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DPU/ICU

Derating and Worst Case Analysis

Document Ref: CNR.IFSI.2002TR06

Issue 1


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Acronyms


AD	Architectural Design
ATP	Acceptance Test Plan
AVM	Avionic Model
BSW	Basic SW
CDR	Critical Design Review
CGS	Carlo Gavazzi Space
CIDL	Configuration Item Data List
CSL	Configuration Status List
CNR	Consiglio Nazionale delle Ricerche
CPP	Coordinated Parts Procurement Board
CPU	Control Processing Unit
CDMS	Command and Data Management System
CDMU	Central Data Management Unit
CQM	Cryogenic Qualification Model
DCU	Detector Control Unit
DDD	Detailed Design Document
DPU	Digital Processing Unit
EEPROM	Electrically Erasable Programmable Read Only Memory
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference

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ESA	European Space Agency
FIRST	Far InfraRed and Submillimeter Telescope
HK	HouseKeeping
HW	HardWare
IBDR	Instrument Baseline Design Review
ICD	Interface Control Document
ICDR	Instrument Critical Design Review
ICU	Instrument Control Unit
IHDR	Instrument Hardware Design Review
IFSI	Istituto di Fisica dello Spazio Interplanetario
ISVR	Instrument Science Verification Review
MCU	Mechanism Control Unit
NA	Not Applicable
OBS	On-Board Software
OBSM	On Board Software Management
PA	Product Assurance
PDU	Power Distribution Unit
PROM	Programmable Read Only Memory
PUS	Packet Utilisation Standard
S/C	SpaceCraft
SCC	SpaceCraft Components
SEU	Single Event Upset
SPIRE	Spectral and Photometric Imaging Receiver

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S/S	SubSystem
SPR	Software Problem Report
SSD	Software Specification Document
SVM	Service Module
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TV	Thermal Vacuum
WBS	Work Breakdown Structure
WCA	Worst Case Analysis

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1 SCOPE

The Istituto di Fisica per lo Spazio Interplanetario (IFSI) of the Italian Consiglio Nazionale delle Ricerche (CNR) is responsible for the design and manufacturing of the three Digital Processing Units/Instrument Control Unit for the three instruments to be flown on board of the ESA satellite Herschel (ex FIRST): HIFI, PAX and SPIRE.

The purpose of this document is to assess the derating concepts used during the design of the DPU/ICU.

The design, manufacturing, electrical and functional tests of the ICU boards and the Basic Software in PROM, are implemented by Carlo Gavazzi Space under a contract with ASI. IFSI is responsible of the mechanical box, the box connectors, the electrical-mechanical integration, the environmental tests and the On Board Software.

It has to be noted that all DPU electronic components will be purchased through the Co-ordinated Parts Procurement Agency set up by ESA and contracted to Tecnologica (Sevilla, Spain) and TOP-REL (Rome, Italy).

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2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD	Name
01	Herschel/Planck Instrument Interface Document, part A
02	Herschel/Planck Instrument Interface Document, part B, Instrument PACS
03	Herschel/Planck Instrument Interface Document, part B Instrument HIFI
04	Herschel/Planck Instrument Interface Document, part B Instrument SPIRE
05	DPU/ICU PA Plan
06	PACS PA Plan
07	HIFI PA Plan
08	SPIRE PA Plan

2.2 Reference documents

Reference Document	Name
01	Derating Requirements Applicable to Electronic, Electrical and Electro-mechanical Components for ESA Space Systems (ESA PSS-01-301)
02	PACS FMECA
03	HIFI FMECA
04	SPIRE FMECA
05	PAD for CGS made inductors
06	PAD for CGS made transformers
07	RFA for CGS made inductors
08	RFA for CGS made transformers

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3 Analysis of the “internal” electronics

For “internal electronics” it is meant all the electronics of the following boards, excluding the electrical interfaces with the spacecraft that will be dealt with in the following section:

- CPU board
- I/F board
- DC/DC Converter Board
- Motherboard.

According to a general statement in the contract ASI-CGS, all design activities are in agreement with the ESA applicable directives, e.g. as per REF 01.

3.1 CPU Board Derating

TBW

3.2 I/F Board Derating


TBW

3.3 DC/DC Converter Board Derating

TBW

3.4 Motherboard Derating

The Motherboard is purely passive and there is no derating analysis to be applied, as the PCB itself will be designed and manufactured according to ESA approved Flight quality rules both for the materials and for the technology design rules.

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4 Analysis of the interfaces with the spacecraft

The interfaces of the DPU/ICU with the spacecraft are:

- mechanical,
- thermal
- electrical.

Only the electrical interfaces will be dealt with in the following and these can be splinted in two:

- Power interface
- Telemetry and Telecommand interface.

4.1 Power interface derating and Worst Case Analysis

The DPU/ICU power interface with the spacecraft is shown in the following figure.


It is to be recalled that in a single DPU/ICU box there will be two completely separated units with one ON while the other is in cold redundancy state. The spacecraft decides which unit is ON, while the other is OFF in cold redundancy, by powering it via the 28 V lines.

The interfaces with the S/C power system are:

- a) the wires from the spacecraft PDU to DPU/ICU connector(s);
 - b) the power connector pins;
 - c) the common mode transformer located in the DC/DC converter board.
- a) The wires from the PDU to DPU/ICU are not considered here as they are S/C provided.
 - b) There are 2 power connector pins for +28 V and 2 power connector pins for 28 V return. The maximum steady current is less than 1 A for PACS and SPIRE and less than 2 A for HIFI, when HIFI is fully operational. The 2 pins are well beyond the 50% required derating as each connector pin is rated 5 A.

WCA: no degradation is foreseen for the Worst Case Analysis for the connectors components characteristics (section 3.6, page 11 of REF 01).

- c) The common mode transformer is designed in agreement with REF 01 with respect to:
 - the voltage applied, to be considered for insulation properties (REF 06 and 08);
 - the current flowing, to be considered for the transformer core selection and wire gauge selection (REF 06 and 08).

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WCA: : no degradation is foreseen for the Worst Case Analysis for transformers, chokes, coils, motor windings components characteristics (section 3.3, page 8 of REF 01).



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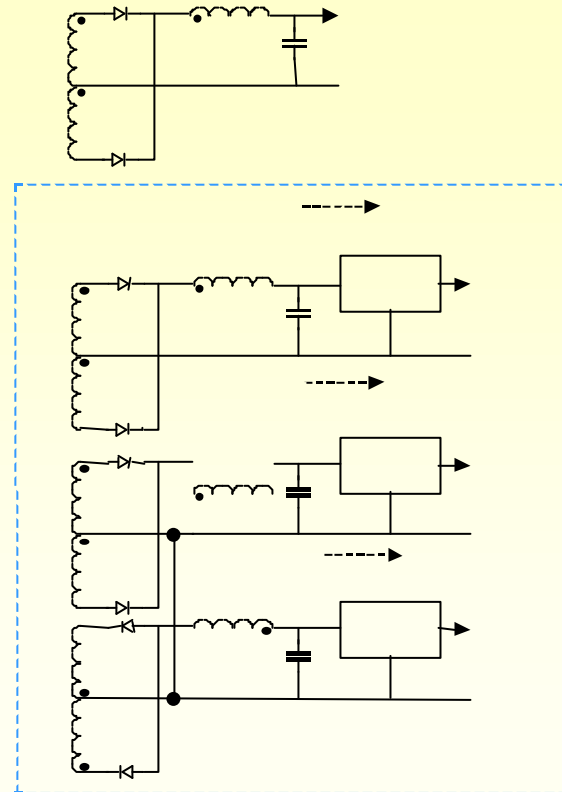
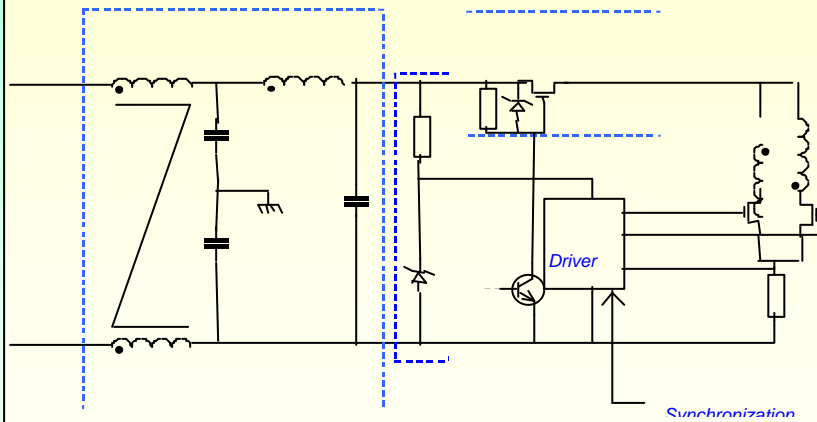
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Redundant Section

Main Section

↑ Current mode control
(simple dynamic
behaviour)



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4.2 Spacecraft Interface Derating and Worst Case Analysis

In the following figure the spacecraft interface circuitry is shown as part of the interface board. The interface is based on the MIL STD 1553B, that is on the spacecraft side (acting as Bus Controller) there is a bus on which are serially transmitted telecommands and serially received the telemetry from the instruments (acting as Remote Terminals).

The chosen configuration is “long stub” and the electrical interface is implemented via a suitable transformer. It is to be noted that there are a Prime (“A”) and Redundant (B”) connections to the Prime CDMS, and the same applies for the Redundant CDMS and the Redundant DPU/ICU.

The transformers used to interface with the spacecraft 1553B bus are purchased via the Co-ordinated Parts Procurement Agency (types HLP6002) and thus they have to be considered “passed” as far as the derating criteria are concerned.

WCA: this interface has to be considered compliant not only because the transformers are purchased via the Co-ordinated Parts Procurement Agency, but also because no degradation is foreseen for the Worst Case Analysis for transformers, chokes, coils, motor windings components characteristics (section 3.3, page 8 of REF 01).



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