National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, TX 77058

EV5-09-EMC-010R
August 25, 2009

TEST REPORT
Electromagnetic Interference (EMI) of the Engineering Evaluation For The ALPHA MAGNETIC SPECTROMETER (AMS-02) -USB422 Assembly

	NAME	PHONE	SIGNATURE/DATE
DISTRIBUTION	ESCG/Duong Nguyen	281-486-6311	
WRITTEN BY	EV5/Hoai Ngo	281-483-8088	Hoai Ngo 9/14/09
APPROVED BY	EV5/ Robert C. Scully	281-483-1499	Robert C Scully 14 Sep 09

Summary Information Sheet

TASK PERFORMANCE SHEET (TPS):	2A0920076
EQUIPMENT UNDER TEST:	Alpha Magnetic Spectrometer (AMS-02) – USB422 Assembly,
PROJECT MANAGER:	Mike Fohey, 281-461-5684
TEST DATE:	July 22-28, 2009
TEST LOCATION:	NASA, Johnson Space Center, Houston, TX Primary EMI Laboratory
EMC PROJECT ENGINEER:	Hoai Ngo, 281-483-8088
NASA JSC EMC LEAD:	Robert C. Scully, 281-483-1499
TEST MANAGER:	Xiang Ni, 281-483-0186
TEST OPERATOR:	Cynthia Hightower, 281-483-4476 Charles brooks, 281-483-8402

1.0 INTRODUCTION

This preliminary test report details the preparation for, and results of, Electromagnetic Interference (EMI) testing accomplished of the Alpha Magnetic Spectrometer (AMS-02) – USB422 Assembly.

2.0 APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of this Test Report to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this report, this document shall have precedence.

SL-E-0002, Book 3, Volumn 1 Dated: August 10, 2001	Space Shuttle – Specification Electromagnetic Interference Characteristics, Requirements for Equipment
ESCG-5132-06-BDL-DOC-0056 Dated August 2006	Electromagnetic Interference/Compatibility Laboratory Test Methods
JSC 27933, Rev B Dated March 03, 2004	EMI/EMC Laboratory Configuration Documents

3.0 CONFIGURATION OF THE EQUIPMENT UNDER TEST

A general block diagram of the EMI test set up for the AMS-02- USB422 Assembly is shown in Fig. 3.1. This setup refers to as the original configuration in the Test Plan that the USB422 provides inline conversion of RS422 synchronous serial signals to a USB 2.0 interface and powers by A31p Laptop vs. USB 5 Vdc, 0.5 ampere supply. Photographs of the test setups for the applicable antenna frequency ranges, including horizontal and vertical polarizations as required in SL-E-0002, are shown in Figs. 3.2 through 3.9. Test equipment uses to perform this test listed in TABLE 3-1.

Since EUT will be used in Space Shuttle Aft Flight Deck during flight, therefore it requires to meet and be tested to Shuttle EMI specifications per SL-E-0002, Book 3, Volume 1. This test set up performs measuring radiated susceptibility as engineering evaluation to monitor and determine if any failure to USB422 Assembly (Class III) when subjects to radiated electric field of 20 V/m stated in SL-E-0002.

Photographs of the test setup show in Fig. 3.10 through Fig. 3.13, additional verification test, in the frequency range from 30 MHz to 200 MHz for the USB422 with connected loopbacks.

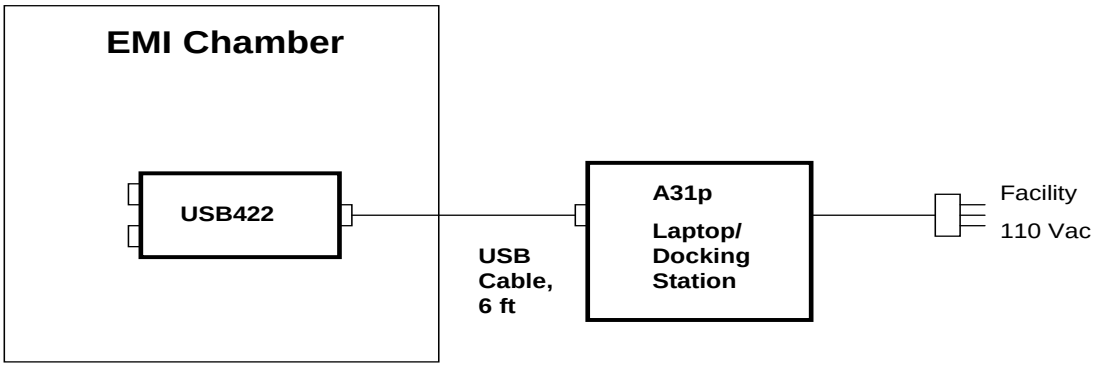

Fig. 3.1. General Test Setup for USB422.

Fig. 3.2. Test Setup, USB422 Assembly.

Fig. 3.3. Test Setup, A31P Laptop located outside the test chamber used to monitor performance of the USB422 Assembly during measurement.

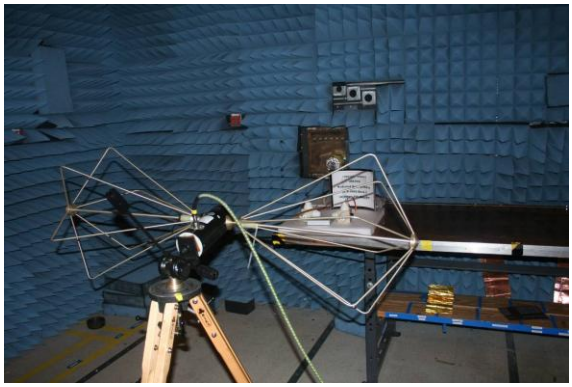

Fig. 3.4. Test Setup, Biconical Antenna, Horizontal Polarization, 30 MHz – 200 MHz.

Fig. 3.5. Test Setup, Biconical Antenna, Vertical Polarization, 30 MHz – 200 MHz.

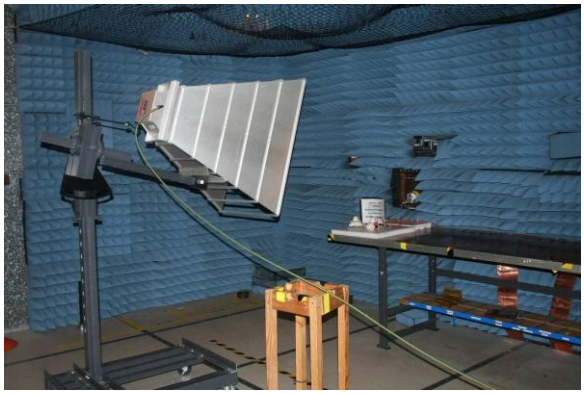

Fig. 3.6. Test Setup, Double Ridge Horn Antenna, Horizontal Polarization, 200 MHz – 1000 MHz.

Fig. 3.7. Test Setup, Double Ridge Horn Antenna, Vartical Polarization, 200 MHz – 1000 MHz.

Fig. 3.8. Test Setup, Horn Antenna, Horizontal Polarization, 1 GHz – 18 GHz.

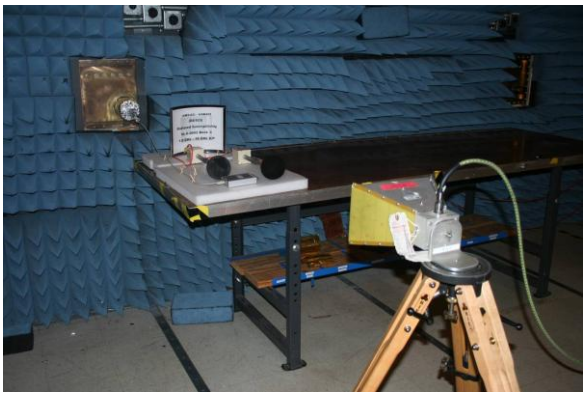

Fig. 3.9. Test Setup, Horn Antenna, Vertical Polarization, 1 GHz – 18 GHz.

Fig. 3.10. Test Setup, USB422 Assembly with loop back installed per Deviation 1.

Fig. 3.11. Test Setup, Closed look USB422 Assembly with loop back installed.

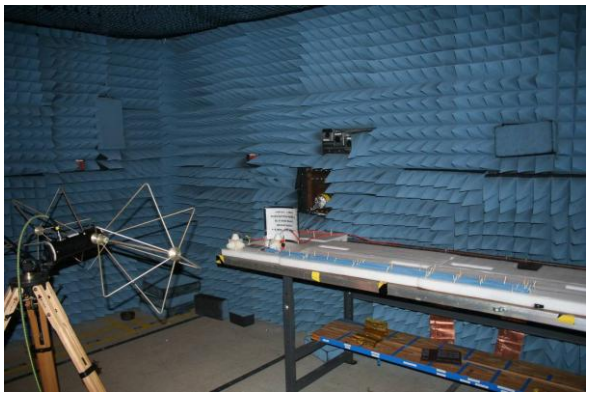

Fig. 3.12. Test Setup, Biconical Antenna, Horizontal Polarization, 30 MHz – 200 MHz.

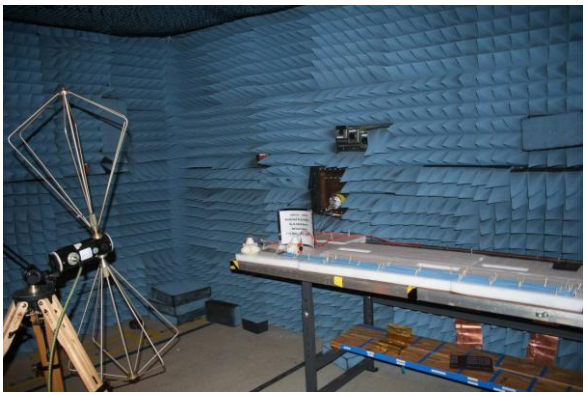

Fig. 3.13. Test Setup, Biconical Antenna, Verticalal Polarization, 30 MHz – 200 MHz.

TABLE 3.1
List of Measurement Equipment

Test equipment	Manufacturer	Model Number	Serial Number	Calibration	
				Number	Due date
BiConical	Amplifier Research	BCH-2030/A	1017	N/A	N/A
Double-Ridge Horn	Ets System	3106	2824	610920005	01/30/10
Double-Ridge Horn	Ets System	3115	6059	610920006	01/30/10
R.F Amplifier	IFI 10kHz-1000 MHz	SMX500	M730-0808	N/A	N/A
R.F Amplifier	IFI 1-2.5GHz	T251-500	D038-0400	N/A	N/A
R.F Amplifier	IFI 2.5-7.5GHz	T7525-500	D039-0400	N/A	N/A
R.F Amplifier	IFI 8-18GHz	T1875-500	D033-0400	N/A	N/A
Signal Generator	Rohde Schwarz 5K-3GHz	SMT-03	100231	M206568	09/10/09
Signal Generator	Rohde Schwarz 2-20GHz	SMP-22	100019	M206381	11/05/09
R.F. Field monitor	Amplifier Research	M5004	28078	N/A	N/A
Probe, Isotropic	Amp. Research 10K-1GHz	FP5000	300489	N/A	01/05/10
Probe, Isotropic	Amp. Research 10K-1GHz	FP5000	300487	N/A	12/18/09
Probe, Isotropic	Amp. Research 80M-40GHz	FP2080	19447	N/A	04/27/10
Probe, Isotropic	Amp. Research 80M-40GHz	FP2080	25256	N/A	04/17/10
EMI Lab RF Cable	MegaPhase 6 ft	D130-NK-NK-72	1004	610920035	04/21/10
EMI Lab RF Cable	ESM Cable Corp 120ft	EW292-NGNG-120	1001	610824004	11/12/09
EMI Lab RF Cable	Adams-Russell	1997-240	1001	610924084	10/09/09

4.0 TEST RESULTS:

This section shows test performed per Space Shuttle requirements. Test results show that the USB422 is in compliance with the requirements, SL-E-0002, as shown in TABLEs 4-1, 4-2 and 4-3.

TABLE 4-1
SL-E-0002 Test

EMI TEST	**DESCRIPTION**	**COMPLY? Y/N**
RS103	Radiated Susceptibility 30 MHz – 18 GHz Electric Field	Y

TABLE 4-2
Summary test data results without fully loopback connected

Frequency (MHz)	Required Levels (V/m)	Injected signal level per polarization		NOTE
		Horizontal	Vertical	
30 - 180	20	20	20	None
180.80	20	15.04	20	EUT malfuntion
181	20	14.21	20	EUT malfuntion
182	20	15.01	20	EUT malfuntion
185	20	12.80	20	EUT malfuntion
190	20	15.50	20	EUT malfuntion
192	20	18.68	20	EUT malfuntion
193 - 18000	20	20	20	None

TABLE 4-3
Summary test data results with loopback connected

Frequency (MHz)	Required Levels (V/m)	Injected signal level per polarization		NOTE
		Horizontal	Vertical	
175 - 200	20	20	20	None

5.0 CONCLUSIONS

EMI measured data indicate the USB422 is compliant with Radiated Susceptibility (Electric Field) requirements in SL-E-0002 for non-critical equipment.

Collected data shows in TABLE 4-2 for EUT not fully concealed with loopback connected was susceptible from 180.8 – 192.0 MHz; but, malfunction did not damage A31p Laptop. Laptop was still able to recognize device connected to USB port after testing was completed.

Deviation was made to test setup to re-perform a portion of the RS testing in which the EUT was susceptible. In original test configuration shows in Fig. 3.1 that the connections TXD, RXD, TXC and RXC were left open and created a path for radiated electric field to enter enclosure. In deviation configuration, loopback cables connected from TXD to RXD and TXC to RXC as shown in Figs. 3.10, 3.11, and 5.1 below. Collected data shows in TABLE 4-3 indicates re-tested from 175 – 200 MHz in both the horizontal and vertical polarizations were not susceptible when applied its required-levels.

To achieve an isolated and sealed enclosure for flight, Cable Assy p/n SED39136111-301 will be connected to TXD, RXD, TXC and RXC connectors on USB422 Assy as shown in Figure 1.1 in the Test Plan, EV5-09-EMC-010P.

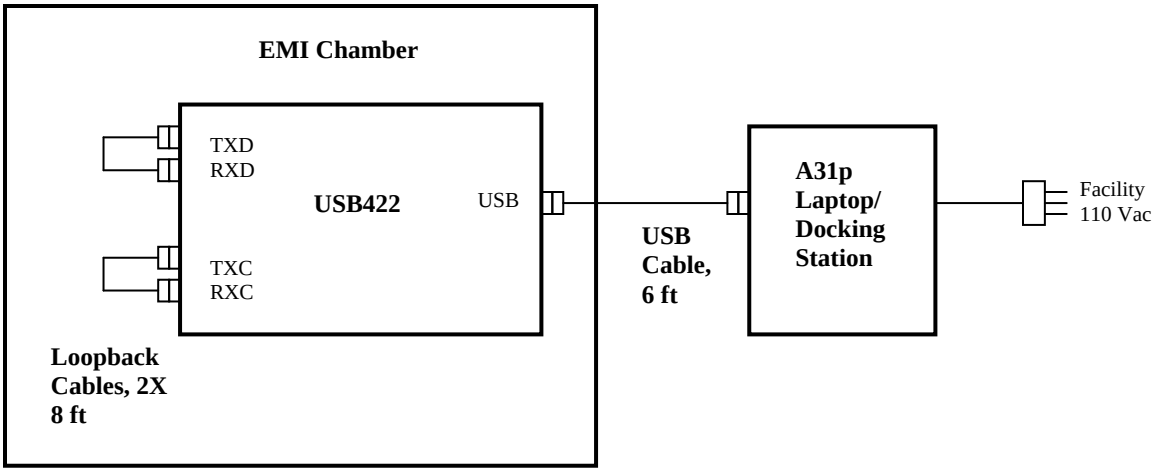

Fig. 5.1 EMI Deviation Test Configuration

6.0 APPENDIX

The appendix contains copies of the following documents:

- Test Request – JSC Form 90
- TRR Checklist
- TRR Attendance Sheet
- Test Readiness Review Board – Form EA-005
- EMG EMC/EMI Facility Readiness Statement Sheet
- EMG EMC/EMI Chamber Test Facility Authorized Operators List sheet
- Integrated Test Hazard Analysis Report, EV5-09-EMC-010HA
- Task Performance Sheets, 2A0920076
- Hazard Analysis Test Article/Test System/Laboratory Inspection Checklist Sheet
- Authorized Personnel Sheet
- Pre-Test Checklist
- EMI Lab Safety Briefing sheets
- Test Plan, EV5-09-EMC-010P
- Measured Data
- Test Process Evaluation Sheet

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TEST REQUEST

REQUESTER PROVIDED INFORMATION

DATE RECEIVED	TEST FILE NO.	LOG NO.	PROPOSED TEST FACILITY
13-JULY 2009	EV5-09-EMC-010		PRIMARY

REQUESTER NAME/ EXTENSION/ E-MAIL	INITIATING OFFICE	DATE OF REQUEST
Duong Nguyen / 281-486-6311 / duong.nguyen@escg.jacobs.com	EA3	6-24-2009

TEST TITLE	PROJECT SUPPORTED
USB422 Assy RS103 Testing	AMS-02

PRIMARY AND SECONDARY OBJECTIVES: Acceptance ☐ Certification Test ☐ Qualification Test ☐ Engineering Evaluation ☒

Subject USB422 Assembly to Shuttle RS103 limits and evaluate performance of hardware.

TEST ARTICLE DELIVERY DATE (to test facility)	DESIRED TEST DATE(S)	DATA NEEDED BY
7-15-2009	7-20-2009	7-24-2009

NUMBER OF TEST SUBJECTS REQUIRED	TEST TIME ESTIMATE	RATIONALE: For specific or quick-response test dates
Astronauts 0	Number of Tests: 1	
Others 0	Hrs/Test:	

BRIEF DESCRIPTION OF TEST ARTICLE:

FLIGHT? CLASS I ☐ CLASS II ☐ CLASS III ☒ **CRITICALITY?** CRIT 1 ☐ CRIT 2 ☐ CRIT 3 ☐ ***NON-FLIGHT?*** ☒

Model No.	USB422
Serial No.	N/A

Other Information: Size, weight, material, quantity, powered, pressurized, etc.?

Test Article: USB422 Assembly
Description: The USB422 Assembly provides inline conversion of RS422 synchronous serial signals to a USB 2.0 interface.
Size: 5 x 3 x 1 IN (L x W x H)
Weight: 1 LB
Material: PCB housed inside Aluminum Enclosure
Quantity: 1 EA
Power Source: 5 VDC from A31p Laptop via USB Cable
Power Draw: 0.5 A Pressurized: N/A

TEST ARTICLE DOCUMENTS AND EQUIPMENT TO BE SUPPLIED BY REQUESTER:

☐ FMEA	☐ Instrumentation List	☒ Hazard Analysis	☒ Personnel
☐ Drawings	☐ Interface Documents	☐ Special Handling Requirements	☐ Other (specify)
☐ Materials List	☐ Test Requirements Document	☒ Test Support Equipment	

FUNDING (To be completed by requesting org analyst)

BUDGET ANALYST NAME/ EXTENSION/ E-MAIL	PROGRAM SUPPORTED	FUNDING CODE

BRANCH CHIEF SIGNATURE / DATE: [signature] TEST MGR IN

TEST BRANCH ASSIGNMENTS

TD/ATD

FEM

FEE

IE

FMEA/HA

ADDITIONAL ENGINEERING

FUNDING APPROVALS

COST ESTIMATE	HOURS	LABOR	MATERIAL	TOTAL
CIVIL SERVICE		$		$
CONTRACTOR		$		$
			Total Due (before testing will begin)	$

REQUESTER BRANCH APPROVAL (after estimate has been provided)

TECHNICAL APPROVER SIGNATURE

FUNDING APPROVER SIGNATURE

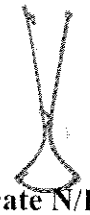
TEST ORGANIZATION BRANCH APPROVAL

TECHNICAL APPROVER SIGNATURE [signature] 16 July 09

FUNDING APPROVER SIGNATURE [signature] July 20, 2009

EVALUATION

JSC Form 90 (Rev April 06)



TRR Checklist

Indicate N/R, initials, and date, for non-required entries

Date: 20 July 2009

EMC Test# **EV5-09-EMC-010**

Engineering Evaluation of the Alpha Magnetic Spectrometer (AMS-02)
Universal Serial Bus (USB422) Assembly

PLEASE SEE ACTION ITEMS ASSIGNED IN EA-005

- [x] Attendance Sheet
- [x] Test Request, JF 90
- [x] Test Readiness Summary Sheet, JF 1850
- [x] Integrated Hazard Analysis Report (IHA)
- [x] Safe Plan of Action (SPA) N/A
- [x] Human Test Subject Approval Letter N/A
- [x] Material Safety Data Sheet (MSDS) N/A
- [x] Battery Certification Letter N/A
- [x] Laser Device Use Request/Authorization, JF 44B N/A
- [x] Lift Plan N/A
- [x] Facility Readiness JOHN GAFFORD TO PROVIDE
- [x] TPS (JF 1225) or DR (JF 2176), WO TO BE OPENED
- [x] Test Plan
- [x] Run Time Log
- [x] Authorized Project Operator List
- [x] Authorized Facility Operator List TO BE PROVIDED BY JOHN GAFFORD

EVALUATION

Building 14 EMI Test Facility
Test Readiness Review
Attendance Sheet

Engineering Evaluation of the Alpha Magnetic Spectrometer (AMS-02) Universal Serial Bus (USB422) Assembly (EV5-09-EMC-010)

Name	Org	Ph #	Function
Rick Deppisch	EV5		*TRR Chairperson*
HOAI NGO	EV5	x38088	*Test Director*
Cynthia Hightower	ESCG	X34476	*Test Conductor*
Charles Harwood	EV5	32038	*Bldg 14 Facility Mgr*
Rick Deppisch	EV5		*EMI Test Laboratory Mgr*
DUONG NGUYEN	JACOBS	2814866311	*Test Requestor*
			Test Article Expert
THU T. NGUYEN	NS226	45694	*JSC Test Safety Office Representative*
Chuck Landrum II	ESCG	32717	*ESCG Safety Officer*
Carolyn Mason	EV5	x38279	*EV5 Branch Mgr or Designee*
			*NT Quality Assurance**
			*ESCG or Customer Quality Assurance**
			*JSC Facility Quality Engineer (QE)**
ETIENNE L. COLEMAN	ESCG/QE	33615	*Customer Quality Engineer (QE)**
			*NASA Medical Officer**
			*Test Crew Member**

Notes:

1) The presence of attendees on this sheet establishes a quorum for TRR proceedings.
2) QA, QE, Medical Office, and Test Crew Member support is determined by the project under test, and will vary. At least one QE and one QA representative, as deemed appropriate by test conditions and requirements must be present. The TRR Chairperson shall ensure the appropriate representatives are present prior to start of the review process, and shall indicate N/R, initial and date, for those not required.

EVALUATION

Date: 20 July 2009

Location: Bldg 14a Rm 2000a

Building 14 EMI Test Facility
Test Readiness Review
Attendance Sheet

Engineering Evaluation of the Alpha Magnetic Spectrometer (AMS-02) Universal Serial Bus (USB422) Assembly (EV5-09-EMC-010)

Name	Org	Ph #	Function
Mitchell Sands	ESCG	x30132	Observer
John Gafford	ESCG	30200	Observer
Sharon Raymond	Boeing EME	281-226-5643	Observer
George May	Boeing EME	281-228-8543	Observer
Charles Brooks	ESCG	38402	Observer Test Conductor
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer
			Observer

EVALUATION

Date: 20 July 2009

Location: Bldg 14a Rm 2000a

Test Readiness Review Board

1. Test Title	2. Page Of
EMC Engineering Evaluation of the Alpha Magnetic Spectrometer (AMS-02) (USB422) Assembly	1 of 1

3. TRRB Date	4. File Number	5. Procedure Number	6. TPS Number
July 20, 2009	EV5-09-EMC-010		

Approvals (Approvals as Required)

The Test Readiness Review Board approves conduct of this test upon completion of the listed open items prior to start of test.

7. TRRB Chairman: Richard Deppisch 20-July 2009	8. Test Requester / Branch Representative: Danny Nguyen 7-20-09
9. Quality Engineer: [signature] 7/20/09	10. Test Crew Member / Representative:
11. Medical Officer: N/A	12. Test Branch / Facility Manager: [signature] 7-20-09
13. Test Safety Officer: [signature] 07/20/09	14. Test Director: [signature] 7/20/09
15. Test Article Expert: Danny Nguyen 7-20-09	16. ESC6 Facility Safety Officer: [signature] 07/20/09

No.	17. Open Items	Assignee	Closed
1	Have EV5 Branch Chief Sign JF90	Rick Deppisch	RMD
2	Provide A Facility Readiness Statement	John Gafford	✓ JG
3	Open The TPS	Duong Nguyen	DVN
4	Provide An Authorized Operators List	John Gafford	✓ JG
5	Provide Project Manager Signature On HA	Duong Nguyen	DVN
6	Update The Lab Parts List In Test Plan Rev 11.1	Cynthia Higginbotham	CH
7	Route The Test Plan For Signature	Duong Nguyen	DVN

18. Open Items Closure Approvals	
Test Director: [signature] 7/21/09	TRRB Chairman: Richard M. Deppisch 21-July 2009

Form EA-005 (September 13, 2002)

EVALUATION

ESCG

5/22/2009

TO: EMI TRR Chairman

FROM: John R. Gafford, EV ESCG Section Manager

SUBJECT: EMG EMC/EMI Facility Readiness Statement

This memo is to verify that the EMG EMC/EMI Facility in B14 is functional and that no open paper exists to inhibit testing.

If you have any questions please feel free to contact me.

Thank you

John Gafford
ESCG 5420 Section Manager
2100 NASA Rd. 1
Houston, TX. 77058
(281) 483-0200 work
(713) 249-5471 cell

ESCG

5/1/2009

TO: TRR Chairman

FROM: John R. Gafford, EV ESCG Section Manager

SUBJECT: EMG EMC/EMI Chamber Test Facility Authorized Operators List

This memo is to verify that Asset Management ESCG personnel Xiang Ni, Cynthia Hightower and Charles Brooks are authorized to operate and have responsibility to speak for the EMG EMI/EMC Test Facility.

If you have any questions please feel free to contact me.

Thank you

John Gafford
ESCG 5420 Section Manager
2100 NASA Rd.1
Houston, TX. 77058
(281) 483-0200 work
(713) 249-5471 cell

EV5-09-EMC-010HA
Revision: Basic

Hazard Analysis for the EMI/EMC Engineering Evaluation of the (AMS-02)-USB422 Interface

Avionic Systems Division
Specialty Engineering Branch

July 20, 2009
Revision: Basic

Verify this is the correct version before use.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

Hazard Analysis for the EMI/EMC Engineering Evaluation of the (AMS-02)-USB422 Assembly

Prepared By

07/20/09
Chuck Landrum II, ESCG Safety Engineer

Approved By

7/20/09
Hoai Ngo, Test Director

7/20/09
Rick Deppisch, TRR Chairman

7/20/09
Mike Fohey, Project Manager

07/20/09
John Ngo, Facility Manager

7/20/09
Darilyn M. Gaston, Chief, Specialty Engineering Branch

07/20/09
Thu Thi Nguyen, NS Test Safety Officer

7-20-09
Duong Nguyen, Test Article Expert

Change Record

Revision	Date	Originator	Description
Basic	July 16, 2009	Chuck Landrum	Initial Release

Table of Contents

Tables and Figures

1.0 Introduction/Purpose

One of the characteristics of an effective safety program is the recognition and control of hazards before mishaps or failures occur. Conducting potentially hazardous tests necessitates a thorough hazard analysis in order to prevent injury to personnel, and to prevent damage to facilities and equipment.

The primary purpose of this hazard analysis is to define and address the potential hazards and controls associated with the EMI/EMC Engineering Evaluation of the (AMS-02)-USB422, performed in building 14 EMI Primary Chamber, room 1000, and to provide the applicable team of personnel with the documented results. It is imperative that each member of the team be familiar with the hazards and controls associated with his/her particular tasks, assignments and activities while interfacing with facility test systems, equipment and hardware.

In fulfillment of the stated purposes, the goal of this hazard analysis is to identify all hazards that have the potential to harm personnel, damage the facility, or its test systems or equipment, test articles, Government or personal property, or the environment. This analysis may also assess the significance and risk, when applicable, of lost test objectives when substantial monetary value is involved. The hazards, causes, controls, verifications, and risk assessment codes have been documented on the hazard analysis work sheets in appendix A of this document.

The preparation and development of this report is in accordance with JPR 1700.1, JSC Safety and Health Handbook.

2.0 Scope

This Hazard Analysis covers the engineering evaluation for the performance of the (AMS-02)-USB422 within specified EMI fields. Loopback tests at specified EMI settings will be conducted utilizing a laptop computer.

As applicable, the safety assessment examines the following elements of the test activity, test hardware, or facility systems and equipment.

a. Test System/Facility Hardware – Structural, Mechanical, Electrical, Chemical, Test Environment, Static/Dynamic Energies, Materials,

b. Test personnel training and interaction with hardware, facility and/or test systems and equipment,

c. Test Procedures, Equipment Operating/Task Instructions, Check Lists, Equipment/Component Configurations, Drawings and Schematics, Preventative Maintenance.

3.0 References

Note: All references must be reviewed prior to use to verify/confirm that the document is the latest revision.

3.1 Documents

Document Number	Revision	Document Title
JPR 1700.1	J	JSC Safety and Health Handbook
EV5-09-EMC-010P	Basic	Test Plan Engineering Evaluation, Electromagnetic Interference (EMI) Electromagnetic Compatibility (EMC) for the Alpha Magnetic Spectrometer (AMS-02)-USB422 Assembly
JSC-64629	B	Hazard Analysis for Electromagnetic Interference/Compatibility (EMI/EMC) Test Facilities Primary Laboratory - Building 14A, Room 1000 Secondary Laboratory - Building 14, Room 133D
EA-WI-024	A	General Operating Procedures Manual for EA Testing Facilities
EV-046	A	Control of Hazardous Energy (Lockout/Tagout and Energy Source Isolation) Process
ESCG-6120-08-C&I-PR-0001, number 112108509	F	Hazard Analysis Test Article/Test System /Laboratory Inspection Checklist

3.2 Drawings/Schematics

Drawing Number	Sheet#	Revision	Title
SED39137921	1	0	USB422 Assembly

4.0 Symbols and Abbreviations

Symbols & Abbreviations	Explanation
HAWS	Hazard Analysis Worksheet
RAC	Risk Assessment Code
JSC	Johnson Space Center
USB	Universal Serial Bus
EUT	Equipment Under Test
LOTO	Lockout Tagout

5.0 Definitions

The following definitions are vital to an understanding of the requirements contained in this document:

a. Hazard — An unsafe or unhealthful condition that could lead to a mishap if it is not corrected.

b. Consequence — The subjective estimate of worst credible outcome in terms of potential personnel injury, equipment/facility damage, and monetary losses. Consequence severity classes are defined as follows.

Class I - **Catastrophic.**
A condition that may cause death or permanently disabling injury, facility destruction on the ground, or loss of crew, major systems, or vehicle during the mission; schedule slippage causing launch window to be missed; cost overrun greater than 50% of planned cost.

Class II - **Critical.**
A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, equipment, or flight hardware; schedule slippage causing launch date to be missed; cost overrun between 15% and not exceeding 50% of planned cost.

Class III - **Moderate.**
A condition that may cause minor injury or occupational illness, or minor property damage to facilities, systems, equipment, or flight hardware; internal schedule slip that does not impact launch date; cost overrun between 2% and not exceeding 15% of planned cost.

Class IV - **Negligible.**
A condition that could cause the need for minor first-aid treatment but would not adversely affect personal safety or health; damage to facilities, equipment, or flight hardware more than normal wear and tear level; internal schedule slip that does not impact internal development milestones; cost overrun less than 2% of planned cost.

c. Likelihood — The relative likelihood a hazard may occur. The complete likelihood range is separated into intervals for additional classification. It is important to note that even though quantitative probability intervals are listed in this document they are only for numeric comparison and that the actual probability or likelihood is derived by subjective estimations of a qualitative nature. The hazard likelihood categories are defined as follows.

Likelihood A – **Likely to occur** – (e.g., 1.0 ≥ Probability > 0.1)
Likelihood B – **Probably will occur** – (e.g., 0.1 ≥ Probability > 0.01)
Likelihood C – **May occur** – (e.g., 0.01 ≥ Probability > 0.001)
Likelihood D – **Unlikely to occur** – (e.g., 0.001 ≥ Probability > 0.000001)
Likelihood E – **Improbable** – (e.g., 0.000001 ≥ Probability)

d. Risk Assessment Code (RAC) — The risk assessment code is the numerical value that represents the hazard risk associated with a given task, project, test, or equipment and is the point of intersection of the consequence severity estimate and the likelihood estimate on the RAC matrix.

e. Risk Assessment Code (RAC) Matrix — A matrix made up of likelihood estimates, consequence severity estimates and risk assessment codes. The matrix is used to derive the risk assessment code once the severity and likelihood have been determined.

f. Hazard Disposition — The status of a hazard after controls are in place. Hazard Dispositions are utilized in this analysis, documented at the bottom of each hazard analysis worksheet, to supplement the risk assessment codes and to further describe the control or status of the hazard. The disposition criteria are defined as follows:

Open/no action — A hazard exists in the system, and no controlling equipment or procedures have been implemented to minimize the hazard.

Closed/controlled — A hazard exists in the system, and appropriate mechanical/electrical/procedural actions have been taken to reduce the hazard to a minimal level.

Closed/eliminated — A hazard that is no longer in the system because it has been eliminated.

Closed/accepted — A hazard of RAC 2 or 3 after controls whose risk has been accepted by NASA management.

g. Hazard Summary — A list of the hazard categories/titles with before and after control RAC's.

h. Verification — The validation method or process that confirms the hazard control. Verifications of the hazard controls are identified via review of test procedures, equipment operating instructions and check lists, test system drawings and schematics, personnel training records, applicable JSC, EA, Division, and Branch work instructions and operating procedures, inspection of test equipment/area and interviews with facility engineers, technicians, test directors, and management.

i. Hazard Analysis Worksheet (HAW) — Tables in the hazard analysis used to document specific information regarding each hazard or hazard category, such as hazard title/description/consequence, system, sub-system, RAC, hazard causes, controls, verifications, remarks, and hazard disposition. There is only one hazard category/title per HAW.

j. The RAC matrix is defined as follows:

Table 1 – Risk Assessment Code Matrix

Verify this is the correct version before use.

CONSEQUENCE CLASS	LIKELIHOOD ESTIMATE				
	A	B	C	D	E
I	1	1	2	3	4
II	1	2	3	4	5
III	2	3	4	5	6
IV	3	4	5	6	7

k. The table below specifies the required action(s) for each RAC.

Table 2 - RAC Action Table

RAC	Action
1	Unacceptable – All operations shall cease immediately until the hazard is corrected or until temporary controls are in place and permanent controls are in work. A safety or health professional must stay at the scene at least until temporary controls are in place. RAC 1 hazards have the highest priority for hazard controls.
2	Undesirable – All operations shall cease immediately until the hazard is corrected or until temporary controls are in place and permanent controls are in work. RAC 2 hazards are next in priority after RAC 1 hazards for control. Program Manager (Directorate level), Organizational Director, or equivalent management is authorized to accept the risk with adequate justification
3	Acceptable with controls – Division Chief or equivalent management is authorized to accept the risk with adequate justification
4-7	Acceptable with controls – Branch Chief or equivalent management is authorized to accept the risk with adequate justification

6.0 Hazard Identification Criteria

As applicable, the following sources were utilized in developing the potential hazards, cause, controls and verifications in this Hazard Analysis:

- System design drawings, schematics, and Configuration Change Orders
- Failure Modes & Effects Analysis
- Detailed Test Procedures, Task Performance Sheets, Checklists, Preventative Maintenance Instruction
- Test system, equipment/hardware, and facility visual inspections
- Review of lessons learned and accident/mishap/injury reports
- Discussion with the test team, design engineers, test article experts, and management
- Materials review for toxicity, contamination, and compatibility/reactivity with system or test environment

7.0 Discussion/Description

7.1 Test System

EMI test facility personnel do not handle and/or operate the (AMS-02)-USB422. Thus, the hardware provider is responsible for providing certified operators for the setup, operation, and removal of the EUT. There will be a software program ran from the A31p laptop through the (AMS-02)-USB422 as needed. The EUT will be conducting loopback tests which will start and end with user input.

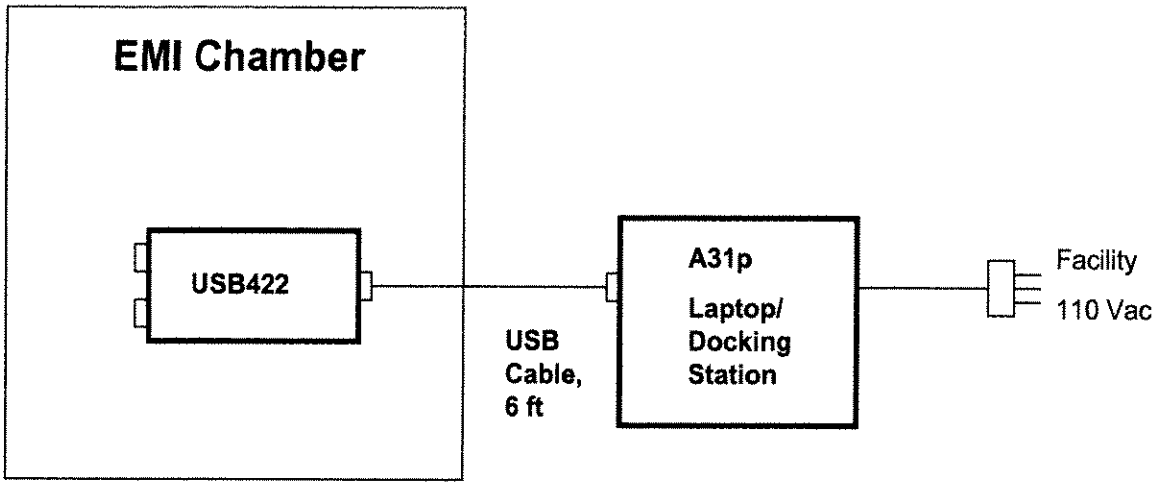


Figure 1 – EMI Test Configuration

7.2 Test Article

The USB422 assembly provides inline conversion of RS422 synchronous serial signals to a USB 2.0 interface. Signal (data) is then set to and recorded on program provided A31p Laptop hard drives.

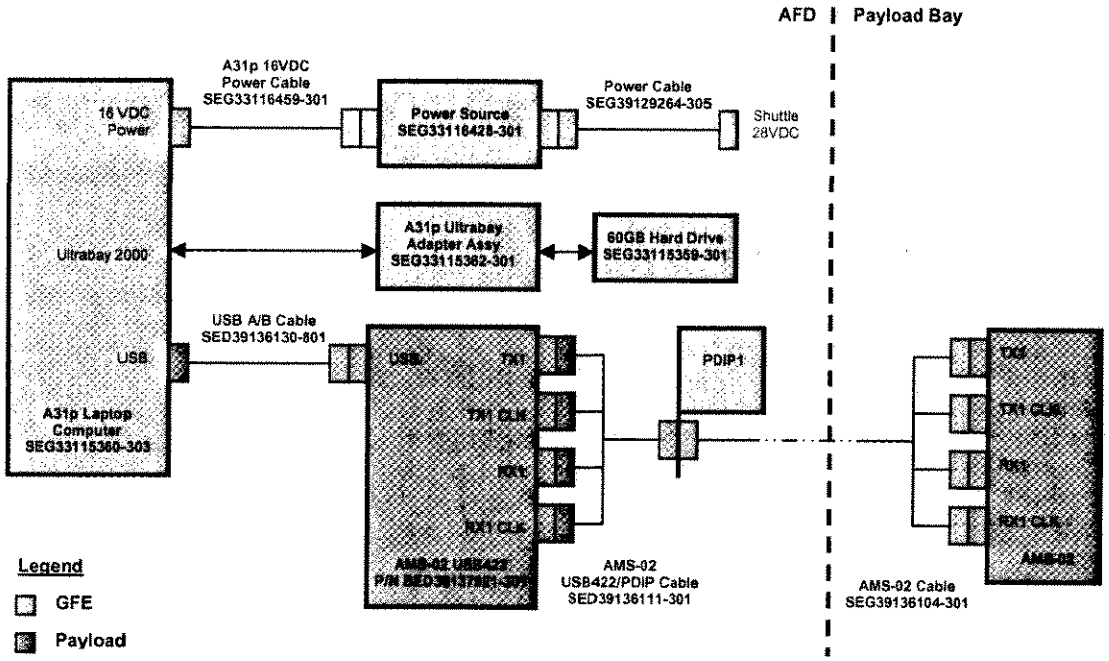


Figure 2 – Expected Flight Configuration

8.0 Unique Material/Chemical Use

Below is the list of applicable materials/chemicals utilized in this activity, project, facility, and/or test/hardware system that are reviewed for potential risk to personnel and/or equipment with respect to one or more of the following; toxicity, contamination to system, and compatibility/reactivity. The hazard controls for the specific material/chemical utilized are listed in the applicable hazard control section of this document. Note: chemical table only populated when applicable.

	Material/Chemical Name	Quantity Used	Approval Method
1	N/A		
2			
3			
4			

9.0 Hazard Summary

Table 3 summarizes the potential system hazards and risk assessment codes associated with this facility equipment, hardware, task, and/or test system. The details of each hazard, such as the specific hazard causes, controls and verifications, are documented on the hazard analysis work sheets in Appendix A.

Table 3 - Hazard Summary Table

Hazard		Consequence/Likelihood/RAC	
		Before Controls	**After Controls**
1	Electrical Discharge/Faults/Surges	I/C/2	I/D/3
2	Test Article Handling	III/C/4	III/D/5

A.1 Hazard Analysis Worksheet – Electrical Discharge/Fault/Surges

Hazard Title: ELECTRICAL DISCHARGE/FAULTS/SURGES			**HAWS No.** 1
System: EMI Chamber	**Subsystem:** USB422	**Severity/Likelihood/RAC**	
		Before Hazard Controls	**After Hazard Controls**
		I/C/2	I/D/3

Hazard Description & Consequence:

Exposure to Electrical discharges/faults/surges results in shock or electrocution to personnel and/or damage to equipment or test article.

Hazard Causes:

1.0 Personnel contact with exposed energized components/conductors.
2.0 Electrical surges or faults.
3.0 Reversed polarity on test equipment.

Hazard Controls:

1.0 All significantly energized electrical components/conductors are enclosed and facility electrical system buildup is in accordance with the National Electric Code. There will be no live electrical work performed during testing operations.
2.0 Facility power incorporates circuit breakers and a grounded electrical system.
3.0 Voltage and polarity are verified prior to connecting test articles, as required in the test procedures.

Hazard Control Verifications:

1.0 JSC drawing, SED39137921, USB422 Assembly, verifies that there are no exposed electrical conductors. Test Plan, EV5-09-EMC-010P, section 11.0, note 1, indicates that there will be no live electrical work performed during testing operations.
2.0 Checklist, ESCG-6120-08-C&I-PR-0001- F, number 112108509, blocks 2 to 4 verify that the facility incorporates circuit breakers, and grounded electrical system.
3.0 Pre-test checklist, ESCG-6120-08-C&I-PR-0001- F, number 112108509, block 10, verifies voltage and polarity on test equipment prior to connecting test articles.

Remarks:

HAW Approval (Use for manned, oxygen, or hazardous testing.)	**Disposition**	
Responsible Engineer, Manager or Test Director/Date:		Open/No Action
	X	Closed/Accepted
Branch Chief/Date: (For Closed/Accepted Disposition Only)		Closed/Controlled
		Closed/Eliminated
		Closed/Eliminated

A.2 Hazard Analysis Worksheet – Test Article Handling

Hazard Title: TEST ARTICLE HANDLING			**HAWS No.** 2
System: EMI Chamber	**Subsystem:** EUT Device	**Severity/Likelihood/RAC**	
		Before Hazard Controls	**After Hazard Controls**
		III/C/4	III/D/5

Hazard Description & Consequence:

Extreme handling of test article results in damage and/or personnel injury.

Hazard Causes:

1.0 Test article is dropped during movement to/from test location.

Hazard Controls:

1.0 Carts will be utilized as necessary to transport test article and associated hardware.
1.1 USB422, is small , approximately 5 in x 3 in, and does not pose a material handling hazard.
1.2 Only trained and authorized personnel handle the test article.

Hazard Control Verifications:

1.0 Test Plan, EV5-09-EMC-010P, section 11, Note 9, verifies requirements for manual material handling.
1.1 Verified through review of JSC drawing SED39137921.
1.2 Authorized Operators List is verified at the TRR.

Remarks:

HAW Approval (Use for manned, oxygen, or hazardous testing.)	**Disposition**	
Responsible Engineer, Manager or Test Director/Date:		Open/No Action
		Closed/Accepted
Branch Chief/Date: (For Closed/Accepted Disposition Only)	X	Closed/Controlled
		Closed/Eliminated

TASK PERFORMANCE SHEET

NASA - LYNDON B. JOHNSON SPACE CENTER

1. PROJECT CODE	2. JPIC	3. NEED DATE	4. CRITICALITY	5. TPS NO.	6. MOD SHEET NUMBER(S)	7. PAGE
SAAMS	AMS	07/20/2009	Crit 3	2A092076		1 of 5

8. TYPE
☐ A CONFIGURATION CHANGE ☐ PERMANENT ☐ TEMPORARY ☒ B NONCONFIGURATION CHANGE

20. ORG. ESCG

21. CONTRACT NO./JOB NO. NNJ05HI05C

9. SHORT TITLE
"Uncontrolled" Perform engineering evalution on USB422 Assy (CIII).

22. ORIGINATOR Duong Nguyen — DATE 7/20/09

10. PURPOSE
Subject USB422 Assy (CIII) to radiated electric fields per Space Shuttle SL-E-0002 Book3 RS103 limit and to verify and document that any failure to USB422 Assy does not propagate back and damage A31p Laptop USB port.

APPROVALS (Printed or Typed and Signed)

23. PROJECT ENGINEER Duong Nguyen — DATE 7-20-09

24. N/A — DATE N/A

25. N/A — DATE N/A

11. REFERENCE DOCUMENTS
Test Plan - EV5-09-EMC-010P
Hazard Analysis - EV5-09-EMC-010HA

12. ADP UPDATE	13. TIME/CYCLE	14. HAZARDOUS	15. HAZARD ANALYSIS
☐ YES ☒ NO ☐ N/A	☐ YES ☒ NO	☒ YES ~~☒ NO~~	EV5-09-EMC-010HA

ESCG DCL 7-20-09

26. N/A — DATE N/A

16. DR LOG
TPS STEP DR NUMBER

17. QARC ORIGINAL STAMP

ORIGINAL
Return to Bldg ____
Rm. ___ QARC/QA ____

18. OPEN STAMP AND DATE
ESC A P62
7-20-09

27. N/A — DATE N/A

28. N/A — DATE N/A

19. FINAL ACCEPTANCE STAMP AND DATE

29. CONTRACT QUALITY ENGINEER Steve Caldwell — DATE 7-20-09

30. GOVERNMENT QUALITY ENGINEER N/A — DATE N/A

HARDWARE / SOFTWARE / FIRMWARE IDENTIFICATION

31. ITEM	32. PART NAME	33. PART NO. / DRAWING NO.	34. SERIAL NO.	35. LOT NO.	36. QTY	37. UNIT	38. CLASS	39. SHELF LIFE
1	USB422, Device ID 4	USB422	N/A	N/A	1	EA	III	N/A
2	A31p Laptop	A31p	N/A	N/A	1	EA	III	N/A
3	A31p Docking Station	2631	N/A	N/A	1	EA	III	N/A
4	USB 2.0 Cable, 6 ft	CABUSBAB6	N/A	N/A	1	EA	III	N/A

9. SHORT TITLE	5. TPS NO.	6. MOD SHEET NUMBER(S)	7. PAGE
"Uncontrolled" Perform engineering evalution on USB422 Assy (CIII).	2A092007G		2 of 5

CALIBRATED TOOLS REQUIRED					Additional items in Block 49 ☐
40. MIP	41. ITEM	42. TOOL NAME / PART NUMBER	43. CALIBRATION NUMBER	44. CALIBRATION DUE DATE	45. QA / DV
N/A	N/A	N/A	N/A	N/A	N/A

TASK PERFORMANCE SHEET

NASA - LYNDON B. JOHNSON SPACE CENTER

9. SHORT TITLE	5. TPS NO.	6. MOD SHEET NUMBER(S)	7. PAGE
"Uncontrolled" Perform engineering evalution on USB422 Assy (CIII).	2A092C076		3 of 5

46. OPER SEQ. NO.	47. GMIP	48. MIP	49. OPERATIONS (Print, Type, or Write Legibly)	50. TECH	51. QA DV	52. GQA
1.			Release the following items from Jacobs Bldg 1:	DVN 7-21-09		
2.			Transfer items in Step 1 to Bldg 14 EMI Test Facility.	DVN 7-21-09		
3.			Received items in Step 1 in Bldg 14 EMI Test Facility.	DVN 7-21-09		
4.			Conduct RS103 test on USB422 Assy (CIII) per Test Plan # EV5-09-EMC-010P.	CH 7/22-23/09		
5.			Release the following items from Bldg 14 EMI Test Facility:	CH 7/23/09		

Qty	Part Number	Description	Class
1 EA	USB422	USB422 Assy, Device ID 4	III
1 EA	A31p	A31p Laptop	III
1 EA	2631	A31p Docking Station	III
1 EA	CABUSBAB6	USB 2.0 Cable, 6 ft	III

Qty	Part Number	Description	Class
1 EA	USB422	USB422 Assy, Device ID 4	III
1 EA	A31p	A31p Laptop	III
1 EA	2631	A31p Docking Station	III
1 EA	CABUSBAB6	USB 2.0 Cable, 6 ft	III

TASK PERFORMANCE SHEET

NASA - LYNDON B. JOHNSON SPACE CENTER

9. SHORT TITLE	5. TPS NO.	6. MOD SHEET NUMBER(S)	7. PAGE
"Uncontrolled" Perform engineering evalution on USB422 Assy (CIII).	2A092007L		4 of 5

46. OPER SEQ. NO.	47. GMIP	48. MIP	49. OPERATIONS (Print, Type, or Write Legibly)	50. TECH	51. QA DV	52. GQA
6.			Transfer items in Step 5 to Jacobs Bldg 1.	DJN 7-28-09		
7.			Received items in Step 5 in Jacobs Bldg 1.	DJN 7-28-09		
8.			Close this TPS			

TASK PERFORMANCE SHEET

NASA - LYNDON B. JOHNSON SPACE CENTER

9. SHORT TITLE	5. TPS NO.	6. MOD SHEET NUMBER(S)	7. PAGE
"Uncontrolled" Perform engineering evalution on USB422 Assy (CIII).	2A092007b		5 of 5

Attachment Index

60. ITEM	61. DOCUMENT/DRAWING NUMBER	62. REV	63. DOCUMENT/DRAWING TITLE	64. NO. OF PAGES	65. NO. OF COPIED SECTIONS	66. QA
1	EMI Test Plan – EV5-09-EMC-010P	Baseline	TEST PLAN Engineering Evaluation Electromagnetic Interference (EMI) Electromagnetic Compatibility (EMC) For The ALPHA MAGNETIC SPECTROMETER (AMS-02) -USB422 Assembly	21	1	N/A
2	Hazard Analysis – EV5-09-EMC-010HA	Baseline	Hazard Analysis for the EMI/EMC Engineering Evaluation of the (AMS-02)-USB422 Interface	13	1	N/A

Created on 11/21/2008 5:09:00 PM

Hazard Analysis Test Article/Test System /Laboratory Inspection Checklist

Checklist Number: ESCG-6120-08-C&I-PR-0001- F, number 112108509
Test Article:_____

Test System/Laboratory: **EMI/EMC, rms 1000, 1000A, 1000B, and 133C**_____

1. Exposed electrical conductors	Yes_____	No__X___	NA_____
2. Circuit breakers on electrical panel	Yes___X___	No_____	NA_____
3. Fuses on test article/test equipment	Yes___X___	No_____	NA_____
4. Proper facility/test article grounding	Yes___X___	No_____	NA_____
5. ESD Certification	Yes___X___	No_____	NA_____
6. Sharp Edges	Yes_____	No___X___	NA_____
7. Surge Supression	Yes___X[16]___	No_____	NA_____
8. Lightning Protection	Yes___X___	No_____	NA_____
9. Trip Hazards	Yes___X[1]___	No_____	NA_____
10. Personnel Training/Certification	Yes___X___	No_____	NA_____
11. Chemical Storage/Usage			
Proper Storage	Yes_____	No_____	NA___X___
Combustibles in storage areas	Yes_____	No_____	NA___X___
12. Controlled Access/Storage	Yes___X___	No_____	NA_____
13. Fire Supression/Detection	Yes___X___	No_____	NA_____
Condition	Good__X____	Bad_____	
14. Emergency Lighting present	Yes___X___	No_____	NA_____

NOTES:

1. Doors of the chambers have raised thresholds that can not be engineered out. These thresholds and the area in front of them are taped with black and yellow tape to warn personnel of hazard. Visitors are also warned of the raised thresholds during the safety orientation.

2. Calibrated Smarts Narda RF detector mounted to the EMI shielded chamber door will detect 1mW/cm² RF leakage.

3. EMI AC/DC converters are voltage/current limited. The voltage is set on the unit for each test.

4. Signage outside of facility indicating no food or drink allowed inside.

EVALUATION

5. MSDS, JSC number 45688, confirms that the absorber is fire retardant.

6. Safety netting is present in primary chamber under the absorber and ferrite tiles to catch any tile that should fall.

7. Luminescent tape outlines the doors to the facility to guide personnel to exit.

8. Flashlights are present in the facility to provide additional lighting for personnel in the event of a power outage.

9. Chambers are grounded by a single point ground to prevent ground loops. There is a plywood/plastic barrior between bottom of both chambers and the building 14 cement floor.

10. Chamber absorber is coated with a blue latex paint coating to prevent carbon leakage and are permanently mounted to the chamber ceiling and wall. Due to the placement of the chamber door, the absorber wall is well away from the main flow personnel activity.

12. Signs are posted, warning of door pinch point hazard.

13. Emergency lighting in the EMI facility is functioning normally.

14. Signs are posted indicating that no radio frequency devices, such as cellular phones are not allowed in the chamber.

15. Signs, warning to the danger to personnel wearing pace makers are posted on the doors to the EMI facility.

16. This step only verified that portable surge protectors are used some test equipment, not that there is surge protection for building 14 as a whole.

17. A portable eyewash is available for testing operations involving test articles that could lead to eye injury, such as battery rupture, etc.

Inspected by: Chuck Landrum II

Date Inspected: 11/21/2008

EVALUATION

Created on 11/21/2008 5:09:00 PM

EVALUATION

EMI TESTING FOR THE
ALPHA MAGNETIC SPECTROMETER
(AMS-02) – USB422 ASSEMBLY
IN PROCESS
JULY 21, 2009 THUR JULY 27,2009
AUTHORIZED PERSONNEL ONLY

CYNTHIA HIGHTOWER	----------	ESCG EMC LAB TECH
CHARLES BROOKS	----------	ESCG EMC LAB TECH
SHAWN NI	----------	ESCG EMC LAB ENGR
DUONG NGUYEN	----------	EUT EXPERT
JOHN NORGARD	----------	ESCG EMC P.E.
RICHARD DEPPISCH	----------	NASA EMC LAB MGR
ANTHONY WONG	----------	Alt NASA EMC LAB MGR
MAYUR AHUJA	----------	ESCG EMC LAB MGR
JOHN NGO	----------	SAFETY/FAC MGR
BOB SCULLY	----------	NASA LEAD EMC ENGR
HOAI NGO	----------	NASA STAFF EMC ENGR
MARY HARRIS	----------	NASA STAFF EMC ENGR
DAN TRAN	----------	NASA STAFF EMC ENGR
ESCG, NT QA &QE	----------	SUPPORT PERSONNEL
CHARLES AWWAD	----------	ESCG Alt FACILITY MGR.
JOHN GAFFORD	----------	ESCG SECTION MGR.
CHUCK LANDRUM	----------	ESCG SAFETY OFFICER

AUTHORIZED OPERATORS/TEST PERSONNEL
PETER DENNETT, TIM URBAN
ALL OTHER CALL X34476 TO ENTER!!!!!!!!!!!!!

Electromagnetic Compatibility Test Facility Pre-Test Checklist (04/04)

ESCG Form Number: **ESCG-5132-08-BDL-PR-0041**

This form must be completed by the EMC test personnel and stamped by a QAS prior to performance of EMC testing.

Date: 07/21/2009 Ref. TPS#. 2A0920076 Ref. TP. NO. EV5-09-EMC-010P

TPS Title : ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY

1. Personnel assigned to test: NASA Project Engineer _____ 7/21/09
Signature

Test Engineer: Cynthia Highbower for Hoang Ni
Signature

Test Technician: Cynthia Highbower
Signature

	Tech.	Engr.	QAS
2. All Test Readiness Review Action Items Closed ?	CH	XN	NA
3. Integrated Hazard Analysis Reviewed and Understood?	CH	XN	NA
4. Current Calibration Status of Required Test Equipment Verified Per Test Plan?	CH	XN	NA
5. Laboratory Configuration Verified per JSC27933 and Test Plan?	CH	XN	NA
6. Applicable Safety Procedures Implemented?	CH	XN	NA
7. List of authorized personnel for this test posted?	CH	XN	NA
8. Review Bldg. 14 Emergency Evacuation Plan W/Facility Customer	CH	XN	NA
9. Temperature, Humidity Recorded?	CH	XN	NA

Temperature 68.9°F Relative Humidity 61.8%

Cal # M214992 Due Date 9/24/09

10. Verify voltage and polarity of the switch box Record Voltage and Polarity: NIO	NIP	NP	NA

Cal #_____ Due Date _____

EVALUATION

EMI Lab Safety Briefing (Sign in Sheet) July 22, 2009

I have attended the EMI Lab Safety Briefing today (or, I have had an individual safety briefing before beginning any tests today) and I understand the lab safety issues/concerns and I will abide by the lab safety rules.

ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY

Name (Please Print)	***Affiliation***	***Telephone***	***E-Mail***
DUONG NGUYEN	JACOBS	2814866311	GLOBAL
PETER DENNETT	PADSOFT	2813343800	pdennett@padsoft.com
Cynthia Hightower	ESCG	34476	GLOBAL

EMI Lab Safety Briefing (Sign in Sheet) July 23, 2009

I have attended the EMI Lab Safety Briefing today (or, I have had an individual safety briefing before beginning any tests today) and I understand the lab safety issues/concerns and I will abide by the lab safety rules.

ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY

Name (Please Print)	***Affiliation***	***Telephone***	***E-Mail***
Duong NGUYEN	JACOBS	2814866311	duong.nguyen@esc.jacobs.com
Cynthia Hightower	ESCG	34426	Global

EVALUATION

EMI Lab Safety Briefing (Sign in Sheet) July 24, 2009

I have attended the EMI Lab Safety Briefing today (or, I have had an individual safety briefing before beginning any tests today) and I understand the lab safety issues/concerns and I will abide by the lab safety rules.

ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY

Name (Please Print)	*Affiliation*	*Telephone*	*E-Mail*
DUONG NGUYEN	JACOBS	2814866311	duong.nguyen@escgjacobs.com
Cynthia Hightower			

EVALUATION

EMI Lab Safety Briefing (Sign in Sheet) July 27, 2009

I have attended the EMI Lab Safety Briefing today (or, I have had an individual safety briefing before beginning any tests today) and I understand the lab safety issues/concerns and I will abide by the lab safety rules.

ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY

Name (Please Print)	***Affiliation***	***Telephone***	***E-Mail***
Cynthia Hightower	ESCG	34076	6bobal
DUONG NGUYEN	JACOBS	2814866311	Global

EMI Lab Safety Briefing (Sign in Sheet) July 28, 2009

I have attended the EMI Lab Safety Briefing today (or, I have had an individual safety briefing before beginning any tests today) and I understand the lab safety issues/concerns and I will abide by the lab safety rules.

ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY

Name (Please Print)	*Affiliation*	*Telephone*	*E-Mail*
Doug NGUYEN	JACOBS	2814866311	Global
Cynthia Higginbotham	ESCG	34476	Global

National Aeronautics and
Space Administration

EV5-09-EMC-010P
July 20, 2009

Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, TX 77058

TEST PLAN
Engineering Evaluation
Electromagnetic Interference (EMI)
Electromagnetic Compatibility (EMC)
For The
ALPHA MAGNETIC SPECTROMETER
(AMS-02) -USB422 Assembly

Signature Page

Duong Nguyen 7-20-09

Prepared by: Jacobs/Nguyen Duong – (281-486-6311)

7/20/09

EV5/Hoai Ngo, Test Director – (281-483-8088)

Jacobs AMS-02 Deputy Project Manager / Mike Fohey (281-461-5684)

for R. Scully 7/20/09

EV5/R.C. Scully, EMC Lead Engineer – (281-483-1499)

7-20 09

JSC Hardware Quality Engineer / Steve Caldwell (281-483-7766)

7/20/09

ESCG/Etienne Coleman, JSC Facility Quality Engineer – (281-483-7615)

EVALUATION

Table of Contents

1.0 Introduction

The introduction must include :

Program Supported: Shuttle ___X___ *ISS* _____ *CRV* _____ *Russian* _____ *Other* _____

Project Name: ***ALPHA MAGNETIC SPECTROMETER (AMS-02)***

Equipment Under Test (EUT) Name and Part Number: ***USB422 Assy***

Expected First Flight Date: ***7/29/2010***

Need Date for Test Completion: ***7/31/2009***

Need Date Driver: ***Engineering evaluation to insure hardware is in compliance with spec and to allow time to address or obtain waivers for any non-compliance.***

Criticality Hardware ___3___ *Function* ___3___
(1,2, or 3; as defined by the governing Program Critical Hardware list)

	Emissions	*Susceptibility*
☐ *EMI Certification Test*	☐	☐
☒ *Engineering Evaluation Test*	☐	☒
☐ *Other (Please specify* _____		

A detailed description of the EUT or complete subsystem, including:

a. *EUT Function:*

The USB422 assembly provides inline conversion of RS422 synchronous serial signals to a USB 2.0 interface. Signal (data) is then set to and recorded on program provided A31p Laptop hard drives.

b. *Operating frequencies (e.g. RF, data rates, clock rates etc.)*

Clock rate = 50 – 70 kBaud

c. *Power Requirements (operating voltage and line current, in line fuses)*

A31P Laptop – 120 Vac
USB422 Assembly - Laptop USB 5 Vdc, 0.5 A

d. *Total Weight (i.e., lift plan required for moving the EUT ?)*

1 Lb

e. A block diagram of the expected flight configuration of the subsystem

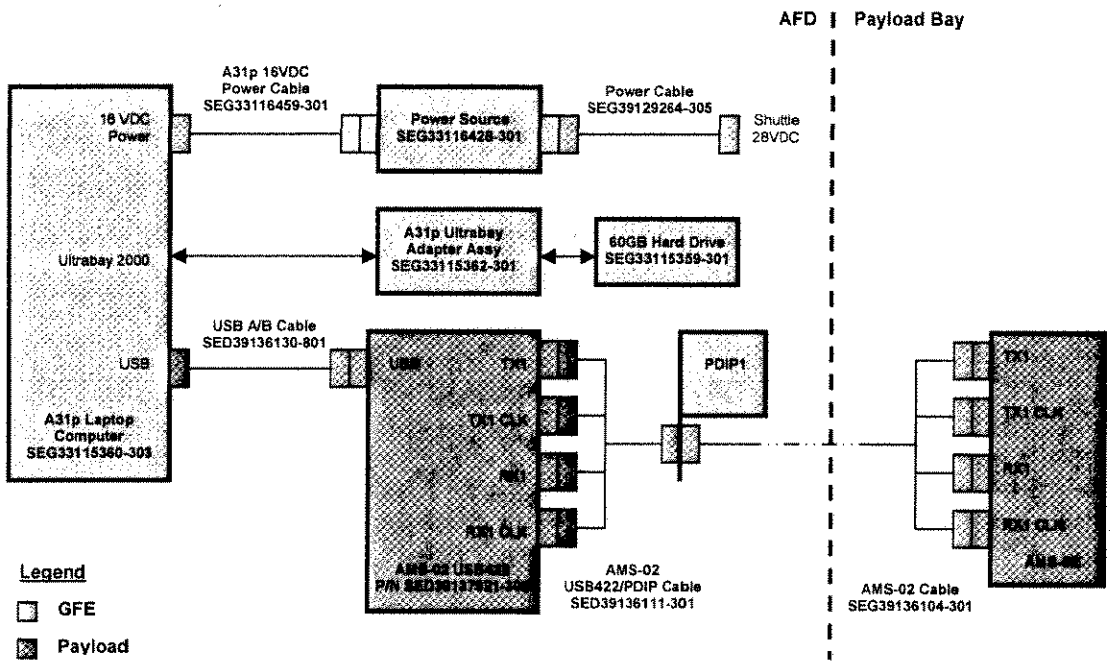


Fig. 1.1 DDRS-02 INTERFACES

2.0 Applicable Documents

List all applicable documents associated with the EMI test of the EUT as detailed in this test plan, including:

a. EUT requirements document (e.g., PTRS, ARM, PRNVP)

PTRS JSC 29789 -

b. EMI specification(s) to be met by the EUT

☐ *SL-E-0002, Book 1, Rev ___, dated _____*
☐ *SL-E-0002, Book 2, Rev ___, dated _____*
☒ *SL-E-0002, Book 3, Volume 1, dated 8/10/2009*
☐ *SSP 30237, Rev ___, dated _____*
☐ *SSP 50094, Rev ___, dated _____*
☐ *JSC 28484, Rev ___, dated _____*
☐ *Other (Please specify)* _____

EVALUATION

c. EMI test facility documents

JSC 27933, Rev B Dated March 03, 2004	EMI/EMC Laboratory Configuration Documents
ESCG-5132-06-BDL-DOC-0056 Dated August 2006	Electromagnetic Interference/Compatibility Laboratory Test Methods

3.0 Test Site

The EMI test facility at NASA Johnson Space Center supports multiple programs, including the International Space Station and Space Shuttle programs. The operation of the test facility is a function of the Avionic Systems Division, Specialty Engineering Branch, and is located in JSC B14/B14A. Detailed information describing the test facility is contained in ESCG-5132-06-BDL-DOC-0056 and covers the following:

a. A description of the test facility.
b. A description of the ground plane, and grounding/bonding methods for EUTs.
c. Facility policy concerning the ambient radiated and conducted electromagnetic emission profile of the test facility.
d. Test facility security measures for overnight storage of EUTs.

Test performs in:

☐ Building 14, EMI Facility, room 133D, Small EMI chamber
☒ Building 14A, EMI Facility, room 1000, Large EMI chamber

4.0 Tests to Be Performed

TABLE 1
Tests to be Performed (SL-E-0002, Book 3, Volume 1)

EMI Test	Description	Prog Reqmt Y/N	EV5 Recmd Y/N	EV5 Rationale for Recommendation	*Hardware Provider Accept Y/N*	*Rationale if No*
RS103	30 MHz-18 GHz, Electric Field	Y	Y	Hardware will be used in Shuttle Environment	Y	N/A

5.0 Test Instrumentation

Detailed information concerning test facility instrumentation is contained in ESCG-5132-06-BDL-DOC-0056 and covers the following:

a. Test equipment nomenclature and bandwidth.

b. Scanning speed used to drive measuring equipment.

c. The characteristics of matching transformers and band-reject filters.

d. Antenna factors of specified antennas, transfer impedance of current probes, impedance of Line Impedance Stabilization Networks (LISN), and insertion losses and impedance curves of 10 microfarad capacitors.

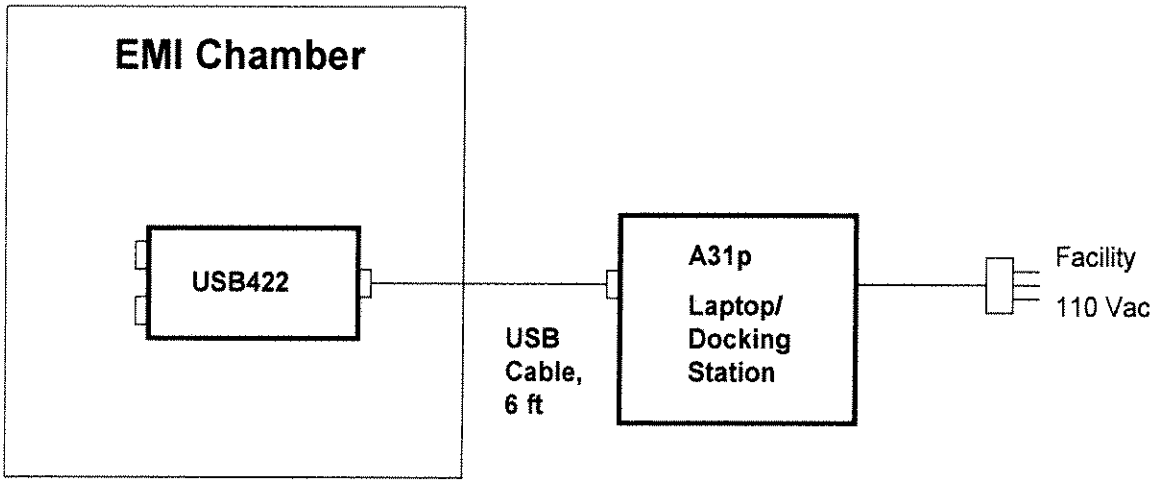
e. Test Facility Hardware Calibration Data/Records

6.0 EUT Test Configuration

All hardware supplied by project will be Class III.

The only difference between the supplied Class III USB422 (EUT) and flight assembly are cosmetic (labeling and velcro material installed on enclosure surface).

Test configuration will differ from expected flight configuration. Test configuration will not use GFE A31p Power Supply and associated cabling that have already been certified by program office. Intent of test is to see if any failure with USB422 assembly could propagate back and damage GFE A31p laptop.



A31P Laptop	P/N A31p	Tag # 401108
A31P Docking Station	P/N 2631	Tag # 401049
USB422 Assembly	P/N USB422	D.I.D. 4
USB Cable, 6 ft	P/N CAB USB AB6	N/A

Fig. 6.1. EMI Test Configuration.

EC - 7.28.09
(SEE DEV 1 > ESCAL 2 @ 39

Fig. 6.1.1.

EVALUATION

7.0 EUT Operation

EMI test facility personnel do not handle and/or operate EUTs. Thus, the Hardware Provider (EUT project management) is responsible for providing certified operators for the set-up, operation, and removal of the EUT.

Based on known information, provide a description of EUT operation, including:

a. *Verifiable modes of operation for each test and operating frequency.*

NASCOM Block Test

- Verify USB422 device is recognized
  Screen display: "Using USB422 device 0x537/0x1004/0xXX"
  XX= device ID

- Verify Data is being transmitted
  Screen display: Status line will update and show Tx increasing until it reaches set limit

- Verify Data is being received
  Screen display: Status line will update and show Rx increasing until it reaches set limit

b. *Control settings on the EUT.*

Amount of data being transmitted and clock rate can be set.

c. *Control settings on any test sets employed or characteristics of input signals.*

Amount of data being transmitted can be set.

d. *Test frequencies at which oscillators, clocks, and so forth may be expected to approach requirements and limits.*

Clock rate = 50 – 70 kBaud

e. *Performance checks (i.e., functional tests) initiated and verified to designate the equipment as meeting minimal working standard requirements. The functionality that is being tested must be verified in the test plan section 11.*

Verify A31p laptop USB port is functioning properly after being subjected to radiated electric field in test configuration. PASS/FAIL Criteria: A31p laptop recognizes device (i.e. memory stick or USB422 assy) connected to USB port

f. *Circuits, outputs, or displays to be monitored during testing shall be enumerated, as well as the criteria for monitoring degradation of performance. If calibrated support equipment is used (i.e. Digital Volt Meters, Analyzers, Power Supply, etc….) include a step to verify NASA Tag #, and due date.*

1. Verify USB422 device is recognized
   Screen display: "Using USB422 device 0x537/0x1004/0xXX"
   XX= device ID

2. Verify Data is being transmitted
   Screen display: Status line will update and show Tx increasing until it reaches set limit

3. Verify Data is being received
   Screen display: Status line will update and show Rx increasing until it reaches set limit

f. Normal, malfunction, and degradation of performance criteria for susceptibility testing verified in the test plan section 11.

Normal: A31p laptop recognizes device connected to USB port.

Malfunction/Degradation: A31p laptop does not recognize device connected to USB port.

g. Special equipment requirements (e.g. thermal constraints, lubrication intervals etc.)

N/A

h. Certified Operators List (if not listed here, provide as an attachment)

Peter Dennett
Duong Nguyen
Tim Urban

j. EUT Emergency shutdown procedure (give rational if not provided).

1. Shutdown laptop
2. Unplug from power source

8.0 Measurements

Detailed information concerning test facility measurement techniques is contained in ESCG-5132-06-BDL-DOC-0056 and covers the following:

a. Test equipment used in performance of the test and the methods of grounding, bonding, or achieving isolation for the measurement instrumentation.

b. Procedures for (1) probing the EUT, (2) determining placement and orientations of probes and antennas, and (3) selecting measurement frequencies and detector functions.

c. Information to be recorded during the test, including frequency and units of recorded information. Sample data sheets, test logs and graphs, including test limits.

d. Modulation characteristics of the susceptibility test signals, such as amplitude, waveform, type of modulation etc.

9.0 Test procedure Changes

This test plan/procedure shall be attached to the Task Performance Sheet (TPS) document, and shall serve to fully document the detailed test procedures to be followed in performance of the requested test(s). Prior to approval, this test plan/procedure is intended to be a living document during the development cycle of the project in preparation for the Test Readiness Review (TRR) process. As such, some sections may be incomplete at various times, or may be revised in part or in entirety, as determined by and concurred with by the assigned EMC Test Director/Project Engineer, the equipment under test (EUT) Project Engineer(s), attending Quality Assurance personnel, and Test Safety Office personnel. Approval of the test plan/procedure, required prior to TRR, is evidenced by signature of the Specialty Engineering Branch Chief or designee, the assigned EMC Test Director/Project Engineer, the EUT Project Engineer's Branch Chief or designee, the EUT Project Engineer, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office.

Once the test plan/procedure document has been approved and the TRR for the subject EUT has been completed, the nature and extent of any changes to the test plan/procedure document proposed for any reason at any time shall be discussed by the assigned EMC Test Director/Project Engineer, the equipment under test Project Engineer(s), and the attending Quality Assurance personnel. All proposed changes shall be individually coordinated with the Specialty Engineering Branch Chief or designee, the EUT Project Engineer's Branch Chief or designee, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office, as appropriate.

Any proposed changes that are determined to

1) Introduce new hazards
2) Increase the probability or severity of hazards previously identified in the Integrated Hazard Analysis reviewed and approved at the TRR
3) Introduce deviations to test rules specifically designed to provide for safety during the test, or
4) Introduce major procedural changes, additions, or deletions shall require a delta TRR prior to commencement or continuation of test.

Any changes agreed to that do not require a delta TRR shall be documented on a Test Plan Change Sheet, and shall be dated and initialed by the assigned EMC Test Director/Project Engineer, the equipment under test Project Engineer(s), and the attending Quality Assurance personnel. All such changes shall be incorporated electronically into, and shall be clearly indicated inside of, the original document as part of a uniquely identified revision release. The revised document shall be circulated for review and signature by the Specialty Engineering Branch Chief or designee, the assigned EMC Test Director/Project Engineer, the EUT Project Engineer's Branch Chief or designee, the EUT Project Engineer, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office prior to final closeout of the controlling TPS.

Any proposed changes that do require a delta TRR shall, after discussion and approval at the delta TRR, be documented on a Test Plan Change Sheet, and shall be dated and initialed by the assigned EMC Test Director/Project Engineer, the equipment under test Project Engineer(s), and the attending Quality Assurance personnel. All such changes shall be incorporated electronically into, and shall be clearly indicated inside of, the original document as part of a uniquely identified revision release. The revised document shall be circulated for review and signature by the Specialty Engineering Branch Chief or designee, the assigned EMC Test Director/Project Engineer, the EUT Project Engineer's Branch Chief or designee, the EUT Project Engineer, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office prior to commencement or continuation of test.

10.0 Emergency Evacuation Plan

The procedure in this Section of the EMC/EMI Test Plan relates to the activities required by EMI Test Team Personnel in the event of an accident, fire, or need for emergency test termination. EMI Test Team Personnel should use good judgment while implementing emergency procedures and are not bound by the order in which they are presented. This procedure shall be reviewed with the Specialty Engineering Branch Chief or designee, the assigned EMC Test Director/Project Engineer, the EUT Project Engineer's Branch Chief or designee, the EUT Project Engineer, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office.

Whenever an accident is recognized, it shall immediately be reported to the Specialty Engineering Branch Chief or designee, the assigned EMC Test Director/Project Engineer, the EUT Project Engineer's Branch Chief or designee, the EUT Project Engineer, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office, giving nature and action. The assigned EMC Test Director/Project Engineer or EMI Test Facility Operator shall then give direction pertinent to the specific emergency.

In the event of fire in or near the EMI Test Facility, the assigned EMC Test Director/Project Engineer or EMI Test Facility Operator shall notify the Fire Department (ext. 33333), the Specialty Engineering Branch Chief or designee, the EUT Project Engineer's Branch Chief or designee, the EUT Project Engineer, representatives from both the Specialty Engineering Branch and EUTs Branch Quality Assurance offices, and a representative from the Test Safety Office. The assigned EMC Test Director/Project Engineer, EMI Test Facility Operator, and the EUT Project Engineer shall direct the following:

Personnel are immediately evacuated to the nearest exit doors that are shown in Fig. 10.1. When exiting the building, pull fire alarm switch located by the exit door. Go to the muster area in front of the building 14 by the second street; stay away at least 75 feet from the building. Do not walk in the roadway north of Building 14 at any time during an emergency evacuation.

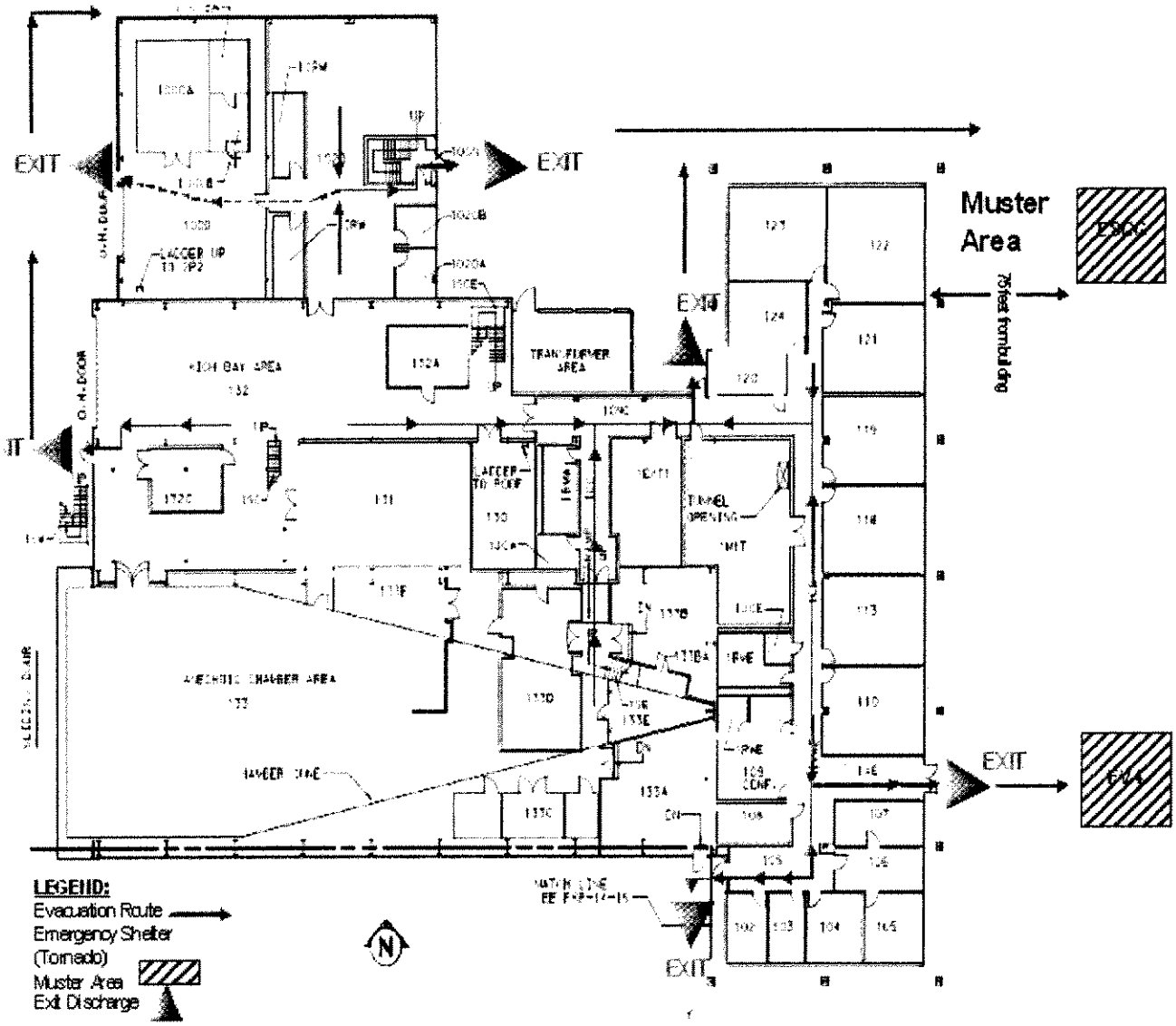


Fig. 10.1 Evacuation map for building 14, first floor.

11.0 Test procedures

The following notes are provided verification steps if applicable for all necessary cautions safety controls. (i.e. keep out zones, controls for batteries, hazardous material handling, safety checklist, etc....).

NOTE 1: NO WORK SHALL BE PERFORMED ON LIVE ELECTRICAL EQUIPMENT DURING THIS/THESE PROCEDURE(s)

NOTE 2: **SECURITY** - In the event that testing is suspended (i.e. lunch break), all equipment under test shall be locked in a controlled area.

NOTE 3: **WARNING** – No personnel are allowed inside the EMI shielded chamber during radiated susceptibility testing (refer to Integrated Test Hazard Analysis Report for radio frequency exposure). Chamber doors are locked and red test beacons are activated.

NOTE 4: **WARNING** – Individuals with pacemakers should not be near the chamber during susceptibility testing due to potential interference.

NOTE 5: CAUTION - Any modifications to electrical components associated with test articles or test equipment that will connect directly to facility power (e.g., modify electrical plugs on test articles or test equipment to match EMI chamber outlet configuration) will be performed only by a licensed electrician, and will be verified for proper electrical configuration in compliance with NFPA 70, visually, prior to connecting power, and with a Volt/Ohm meter after connecting power.

NOTE 6: All power up/down steps are applicable to Equipment Under Test (EUT) performed by EUT certified operator and record on the time log sheet in section 13.0.

NOTE 7: Connectors are not ESD sensitive. Verify connectors prior to connection that there are no bent pins or dust/debris.

NOTE 8: Steps may be performed out of sequence.

NOTE 9: All personnel involved in manual material handling operations will wear safety-toed shoes and cut resistant gloves. For equipment over 50 lbs or two awakward to be carried close to the body, will be carried by two or more people. Carts will utilized whenever possible.

TABLE 11-1

SUSCEPTIBILITY SCANNING

Frequency Range	Analog Scans Maximum Scan Rates	Stepped Scans Maximum Step Size
30 Hz - 1 MHz	$0.0333f_o$/sec	$0.05\ f_o$
1 MHz - 30 MHz	$0.00667\ f_o$/sec	$0.01\ f_o$
30 MHz - 1 GHz	$0.00333\ f_o$/sec	$0.005\ f_o$
1 GHz - 8 GHz	$0.000667\ f_o$/sec	$0.001\ f_o$
8 GHz - 40 GHz	$0.000333\ f_o$/sec	$0.0005\ f_o$

11.1 RS103, Radiated Susceptibility, 30 MHz to 18 GHz

Test equipment	Manufacturer	Model Number	Serial Number	Calibration	
				Number	Due date
BiConical	Amplifier Research	BCH-2-30	1017	N/A	N/A
Double-Ridge Horn	Ets System	3106	2824	610920005	01/30/10
Double-Ridge Horn	Ets System	3115	6059	610920006	01/30/10
R.F Amplifier	IFI 10kHZ-1000 MHz	SMX500	M730-0808	N/A	N/A
R.F Amplifier	IFI 1-2.5GHz	T251-500	D038-0400	N/A	N/A
R.F Amplifier	IFI 2.5-7.5GHz	T7525-500	D039-0400	N/A	N/A
R.F Amplifier	IFI 8-18GHz	T1875-500	D033-0400	N/A	N/A
Signal Generator	Rohde Schwarz 5K-3GHz	SMT-03	100231	M206568	09/10/09
Signal Generator	Rohde Schwarz 2-20GHz	SMP-22	100019	M206381	11/05/09
R.F. Field monitor	Amplifier Research	5004	28078	N/A	N/A
Probe, Isotropic	Amp. Research 10K-1GHz	FP5000	300489	01/05/10	01/05/10
Probe, Isotropic	Amp. Research 10K-1GHz	FP5000	300487	12/18/09	12/18/09
Probe, Isotropic	Amp. Research 80M-40GH	FP2080	19447	04/27/10	04/27/10
Probe, Isotropic	Amp. Research 80M-40GH	FP2080	25256	04/17/10	04/17/10
EMI Lab RF Cable	MegaPhase 6 ft	D130-nk-nk	1004	610920035	04/21/10
EMI Lab RF Cable	ESM Cable Corp 120ft	EW292-ngng	1001	610824004	11/12/09
EMI Lab RF Cable	Adams-Russell	1997-240	1001	610820084	10/09/09

Note: This table may be modified to reflect the test equipment actually used for the RS103 measurements, if different than listed above, but each entry in the table must be verified and/or updated to reflect any changes made to the test setup.

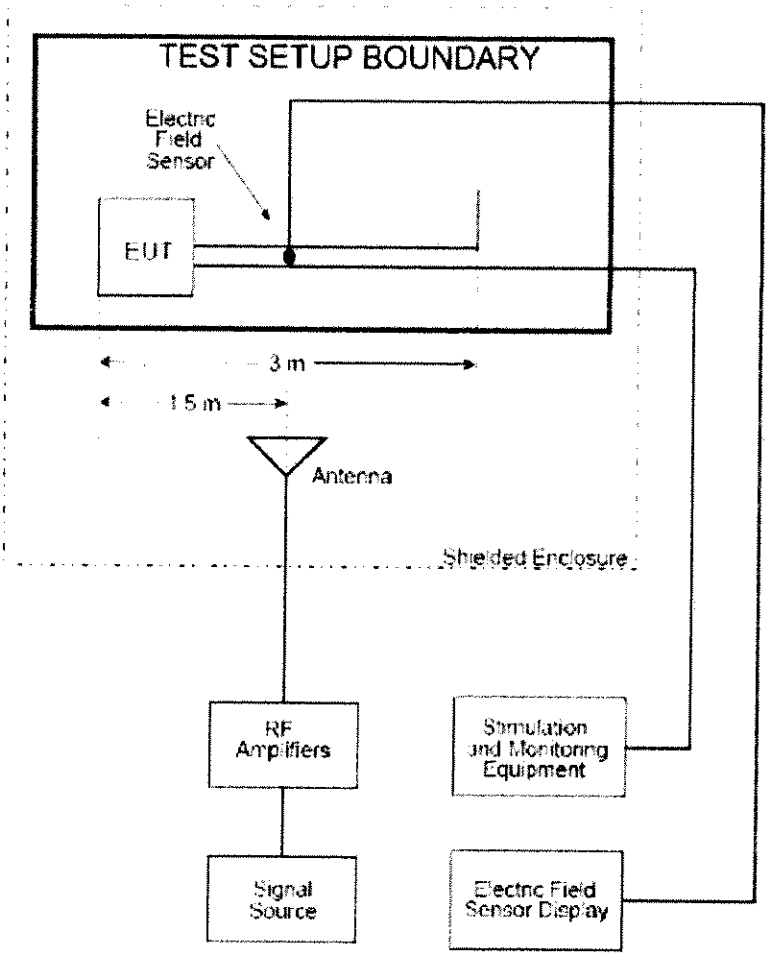


Fig. RS103-1. Basic Measurement Setup

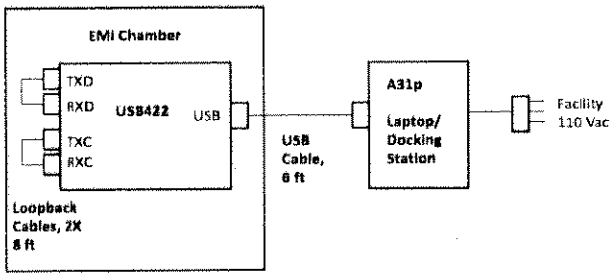
Step	Operations	Tech	QA
1.0	Configure the EUT per Fig. 6.1.	DVN 7-22-09	
2.0	Configure the EMI measurement set up per Fig. RS103-1.	CH 7/22/09	
3.0	Power on the EUT and allow a sufficient time for stabilization.	CH 7/22/09	
4.0	Perform EUT functional performance procedure per Appendix A.		
5.0	Set the signal source to 1 kHz, 99% AM square wave modulation, and using appropriate amplifier and transmit antenna, establish an electric field at the test start frequency. Gradually increase the electric field level until it reaches the applicable limit.	CH 7/22/09	
6.0	Scan the required frequency ranges in accordance with the rates and durations specified in TABLE 11-1. Maintain field strength levels in accordance with the applicable limit, 20 V/m with AM Modulation. Monitor EUT performance for susceptibility effects.	CH 7/22/09	
7.0	If susceptibility is noted, determine the threshold level: (a) When a susceptibility condition is detected, reduce the interference signal until the EUT recovers. (b) Reduce the interference signal by an additional 6 dB. (c) Gradually increase the interference signal until the susceptibility condition reoccurs. The resulting level is the threshold of susceptibility. (d) Record this level, frequency range of occurrence, frequency and level of greatest susceptibility, and other test parameters, as applicable.	CH 7/22-28/09	
8.0	Perform testing over the required frequency range with the transmit antenna vertically polarized. Repeat the testing above 30 MHz with the transmit antenna horizontally polarized.	CH 7/22-28/09	
9.0	Perform EUT functional performance procedure per Appendix A.	DVN 7-22 thru 7-28-09	
10.0	Check that the EUT measured data is attached to this test plan.		
11.0	Power down the EUT.	DVN 7-22 thru 7-28-09	
12.0	End this procedure.	CH 7/22/09	

EVALUATION

12.0 Procedure Deviation

(*This page can be made copies if applicable*)

Test Procedure deviation sheet

Seq. No	Operations	Tech	QA
	Deviation #1- The purpose of this deviation was to re-perform a portion of the RS testing with an alteration to Figure 6.1 by adding Class III loopback cables to EUT see Figure 6.1.1 below.		
1.0	Update Figure 6.1 to include Class III loopback cables per Figure 6.1.1.	DVN 7-28-09	
			
	ITEM / Part Number / Tag/DID # / Qty A31P Laptop — P/N A31p — Tag # 401108 — 1 EA A31P Docking Station — P/N 2631 — Tag # 401049 — 1 EA USB422 Assembly — P/N USB422 — D.I.D. 4 — 1 EA USB Cable, 6 ft — P/N CABUSBAB6 — N/A — 1 EA Loopback Cable, 8 ft — P/N CA-2009-120 — N/A — 2 EA		
	Figure 6.1.1 EMI Deviation #1 Test Configuration		
2.0	Perform RS103 Frequency Range 175 MHz – 200 MHZ in the Horizontal and Vertical Polarization at 20 V/m per SL-E-0002 Book 3 Specification.	CH 7/28/09	
	End Procedures.	CH 7/28/09	
	Duong Nguyen — 7-28-09 Duong Nguyen — Date AMS-02 Project Engineer		
	Cynthia Hightower for Hoai Ngo — 7/28/09 Hoai Ngo — Date NASA Project Engineer		
	Etienne Coleman — 7/28/09 Etienne Coleman — Date Quality Engineer		

EVALUATION

13.0 Historical On-Time Log Sheet

(Record all on/off times of EUT here)

(This page can be made copies if applicable)

Procedure Step #	Applicable Note	Power Up		Power Down		By
		Date	Time	Date	Time	
11.1 / 8	RS103	07/22/09	8:32am	07/22/09	12:00pm	C.H.
11.1 / 8	RS103	07/22/09	1:30pm	07/22/09	4:00pm	C.H.
11.1 / 8	RS103	07/23/09	8:17am	07/23/09	10:00am	C.H.
11.1 / 8	RS103	07/23/09	1:30pm	07/23/09	4:00pm	C.H.
11.1 / 8	RS103	07/24/09	9:00am	07/24/09	12:00pm	C.H.
11.1 / 8	RS103	07/24/09	1:00pm	07/24/09	4:00pm	C.H.
11.1 / 8	RS103	07/27/09	9:12am	07/27/09	12:00pm	C.H.
11.1 / 8	RS103	07/27/09	1:30pm	07/27/09	4:00pm	C.H.
11.1 / 8	RS103	07/28/09	8:17am	07/28/09	12:00pm	C.H.
11.1 / 8	RS103	07/28/09	1:30pm	07/28/09	2:00pm	C.H.
DEV #1/ 2	175-200MHz H/P	07/28/09	2:00pm	07/28/09	3:00pm	C.H.
DEV #1/ 2	175-200MHz V/P	07/28/09	3:00pm	07/28/09	3:20pm	C.H.

EVALUATION

Appendix A

USB422 Functional Checkout Test during EMI RS Testing

This procedure can be used to verify a USB422 unit is operating correctly and is programmed to support AMS-02 operations including TX Test and Loopback Test RX on PCB – Checkout of PCB Loopback

1. Unplug any USB422 device this is plugged into the machine and exit any DDRS02 application.
2. Verify the computer is booted and running Microsoft Windows XP or later.
3. Plug in the USB422 device under test to any USB port on the computer.
4. Remove any connection to RxClock
5. Start the MsDos prompt window from the desktop
6. Change to the nascom subdirectory
7. Execute the NASCOM Block Test with: "

   nbt --did X --generate 1000 --rx binarydata --clock 512 --loopback

   Where X is the device serial number under test.

   File where data is stored = binarydata

8. Verify the USB422 device is located. It will be identified by the line "Using USB422 device 0x537/0x1004/0xXX where XX is the PCB serial number.
9. Observe clock is configured for 58.37 kBaud. Observe clock speeds reported are within 50 and 70 kBaud rates during activity.
10. Verify that the status line is updating and showing Tx and RX data increasing.
11. Wait for 1000 blocks received. Observe and report any errors.
12. Press 'q' to exit the program.
13. Allow USB422 Assembly to sit idling and polling for data during testing intervals.
14. Repeat steps 7 thru 13 once per hour during and after final testing intervals.
15. Test completed.

ALPHA MAGNETIC SPECTROMETER

(AMS-02) – USB422 ASSEMBLY

EV5-09-EMC-010P

SL-E-0002 BOOK 3

SPACE SHUTTLE SPEC.

(RS103)

RADIATED SUSCEPTIBILITY

EVALUATION DATA

(RS103) Radiated Susceptibility Electric Field

EUT NAME:	ALPHA MAGNETIC SPECTROMETER (AMS-02)	**TEST DATE:**	07/22-24/2009, 07/27-28/2009
TEST CLASSIFICATION:	Evaluation	**TEST SITE:**	JSC Building B14A Room 1000
TEST SPEC:	Space Shuttle SL-E-0002 BOOK 3	**TEST CYCLE:**	AM Modulation 99% at 1kHz
TYPE OF TEST:	(RS103) Radiated Susceptibility	**TEST CONDUCTOR:**	Cynthia Hightower
TPS#:	2A0920076	**TEST RESULT:**	PASS
TP#:	EV5-09-EMC-010P	**COMMENT:**	**Gaps In Frequency Represent A Continuous Linear Sweep. Threshold Data Are Reduced R.F. Level All Polarity Of The Antenna Is Stated**
SECTION#:	11.1		
STEP#:	8		

Equipment List

TEST EQUIPMENT	CAL. NUMBER	CAL. DATE
Signal Generator - Rohde & Schwarz, Model SMT03, SN 100231	M206568	09/10/09
Signal Generator - Rohde & Schwarz, Model SMP22, SN 100019	M206381	11/05/09
Biconi Ant. - Antenna Research Asso, Model BCH-2030/A, SN 1017	N/A	N/A
Large Double Ridge Horn - ETS, Model 3106, SN 2824	610920005	01/30/10
Small Double Ridge Horn - ETS, Model 3115, SN 6059	610920006	01/30/10
RF Field Monitor - Amplifier Research, Model M5004, SN 28078	N/A	N/A
Isotropic Proble - Amplifier Research, Model FP5000, SN 300489	N/A	01/05/10
Isotropic Proble - Amplifier Research, Model FP5000, SN 2300487	N/A	12/18/09
Isotropic Proble - Amplifier Research, Model FP2080, SN 19447	N/A	04/27/10
Isotropic Proble - Amplifier Research, Model FP2080, SN 25256	N/A	04/17/10
RF Ampifier - IFI, Model SMX500, S/N M730-0808	N/A	N/A
RF Ampifier - IFI, Model T251-500, SN D038-0400	N/A	N/A
RF Ampifier - IFI, Model T7525-500, SN D039-0400	N/A	N/A
RF Ampifier - IFI, Model T1875-500, SN D033-0400	N/A	N/A
RF Cable -MegaPhase Corp, Model D130-NK-Nk-72, SN 1004	610920035	04/21/10
RF Cable - EMS Cables Corp, Model EW292-NGNG-120, SN 1001	610824004	11/12/09
RF Cable - Adams Russell Corp, Model 1997-240, SN 1001	610924084	10/09/09

Horizontal Polarization

FREQUENCY (MHz)	SSP30237 Limit (V/m)	Injected Test Signal: Proble #1 Level (V/m)	Injected Test Signal: Proble #2 Level (V/m)	Remarks	Test Sample Response
30.000	20.00	20.25	14.10	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
40.000	20.00	20.18	19.19	Data Pass Maintain R.F. V/m Level @ Limit	
50.000	20.00	20.23	20.89	Data Pass Maintain R.F. V/m Level @ Limit	
60.000	20.00	17.54	20.05	Data Pass Maintain R.F. V/m Level @ Limit	
70.000	20.00	18.05	20.32	Data Pass Maintain R.F. V/m Level @ Limit	
80.000	20.00	19.39	20.30	Data Pass Maintain R.F. V/m Level @ Limit	
90.000	20.00	20.12	20.42	Data Pass Maintain R.F. V/m Level @ Limit	↓

EVALUATION

Component: ALPHA MAGNETIC SPECTROMETER (AMS-02) - USB422 ASSEMBLY

Horizontal Polarization					
FREQUENCY (MHz)	SSP30237 Limit (V/m)	Injected Test Signal: Proble #1 Level (V/m)	Injected Test Signal: Proble #2 Level (V/m)	Remarks	Test Sample Response
100.000	20.00	20.99	17.66	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
180.000	20.00	12.20	20.10	Data Pass Maintain R.F. V/m Level @ Limit	↓
180.800	20.00	9.47	15.04	Equipment under Test Malfunction	Susceptible
181.000	20.00	8.49	14.21	Equipment under Test Malfunction	
182.000	20.00	9.92	15.01	Equipment under Test Malfunction	
185.000	20.00	8.60	12.80	Equipment under Test Malfunction	
190.000	20.00	11.12	15.50	Equipment under Test Malfunction	
192.000	20.00	13.69	18.68	Equipment under Test Malfunction	↓
193.000	20.00	15.18	20.06	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
195.000	20.00	15.35	20.00	Data Pass Maintain R.F. V/m Level @ Limit	
200.000	20.00	15.89	20.39	Data Pass Maintain R.F. V/m Level @ Limit	
300.000	20.00	20.03	19.23	Data Pass Maintain R.F. V/m Level @ Limit	
400.000	20.00	20.13	19.44	Data Pass Maintain R.F. V/m Level @ Limit	
500.000	20.00	20.31	17.00	Data Pass Maintain R.F. V/m Level @ Limit	
600.000	20.00	20.21	18.00	Data Pass Maintain R.F. V/m Level @ Limit	
700.000	20.00	19.07	20.70	Data Pass Maintain R.F. V/m Level @ Limit	
800.000	20.00	20.00	19.98	Data Pass Maintain R.F. V/m Level @ Limit	
900.000	20.00	20.23	19.24	Data Pass Maintain R.F. V/m Level @ Limit	
1000.000	20.00	20.41	14.15	Data Pass Maintain R.F. V/m Level @ Limit	
2000.000	20.00	20.84	5.33	Data Pass Maintain R.F. V/m Level @ Limit	
2500.000	20.00	20.36	7.01	Data Pass Maintain R.F. V/m Level @ Limit	
3000.000	20.00	20.02	19.75	Data Pass Maintain R.F. V/m Level @ Limit	
3500.000	20.00	20.61	20.40	Data Pass Maintain R.F. V/m Level @ Limit	
4500.000	20.00	20.01	16.60	Data Pass Maintain R.F. V/m Level @ Limit	↓
5500.000	20.00	20.95	12.40	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
6500.000	20.00	20.75	8.67	Data Pass Maintain R.F. V/m Level @ Limit	
7500.000	20.00	20.23	13.47	Data Pass Maintain R.F. V/m Level @ Limit	
8000.000	20.00	20.27	12.07	Data Pass Maintain R.F. V/m Level @ Limit	
9000.000	20.00	20.72	19.93	Data Pass Maintain R.F. V/m Level @ Limit	
10000.000	20.00	20.25	19.55	Data Pass Maintain R.F. V/m Level @ Limit	
11000.000	20.00	20.38	17.54	Data Pass Maintain R.F. V/m Level @ Limit	
12000.000	20.00	20.84	16.84	Data Pass Maintain R.F. V/m Level @ Limit	
13000.000	20.00	20.81	18.80	Data Pass Maintain R.F. V/m Level @ Limit	
14000.000	20.00	20.64	20.93	Data Pass Maintain R.F. V/m Level @ Limit	
15000.000	20.00	20.11	15.36	Data Pass Maintain R.F. V/m Level @ Limit	
16000.000	20.00	15.34	20.62	Data Pass Maintain R.F. V/m Level @ Limit	↓
17000.000	20.00	15.38	20.11	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
18000.000	20.00	12.47	20.34	Data Pass Maintain R.F. V/m Level @ Limit	↓

Component: ALPHA MAGNETIC SPECTROMETER (AMS-02) - USB422 ASSEMBLY

Vertical Polarization

FREQUENCY (MHz)	SSP30237 Limit (V/m)	Injected Test Signal		Remarks	Test Sample Response
		Proble #1 Level (V/m)	Proble #2 Level (V/m)		
30.000	20.00	20.24	18.36	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
40.000	20.00	20.64	19.43	Data Pass Maintain R.F. V/m Level @ Limit	
50.000	20.00	20.61	19.81	Data Pass Maintain R.F. V/m Level @ Limit	
60.000	20.00	20.08	19.77	Data Pass Maintain R.F. V/m Level @ Limit	
70.000	20.00	20.07	19.50	Data Pass Maintain R.F. V/m Level @ Limit	
80.000	20.00	20.27	19.24	Data Pass Maintain R.F. V/m Level @ Limit	
90.000	20.00	20.25	19.50	Data Pass Maintain R.F. V/m Level @ Limit	
100.000	20.00	20.10	20.31	Data Pass Maintain R.F. V/m Level @ Limit	
120.000	20.00	19.00	20.20	Data Pass Maintain R.F. V/m Level @ Limit	
140.000	20.00	19.21	20.32	Data Pass Maintain R.F. V/m Level @ Limit	
160.000	20.00	19.93	20.73	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
180.000	20.00	20.56	20.03	Data Pass Maintain R.F. V/m Level @ Limit	
190.000	20.00	20.75	20.51	Data Pass Maintain R.F. V/m Level @ Limit	
200.000	20.00	20.72	18.41	Data Pass Maintain R.F. V/m Level @ Limit	
250.000	20.00	20.08	20.73	Data Pass Maintain R.F. V/m Level @ Limit	
300.000	20.00	20.83	18.75	Data Pass Maintain R.F. V/m Level @ Limit	
400.000	20.00	20.09	17.89	Data Pass Maintain R.F. V/m Level @ Limit	
500.000	20.00	20.14	20.38	Data Pass Maintain R.F. V/m Level @ Limit	
600.000	20.00	18.44	20.70	Data Pass Maintain R.F. V/m Level @ Limit	
700.000	20.00	17.01	20.28	Data Pass Maintain R.F. V/m Level @ Limit	
800.000	20.00	18.59	20.51	Data Pass Maintain R.F. V/m Level @ Limit	
900.000	20.00	20.02	20.09	Data Pass Maintain R.F. V/m Level @ Limit	
1000.000	20.00	18.49	20.32	Data Pass Maintain R.F. V/m Level @ Limit	
2000.000	20.00	17.03	20.11	Data Pass Maintain R.F. V/m Level @ Limit	
2500.000	20.00	14.28	20.54	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
3500.000	20.00	20.32	17.45	Data Pass Maintain R.F. V/m Level @ Limit	
4500.000	20.00	17.36	20.00	Data Pass Maintain R.F. V/m Level @ Limit	
5500.000	20.00	20.04	16.99	Data Pass Maintain R.F. V/m Level @ Limit	
6500.000	20.00	20.00	18.07	Data Pass Maintain R.F. V/m Level @ Limit	
7500.000	20.00	17.34	20.23	Data Pass Maintain R.F. V/m Level @ Limit	
8000.000	20.00	20.44	14.46	Data Pass Maintain R.F. V/m Level @ Limit	
9000.000	20.00	20.70	20.07	Data Pass Maintain R.F. V/m Level @ Limit	
10000.000	20.00	20.97	19.45	Data Pass Maintain R.F. V/m Level @ Limit	
11000.000	20.00	20.15	16.42	Data Pass Maintain R.F. V/m Level @ Limit	
12000.000	20.00	20.84	12.59	Data Pass Maintain R.F. V/m Level @ Limit	
13000.000	20.00	20.74	8.42	Data Pass Maintain R.F. V/m Level @ Limit	
14000.000	20.00	20.65	10.55	Data Pass Maintain R.F. V/m Level @ Limit	
15000.000	20.00	20.43	17.93	Data Pass Maintain R.F. V/m Level @ Limit	
16000.000	20.00	16.67	20.95	Data Pass Maintain R.F. V/m Level @ Limit	
17000.000	20.00	17.70	20.05	Data Pass Maintain R.F. V/m Level @ Limit	
18000.000	20.00	20.33	20.55	Data Pass Maintain R.F. V/m Level @ Limit	

ALPHA MAGNETIC SPECTROMETER

(AMS-02) – USB422 ASSEMBLY

EV5-09-EMC-010P

SL-E-0002 BOOK 3

SPACE SHUTTLE SPEC.

(RS103)

RADIATED SUSCEPTIBILITY

DEVIATION # 1 DATA

(RS103) Radiated Susceptibility Electric Field

EUT NAME:	ALPHA MAGNETIC SPECTROMETER (AMS-02)	**TEST DATE:**	28-Jul-09
TEST CLASSIFICATION:	Evaluation	**TEST SITE:**	JSC Building B14A Room 1000
TEST SPEC:	Space Shuttle SL-E-0002 BOOK 3	**TEST CYCLE:**	AM Modulation 99% at 1kHz
TYPE OF TEST:	(RS103) Radiated Susceptibility	**TEST CONDUCTOR:**	Cynthia Hightower
TPS#:	2A0920076	**TEST RESULT:**	PASS
TP#:	EV5-09-EMC-010P	**COMMENT:**	Gaps In Frequency Represent A Continuous Linear Sweep. Threshold Data Are Reduced R.F. Level All Polarity Of The Antenna Is Stated. This Test was performed using a Class III LoopBack Cable
DEVIATION #:	1		
STEP#:	2		

Equipment List

TEST EQUIPMENT	CAL. NUMBER	CAL. DATE
Signal Generator - Rohde & Schwarz, Model SMT03, SN 100231	M206568	09/10/09
Signal Generator - Rohde & Schwarz, Model SMP22, SN 100019	M206381	11/05/09
Biconi Ant. - Antenna Research Asso, Model BCH-2030/A, SN 1017	N/A	N/A
Large Double Ridge Horn - ETS, Model 3106, SN 2824	610920005	01/30/10
Small Double Ridge Horn - ETS, Model 3115, SN 6059	610920006	01/30/10
RF Field Monitor - Amplifier Research, Model M5004, SN 28078	N/A	N/A
Isotropic Proble - Amplifier Research, Model FP5000, SN 300489	N/A	01/05/10
Isotropic Proble - Amplifier Research, Model FP5000, SN 2300487	N/A	12/18/09
Isotropic Proble - Amplifier Research, Model FP2080, SN 19447	N/A	04/27/10
Isotropic Proble - Amplifier Research, Model FP2080, SN 25256	N/A	04/17/10
RF Ampifier - IFI, Model SMX500, S/N M730-0808	N/A	N/A
RF Ampifier - IFI, Model T251-500, SN D038-0400	N/A	N/A
RF Ampifier - IFI, Model T7525-500, SN D039-0400	N/A	N/A
RF Ampifier - IFI, Model T1875-500, SN D033-0400	N/A	N/A
RF Cable -MegaPhase Corp, Model D130-NK-Nk-72, SN 1004	610920035	04/21/10
RF Cable - EMS Cables Corp, Model EW292-NGNG-120, SN 1001	610824004	11/12/09
RF Cable - Adams Russell Corp, Model 1997-240, SN 1001	610924084	10/09/09

Horizontal Polarization

FREQUENCY (MHz)	SSP30237 Limit (V/m)	Injected Test Signal: Probe #1 Level (V/m)	Injected Test Signal: Probe #2 Level (V/m)	Remarks	Test Sample Response
175.000	20.00	18.90	20.02	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
180.000	20.00	16.50	20.09	Data Pass Maintain R.F. V/m Level @ Limit	
180.800	20.00	17.52	20.00	Data Pass Maintain R.F. V/m Level @ Limit	
181.000	20.00	17.00	20.10	Data Pass Maintain R.F. V/m Level @ Limit	
182.000	20.00	16.99	20.45	Data Pass Maintain R.F. V/m Level @ Limit	
185.000	20.00	17.29	20.72	Data Pass Maintain R.F. V/m Level @ Limit	
190.000	20.00	19.87	20.00	Data Pass Maintain R.F. V/m Level @ Limit	

EVALUATION

Horizontal Polarization					
FREQUENCY (MHz)	SSP30237 Limit (V/m)	Injected Test Signal		Remarks	Test Sample Response
		Probe #1 Level (V/m)	Probe #2 Level (V/m)		
192.000	20.00	19.09	20.00	Equipment under Test Malfunction	Not Susceptible
193.000	20.00	19.00	20.85	Data Pass Maintain R.F. V/m Level @ Limit	↓
195.000	20.00	20.17	20.45	Data Pass Maintain R.F. V/m Level @ Limit	↓
200.000	20.00	16.65	20.79	Data Pass Maintain R.F. V/m Level @ Limit	↓

EVALUATION

Component: ALPHA MAGNETIC SPECTROMETER (AMS-02) - USB422 ASSEMBLY DEVIATION # 1

Vertical Polarization					
FREQUENCY (MHz)	SSP30237 Limit (V/m)	Injected Test Signal		Remarks	Test Sample Response
		Probe #1 Level (V/m)	Probe #2 Level (V/m)		
175.000	20.00	20.56	20.90	Data Pass Maintain R.F. V/m Level @ Limit	Not Susceptible
180.000	20.00	20.04	16.90	Data Pass Maintain R.F. V/m Level @ Limit	
180.800	20.00	20.63	20.80	Data Pass Maintain R.F. V/m Level @ Limit	
181.000	20.00	20.46	20.39	Data Pass Maintain R.F. V/m Level @ Limit	
182.000	20.00	20.63	20.91	Data Pass Maintain R.F. V/m Level @ Limit	
185.000	20.00	20.55	20.82	Data Pass Maintain R.F. V/m Level @ Limit	
190.000	20.00	20.40	20.65	Data Pass Maintain R.F. V/m Level @ Limit	
192.000	20.00	20.30	20.00	Data Pass Maintain R.F. V/m Level @ Limit	
193.000	20.00	20.11	20.28	Data Pass Maintain R.F. V/m Level @ Limit	
195.000	20.00	20.46	19.61	Data Pass Maintain R.F. V/m Level @ Limit	
200.000	20.00	20.02	20.73	Data Pass Maintain R.F. V/m Level @ Limit	

Electromagnetic Interference/ Electromagnetic Compatibility (EMI/EMC) Test Facility
Test Process Evaluation Sheet

EVALUATION

Test Article: ALPHA MAGNETIC SPECTROMETER (AMS-02) – USB422 ASSEMBLY EV5-09-EMC-010P

Type of Test:
- ☐ Certification
- ☑ Evaluation
- ☐ Emissions
- ☑ Susceptibility
- ☐ Pass
- ☐ Fail

Test Date: 7-22-09 THRU 7-28-09

Your evaluation of our service product will enable us to provide continued improvement and serve you better.

Evaluator Name:	Organization/Mail Code:	Phone:
DUONG NGUYEN	JACOBS	281-486-6311

Please provide a score in the range of 0 (poor) to 100 (excellent) to rate our performance:

Test Planning/Reporting Phase:

Ease of test coordination:	100
Satisfaction with test dates:	100
Timely completion of test plan:	100
Timely completion and scheduling of TRR:	100
Timely test reporting:	N/A
Technical adequacy of test report:	N/A

Laboratory Operations:

Completion of test objectives:	100
Competence of test personnel:	100
Satisfaction with time utilization:	100
Test data availability at test completion:	100
Explanation of rework required (if applicable):	100

Signature:	Date:
Duong Nguyen	7-28-09

For Lab Use Only:	Planning/Reporting:
Average of Evaluators Scoring:	Laboratory Ops:

Return responses to:

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