LADEE Mission

Interface Requirements Document

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LADEE Mission
<instrument name> INTERFACE REQUIREMENTS DOCUMENT

INTERFACE REQUIREMENTS CHANGE LOG

Date	Revision	Changes
[TBS]	**Initial Draft**	Initial draft

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Table of Contents

1. PURPOSE

This Interface Requirements Document (IRD) defines the <instrument name> interface requirements to the LADEE spacecraft. The requirements agreed to by the signatories of this document will form the basis of the <instrument name> Interface Control Document.

NOTES:

- "Output" and "Input" are used through this document as meaning from the point of view of the instrument, except in the specific instances where a different reference frame is explicitly defined.
- The Instrument Requirements Document's format and paragraph numbers are common for all the LADEE Science instruments. As a result, for any individual instrument there will be sections that are not applicable, and all subparagraphs below a paragraph marked "N/A" may be deleted. Additional depth in the outline may be added as needed.

2. <instrument name> DESCRIPTION

This section provides a general overview of the instrument. Specific requirements follow in later sections.

2.1 Operational Overview

Describe how the instrument will be used in all post-launch phases, including cruise phase checkouts, EDL, and Mars Surface Operations.

3. APPLICABLE AND REFERENCE DOCUMENTS

The Applicable documents listed in Table 3.1 below form an integral part of the requirements specified herein.

Table 3.1 Applicable Documents

Applicable Document	Doc ID Number	IRD Ref	Web Location
Example Documents:			
Digital Time Division Command/Response Multiplex Date Bus	MIL-STD-1553B	5.1.2	http://centauri.larc.nasa.gov/msl/pip/MIL-STD-1553B-Base.pdf
Biological Contamination Control for Outbound and Inbound Planetary Spacecraft (Revalidated 10/23/03)	NPD 8020.7F	10.3	http://nodis3.gsfc.nasa.gov/library/displayDir.cfm?Internal_ID=N_PD_8020_007F_&page_name=main
Planetary Protection Provisions for Robotic Extraterrestrial Missions; April 16, 1999	NPR 8020.12B	10.3	http://nodis3.gsfc.nasa.gov/library/displayDir.cfm?Internal_ID=N_PR_8020_012B_&page_name=main

The following list summarizes documents, or specific portions there of, that are referenced within this document. Relevance is specified within the body of this document.

Table 3.2 Reference Documents

Reference Document	Doc ID Number	IRD Ref	Web Location
		x.x.x	

4. CABLES, HARNESSES AND CONNECTORS

describe the interfaces

4.1 ELECTRICAL HARNESS

(Note: Ground support equipment cables are covered in Paragraph 12.4)

4.1.1 Harness Designations

4.2 ELECTRICAL CONNECTORS

4.2.1 Connector Location

4.2.2 Connector Keying Requirements

4.2.3 Electrical Connector Designations

4.3 FIBER OPTIC CABLES

4.4 DIRECT ACCESS CONNECTOR TEST POINTS

4.5 MARKING

5. ELECTRICAL POWER INTERFACES

5.1 Unregulated Power Switches

5.2 Unregulated Power Requirements

5.3 Power Switch Current Requirements

5.4 Fault Protection

5.5 Failure Propagation

5.6 Power Requirements

Include allocation by Mission Phase, & Instrument operational modes (e.g., Nominal data collect/Standby/Survival/etc.) Instrument Power Profile,

5.7 Electromagnetic Interference/Compatibility (EMI/EMC)

5.4 GROUND AND ELECTRICAL ISOLATION

5.4.8 Analog Current Input Interfaces

NOTE: Output/Input are used here as meaning from the point of view of the instrument

6. COMMAND AND DATA HANDLING (C&DH) INTERFACES

6.1 DATA TRANSMIT FROM INSTRUMENT TO LADEE INTERFACE

6.1.1 Low Power/Low Speed U-ART Specifications

6.1.1.1 Rate(s) of Data Generation

6.1.3.2 Telemetry Interface

6.1.3.3 Science Data Interface Signal Details

6.1.2 1553 Specifications

6.1.2.1 Implementation

6.1.2.2 Cross-Strapping

6.1.2.3 Remote Terminal Address Specification

6.1.3 High Speed LVDS Specifications

6.1.3.1 Rate(s) of Data Generation

6.1.3.2 Telemetry / Command Interface

6.1.3.3 Science Data Interface Signal Details

6.1.4 High Speed RS-422 Specifications

6.1.4.1 Rate(s) of Data Generation

6.1.4.2 Telemetry / Command Interface

6.1.4.3 Science Data Interface Signal Details

6.1.5 Time Tic Interface

This section describes any required interface between the spacecraft timeclock and the instrument.

6.1.6 Discrete Output Interfaces

NOTE: Output/Input are used here as meaning from the point of view of the instrument

6.1.6.1 Discrete Output Allocation

6.1.6.2 Discrete Output Commands

6.1.6.3 Discrete Output Electrical Interface Characteristics

6.1.6.4 Discrete Output Isolation Requirements

6.1.6.5 Discrete Output Electrical Interface

6.1.6.6 Discrete Output Signal Polarity

6.1.7 Discrete Input Interfaces

NOTE: Output/Input are used here as meaning from the point of view of the instrument

6.1.7.1 Discrete Output Allocation

6.1.7.2 Discrete Output Commands

6.1.7.3 Discrete Output Electrical Interface Characteristics

6.1.7.4 Discrete Output Isolation Requirements

6.1.7.5 Discrete Output Electrical Interface

6.1.7.6 Discrete Output Signal Polarity

6.1.8 Analog Sensor Interfaces

This section discusses analog sensor interfaces, e.g. temp sensors, current sensors, voltage sensors, etc., that require an interface directly with the spacecraft avionics.

6.1.7.1 Analog Sensor Allocation

6.1.7.2 Analog Sensor Functionality

6.1.7.3 Analog Sensor Electrical Interface Characteristics

6.1.7.4 Analog Sensort Isolation Requirements

6.1.7.5 Analog Sensor Electrical Interface

6.1.7.6 Analog Sensor Temperature Characteristics

6.1.7.7 Analog Sensor Scale Factors

6.1.7.8 Analog Sensor Processing Accuracy

6.1.7.9 Analog Sensor Installation

6.2 DATA COMPRESSION

This section describes data compression on <instrument name> instrument data to be performed by the Spacecraft Flight Computer.

6.2.1 Data Compression Ground Rules

This section describes any ground rules for application of data compression to <instrument name> instrument data.

6.2.2 <instrument name> Data Stream into the Spacecraft NVRAM Pre-compression

6.2.3 NVRAM Data Stream Post-Compression

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7. SOFTWARE INTERFACES

7.1 <instrument name> COMMAND DICTIONARY

This section defines the low-level commands (i.e., bit level protocol over spacecraft electrical interface to the instrument) required to communicate directly with the instrument, and also describes any high-level commands to be implemented in spacecraft flight software that are required to facilitate instrument operations.

7.2 <instrument name> TELEMETRY DICTIONARY

This section provides the definition of the <instrument name> telemetry format, and describes the telemetry content within the context of the specified format.

7.3 DATA PRODUCTS

7.4 ALGORITHMS REQUIRED TO RUN ON SPACECRAFT FLIGHT COMPUTER

This section defines any instrument-unique algorithms that are required to run on the spacecraft flight computer.

7.5 COMPUTER AND MEMORY RESOURCES

This section defines the spacecraft resources, including software, Dynamic RAM (DRAM), Non-Volatile RAM (NVRAM), and spacecraft flight computer CPU that are required by the <instrument name>

7.5.1 DRAM Allocation

7.5.2 Sequence Engines

7.5.3 Non-Volatile RAM (NVRAM)

NVRAM is use by LADEE for storage of Science data on the Rover. Total NVRAM reserved for science investigations is expected to be on the order of 0.7 GBytes.

7.1.3.1 NVRAM Allocation

The estimated NVRAM required to support the investigation, referencing Sol Types defined in the Proposal Information Package will be defined and discussed in this section

7.5.4 SFC CPU

7.1.4.1 SFC CPU Allocation for <instrument name>

7.6 TIMING

7.6.1 Execution of Events

7.2.1.1 Spacecraft Time Update / Hardware Time Tick Timing

7.2.1.2 <instrument name> Back-to-Back Command Timing

7.6.2 Frequency & Jitter

7.2.2.1 Commands
7.2.2.1.1 NORMAL Command Frequency & Jitter
7.2.2.1.2 IMMEDIATE Command Frequency & Jitter
7.2.2.1.3 TIME UPDATE Frequency & Jitter

7.6.3 Time Tagging

7.6.4 Power-Up Timing

7.6.5 Reset Timing

7.2.5.1 Spacecraft Flight Software Reset Timing

7.6.6 Safing Timing
7.7 FAULT PROTECTION
7.7.1 <instrument name> Aliveness Checking
7.3.1.1 Perform <instrument name> Aliveness Checking
7.7.2 Fault Protection Control
7.3.2.1 Fault Protection Detection Control
7.3.2.2 Fault Protection Response Control
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7.3.3.1 Switch Closure
7.3.3.2 Voltage Level
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7.11.1 Software Interfaces Implemented Over UART
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7.11.2.1.2 MIL-STD 1553B Message Byte Ordering
7.11.2.1.3 <instrument name> MIL-STD 1553B RT Addresses
7.11.2.2 <instrument name> Command Interface
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7.11.2.2.2 <instrument name> Command Messages
7.11.2.3 <instrument name> Engineering/Telemetry Interface
7.11.2.3.1 <instrument name> Engineering/Telemetry Subaddresses
7.11.2.3.2 <instrument name> Engineering/Telemetry Messages
7.11.3 Software Interfaces Implemented Over high speed point-to-point (LVDSor RS-422)
7.11.3.1 LVDS Message Bit Ordering

7.11.3.2 LVDS Message Byte Ordering

7.11.3.3 LVDS Frame Sizing to the ~~SSR~~ NVRAM

7.11.3.4 Science Data
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7.11.3.4.4 <instrument name> Science Data Initiation
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7.11.3.4.6 <instrument name> Science Image Processing

7.11.4 Software Interfaces Implemented Through Discrete Lines

6.11.4.1 Discrete Output Signals to the <instrument name> from the C&DH
6.11.4.1.1 Software Control of the RESET Discrete
6.11.4.1.2 Software Control of the Image Select Discrete

6.11.4.2 Discrete Input Signals from the <instrument name> to the C&DH

7.12 SERVICES

All instrument-related software which executes on the SFC shall use existing spacecraft software services where available. These services are used across the breadth of flight software executing on the SFC and assure uniform usage to and access of spacecraft resources. Examples of these services are:
Ground command processing
Pushing of telemetry
Uplink of files
File system
Electrical power system interface
Fault protection
Time
NVRAM interface

8. MECHANICAL INTERFACES

This section includes discussion of Coordinate System, Instrument mass properties, Envelope and dimensions,

8.1 COORDINATE SYSTEM

8.2 INSTRUMENT MASS RESPONSIBILITIES

8.3 PHYSICAL CHARACTERISTICS

8.3.1 Envelope and Dimensions

This section defines the not-to-exceed envelope required for the instrument including within the envelope any instrument-required keep-out zones, as well as the CBE physical dimensions of the hardware.

8.3.2 Mass Properties

This section includes:

- Instrument Mass
- Instrument Centers Of Mass

Instrument Moments Of Inertia

8.4 MOUNTING INTERFACE DEFINITION

8.4.1 Instrument Component Locations

8.4.2 Mounting Surfaces

8.4.3 Mounting Hardware

8.4.4 Mounting Hole Locations

8.4.5 Instrument Component Locations

8.4.6 Fields of View

8.4.7 Sun Avoidance

8.4.8 Alignment Reference

8.4.9 Flight Calibration Target(s), Fiducials, Alignment Cubes, etc.

8.4.10 Grounding and Ground Straps

8.4.11.0 Grounding and Ground Strap Attachment

8.4.11.0 Blanket Grounds

8.4.11.0 Ground Surface Cleaning

8.5 Intra-instrument Cables Between Non-collocated Elements

This section provides descriptions and requirements on Intra-instrument cables between non-collecated instrument elements. The Intra-instrument Cables between non-collocated instrument elements will be designed and fabricated by the LADEE flight system to meet the instrument provider's requirements.

8.6 VENTING

8.7 PURGE / VACUUM MECHANICAL INTERFACES

8.8 RADIATOR MECHANICAL INTERFACE

8.9 MICROPHONICS

This section discusses both induced microphonics and sensitivity to microphonics.

8.10 MECHANISMS

This section discusses mechanisms that operate at the instrument's interface, for example, a deployable dust cover. Mechanisms that are fully internal to the instrument are described here to the extent required to define any influence that extends to the spacecraft side of the instrument's interface.

8.11 RESERVED - OTHER INSTRUMENT SPECIFIC INTERFACES

Section 8.11 and 8.12 are reserved to address instrument specific interfaces not covered elsewhere in this document, e.g., contact force, stray light, etc.)

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9. THERMAL INTERFACE

9.1 THERMAL INTERFACE DATA

9.1.1 Thermal Models

9.1.2 Thermal Analyses

9.1.3 Thermal Isolation

9.1.4 <instrument name> Instrument (external)

9.2 THERMAL MAINTENANCE / CONTROL

9.2.1 Thermal Control Hardware

8.2.1.1 Active Thermal Control Elements

8.2.1.1.1 Heaters and Temperature Sensors

8.2.1.1.2 Thermal Control Hardware Installation

9.3 INSTRUMENT FLIGHT ALLOWABLE TEMPERATURES

9.3.1 Instrument Alarm Limits

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10. ENVIRONMENTAL INTERFACES

10.1 SYSTEM ENVIRONMENTS

10.2 CONTAMINATION CONTROL

10.2.1 Particulate Contamination Control

10.2.2 Organic Contamination Control

10.2.2 Surface Cleanliness

10.2.3 Non-metallic Materials

10.3 PLANETARY PROTECTION

10.3.1 Pre-Delivery Bioburden Control

10.3.2 Bioassay Requirements

10.3.3 Exposed Surface Area

11. OPERATIONAL CONSTRAINTS AND FLIGHT RULES

11.1 TIME OF DAY CONSTRAINTS ON OPERATIONS
e.g., nominal ops must be during daylight
11.2 OPERATIONAL TIMELINE CONSTRAINTS

12. INTEGRATION AND TEST

12.1 INTEGRATION

12.1.1 Alignment

12.2 SYSTEM-LEVEL ENVIRONMENTAL TESTING

12.2.1 System-level Vibration

12.2.2 System-level Pyro-shock

12.2.3 System-level Thermal Balance Test

12.2.4 System-level EMI/EMC Test

12.3 BENCH ACCEPTANCE TEST

12.3.1 Calibration/Verification

12.4 INTEGRATION AND TEST EQUIPMENT / GROUND SUPPORT EQUIPMENT

12.4.1 Bench Checkout Equipment (BCE)

12.5.1.1 BCE Accommodations

12.5.1.2 BCE Contamination Control

12.4.2 Protective Covers

12.4.3 GSE Cables

12.4.4 Mass Simulator

12.4.5 Electronics Simulator

13. GROUND OPERATIONS - HANDLING AND ENVIRONMENTAL REQUIREMENTS

13.1 HANDLING PROCEDURES

13.1.1 Instrument Flight Hardware

13.1.2 Ground Support Equipment

13.2 HANDLING FIXTURES

13.3 STORAGE REQUIREMENTS

13.3.1 Instrument Flight Hardware

13.3.2 Ground Support Equipment

13.4 PURGE REQUIREMENTS

Note: Mechanical characteristics of the Purge System are in Paragraph 8.6.

13.4 REMOVE BEFORE FLIGHT ("RED TAG") ITEMS

13.5 INSTALL BEFORE FLIGHT ("GREEN TAG") ITEMS

13.6 SHIPPING AND HANDLING

14. RESERVED

15. DOCUMENTATION AND DELIVERABLES

15.1 OPERATIONS MANUALS AND PROCEDURES

15.2 END ITEM DATA PACKAGE

Appendix A - Acronyms & Abbreviations

BCE	Bench Checkout Equipment
CBE	Current Best Estimate
C&DH	Command and Data Handling
EDL	Entry, Descent and Landing
EMI	Electromagnetic Interference
EMC	Electromagnetic Compatibility
GSE	Ground Support Equipment
ICD	Interface Control Document
JPL	Jet Propulsion Laboratory
IRD	Instrument Requirements Document
SFC	Spacecraft Flight Computer

Appendix B - <instrument name> Flight Software Algorithms .