An Installer's Guide to LISA

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1 Introduction

This document serves as an installer's introduction to the L-band Interference Surveyor/Analyzer (LISA) instrument. LISA was developed under ESTO Project NAS5-02001, entitled "Digital Receiver with Interference Suppression for Microwave Radiometry." The PIs for project are Joel T. Johnson and Steven W. Ellingson, both of the Ohio State University (OSU)*.

This document includes the form *General Experiment Information and Request Worksheet* (see final pages of this document) required by the NASA Wallops Flight Facility (WFF).

1.1 Experiment Background

Microwave radiometry at L-band is a crucial technology for meeting NASA goals in remote sensing of soil moisture and sea salinity. Standard systems are designed to operate in the "protected" frequency band 1413 $\pm$ 10 MHz. However, previous airborne L-band radiometer measurements have been corrupted in some cases by radio frequency interference (RFI). LISA is designed to provide more information on RFI properties at L-band, so that future systems can be designed to be more resistant to RFI corruption. This information will also support the efforts of the above referenced ESTO project, which focuses on extending L-band radiometer frequencies outside the protected band through the inclusion of an interference suppression processor in the

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system. Knowledge of RFI properties in a wider bandwidth surrounding 1413 MHz is critical for this project.

1.2 Goals/Objectives

The LISA experiment has two primary goals:

1. Survey/analyze RFI properties (including both average and peak powers) in a wide bandwidth surrounding 1413 MHz.

2. Survey/analyze the protected band (1413 $\pm$ 10 MHz) to clarify the influence of in-band and out-of-band sources on standard systems.

An airborne platform is crucial for this experiment because RFI source propagation losses for a ground based system are much greater, and because platform motion will provide a variety of RFI environments for the study.

2 Description of Equipment

LISA consists of an antenna/front end unit (AFEU) for mounting in the P-3 bomb bay, and a standard 19-in equipment rack inside the P-3 cabin.

The AFEU is shown in Figure 1. The antenna used is a low-gain, wideband planar spiral placed in a circular aperture in the AFEU enclosure. The AFEU enclosure is a rectangular aluminum box of dimensions 12-in $\times$ 17-in $\times$ 3-in. The AFEU includes ambient-temperature terminator and noise generator calibration sources, as well as the LNA and RF amplifier stages of the receiver. Use of a low-gain antenna for this application is desirable, as the goal of the measurement is to observe as many RFI sources as possible. The AFEU should be mounted with the antenna facing toward the nadir. The plane of the spiral should nominally be flush with the surface of the aircraft, although this is not critical: the AFEU can be recessed into the bomb bay by a few inches, as long as the antenna field-of-view is not significantly blocked. Alternatively, the AFEU can also be mounted slightly outside the airframe if necessary. A pair of L-brackets are mounted on opposite sides of the AFEU and are

intended for use in mounting. Holes and mounting hardware may be placed anywhere on the extended edges of the L-brackets.

The remaining system components are located in the equipment rack, and include the receiver downconversion, "survey", and "analysis" stages. In general, "survey" (power spectral density measurements over large bandwidths) is performed by an Agilent Technologies Model E4407B spectrum analyzer, while "analysis" (waveform capture of specific signals) uses a custom coherent digital receiver with 16 MHz instantaneous bandwidth. A computer for control of the entire system and a universal power supply are also included in the equipment rack.

The interface between the AFEU and the equipment rack is via three coaxial cables. The cables may be of any type as long as they are 50Ω with less than 10 dB attenuation. RG-223 is recommended although RG-58 will suffice. The cables must end in SMA male connectors at both ends, and there must be no DC blocks (e.g., series capacitors) anywhere between the AFEU and the equipment rack.

The three connections between the AFEU and equipment rack are labeled J1, J2, and J3 at both ends:

- J1 provides DC power for the AFEU's RF electronics. It also carries a binary control signal from the equipment rack to the AFEU, by means of a small change in the level of the DC voltage, which is used to control the state of the antenna switch.

- J2 provides DC power for the AFEU's noise generator. It also carries a binary control signal from the the equipment rack to the AFEU, by means of a small change in the level of the DC voltage, which is used to control the noise generator.

- J3 carries the RF output of the AFEU back to the equipment rack.

The equipment rack is shown in it's operational state in Figure 2. As of September 3, 2002, LISA is installed in a standard flight-certified equipment rack on loan from the NASA Wallops Flight Facilty. Note that a pull-out keyboard/monitor is used.

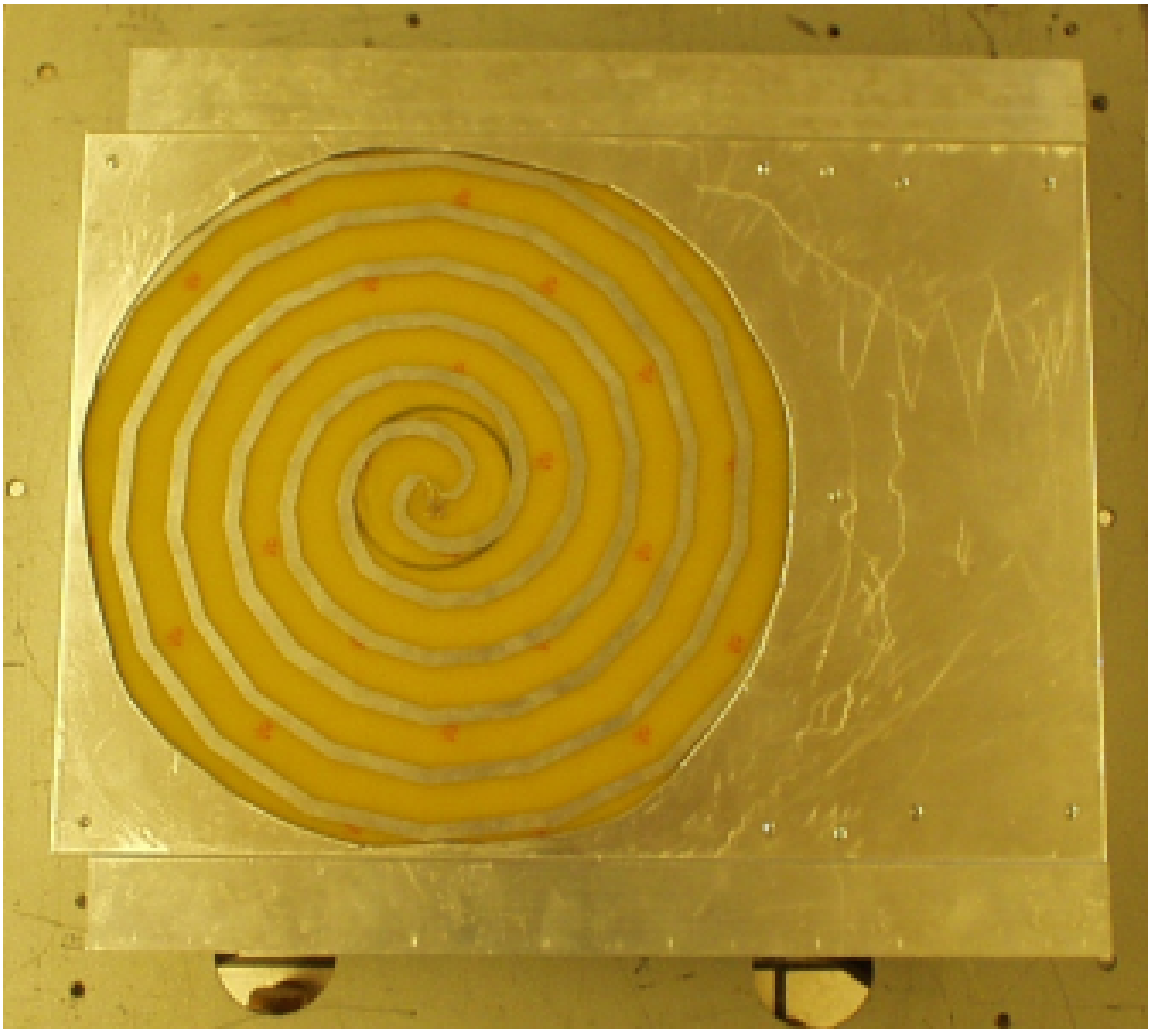

Figure 1: The antenna side of the AFEU; i.e., this would be the view from the ground with the aircraft overhead. Note L-brackets (included to aid in mounting) on top and bottom (with respect to orientation in this picture). Connectors J1, J2, and J3 are mounted close together on one of the long sides of the enclosure.

The operator requires access to this keyboard as well as to the spectrum analyzer mounted above it while the system is operational. In addition, the operator may require access to the rear of the rack after the system is installed.

The entire LISA instrument is powered from a single 115VAC outlet, from which the UPS is powered. All other equipment in the rack is powered via 115VAC outputs from the UPS.

Figures 3 and 4 show the LISA equipment rack as it appears in the "stowed" configuration; e.g., keyboard/monitor unit retracted, rack ready to be moved.

Figure 2: The LISA equipment rack, as it appears when the system is running. (Note that the cardboard box, blue plastic bag, and metal enclosure (actually, the AFEU) are not part of the equipment rack and just happened to be stacked there when this picture was taken.)

Figure 3: The front of the LISA equipment rack, as it appears when the system is stowed. From top to bottom: Spectrum Analyzer (removed in this picture), LISA electronics box, 1U keyboard/monitor unit, computer, DC power supply, UPS.

Figure 4: The rear of the LISA equipment rack, as it appears when the system is stowed.

General Experiment Information and Request Worksheet

General Information

1.Experiment Description

Experiment Name and Acronym: L-BAND INTERFERENCE SURVEYOR/ANALYZER (LISA)
Measurements: L-BAND INTERFERENCE
Measurement Technique(s): PASSIVE MICROWAVE RADIOMETRY
Detection Limit: NOT YET DETERMINED.
Time resolution: N/A
Do you have any known incompatibilities with any other instruments? NO.

2. Points of Contact

NASA HQ Sponsor Name: FRANK PERI *
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Foreign Nationals

List Names and contact information to obtain information for base and aircraft access.

* ALT. NASA (TECHNICAL) CONTACT:-
ED KIM, (301) 614-5653, EDWARD.J.KIM@GSFC.NASA.GOV
ALSO NOTE:
THIS INSTRUMENT IS TO "PIGGYBACK" ON AESMIR FLIGHTS,
POC ED KIM (SEE ABOVE).

Hazardous Materials/Equipment (List information for each item for Aircraft and/or Ground Use.

1. Lasers

Laser type:
Laser Class:
Laser wavelength:
Output power/energy:
Output power/energy pulse width:
Output power/energy rep rate:
Shielding Requirements:

N/A

2. Radio Frequency Emitters

Description:
RF Power:
Frequency Range:
Operational Constraints:
Installation Constraints:

N/A

3. Compressed Gasses

Gas Description (Mixture/concentration):
Cylinder Internal volume:
Cylinder Pressure:
Number of Cylinders Required:

N/A

4. Chemicals (solids & liquids):

Description (Name, concentration):
Total Quantity
Container Description:
Purpose:

N/A

5. Radioactive Materials

Source:
Half-Life:
Quantity:

N/A

6. Cryogens

Material Description:

N/A

Container Description:
Quantity Required on Flight Days:
Quantity Required on Non-Flight Days:
Operational Constraints:
Installation Constraints:

7. Batteries/UPS

Battery& UPS Description (Manufacturer Name & model no.): APC SU1000RM2U (SEALED LEAD-ACID)
Battery Type:

8. Pressure Vessels (Containment vessels, compressor tanks) } N/A

Description (purpose, contents):
Internal Volume:
Vessel Pressure:
Installation Constraints:

9. Motors/Pumps } N/A

Description:
Manufacturer Name/Model No.:
Motor Type (capacitor start, brush less, explosion proof);

10. Heaters } N/A

Description (system components, location):
Manufacturer Name/Model No.:
Max. Temperatures:
Comments:

11. Power Distribution Equipment (non-aircraft outlets, power converters)

Description: SEE (7) - INCLUDES 6 AC OUTLETS.
Manufacturer Name/Model No.:

A/C INSTALLATION

1. Seats & Operators

Total Number of Seats Required During Experimenter Check-out Flights: 1
Total Number of Seats Required During Transit Flights: 1
Total Number of Seats Required During Science Flights: 1
Required Location of Seats: IN FRONT OF RACK, ALLOWING ACCESS TO PULL-OUT KEYBOARD/MONITOR,

2. Racks and Floor Mounted Equipment

Number & Type of Racks Required: 1-EA STANDARD 19" RACK
Estimated weights of cabin rack: 200 LBS. (EST.)

3. Storage Boxes

Provide estimate of storage volume and weight for transport on the P-3B: 54 CU. FT. / 200 LBS.
Special Installation constraints: PLEASE POSITION TO ALLOW ACCESS TO REAR OF RACK (NO SEAT REQUIRED)

4. Probes, Sensors, Antenna, view ports, Etc.

Probes

Description:
NASA Part number (if any):
Current Location & Ownership of Probe:
Preferred location on P-3B:
Sampling Direction (fwd. or aft):
Probe Alignment (with A/C or with free stream):
Equipment to be installed w/ probe:
Max. Allowable Distance from Rack:
Special Installation Constraints:

N/A

Optical Windows

Optical window size:
NASA Serial Number (if any):
Current location and ownership of window:
Preferred location on P-3B:
Optical Passband:
Preferred Material and Coating:
Window Cleaning Requirements:
Special Installation Constraints:

N/A

Exhaust Port (s)

Description:
Current Location & ownership of exhaust port:
Preferred location on P-3B:
Contents of Exhaust:
Special Installation Constraints:

N/A

Antenna(s)

Description: FLAT SPIRAL MOUNTED IN 12" x 17" x 3" ENCLOSURE
Antenna Size:
Current location & Ownership of Antenna: WITH RACK @ NASA/GSFC AS OF 9/9/02
Preferred Location: BOMB BAY
Antenna Orientation: SPIRAL FACING NADIR
RF Power: N/A
RF Frequency: 1200 - 1800 MHz
Special Installation Constraints:
ANTENNA-RACK INTERFACE IS VIA 3 COAXIAL CABLES, TYPE RG-58 OR RG-223, WITH SMA-MALE CONNECTORS. NO DC BLOCKS, PLEASE.

Equipment Covering/shields

Description:
Operational Requirements:
Special Installation Constraints:
Special Equipment
List Any Other Equipment Required:

NO SPECIAL REQUIREMENTS.

5. Aircraft power requirements

115v	60 Hz	single phase:	REQUIRE SINGLE OUTLET. (POWERS UPC)
115v	400 Hz	three phase:	NONE.
28vdc:			NONE.

Other Electrical Requirements:

Power (Volts, Watts):
Load Name:
Start Current:
Run Current:
Regulation:
Comments:

NONE BEYOND SINGLE 115VAC OUTLET. EXACT CURRENT DRAW UNKNOWN BUT ESTIMATED TO BE < 5A.

OPERATIONS (state desired, acceptable, unacceptable)

Aircraft Interior Environmental Conditions (where applicable)

Required Temp. Range:
Desirable Temp. Range:
Desirable Humidity Range:
Undesirable Flight Conditions:
Desirable Max Vibration:
Desirable Attitude Range:
Environment Critical Components:

NO SPECIAL REQUIREMENTS.

Aircraft Access

Pre-flight time required at aircraft: 1 HR.
In-flight warm up time required: 15 MIN.
Post-flight Power/Button-up time required: 1 HR.
No fly-day time required at Aircraft: 1 HR. MAX
Ground Support Equipment Required: NO SPECIAL REQUIREMENTS

Aircraft Maneuvers

Describe in-flight calibration maneuvers:

Describe desired flight attitudes (pitch/roll limits):

Describe desired airspeed:

Describe required flight altitudes:

Describe airspeed limitations:

Undesirable Flight Conditions:

NO SPECIAL REQUIREMENTS — THIS SYSTEM CO-OBSERVES WITH OTHER SYSTEMS. ALL ELSE BEING EQUAL, LEVEL, SLOW, HIGH-ALTITUDE FLIGHT PREFERED.

Work Area Requirements (ground facilities)

Space requirements (square ft): 100
Tables/chairs: 1/2

Fume hood: NO
Exhaust: NO
Power: 1 EA. 115VAC OUTLET
Network connections: NO
Phones NO
Fax: NO
Chemical storage: NO
Water: NO
Refrigeration: NO
Gases: NO
Special needs (i.e. laser curtain, location relative to other experimenters, carts, etc.): NONE.

Other: NONE.