. Table 1 lists the Antenna / MCI equipment and corresponding port number and standard followed for command and control.

Equipment	Port	Standard	Command Set Version
Motor	10000	TCP/IP	MCI Command Set Version 0.1
Pedestal Hub Pressure	10000	TCP/IP	MCI Command Set Version 0.1
Reflector Subsystem	10000	TCP/IP	MCI Command Set Version 0.1
Ambient	10000	TCP/IP	MCI Command Set Version 0.1

Table 1 FE Antenna / MCI Software Interfaces

2.2 Frontend Subsystem to Site

The FES interface to the Site Infrastructure is now described. The FES in the pedestal requires, mechanical, electrical and network interfaces. Each of these interfaces are now presented.

2.2.1 Mechanical Interface

The mechanical interface required between the FES and the Antenna are for the feed wiring and cryogenic tube interface

Compressor Space Requirements

The compressor space requirements has been addressed [AP1] with a 19”W x 37”H x 27”D area made available on the antenna’s turning head of Figure 6. A M1254 Austin Scientific cryopump helium compressor (Figure 7) has the physical characteristics, 48.3 cm x 40.6sm x 49.65 cm, and has a mass of 68kg.

The mating interface to the turning head will be completed on site. After the interface has been created, this document will be updated with the exact layout.

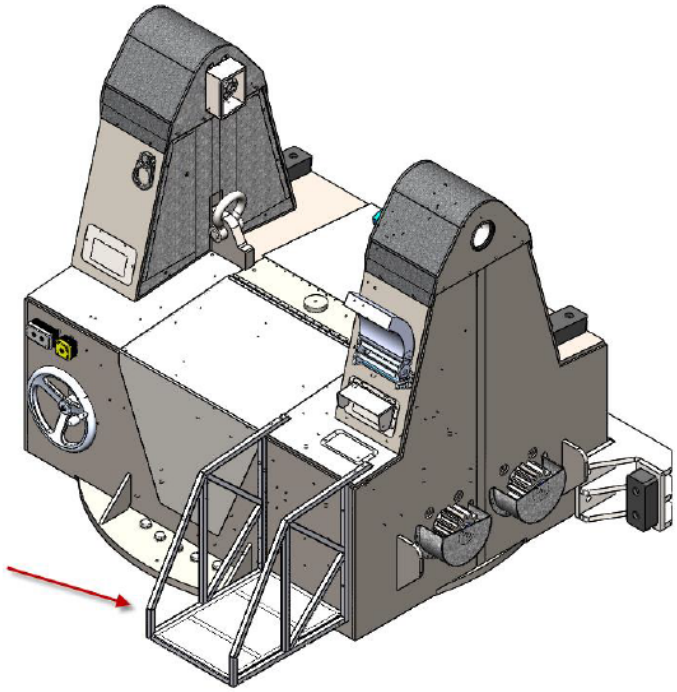

Figure 6: Compressor Mechanical Interface - Space on the Turning Head

Figure 7: M1245 Austin Scientific Cryopump Helium Compressor

2.2.2 Electrical Interface

The electrical interface to be supplied to the compressor is 220/480 VAC 3 phase Delta 40/20 amperes via a 3 conductor cable located in the frontend turning head.

The second electrical interface to be supplied is located in the frontend hub section. Five NEMA 5-20 Dual Quad Receptacles supplying 120 VAC Single Phase @ 20 amperes are required.

The physical location of the electrical interfaces are to be determined when Haystack personnel visits before the Antenna's Field Acceptance Test (FAT) June 11-13 2015.

2.2.2.1 Space Requirements

To distribute power, space is required in the frontend hub section to interface to the sites electrical and network infrastructure. The signal chain requires an area of 36" x 30" x TBD" to mount an electrical / network distribution to the wall.

2.2.3 Timing Interface

A 5 MHz signal, to be received from the BES via the site infrastructure, requires a LMR-400 cable with a Female Coaxial N-Type connector, (CN1 – 5MHz in Figure 8).

2.2.4 Network Interface

The FE requires a network interface for command and control: One 1Gbps Ethernet RJ45 interface is required for the MCI. This interface requires 4 IPv4 addresses

2.3 Frontend Interface to Backend Subsystem

The purpose of this subsystem is the signal interface required between the Frontend, located at the Antenna, and the Backend, located on the site operations building at KPGO. The signal interface distributes the high and low band from the frontend and the calibration data and management within the signal chain. The eventual destination of the received signal recorded are the VGOS correlation center for processing. The signals are sourced at the FE Feed (Figure 8).

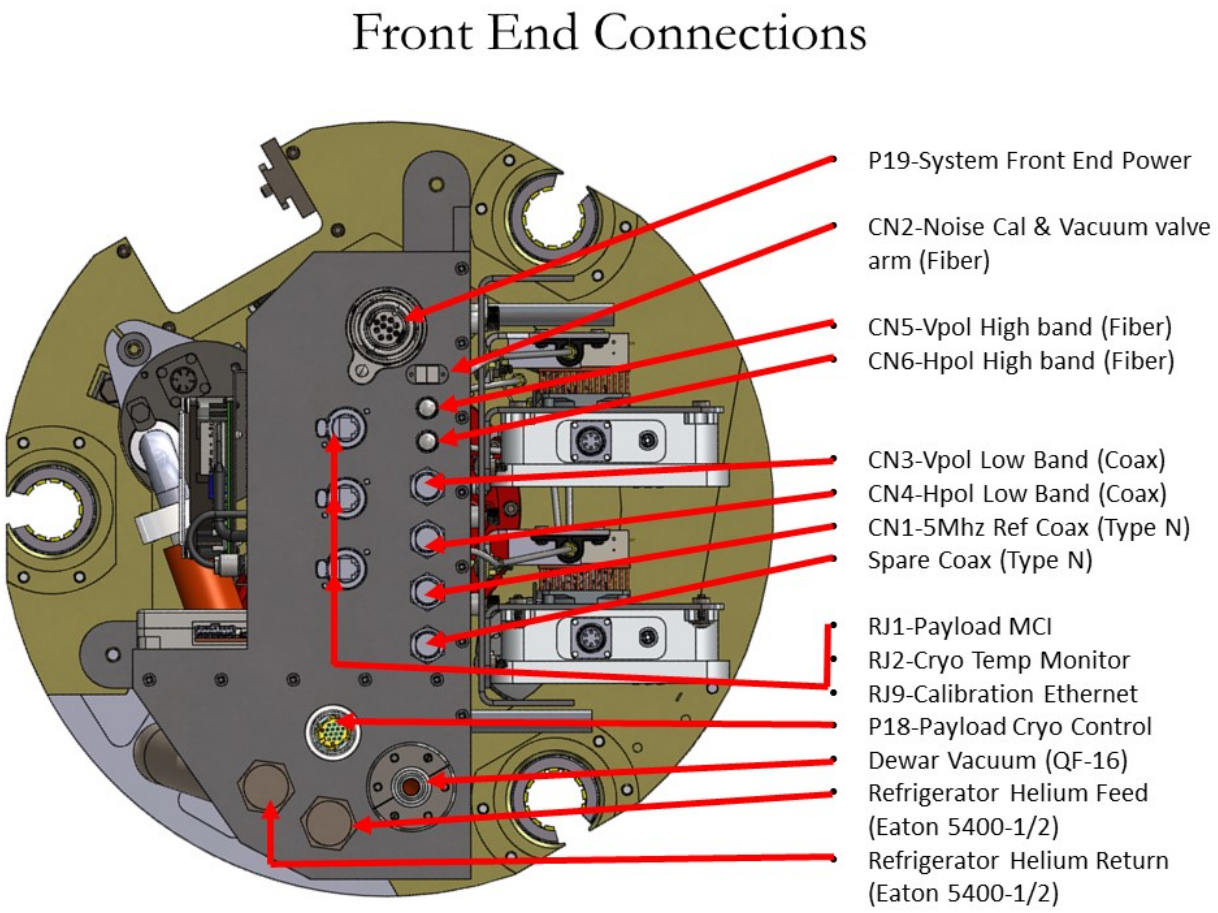

Figure 8: Frontend Signal / Timing Connections

Four signal interfaces, CN3-Vpol low band, CN4-Hpol low band, CN5-Vpol high band, and CN6-Hpol high band. Table 2 describes each of the signal interfaces and the physical connection.

Signal Interface	Physical Connection	Qty	Description
Low Band	Female Coaxial SMA Connector	2	Requires run of LMR-400UF FE
High Band	Female FC/APC	2	Requires run of single mode fiber
Phase Calibration	Female Coaxial SMA Connector	1	Requires run of LMR-400UF FE

Table 1 Frontend to Pedestal Interface

The LMR-400 is a product of Times Microwave and a registered trademark. The LMR-400 is a low-loss braided coaxial cable, 3/8 inch, 50 Ohm, and has a stranded outer conductor and a bare copper center conductor.

Appendix A – Acronyms

BNC	Bayonet Neill–Concelman
Cal	Calibration
CDMS	Calibration and Data Management System
FE	Frontend
FES	Frontend Subsystem
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronics Engineers
IPv4	Internet Protocol Version 4
KPGO	Kokee Park Geophysical Observatory
LMR	Times Microwave Low loss braided coaxial cable
MCI	Monitor and Control Interface
MIT	Massachusetts Institute of Technology
Ops	Operations
RFI	Radio Frequency Interference
SC	Signal Chain
SFP+	Enhanced small form-factor pluggable transceiver
SGP	Space Geodesy Project
SMA	SubMiniature version A (connector)
VGOS	VLBI Global Observing System
VLBI	Very Long Baseline Interferometry