**EChO instrument**

**Experiment Interface Document – Part B**

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# Document Scope & Objectives

The EID documentation consists of one EID-A and one EID-B.

The purpose of the EID documentation is to ensure that:

* The Principal Investigator (hereafter PI) design, procure, build, qualify, test and calibrate their instrument in line with the technical and programmatic requirements and constraints defined in the EID-A
* The EChO spacecraft (hereafter SC) Prime Contractor designs, builds and verifies the SC such that the instruments can be successfully integrated and tested into the system, in-line with the instrument interface definitions and resources provided in the EID-Bs.

**EID-A:** The EID-A, together with its Applicable Documents, defines the interface, the design, the operational, the verification, the management and the programmatic requirements applicable to the instrument.

**EID-B:** The EID-B, in response to the instrument technical requirements of the EID-A, specifies in detail the instrument interface information. The EID-B is the formal Interface Control Document (hereafter ICD) between the instrument and the spacecraft. Also, the EID-B defines the specific programmatic agreements between the ESA Project Office and the Principal Investigator.

The EID-B will also include all specific instrument requirements applicable to the platform. These requirements will be declared in the relevant technical sections of the document. In the case of requirements directly derived from science performance requirements, supporting text to these requirements describes the link back to the relevant requirement in the SciRD, and/or supporting design/analysis documentation that justifies the requirement.

Once the EID-A and the EID-B have reached a satisfactory level of maturity, they will be placed under formal configuration and change control. The documentation tree for the top ESA requirements is shown in Figure 1.

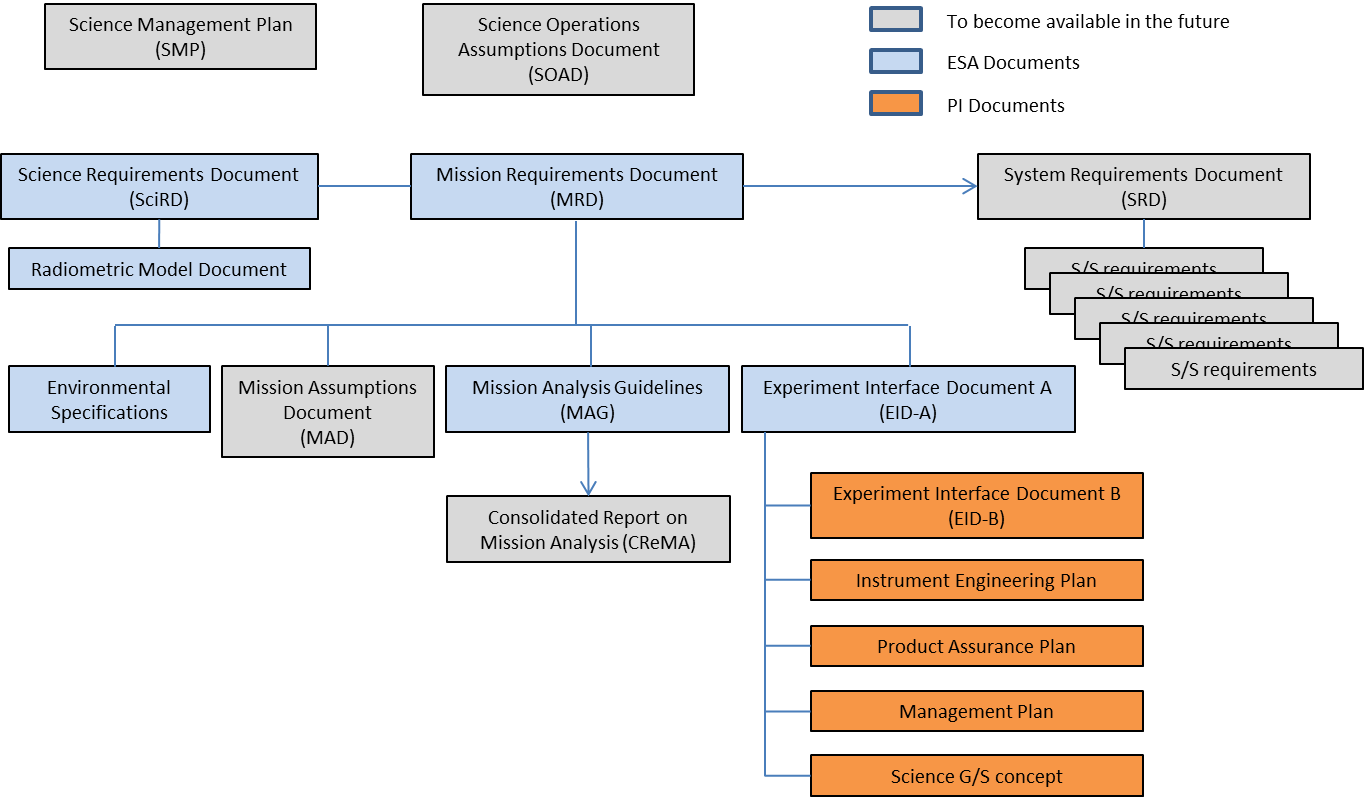


Figure : Top ESA Documents Tree

## Conventions

All requirements in this document are to be written in normal text, identified by a **unique** identifier with the following format **EIDB-R XXXX.**

e.g. a requirement will appear in the following form:

**EIDB-R-1230** The platform shall ensure…

*Notes to authors:*

*The unique identifier ascribed to the requirement must be maintained throughout the lifetime of the EID-B and must never be re-allocated to another requirement. For example requirements must never be re-numbered to keep them in sequence as a result of changes in document order.*

*The author is directed to chapter 8 of ECSS-E-ST-10-06C ‘Space engineering: Technical requirements specification’ for guidance on the writing of technical specifications. A synthesised guide is provided here.*

*Well written requirements have the following characteristics – they are:*

* ***Described in quantifiable terms***
* ***Justified:*** *in the case of this document, i*t is required that requirements related to science performance are supported by supporting text to these requirements describes the link back to the relevant requirement in the SciRD, and/or supporting design/analysis documentation that justifies the requirement
* ***Unique***
* ***Identifiable***
* ***Singular:*** *i.e. they are separately stated*
* ***Complete:*** *i.e. they are self-contained*
* ***Tolerance specified:*** *The range of values which represents conformity for each specified parameter should be provided.*

*The required verbal form:*

*The verbal form “shall” shall be used whenever a provision is a requirement.*

*The verbal form “should” shall be used whenever a provision is a recommendation.*

*The verbal form “may” shall be used whenever a provision is a permission.*

*The verbal form “can” shall be used to indicate possibility or capability.*

*List of terms that* ***shall not be used*** *in a TS requirement:*

*“and/or”,*

*“etc.”,*

*“goal”,*

*“shall be included but not limited to”,*

*“relevant”,*

*“necessary”,*

*“appropriate”,*

*“as far as possible”,*

*“optimize”,*

*“minimize”,*

*“maximize”,*

*“typical”,*

*“rapid”,*

*“user‐friendly”,*

*“easy”,*

*“sufficient”,*

*“enough”,*

*“suitable”,*

*“satisfactory”,*

*“adequate”,*

*“quick”,*

*“first rate”,*

*“best possible”,*

*“great”,*

*“small”,*

*“large”,*

*“state of the art”.*

*Example Requirements and justification related to the need for a purging system:*

*------------------------------------------------------------------------------------------------*

***EIDB-R-1230*** *The prime contractor shall ensure after instrument delivery almost continuous purging of the structural housing with clean and dry nitrogen gas until launch. The longest duration without purging shall be limited to TBD minutes per any 24 hours. For the purging to be interrupted, the external environment shall be equivalent to ISO class 8 with a relative humidity of 55 ± 10%.*

***EIDB-R-1240*** *The Prime Contractor shall purge the instrument, after delivery, with gas quality grade 5.0, i.e., 99.999% vol N2, 2 vpm O2, 3 vpm H2O, 0.1 vpm hydrocarbons. Synthetic air of the same quality may be used. Before delivery, gas quality used will be Grade 6.0 (or BIP 5.2).*

***EIDB-R-1250*** *The minimum flow rate of the purging system shall be 0.5 litres/hour.*

***EIDB-R-1260*** *The purge shall be maintained with a log of all purge interruptions.*

*Note: requirements* ***EIDB-R-1230, 1240, 1250*** *&* ***1260*** *support the objective of maintaining the cleanliness of the detectors to XXXX g/cm2 until launch, which is turn supports the instrument performance to allow satisfaction of SciRD requirements* ***SCI-R-020, SCI-R-030*** *– see [RDXX] ‘detector cleanliness requirement analysis’, and [RDXX] ‘purging system sizing’.*

*------------------------------------------------------------------------------------------------*

# Applicable and reference documents

## Applicable Documents

Applicable Documents [ADs] are applicable in their entirety or to the extent called up in individual sections of this document and are listed below as dated or undated references. These may be cited at appropriate places in the text of the EID-B.

Ref. No. Document

1. EChO Experiment Interface Document – Part A
2. ECSS-E-30 Part 1A
3. …

*Notes to authors: Tailor for the particular instrument in question.*

## Reference Documents

Reference documents [RDs] contain supplementary information about the mission and related issues. They do not contain directly applicable requirements. However, clauses of reference documents may have been copied directly, or modified, into Applicable Documents, through which these clauses are then applicable.

The following documents as of the current issue, as indicated or most recent in the event of updates, are possible sources of clarification for the content of the EID-B.

Ref. No. Document

* + 1. EChO Payload Definition Document, issue 2.3, July 2012.
    2. …
    3. …

*Notes to authors: Tailor for the particular instrument in question.*

# Acronyms

*Notes to authors: Tailor for the particular instrument in question.*

|  |  |
| --- | --- |
| ABCL | As Built Configuration List |
| AC | Alternating Current |
| AFT | Abbreviated Functional Test |
| AIT | Assembly, Integration and Test |
| AIV | Assembly, Integration and Verification |
| AKE | Attitude Knowledge Error |
| AOCS | Attitude and Orbit Control System |
| APE | Absolute Pointing Error |
| APS | Active Pixel Sensor |
| ASIC | Application Specific Integrated Circuit |
| AVM | Avionics Validation Model |
| BOL | Beginning of Life |
| CCB | Configuration Control Board |
| CCD | Charge Coupled device |
| CCSDS | Consultative Committee for Space Data Systems |
| CE | Cold Element |
| CoG | Centre of Gravity |
| CIDL | Configuration Item Data List |
| CoM | Centre of Mass |
| CPU | Central Processing Unit |
| DC | Direct Current |
| DCL | Declared Part list |
| DDV | Design Development Validation |
| DMS | Data Management System |
| DPU | Digital Processing Unit |
| DTMM | Detailed Thermal Model |
| ECR | Engineering Change Request |
| ECSS | European Cooperation for Space Standardization |
| EGSE | Electrical Ground Support Equipment |
| EID | Experiment Interface Document |
| EIDP | End Item Data Package |
| EGSE | Electrical Ground Support Equipment |
| ELDRS | Enhanced Low Dose rate Sensitivity |
| EMC | Electromagnetic Cleanliness/Compatibility |
| EMI | Electromagnetic Interference |
| EOL | End of Life |
| EPS | Electrical Power Subsystem |
| EQM | Electrical Qualification Model |
| ESD | Electro-Static Discharge |
| EUV | Extreme Ultra-Violet |
| FDIR | Failure Detection Isolation and Recovery |
| FEE | Front End Electronics |
| FEM | Finite Element Model |
| FFT | Full Functional Test |
| FM | Flight Model |
| FMEA | Failure Modes, Effects Analysis |
| FoR | Field of Regard |
| FOSY | Factor of Safety - Yield |
| FOSU  FOV, FoV | Factor of Safety - Ultimate  Field of View |
| FS | Flight Spare |
| GSE | Ground Support Equipment |
| HE | Hot Element |
| HSIA | Hardware Software Interaction Analysis |
| HV-HPC | High Voltage High power Pulse Commanl |
| H/W | Hardware |
| ICDR | Instrument Critical Design Review |
| ILS | Instrument Line of Sight |
| I/O | Input/Output |
| IPDR | Instrument Preliminary Design Review |
| IR | Infra Red |
| KIP/MIP | Key/Major inspection point |
| LEOP | Launch and Early Orbit Phase |
| LET | Linear Energy Transfer |
| LCL | Latching Current Limiters |
| LISN | Line Impedance Stabilization Network |
| LOS | Line Of Sight |
| MCU | Multiple cell upset |
| MGA | Medium Gain Antenna |
| MGSE | Mechanical Ground Support Equipment |
| MICD | Mechanical Interface Control Document |
| MLI | Multi Layer Insulation |
| MOC | Mission Operations Centre |
| MOS | Metal Oxide Semiconductor |
| MTL | Mission Time Line |
| NCR | Non-Conformance Report |
| NIEL | Non-Ionizing Energy Loss |
| OBC | On Board Computer |
| PA | Product Assurance |
| PDE | Pointing Drift Error |
| PCDU | Power Conditioning and Distribution Unit |
| PI | Principal Investigator |
| PS | Project Scientist |
| QA | Quality Assurance |
| QM | Qualification Model |
| RADLAT | Radiation Loat Acceptance Testing |
| RDM | Radiation Design Margin |
| RF | Radio Frequency |
| RFW | Request for Waivers |
| RHA | Radiation Hardness Assurance |
| RMS | Radiated Magnetic Susceptibility |
| RPE | Relative Pointing Error |
| RTU | Remote Terminal Unit |
| RVT | Radiation Verification Testing |
| S/C | Spacecraft |
| SEB | Single Event Burnout |
| SEDR | Single Event Dielectric Rupture |
| SEE | Single Event Effect |
| SEL | Single Event Latch-up |
| SEU | Single Event Upset |
| SEFI | Single Event Functional Interrupt |
| SEGR | Single Event Gate Rupture |
| SET | Single Event Transient |
| SMM | Structural Mathematical Model |
| SOC | Science Operations Centre |
| SpW | Space Wire |
| SRDB | System Requirement database |
| SRP | System Reference Point |
| SSMM | Solid State Mass Memory |
| STM | Structural Thermal Model |
| SVT | System Verification Test |
| SWT | Science Working Team |
| TBC | To Be Confirmed |
| TBD | To Be Determined |
| TC/ TM | Telecommand / Telemetry |
| TID | Total Ionizing Dose |
| TIDL | Total Ionizing Dose Level |
| TIDS | Total Ionizing Dose Sensitivity |
| TNIDL | Total Non Ionizing Dose Level |
| TNIDS | Total Non Ionizing Dose Sensitivity |
| TCM | Trajectory Control Manoeuvre |
| TCS | Thermal Control System |
| TM | Telemetry |
| UFOV, UFoV | Unobscured Field of View |
| URF | Unit Reference Frame |
| URP | Unit Reference Point |
| UV | Ultra-Violet |
| WBS | Work Breakdown Structure |
| WCA | Worst case analysis |

# Key Personnel and Points of Contact

*Notes to authors: Please provide a list of key personnel, their institutes and relevant responsibilities.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Role** | **Person** | **Institute** | **Contact Information** |
|  |  |  |  |
|  |  |  |  |

Table : Key personnel

# INSTRUMENT DESCRIPTION

## Scientific Objective

*Notes to authors: Please restrict this section to a maximum of 1 page.*

## Scientific Performance Summary

*Notes to authors: Please restrict this section to a maximum of 2 pages.*

## Instrument Description

*Notes to authors: This should be a condensed synthesis of the information contained in the Instrument Design Report. Only enter into a level of detail that is supportive of the goal of the document, which is I/F definition.*

### Functional Description

*To be completed by the PI.*

### Hardware Description

*To be completed by the PI.*

### Software Description

*To be completed by the PI.*

### Instrument performance budgets

*To be completed by the PI. This chapter should include as a minimum the Noise budget and throughput + QE budget of the optical and detection chain*

# Instrument Design and interface

*Notes to authors: In this chapter the PI shall:*

* *state compliance with the EID-A design and interface requirements*
* *provide detailed interface definition*
* *specify, using a unique identifier, the requirements of the instrument onto the SC.*

*Accordingly, in order to ease the preparation of the EID-B, the document structure mirrors more-or-less exactly that of the EID-A.*

## General Design

### HW Identification and Labelling

*To be completed by the PI.*

### Standard Metric System

*To be completed by the PI.*

### Lifetime

*To be completed by the PI.*

### Maintainability

*To be completed by the PI.*

### Single Point Failure

*To be completed by the PI.*

### Fault tolerance

*To be completed by the PI.*

### Venting

*To be completed by the PI.*

## Co-ordinate system

*To be completed by the PI*

### Unit co-ordinate system

*To be completed by the PI.*

## Alignment, Pointing and Straylight

### Instrument Alignment & Location

*To be completed by the PI.*

### Instrument pointing

*To be completed by the PI*

### Straylight

*To be completed by the PI.*

## Mechanical Interface and Design

*To be completed by the PI.*

### Mechanical Interface Control Drawings

*To be completed by the PI.*

*Note to author: It is anticipated that this section will reference an appendix or a separate document containing the MICD, and will be restricted to a list of the instrument MICDs only.*

### Mass

*To be completed by the PI.*

### Centre of Mass

*To be completed by the PI.*

### Moments of Inertia

*To be completed by the PI.*

### Unit Dimensions

*To be completed by the PI*

### Mounting

*To be completed by the PI.*

### Aperture covers

*To be completed by the PI.*

### Structural Design

*To be completed by the PI.*

### Mechanisms

*To be completed by the PI.*

### Mechanical environment

*To be completed by the PI.*

### Accommodation and mechanical interfaces

*To be completed by the PI.*

## Optical interfaces

*Note: chapter 4.5 in the EID-A is already tailored to EchO*

## Fine Guidance Sensor

*Note: chapter 4.6 in the EID-A is already tailored to EchO*

## Thermal Interface and Design

*Note: chapter 4.7 in the EID-A is already tailored to EchO*

### Definitions

*To be completed by the PI.*

### Thermal Control Margins

*To be completed by the PI.*

### Thermal Control responsibilities

*To be completed by the PI.*

### Thermal Design

*To be completed by the PI.*

### Thermal hardware interfaces

*To be completed by the PI.*

### Thermal interface

*To be completed by the PI.*

### Environment

*To be completed by the PI.*

## Electrical Interface and Design

### Power Generation and distribution

*To be completed by the PI.*

### Instrument power supply

*To be completed by the PI.*

### Power interface

*To be completed by the PI.*

## Data Management Interface and Design

### General

*To be completed by the PI.*

### Instrument Commanding

*To be completed by the PI.*

### Instrument Telemetry

*To be completed by the PI.*

### On-board Time Distribution

*To be completed by the PI.*

### Solid State Mass Memory

*To be completed by the PI.*

### Electrical Interfaces and Redundancy

*To be completed by the PI.*

### Spacewire interface

*To be completed by the PI.*

### 1553 Bus

*To be completed by the PI.*

### Discrete Signals

*To be completed by the PI.*

## Software Design and Interface

### Software Design

*To be completed by the PI.*

### Software Implementation

*To be completed by the PI.*

### Instrument Autonomy and FDIR

*To be completed by the PI.*

## Electromagnetic Design and Interface

*To be completed by the PI.*

### General Concept

*To be completed by the PI.*

### General EMC

*To be completed by the PI.*

### Unit EMC

*To be completed by the PI.*

### Magnetic cleanliness

*To be completed by the PI.*

## Instrument Handling

*To be completed by the PI.*

### Transport Container

*To be completed by the PI.*

### Cleanliness

*To be completed by the PI.*

### Physical Handling

*To be completed by the PI.*

## Mission Environment

*To be completed by the PI.*

### Radiation Environment

*To be completed by the PI.*

### Charging

*To be completed by the PI.*

### Cleanliness

*To be completed by the PI.*

### Micrometeorite Environment

*To be completed by the PI.*

# Ground segment and mission Operations

*Note to authors: To be completed by the PI. In this chapter, the PI shall state compliance with the ground segment and mission operations requirements as well as provide detailed description of the instrument operation.*

## Ground segment

*To be completed by the PI and to include summary description of the science ground segment.*

## Instrument operation

*To be completed by the PI.*

## Instrument data products (telemetry, HK…)

*To be completed by the PI.*

## Testing, training and simulation

*To be completed by the PI.*

## Instrument documentation and data inputs

*To be completed by the PI.*

# Instrument verification

## Definitions

## Verification concept and methods

*To be completed by the PI, and to include calibration activities.*

## Mathematical models

*To be completed by the PI with a summary description of the relevant mathematical models. This section will also include any applicable instrument performance model/s.*

*Note to authors: it is anticipated that these will be detailed in a separate PI-document, and reference to that document shall be made here. For the AO only a synthesis is expected.*

## Testing

*To be completed by the PI.*

## HW inspections

## Final acceptance

## System level AIT

*To be completed by the PI.*

# Instrument PA plan

*Note to authors: it is anticipated that this will be detailed in a separate PI-document will be provided later, and reference to that document shall be made here. For the AO only a synthesis is expected.*

# Management Plan

*Note to authors: it is anticipated that this will be detailed in a separate PI-document, and reference to that document shall be made here. For the AO only a synthesis is expected.*

# Instrument SUMMARY SHEET

*Notes to authors: Please restrict this section to a maximum of 1 page.*

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| Scientific goal summary | N/A |  |
| Scientific performance summary | N/A |  |
| Key instrument numbers | N/A | Focal length, aperture, frequency range, wavelength range…. |
| Number of units | N/A | Clear identification of all units with main functions |
| Mass | Kg | Individual mass of each unit and total mass |
| Power | W | Individual power of each unit and total power |
| Volume | m x m x m | Individual volume of each unit. |
| Accommodation key issues | N/A |  |
| Operation | N/A | Short description of the operational modes of the instrument |
| Instrument view | N/A | Provide a drawing showing the present configuration of the instrument. |

**ANNEX Performance budget and instrument requirements**

The purpose of this section is to start as early as possible the definition of a robust requirement flow down, from science and mission level down to instrument and platform, as part of the overall system engineering work to be performed during the project life cycle (see EID-A section 8.2.5).

The proposer shall list in this annex the instrument performance requirements applied to the instrument design. For each instrument performance requirement, the following shall be provided in a tabular format:

- Parent requirement in the Mission or Science Requirements Document (unless created requirement).

- Justification of any budget from system level performance down to instrument and spacecraft performances. For example if a system PSF (Point Spread Function) performance is considered in the MRD, the proposer shall provide the assumed S/C contributions (e.g. as provided in the EID-A) and the resulting requirement expected on the instrument PSF. In case the apportionment cannot be made, a way forward shall be proposed.

- Resulting requirements at instrument level.

|  |  |  |
| --- | --- | --- |
| Inst. Req. Id | MRD parent requirement (s) | Budget justification |
| INST-R-XXX | MRD-R-YYY |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |