

SPIRE-AST-DOC-002345

Title: **PLM EMC Control and Verification Plan**

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1 Introduction

This Control Plan defines the EMC design and qualification program with its management tools and control methods to be used by ASED in order to ensure overall EMC of the payload module of HERSCHEL equipped with the instruments FPU's of HIFI, PACS and SPIRE, inclusive the cryostat control electronic.

The approach to manage and to demonstrate the compatibility is presented.

This document is not applicable to equipment of lower level sub-contracts, who may, however, review and confirm/correct/comment the assumptions made on their equipment (e.g. w.r.t. grounding and frequency plannings).

For the HERSCHEL customer this document demonstrates the high level of reliability in EMC control as well as the correct understanding of the requirements imposed on the hardware under control and responsibility of ASED. This document shall be used as input to the satellite level EMC Control Plan. The EMC design and qualification program is based on the HERSCHEL H/W organisation tree, fig. 1-1, which reflects the understanding of both, test H/W levels and ASED responsibility (for design and test). It shall not be compared with the HERSCHEL H/W tree that is defined for other objectives.

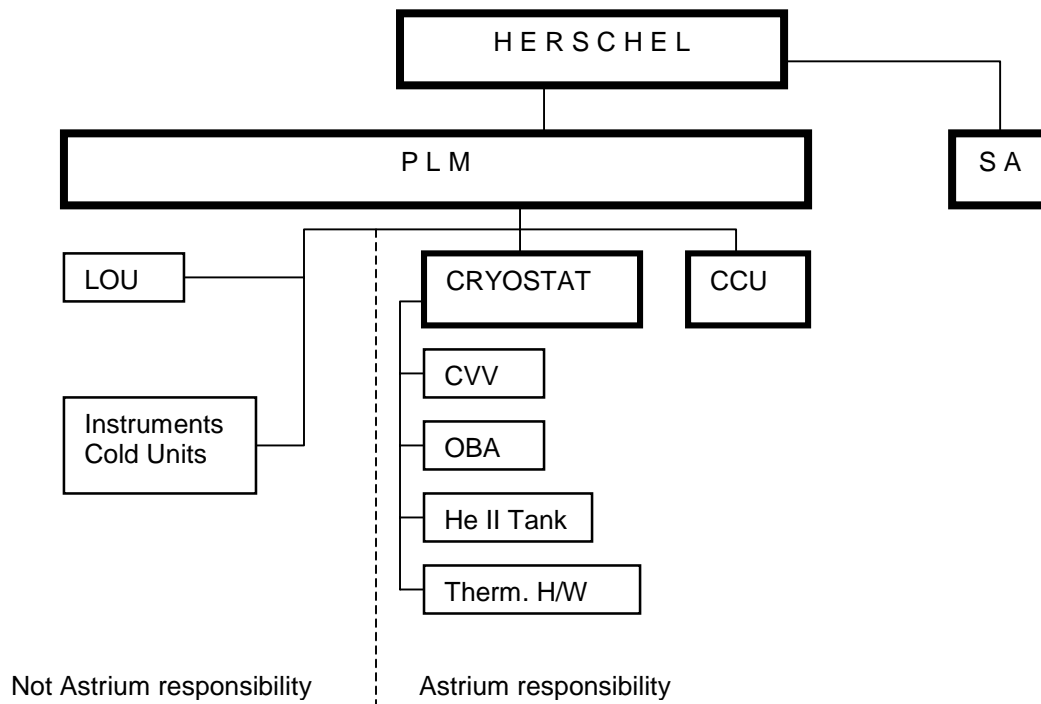


Fig 1-1: HERSCHEL PLM Hardware Organisation

2 Documents

2.1 Applicable documents

[AD1]	HERSCHEL EMC/ESD Control Plan	H-P-1-ASPI-PL-0038
[AD2]	HERSCHEL EMC Specification	H-P-1-ASPI-SP-0037
[AD3]	HERSCHEL GDIR	H-P-1-ASPI-SP-0027

2.2 Reference Documents

[RD1]	HERSCHEL Grounding Scheme	HP-2-ASED-DW-0001
[RD2]	Herschel/Planck EMC Analysis	HP-1-ASPI-AN-0202
[RD3]	Analysis on Feasibility of the CTA Internal RS Test Option	HP-2-ASED-AN-0001

3 EMC Management

3.1 Approach

The challenge of HERSCHEL is to realise a high performance mission with further aspects to be traded-off. This objective will be met by:

1. Effective specification with a good balance between specification margin and risk
2. Re-use of design and hardware already being used for ISO, a quite similar satellite which has performed its mission successfully.
3. Close co-operation with the HERSCHEL project and all of its subcontractors to provide for transparency of the objectives and identify areas of inconsistencies before they lead to harm for the HERSCHEL satellite project.

The figure below shows in general terms how the "EMC Management" will be performed. It clarifies also the evidence of the applicable documentations for HERSCHEL PLM w.r.t. EMC.

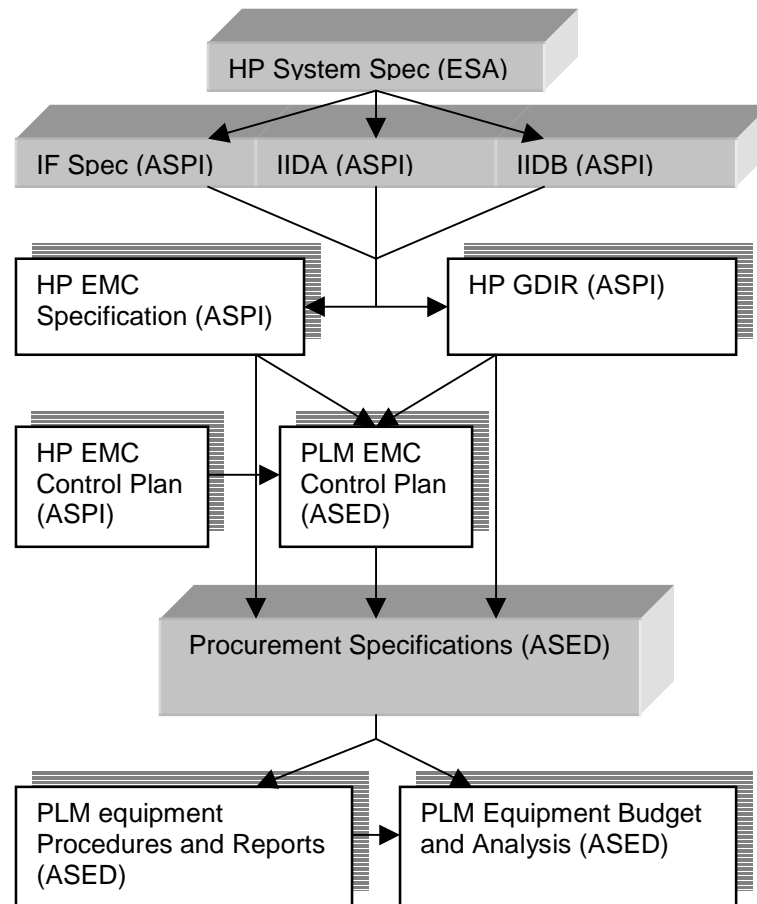


Fig. 3.1-1: EMC Management

The EMC design shall be reviewed periodically and in any case of change of any assumptions on which the design is based on (e.g. grounding concept, frequency planning). Critical areas in design, once addressed, shall be analysed asap. Therefore, first analysis models shall be kept simple and worst case, and standard EMC rules shall be considered (ref. [RD2] for a general example to calculate in 1st step a sensor link susceptibility). If the critical area w.r.t. EMC is confirmed by the simple model analysis result, it shall be decided either to go to design corrections or to re-analysis with a more precise model.

The simplicity of the analysis will result in an increase of visibility on critical areas and to the possibility to trade-off design corrections against each other quickly.

3.2 Responsibilities

ASED is responsible for the adequate design and the performance of all equipment subcontracted by ASED.

Although being formally not responsible for the payload instrument, ASED will support the Prime contractor by review of the EMC design of the payload instruments because the electromagnetic emission/susceptibility measured on PLM level will be a result of the instruments FPUs and their interactions inside the cryostat.

3.3 EMC Design

3.3.1 General

EMC design is based on the grounding concept meanwhile usual and well justified in the space businesses: The Distributed Single Point Grounding Concept (DSPG). The quality of the DSPG concept will determine the EMC performance of the equipments, instrument and HERSCHEL. Good quality means in general:

- All bonding have to made low resistive and low inductive, considering thermal constraints,
- digital interfaces have to be differential with optimised balanced signals,
- analogue TM/TC and non-differential interfaces must use lines isolated from ground.

Following the equipments/instruments specification will consequently lead to a design being adequate for EMC. Design risks will be reduced by reviews on the electrical design in the frame of the periodically performed progress meetings and reviews on HERSCHEL equipments and instruments (ref. §3.1).

Any EMC analysis necessary will be based on the grounding concept and the frequency plan. Both should be reviewed by each instrument Team and confirmed, commented or corrected respectively.

3.3.2 Frequency Plan

The satellite frequency plan is the basis for analysis of the electromagnetic behaviour of the PLM. In this chapter the frequencies of the CCU are listed. The table shall be used as input for the satellite frequency planning done by ASPI. It will be updated as soon as CCU design status allow a precisement of the frequencies used.

Designation	Frequency		Comment	Level	Source
CCU DC/DC CV	125	kHz		Cryostat	Fax HP-2-ASED-0090/01, 12.09.2001
CCU HK	4	kHz		Cryostat	

Table 3.3.2-1: CCU Frequencies (Input to HERSCHEL PLM Frequency Plan)

3.3.3 Grounding Diagram

The proposed grounding concept is shown in the scheme [RD1]. It comprises a DSPG system for minimisation of pick-up noise as well as minimisation of emission. In general the principle is based on the use of single ended or differential driver interfaces in combination with differential receivers or opt coupled interfaces. As a feature derived from ISO, there is no dedicated ground connection for the cryostat foreseen, i.e.: Grounding of the cryostat can be accomplished by outer cryoharness overall shield and coaxial outer conductors only (last done for ISO).

3.4 EMC Verification

The objective of the HERSCHEL PLM /equipment verification program is the demonstration of HERSCHEL auto-compatibility (i.e. proper functioning in fully assembled configuration incl. compliance to the EMC specification, ref. [AD2]).

3.4.1 Methods

One can distinguish 3 different verification methods used to demonstrate EMC:

1. *Review of Design (ROD)*

This verification method comprises the visual examination of hardware related diagrams and drawings, descriptive files or hardware itself w.r.t. finishes, surface properties, dimensions etc.

2. *Analysis and Similarity Study (A/S)*

These verification methods may be used instead of or in combination with test data.

Similarity studies may be used when equipment or parts of equipment are similar or identical w.r.t. design and manufacturing to another product which has previously been qualified against similar requirements. Comparing test results, the test set-ups (especially harness characteristics and routing) shall be analysed.

3. *Test (T)*

Testing is the most preferred verification method for EMC requirements and will provide the most reliable information on the EMC/RFC performance.

3.4.2 Test Items

The following configurations are considered as suitable for EMC testing:

HERSCHEL PLM

- Cryostat ([EQM](#): modified ISO [QM](#) cryostat)
- HIFI FPU with LOU
- [PACS FPU](#)
- SPIRE FPU
- SPIRE JFETs (Photometer and Spectrometer)
- Optical Bench [Assembly](#)
- PLM Thermal H/W (e.g. MLI)

Cryostat Control Unit (CCU)

- Unit level without MLI.

Solar Array

- [Sunshade with OSR on front side and MLI on rear side](#)
- [Sunshield with Solar Cells on front side and MLI on rear side.](#)
- [Support structure \(Struts, covered with MLI\).](#)

4 HERSCHEL EMC Qualification Planning

4.1 Baseline Planning

In order to verify the proper instrument operation in the environment EMC tests shall be performed on every relevant model of PLM, i.e.:

- the EQM Integrated Module consisting of a refurbished ISO cryostat including CQM FPU's,
- the PFM Integrated Module which will be fully flight representative, and
- the satellite level

Tests on **EQM Integrated Module** shall be performed for an early identification of any EMI emission and susceptibility. The modified ISO QM cryostat will be used including the focal plane units of PLM operating at representative temperatures to have the detectors at representative sensitivity. The cryo and the warm harness and its routing will be at least electrically flight representative. The optical windows to the HHLOU will be open to feed in the LO signals. The risk of straylight entering the cryostat in excess of allowable levels may have to be assessed. If necessary, specific shielding have to be applied. A specific Cryogenic Test Adapter (CTA) to be mounted on the CVV will allow to provide the environment necessary to put the instruments to the sensitivity required for any susceptibility test. [The warm units will be integrated in a SVM dummy and interconnected with a representative harness.](#)

The **PFM Integrated Module** shall be used for final [acceptance](#) w.r.t. EMC. It is fully representative except that the SVM equipment are not located in the SVM but on an external plate and w.r.t. the harness routing between the cryostat and the equipment of the service module.

The **PFM HERSCHEL S/C** is the most representative level as the SVM avionics equipment is complete and connected to the electronic equipment inside the CVV and on the CVV. EMC tests will be performed on this level in order to confirm the compatibility with the Launcher EMC requirements and to confirm the EMC performance [of the spacecraft](#). It is important to note that although the satellite level tests will be performed by ASED, the responsibility for the test results is subject of system analysis and evaluations.

It follows a table showing operational and structural representativities and corresponding objectives of the different test models w.r.t. EMC qualification.

Configuration:	
EQM Integrated Module	<ul style="list-style-type: none"> • ISO modified QM Cryostat • Flight Optical Bench Assembly • CQM FPU/Outer CVV electronic (LOU and BOLA) and CVV instrumentation • CVV inner cryo harness, el. representative • CVV outer cryo-harness, representative • Equipped with CPA (closed CPM) • CVV cover tbd • Avionics Modules: Warm units integrated in a SVM dummy and interconnected with representative harness. (no SVM) • No telescope, no sunshield/sunshade
PFM Integrated Module	<ul style="list-style-type: none"> • Full flight configuration except: <ul style="list-style-type: none"> - CVV cover closed - No Telescope - No sunshield/sunshade
PFM Herschel S/C	<ul style="list-style-type: none"> • Full flight configuration except: <ul style="list-style-type: none"> - CVV cover closed
Facility	
EQM Integrated Module	<ul style="list-style-type: none"> • Cleanroom 100000 • Reference RF/IR sources (if needed)
PFM Integrated Module	<ul style="list-style-type: none"> • Cleanroom 100000 • Reference RF/IR sources (if needed)
PFM Herschel S/C	<ul style="list-style-type: none"> • Cleanr./Anech. Chamber (for RE) • Reference RF/IR sources (tbdtbc)
EMC Tests	
EQM Integrated Module	<ul style="list-style-type: none"> • PLM CE (no test limits) on PLM units, primary power and secondary power • PLM CS on PLM units, primary power • Optional CS on detection cable bundles • Optional CS simulating RS -tbdt • PLM ESD • Optional RS test -tbdt
PFM Integrated Module	<ul style="list-style-type: none"> • PLM CE (no test limits) on PLM units, prim. + sec. PWR • PLM CS on PLM units, prim. PWR • no RE/RS
PFM Herschel S/C	<ul style="list-style-type: none"> • CE in general, inside satellite (no test limits) • RE E- and H-field, 14 kHz to 18 GHz • RS (tbdt PLM configurations)

Fig.4.1-1: EMC Tests and Configurations

5 Verification Matrix

It follows a [first draft](#) of the EMC verification matrix with reference to the requirements in [the EMC specification \[AD2\]](#). The matrix addresses the particular requirement and propose a suitable verification method.

EMC Verification Matrix:

§		Key Words	Applicability				EQM				PFM			
			S/C	Int. Module	CCU		Int. Module	CCU			S/C	Int. Module	CCU	
3.1.1	EMCSYS-000	S/C requirement, general	a									R		
3.1.2	EMCSYS-020	EGSE and MGSE to be designed to meet EMC with S/C	a									R		
3.1.3.1	EMCSYS-030	Radiation from Launch Vehicle	a									R		
3.2.1	EMCSYS-040	6 dB CE/CS margin on S/C level to be demonstrated	a									A		
3.2.2.1.1	EMCSYS050	NB emissions in VEB plane	a									T		
3.2.2.1.1	EMCSYS-052	Measurements at UHF and C-band	a									T		
3.2.2.1.1	EMCSYS-055	Test once with Power supply, once with batterie	a									R		
3.2.2.1.2	EMCSYS-60	NB E-field emissions at 3 points around the cryostat from 14 kHz - 18 GHz	a									R		
3.2.2.2.1	EMCSYS-070	S/C RS E-field 14 kHz - 18 GHz	a									T		
3.2.2.2.2	EMCSYS-075	S/C RS H-field, 30 Hz - 66 kHz	a									T		
3.2.2.2.3	EMCSYS-080	S/C RS test with from three directions, tbd S/C configurations	a									T		
3.2.2.3	EMCSYS-080	CE tests to be done for those areas not already tested on subsystem level.	a	a	a			R	R			R	R	R
3.2.2.3	EMCSYS-92	CE tests on power lines between PCDU and instruments	a	a				T				T	T	
3.2.2.3	EMCSYS-094	Analysis to be run in case of limits exceeding. Approach in agreement with ESA	a	a				A				A	A	
3.2.2.3	EMCSYS-096	CE measurements on TBD linkes between the SM and PM	a									R		
3.2.2.3	EMCSYS-098	Voltage ripple between SVM and PLM structure	a									T		
3.2.3.1	EMCSV-000	The followong SVM tests in First and Planck configuration												
3.2.3.1.1	EMCSV-005	SVM CE												
	EMCSV-010	SVM CE												
	EMCSV-020	SVM CE												
	EMCSV-030	SVM CE												
3.2.3.1.2	EMCSV-040	SVM CS												
3.2.3.2.1	EMCPLM-000	PLM CE towards SVM on primary power lines		a				T					T	
	EMCPLM-010	PLM CE on instruments pre-amps and detector power lines (sec. power)		a				T					T	
3.2.3.2.2	EMCPLM-020	PLM CS on primary power lines (28 V)		a				T					T	

§		Key Words	Applicability				EQM				PFM			
			S/C	Int. Module	CCU		Int. Module	CCU			S/C	Int. Module	CCU	
3.2.3.2.3	EMCPLM-030	PLM RS and CS simulating RS test (TBC)		a				T						
	EMCPLM-040	Detectors for RS test in cold conditions, susceptibility criteria based on detection noise		a				R						
3.2.4.1	EMCEQ-000	General test requirements	a	a	a			R	R			R	R	R
	EMCEQ-010	General test requirements	a	a	a			R	R			R	R	R
	EMCEQ-020	General test requirements	a	a	a			R	R			R	R	R
	EMCEQ-030	General test requirements	a	a	a			R	R			R	R	R
	EMCEQ-040	General test requirements	a	a	a			R	R			R	R	R
	EMCEQ-045	General test requirements	a	a	a			R	R			R	R	R
3.2.4.2	EMCEQ-050	EMC qualification on flight equivalent units	a	a	a			R	R			R	R	R
3.2.4.3	EMCEQ-060	EMC test documentation	a	a	a			R	R			R	R	R
3.2.4.4	EMCEQ-070	Bandwidths	a	a	a			R	R			R	R	R
	EMCEQ-070	Video filtering to be set to the greatest value	a	a	a			R	R			R	R	R
3.2.4.5		All levels given in rms	a	a	a			R	R			R	R	R
3.2.4.6.1.1.1	EMCEQ-100	RE-E-field general			a				T					
3.2.4.6.1.1.2	EMCEQ-120	RE-E-field test methods			a				R					
3.2.4.6.1.1.2	EMCEQ-130	RE-E-field test methods			a				R					
3.2.4.6.1.1.2	EMCEQ-140	RE-E-field test methods			a				R					
3.2.4.6.1.2.1	EMCEQ-150	RE H-field, DC			a				T					
3.2.4.6.1.2.1	EMCEQ-160	RE H-field, DC			a				R					
3.2.4.6.1.2.1	EMCEQ-170	RE H-field, DC			a				R					
3.2.4.6.1.2.2	EMCEQ-180	RE H-field, narrowband			a				T					
3.2.4.6.2.1	EMCEQ-200	RS E-field			a				T					
3.2.4.6.2.1	EMCEQ-210	RS E-field			a				R					
3.2.4.6.2.1	EMCEQ-220	RS E-field			a				R					
3.2.4.6.2.1	EMCEQ-230	RS E-field			a				R					
3.2.4.6.2.1	EMCEQ-240	RS E-field			a				R					
3.2.4.6.2.2	EMCEQ-250	RS H-field AC			a				T					
3.2.4.6.2.2	EMCEQ-260	RS H-field AC			a				R					
3.2.4.6.2.2	EMCEQ-270	RS H-field AC			a				R					
3.2.4.6.2.2	EMCEQ-280	RS H-field, DC			a				T					
3.2.4.7	EMCEQ-300	ESD		a	a				T					
3.2.4.7	EMCEQ-310	ESD Test conditions		a	a			R	R					
3.2.4.7	EMCEQ-320	ESD Test conditions		a	a			R	R					
3.2.4.7	EMCEQ-330	ESD Test conditions		a	a			R	R					
3.2.4.7	EMCEQ-340	ESD Test conditions		a	a			R	R					
3.2.8.8.1.1	EMCPCDU-000	PCDU CE BB												
3.2.4.8.1.2	EMCPCDU-010	PCDU CE single transient event												
3.2.4.8.1.2	EMCPCDU-020	PCDU CE single transient event												
3.2.4.8.1.2	EMCPCDU-030	PCDU CE single transient event												

§		Key Words	Applicability				EQM				PFM			
			S/C	Int. Module	CCU		Int. Module	CCU			S/C	Int. Module	CCU	
3.2.4.8.1.2	EMCPCDU-040	PCDU CE single transient event												
3.2.4.8.1.2	EMCPCDU-050	PCDU CE single transient event												
3.2.4.8.1.2	EMCPCDU-060	PCDU CE single transient event												
3.2.4.8.1.3	EMCPCDU-070	PCDU CE single transient event												
3.2.4.8.1.4	EMCPCDU-080	PCDU CE NB												
3.2.4.8.1.5	EMCPCDU-090	PCDU CE test conditions												
3.2.4.8.2.1	EMCEQ-400	Equipment BB CE diff. mode			a				T					T
3.2.4.8.2.1	EMCEQ-410	Equipment BB CE diff. mode			a				R					R
3.2.4.8.2.2a	EMCEQ-420	Equipment CE narrowband			a				T					T
3.2.4.8.2.2b	EMCEQ-430	Equipment CE narrowband test conditions (e.g. LISN)			a				R					R
	EMCEQ-440	Equipment CE narrowband test conditions (e.g. LISN)			a				R					R
	EMCEQ-450	Equipment CE narrowband test conditions (e.g. LISN)			a				R					R
	EMCEQ-460	Equipment CE narrowband test conditions (e.g. LISN)			a				R					R
3.2.4.8.2.3	EMCEQ-470	Equipment inrush current			a				T					T
3.2.4.8.2.3	EMCEQ-475	Equipment inrush current			a				R					R
3.2.4.8.2.3	EMCEQ-480	Equipment inrush current			a				R					R
3.2.4.8.2.3	EMCEQ-585	Equipment inrush current			a				T					T
3.2.4.8.2.3	EMCEQ-490	Equipment inrush current			a				T					T
3.2.4.8.3	EMCPCDU-100	PCDU CS												
3.2.4.8.3	EMCPCDU-110	PCDU CS												
3.2.4.8.3	EMCPCDU120	PCDU CS												
3.2.4.8.3	EMCPCDU-130	PCDU CS												
3.2.4.8.3	EMCPCDU-140	PCDU CS												
3.2.4.8.4	EMCEQ-500	Equipment and PLM CS			a				T					T
3.2.4.8.4	EMCEQ-510	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-520	Equipment and PLM CS			a				T					T
3.2.4.8.4	EMCEQ-530	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-535	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-540	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-545	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-550	Equipment and PLM CS			a				T					T
3.2.4.8.4	EMCEQ-560	Equipment and PLM CS			a				T					T
3.2.4.8.4	EMCEQ-565	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-570	Equipment and PLM CS			a				T					T
3.2.4.8.4	EMCEQ-580	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-585	Equipment and PLM CS			a				R					R
3.2.4.8.4	EMCEQ-587	Equipment and PLM CS			a				R					R
3.2.4.9.1	EMCEQ-600	General			a				R					R

§		Key Words	Applicability				EQM				PFM			
			S/C	Int. Module	CCU		Int. Module	CCU			S/C	Int. Module	CCU	
3.2.4.9.2	EMCEQ-610	CE Requirements on Signal Lines			a			R					R	
3.2.4.9.2	EMCEQ-620	CE Requirements on Signal Lines			a			R					R	
3.2.4.9.2	EMCEQ-630	CE Requirements on Signal Lines			a			T					T	
3.2.4.9.3	EMCEQ-640	CS Requirements on Signal Lines			a			R					R	
3.2.4.9.3	EMCEQ-650	CS Requirements on Signal Lines			a			T					T	
3.2.4.9.3	EMCEQ-660	CS Requirements on Signal Lines			a			R					R	
3.2.4.9.3	EMCEQ-670	CS Requirements on Signal Lines			a			R					R	
3.2.4.9.3	EMCEQ-680	CS Requirements on Signal Lines			a			R					R	
3.2.4.9.4	EMCEQ-690	CS/CE on MIL Bus			a			R					R	
4.	EMCSYS-100	S/C Testing Conditions	a								R			
4.	EMCSYS-110	S/C Testing Conditions	a								R			
4.	EMCSYS-120	S/C Testing Conditions	a								R			
5.	EMCPLM-100	Module Testing Conditions		a			R					R		
6.	EMCEQ-700	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-705	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-710	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-715	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-720	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-730	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-740	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-745	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-745	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-750	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-755	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-760	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-765	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-770	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-775	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-780	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-785	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-790	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-795	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-800	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-805	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-810	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-815	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-820	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-825	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-830	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-835	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-840	Equipment, S/S Test Cond.			a			R					R	
6.	EMCEQ-845	Equipment, S/S Test Cond.			a			R					R	

§		Key Words	Applicability				EQM			PFM			
			S/C	Int. Module	CCU		Int. Module	CCU		S/C	Int. Module	CCU	
6.	EMCEQ-847	Equipment, S/S Test Cond.			a			R				R	
6.	EMCEQ-850	Equipment, S/S Test Cond.			a			R				R	
6.	EMCEQ-855	Equipment, S/S Test Cond.			a			R				R	
6.	EMCEQ-857	Equipment, S/S Test Cond.			a			R				R	
6.	EMCEQ-860	Equipment, S/S Test Cond.			a			R				R	

Legend:

a: Applicable

A: Verification per Analysis

R: Verification per Review of Document

T: Verification per Test

Int. Module: Integrated Payload Modul

	Name	Dep./Comp.		Name	Dep./Comp.
	Alberti von Mathias Dr.	SM 34		Rühe Wolfgang	ED 6
	Alo Hakan	OTN/IP 35		Runge Axel	OTN/EN 64
	Barlage Bernhard	ED 11		Sachsse Bernt	ED 21
	Bayer Thomas	ED 541		Schäffler Johannes	OTN/EN 64
X	Faas Horst	EA 65	X	Schink Dietmar	ED 422
	Fehringer Alexander	SM 33	X	Schlosser Christian	OTN/EN 64
	Frey Albrecht	ED 422	X	Schwabbauer Paul Dr.	OTN/ED 421
	Grasl Andreas	OTN/EN 64		Schweickert Gunn	SM 34
	Grasshoff Brigitte	ED 521		Stauss Oliver	SM 33
	Hartmann Hans Dr.	ED 422		Steininger Eric	ED 422
X	Hauser Armin	SM 31		Stritter Rene	ED 11
	Hinger Jürgen	SM 31		Suttner Klaus	SM 32
X	Hohn Rüdiger	ED 541		Tenhaeff Dieter	SM 34
X	Hölzle Edgar	ED 421		Thörmer Klaus-Horst Dr.	OTN/ED 65
	Huber Johann	ED 543		Wagner Adalbert	OTN/IP 35
	Hund Walter	SE 76		Wagner Klaus	SM 31
X	Idler Siegmund	ED 432	X	Wietbrock, Walter	ED 521
	Ivány von András	ACE 32		Wöhler Hans	SM 34
	Jahn Gerd Dr.	SM 31		Zipf Ludwig	ACE 32
X	Kalde Clemens	ED 532			
	Kameter Rudolf	OTN/EN 64			
	Kersting Stefan	OTN/EN 63	X	Alcatel	ASPI
	Kettner Bernhard	SM 34	X	ESA/ESTEC	ESA
X	Knoblauch August	ED 531			
	Koelle Markus	ED 533		Instruments:	
X	Kroeker Jürgen	ED 542		MPE (PACS)	MPE
	Kunz Oliver	SM 31		RAL (SPIRE)	RAL
	Lamprecht Ernst	OTN/SM 222		SRON (HIFI)	SRON
X	Lang Jürgen	SE 76			
	Langfermann Michael	ED 541		Subcontractors:	
	Mack Paul	OTN/EN 64		Air Liquide	AIR
	Maier Hans-Ulrich	ED 11		Astrium Sub-Subsyst. &	ASSE
	Mauch Alfred	SM 34		Austrian Aerospace	AAE
	Moritz Konrad Dr.	ED 65		APCO Technologies S. A.	APCO
	Müller Lutz	OTN/EN 64		Astrium GmbH Space Infrastr.	ASIP
	Muhl Eckhard	OTN/EN 64		BOC Edwards	BOCE
	Pastorino Michel	ASPI Resid.		EADS CASA ESPACIO	CASA
	Peitzker Helmut	ED 65		Eurocopter	ECDE
	Peltz Heinz-Willi	SM 33		HTS AG Zürich	HTSZ
	Peters, Gerhard	ED 531		Linde	LIND
	Pietroboni Karin	ED 65		Patria New Technologies Oy	PANT
	Puttlitz Joachim	OTN/EN 64		Phoenix, Volkmarsen	PHOE
	Raupp Helmut	SM 33		Rembe, Brilon	REMB
	Rebholz Reinhold	ED 541		SENER Ingenieria SA	SEN
	Reuß Friedhelm	ED 62			