

**Critical Design Review (CDR)**  
**Of**  
**ULTRA VIOLET IMAGING TELESCOPE (UVIT)**  
(June 17<sup>th</sup> -18<sup>th</sup> 2011, ISAC, Bengaluru)

**EMI/EMC Test on the Detector System**

**UVIT-CDR-01-004**

**Indian Institute of Astrophysics**  
**Bangalore-560034**

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**EMI/ EMC Test On  
EM UVIT Detector System  
Version 0.1**

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## **1. UVIT Payload on ASTROSAT**

UVIT is one of the five payloads on ASTROSAT, first Indian Multi wavelength Astronomical satellite. UVIT aims to image selected parts of the sky in three distinct spectral regions (FUV, NUV and VIS) using two identical telescopes. Before launching the satellite, it is mandatory to test the satellite on the ground itself with all its subsystems and payloads. So, it is also mandatory for us to test the UVIT payload individually, scientifically and technically at IIA before its integration with the spacecraft.

The scientific and technical tests will be done on Engineering Model as well as Flight Model. Tests on Engineering Model of Payload are, to find any error in payload subsystem design, so that error can be corrected in Flight Model Design of the payload for the accuracy and objective fulfillment of the payload. Keeping all these concerns in mind there are EMI/ EMC test is listed for UVIT payload.

The detector system of UVIT is made of many parts, and these parts sit at different locations. The main Electronic Unit “EU”, which is the link to S/C, sits on the deck, while 3 CPUs + 3 HVUs sit in the focal volume of UVIT. By design, body of all these parts is connected to the electrical ground. Thus, when CPUs & HVUs are mounted on the structure of UVIT, the structure acts as a ground plane, similarly the deck acts as ground plane for the EU. As cylinder of the S/C is not metallic, the structure of UVIT and the deck represent two isolated grounds. In order to minimize EMI with low-level signals between EU and the other units, it is recommended that the two ground planes (as above) have a low impedance. This note concerns possible ways of implementing a low impedance connection between the two ground planes, and checking its adequacy.

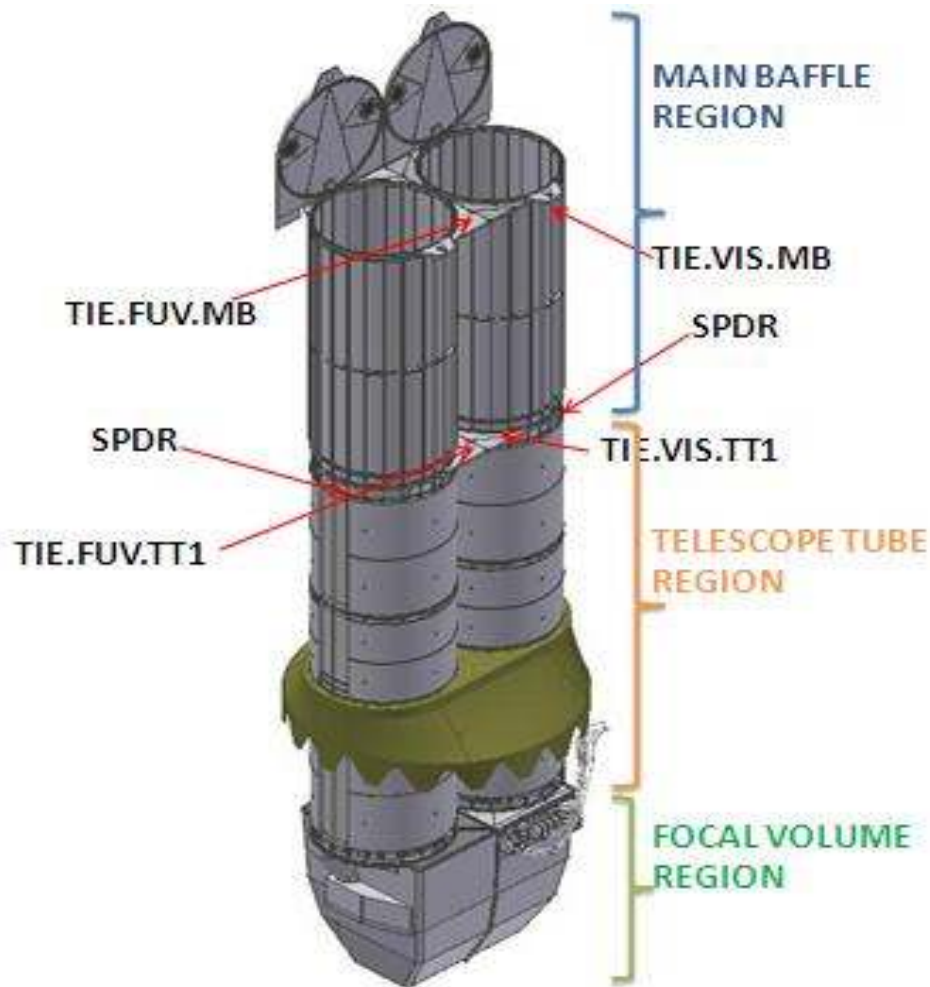
## **2. Connection between the Two Grounds:**

It is proposed that large Cu-braids are taken from top-plane of the Ti Cone (using the 4 Nos M10 holes) to the deck where EU is mounted.

Type/Nos of braids, and length of these to be decided between UVIT & ASTROSAT, and a sketch to be enclosed of the routing.– UVIT+ASTROSAT to do.

## **3. EMI/ EMC test on EM UVIT Detector System at ISAC:**

The configuration of UVIT for EMI/ EMC test, at ISAC will have CPU, HVU, EU, with proper electrical ground connections from UVIT to satellite ground. The main aim of conducting EMI/ EMC test is to check the Dark Image of the Detector and all functional tests to check the proper communication, how much it gets affected with EMI/ EMC.



A) The following tests shall be done to verify the payload with the following tests:

- a) Conducted Emissions on Primary Power lead (15 kHz to 50 MHz)
- b) Conducted Susceptibility Tests on Primary Power lead
  - Sine Susceptibility, CS02 (50 kHz to 50 MHz)
  - Spike Susceptibility, CS06 (36 V<sub>peak</sub>)
- c) Radiated Emission Test (Electric Field - 14 kHz to 18 GHz)
- d) Radiated Susceptibility Test (Electric Field - 20 MHz to 18 GHz)

B) On CPU and EU an integrated EMI/ EMC test as per MIL-STD-461E and ESD test as per IEC 61000-4-2 Ed 1.2, April 2002, has been done at the supplier end (David Florida Laboratory, [DFL]), the list of the test is as follows:

- a) Conducted Emissions: CE 102, Power Leads, 10 KHz to 10 MHz.
- b) Conducted Susceptibility: CS101, Power Leads, 30Hz to 150 KHz.
- c) Conducted Susceptibility: CS114, Bulk Cable Injection, 10 KHz to 200 MHz.
- d) Conducted Susceptibility: CS115, Bulk Cable Injection, Impulse Excitation
- e) Conducted Susceptibility: CS116, Damped Sinusoidal Transients, Cables and Power Leads, 10 KHz to 100 MHz.
- f) Radiated Emissions: RE102, Electric Field, 10 KHz to 1 GHz.
- g) Radiated Susceptibility: RS103, 2 MHz to 1 GHz. (10 Times max generated frequency)
- h) ESD Test: Direct Discharge
- i) ESD Test: Indirect Discharge

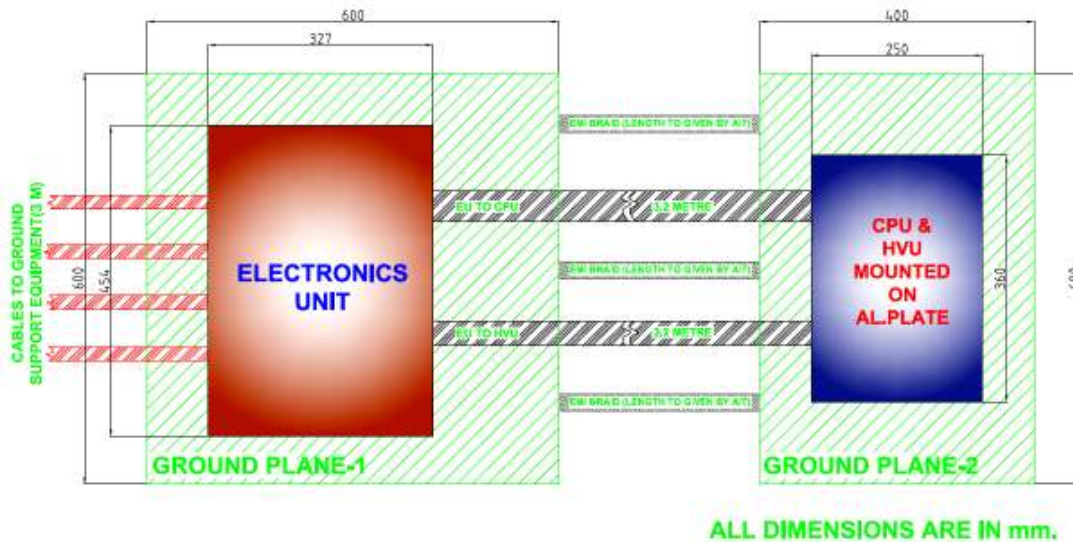
C) HVU individually tested at MSSL as per MIL-STD-461E, the list of the test is as follows:

- a) Conducted Emissions: CE 102, Power Leads, 10 KHz to 10 MHz.
- b) Conducted Susceptibility: CS101, Power Leads, 30Hz to 150 KHz.
- c) Conducted Susceptibility: CS114, Bulk Cable Injection, 10 KHz to 200 MHz.
- d) Conducted Susceptibility: CS115, Bulk Cable Injection, Impulse Excitation.
- e) Conducted Susceptibility: CS116, Damped Sinusoidal Transients, Cables and Power Leads, 10 KHz to 100 MHz.
- f) Radiated Emissions: RE102, Electric Field, 10 KHz to 1 GHz.
- g) Radiated Susceptibility: RS103, 2 MHz to 18 GHz.
- h) ESD Test: Direct Discharge.
- i) ESD Test: Indirect Discharge.

Now, a plan has to be workout to conduct the EMI/ EMC test on EM-UVIT at ISAC as per the ISAC MIL standards.

Following is the test configurations, to be carry out:

- 1) Change the ground plane into a two ground planes connected by the same lengths/number/type of Cu braids as to be used in ASTROSAT, and repeat the EMI test. Compare the results with those obtained in CSA. See figure 1 for the test configuration.



**Figure 3. 1 EMI Test Configuration with 2 ground Planes**

The inputs/outputs to be tested can be taken from documents from Routes; in particular, the video signal from Star250 can be seriously affected by EMI and it must be closely monitored through any increase in noise of dark frames obtained in imaging.

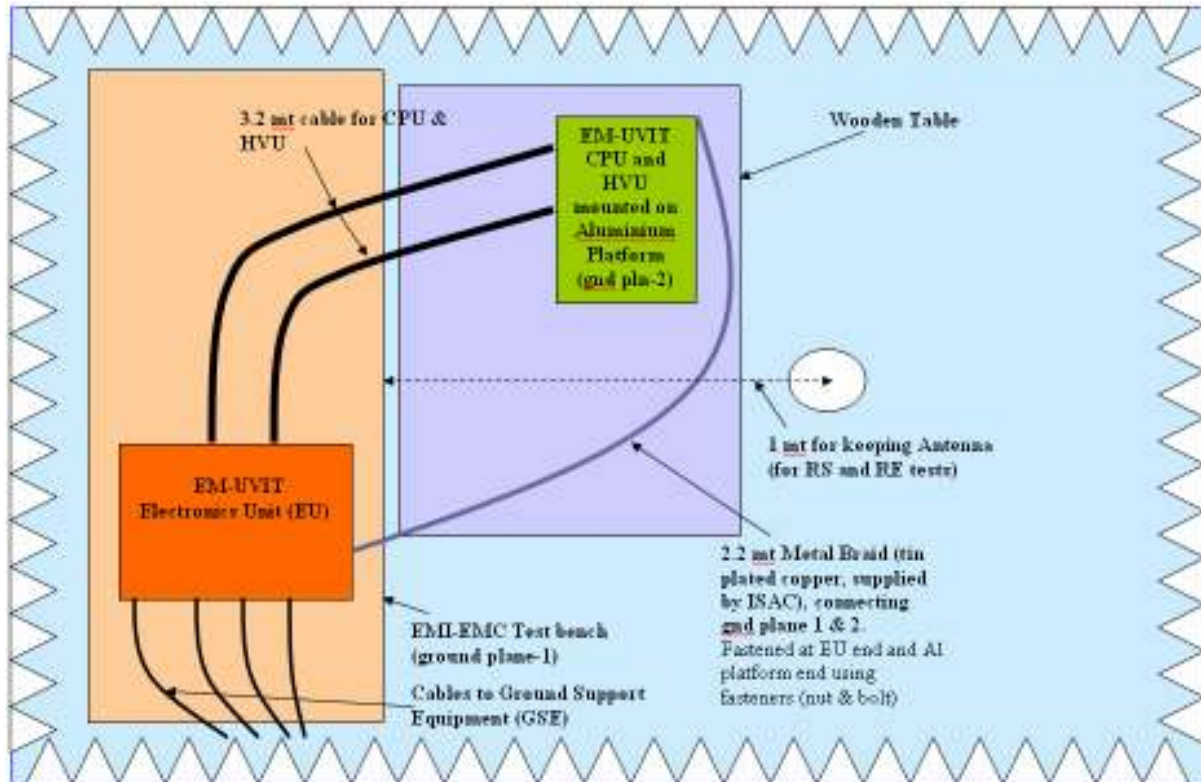
Following are the documents from Routes to be referred to get the above mentioned details.

- a) *DFL EMI EMC Testing.xls*
- b) *UVIT 990-00018-PLN Rev 1 0 EMC Test Plan and Procedure-final.pdf*.
- c) *UVIT\_HVU\_EMC\_test\_req\_TS07002\_02*.
- d) *EM\_HVU\_EMC\_Test\_Report\_TR07003\_01*.

The above mentioned documents are on <ftp://ftp.iiap.res.in/amits/EMI-EMC-Docs> and password protected. If you want the access please mail on [amits@iiap.res.in](mailto:amits@iiap.res.in).

## 4. Test Details

During these tests detector unit was mounted on sepearte wooden table (requirement from subsystem). In spacecraft , detector subsystem was loacted on CFRP deck. Detector is connected to electronics system through 1” braid. The placement of subsystems during EMI-EMC test is given in the following figure.



**Figure 4. 1 EM UVIT DS Test Setup in EMI/EMC LAB at ISAC**

Note:

Conducted Emission and Radiated Emission tests were also carried out with electronics and detector systems mounted on same ground plane (EMI-EMC test table).

## 5. Test Results

Following are the Test Results of the Test.

For Details refer Document

EMI / EMC TEST RESULTS OF EM UVIT DETECTOR SYSTEM of ASTROSAT SPACECRAFT.doc “EID-EMCF-RP-06-02-10”.

## RESULTS of EMI/ EMC Test on EM UVIT detector System

### Indian Institute of Astrophysics, Bangalore

EMI-EMC Test on Engineering Model of UVIT Detector (NUV) conducted as per ISRO test procedure and specifications  
Tests conducted in EMI/EMC lab at ISRO Satellite Centre from 01.02.2010 to 05.02.10

#### Members Present

#### IIA (UVIT)

Prof Swarna Kanti  
Ghosh (TIFR)  
Amit Kumar

#### ISAC

Shri P.V.N.Murthy  
Ms. Mini

EMC

Name of Test	Frequency Bands	Result	Remarks	Pass Criteria [Frame Stdv <=30]	
Conducted Emission (CE-03 & CE-07) [Live Line and Return Line]	15KHz to 50 MHz	Pass			
Radiated Emission (RE-02)	14KHz to 30MHz	Pass with Margin			
	30 MHz to 300MHz (Horizontal Polarization)	Pass			
	30 MHz to 300MHz (Vertical Polarization)	Pass			
	300MHz to 1GHz	Pass			
	1GHz to 18GHz	Pass			
Radiated Susceptibility (RS)	20MHz to 200MHz	Failed at frequency band (33-34.8MHz) and (59.5-63MHz) [See RS20M-200MHz and RS 20MHz-200MHz (Time Vs Freq) worksheets for more details]	Needs a Review of emissions at 33-34.8 MHz and 59.5-63MHz; frequency bands from other subsystems and payloads on ASTROSAT (See Note Below)	Frame Stdv > 30 at Freq Band 33-34.8MHz (Max stdv 31.28) & 59.5-63MHz (Max stdv 88.48)	Radiated Voltage level 5V/m (134dBuV/m)
	200MHz to 1GHz	Pass		Frame Stdv < 30	Radiated Voltage level 5V/m (134dBuV/m)



	1Ghz to 2GHz	Pass		Frame Stdv < 30	Radiated Voltage level 5V/m (134dBuV/m)
	2GHz to 4GHz	Pass		Frame Stdv < 30	Voltage level 5V/m (134dBuV/m)
	4GHz to 8GHz	Pass		Frame Stdv < 30	Radiated Voltage level 5V/m (134dBuV/m)
	8GHz to 10GHz	Pass		Frame Stdv < 30	Radiated Voltage level 5V/m (134dBuV/m)
	10GHz to 18GHz	Pass		Frame Stdv < 30	Radiated Voltage level 5V/m (134dBuV/m)
Conducted Susceptibility (CS-02)	50K-50MHz	Pass		Frame Stdv < 30	
<b>Name of Test</b>		<b>Result</b>	<b>Remarks</b>		
	<b>Spike Injection Level</b>				
Conducted Susceptibility (CS-06)	0-5V injection on power lines	Pass		Frame Stdv < 30	
	10-15V injection on power lines	Pass		Frame Stdv < 30	
	20-25V injection on power lines	Pass		Frame Stdv < 30	
	30-36V injection on power lines	Pass		Frame Stdv < 30	

**Note:** To give final conclusion (from ISAC, Pass/Fail) on this EMI/ EMC test of EM-UVITDS, Project Office needs to look into Radiated Emissions Report of all the subsystems and Payloads of ASTROSAT for affected frequency bands (33-34.8 MHz & 59.5-63MHz)

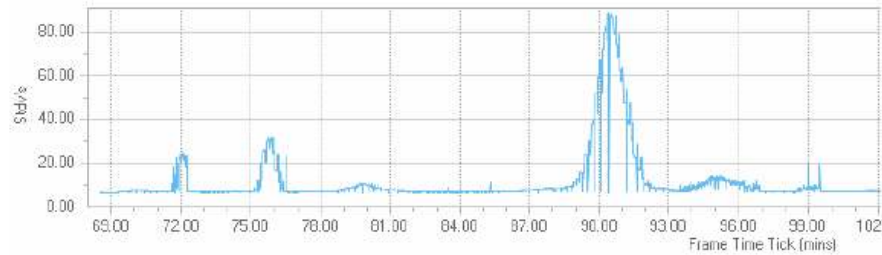
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This Sheet Explains the Observations on Standard Deviation of Image Frame for RS and CS tests

PS: From Canadian Science Team, Oct 2008: " Below 30 count Standard Deviation is OKAY" [Ref: CSA (Routes)-CDR Slides of Environment testing]

Name of Test	Frequency Range	Data File Name	Frame Stdv with EMI	Stdv (Stdv)	Frame Stdv without EMI	Notes	Conclusion
RS	20M-200MHz	s_0094_1_0035	6.62-88.61	10.39	6.19-6.81	First Peak of Stdv 31.23 at 75.83 min; 12585th Frame. Peak of Stdv 88.48 at 90.38 min; 37650th Frame. See RS20M-200MHz and RS 20MHz-200MHz (Time Vs Freq) worksheets for more details	Failed at freq band 33-34.8MHz and 59.5-63MHz. Stdv peak (88.48) at 61.6238 MHz, Stdv Start corrupting from Freq 59.5MHz and Recovered at 63MHz.



Frame Time Tick (mins): It shows the time (in minutes) how long the system is ON (it get RESET if system resets)

## 6. Conclusion

Subsystem was susceptible at frequency bands of 33MHz to 34.8MHz and 59.5MHz to 63MHz. Observed maximum standard deviations in frequency band 33MHz to 34.8MHz is 31.28 and for frequency band 59.5MHz to 63MHz is 88.48. (Acceptable standard deviation is  $\leq 30$ ).