



# ROSETTA

## Technical Note

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 1 of 76

Title:

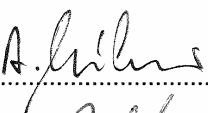
### COORDINATE SYSTEMS FOR ROSETTA

CI-No. :

DRL-No. :

Model :

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Doc. No: RO-DSS-TN-1081

Issue : 6d

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Sheet: 2

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Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 3

## DOCUMENT UPDATES

|    |            |                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|----|------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1  | 25.05.2000 | all                                                                              | First issue                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| 2  | 26.10.2000 | §1<br>§2<br>§7<br>§8<br>§10.7<br>§109<br>§11<br>§11.2<br>§11.3<br>§11.4<br>§11.5 | Document completely revised<br>Update of Scope<br>Reference Documents added<br>Definitions extended<br>New HGA data added<br>SAS chapter new defined, SAS-1,2 swapped!<br>NAVCAM Unit A and B swapped!<br>SSP new implemented<br>MGA-S new<br>MGA-X new<br>LGA-1 new<br>LGA-2 new                                                                                                                                                                                                                                                                                                 |  |
| 3  | 29.11.2000 | §11.1.1<br>§11.1.2<br>§11.2.4<br>§11.2.5<br>§11.4<br>§12.1<br>§12.4<br>§12.5     | Yu-axes are in the Xsc Zsc plane<br>Figure IMU-A completed. Directions of IMU-A reference axis corrected.<br>Figure SAS-3 unit system: Panel definition adjusted. Position and Direction parameter names adjusted.<br>Figure SAS-4 unit system: Panel definition adjusted. Position and Direction parameter names adjusted.<br>Figure NAVCAM overview: Names of unit axes adjusted.<br>Figure Lander unit system: Direction of Xsc swapped. Position and direction of SSP adjusted.<br>Direction of LGA-1 boresight axes adjusted.<br>Direction of LGA-2 boresight axes adjusted. |  |
| 4  | 28.02.2001 | all<br><br>all<br><br>all<br>§8.4                                                | Transformations from the unit mirror frames to the S/C frame added.<br>Transformations from unit functional frames to the mirror frames added.<br>Measured unit frames (misalignments) removed.<br>Xsc of HGAROT1 attachment point adjusted.                                                                                                                                                                                                                                                                                                                                      |  |
| 5  | 20.12.2001 | § 8.2.1                                                                          | Table T_ and Query Q_ renamed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| 6  | 18.01.2002 | 20<br>28<br>32<br>46<br><br>64<br>79                                             | Direction cosines corrected.<br>HGAROT2 attachment point corrected.<br>RW direction cosines corrected.<br>AST-SAS axis set definition taken out; they use same definition.<br>missing direction cosine added.<br>bookmark error removed.                                                                                                                                                                                                                                                                                                                                          |  |
| 6a | 19.04.2002 | 7<br><br>19<br>30<br>34 - 78                                                     | Description of the relation between the "Q_unit_ALIGN" tables and the data source tables "T_".<br>Q_UL_SA replaced by Q_UL_SA_PERF.<br>Old query name corrected by Q_SAT_RW_ALIGN.<br>Alignment queries renamed by Q_SAT_unit_ALIGN.                                                                                                                                                                                                                                                                                                                                              |  |
| 6b | 16.05.2002 | All                                                                              | Removal of many typographical and "cut and paste" errors.<br>The significant changes are highlighted in yellow.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| 6c | 21.10.2002 | See change bars                                                                  | References to the Rosetta Flight Dynamics Database updated;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| 6d | 17.09.2003 | 61, 64-65                                                                        | Modification of STR-B Orientation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |



## TABLE OF CONTENTS

|                                                                         |    |
|-------------------------------------------------------------------------|----|
| 1. <u>SCOPE</u> .....                                                   | 9  |
| 2. <u>APPLICABLE DOCUMENTS</u> .....                                    | 9  |
| 3. <u>REFERENCE DOCUMENTS</u> .....                                     | 9  |
| 4. <u>ACRONYMS</u> .....                                                | 10 |
| 5. <u>ABBREVIATIONS</u> .....                                           | 10 |
| 6. <u>PARAMETER NAME DEFINITION IN THE RFDDB</u> .....                  | 10 |
| 7. <u>DEFINITIONS</u> .....                                             | 11 |
| 7.1 TRANSFORMATION MATRIX .....                                         | 11 |
| 7.2 SPACECRAFT MECHANICAL AXES ( $X_{SC}$ , $Y_{SC}$ , $Z_{SC}$ ) ..... | 11 |
| 7.3 UNIT MECHANICAL AXES ( $X_U$ , $Y_U$ , $Z_U$ ) .....                | 12 |
| 7.4 DIRECTION COSINE MATRIX .....                                       | 12 |
| 7.5 UNITS AND FRAMES .....                                              | 12 |
| 7.5.1 <u>General</u> .....                                              | 12 |
| 7.5.2 <u>Units overview</u> .....                                       | 13 |
| 8. <u>RELEVANT GEOMETRICAL UNITS</u> .....                              | 14 |
| 8.1 CENTRAL BODY .....                                                  | 14 |
| 8.1.1 <u>General description</u> .....                                  | 14 |
| 8.1.2 <u>Coordinate systems</u> .....                                   | 14 |
| 8.2 SOLAR ARRAY +Y .....                                                | 15 |
| 8.2.1 <u>General description</u> .....                                  | 15 |
| 8.2.2 <u>Coordinate systems</u> .....                                   | 15 |
| 8.2.3 <u>Parameters</u> .....                                           | 16 |
| 8.2.4 <u>Variables</u> .....                                            | 17 |
| 8.3 SOLAR ARRAY -Y .....                                                | 18 |
| 8.3.1 <u>General description</u> .....                                  | 18 |
| 8.3.2 <u>Coordinate systems</u> .....                                   | 18 |
| 8.3.3 <u>Parameters</u> .....                                           | 19 |
| 8.3.4 <u>Variables</u> .....                                            | 20 |



|        |                                            |    |
|--------|--------------------------------------------|----|
| 8.4    | HGAROT1 .....                              | 21 |
| 8.4.1  | <u>Introduction</u> .....                  | 21 |
| 8.4.2  | <u>General description</u> .....           | 22 |
| 8.4.3  | <u>Coordinate systems</u> .....            | 22 |
| 8.4.4  | <u>Parameters</u> .....                    | 23 |
| 8.4.5  | <u>Variables</u> .....                     | 24 |
| 8.5    | HGAROT2 .....                              | 25 |
| 8.5.1  | <u>Introduction</u> .....                  | 25 |
| 8.5.2  | <u>General description</u> .....           | 25 |
| 8.5.3  | <u>Coordinate systems</u> .....            | 25 |
| 8.5.4  | <u>Parameters</u> .....                    | 26 |
| 8.5.5  | <u>Variables</u> .....                     | 27 |
| 8.6    | CORNER POINT POSITIONS .....               | 28 |
| 9.     | <u>ACTUATORS</u> .....                     | 29 |
| 9.1    | REACTION WHEELS .....                      | 29 |
| 9.1.1  | <u>Introduction</u> .....                  | 29 |
| 9.1.2  | <u>General description</u> .....           | 29 |
| 9.1.3  | <u>Parameters</u> .....                    | 31 |
| 9.2    | REACTION CONTROL SYSTEM (THRUSTERS) .....  | 32 |
| 9.2.1  | <u>Introduction</u> .....                  | 32 |
| 9.2.2  | <u>General description</u> .....           | 32 |
| 9.2.3  | <u>Parameters</u> .....                    | 34 |
| 10.    | <u>PAYLOAD UNIT REFERENCE FRAMES</u> ..... | 35 |
| 10.1   | ALICE .....                                | 35 |
| 10.1.1 | <u>General description</u> .....           | 35 |
| 10.1.2 | <u>Coordinate systems</u> .....            | 35 |
| 10.1.3 | <u>Parameters</u> .....                    | 36 |
| 10.2   | MIRO .....                                 | 37 |
| 10.2.1 | <u>General description</u> .....           | 37 |
| 10.2.2 | <u>Coordinate systems</u> .....            | 37 |
| 10.2.3 | <u>Parameters</u> .....                    | 38 |
| 10.3   | OSIRIS-NAC .....                           | 39 |
| 10.3.1 | <u>General description</u> .....           | 39 |
| 10.3.2 | <u>Coordinate systems</u> .....            | 39 |
| 10.3.3 | <u>Parameters</u> .....                    | 40 |
| 10.4   | OSIRIS-WAC .....                           | 41 |
| 10.4.1 | <u>General description</u> .....           | 41 |
| 10.4.2 | <u>Coordinate systems</u> .....            | 41 |
| 10.4.3 | <u>Parameters</u> .....                    | 42 |



|             |                                            |           |
|-------------|--------------------------------------------|-----------|
| <b>10.5</b> | <b>VIRTIS</b>                              | <b>43</b> |
| 10.5.1      | <u>General description</u>                 | 43        |
| 10.5.2      | <u>Coordinate systems</u>                  | 43        |
| 10.5.3      | <u>Parameters</u>                          | 44        |
| <b>11.</b>  | <b><u>SENSOR UNIT REFERENCE FRAMES</u></b> | <b>45</b> |
| <b>11.1</b> | <b>IMU ASSEMBLY</b>                        | <b>45</b> |
| 11.1.1      | <u>Introduction</u>                        | 45        |
| 11.1.2      | <u>IMU-A</u>                               | 46        |
| 11.1.2.1    | General description                        | 46        |
| 11.1.2.2    | Coordinate systems                         | 46        |
| 11.1.2.3    | Parameters                                 | 47        |
| 11.1.3      | <u>IMU-B</u>                               | 48        |
| 11.1.3.1    | General description                        | 48        |
| 11.1.3.2    | Coordinate systems                         | 48        |
| 11.1.3.3    | Parameters                                 | 49        |
| 11.1.4      | <u>IMU-C</u>                               | 50        |
| 11.1.4.1    | General description                        | 50        |
| 11.1.4.2    | Coordinate systems                         | 50        |
| 11.1.4.3    | Parameters                                 | 51        |
| <b>11.2</b> | <b>SAS</b>                                 | <b>52</b> |
| 11.2.1      | <u>Introduction</u>                        | 52        |
| 11.2.2      | <u>SAS-1</u>                               | 53        |
| 11.2.2.1    | General description                        | 53        |
| 11.2.2.2    | Coordinate systems                         | 53        |
| 11.2.2.3    | Parameters                                 | 54        |
| 11.2.3      | <u>SAS-2</u>                               | 55        |
| 11.2.3.1    | General description                        | 55        |
| 11.2.3.2    | Coordinate systems                         | 55        |
| 11.2.3.3    | Parameters                                 | 56        |
| 11.2.4      | <u>SAS-3</u>                               | 57        |
| 11.2.4.1    | General description                        | 57        |
| 11.2.4.2    | Coordinate systems                         | 57        |
| 11.2.4.3    | Parameters                                 | 58        |
| 11.2.5      | <u>SAS-4</u>                               | 59        |
| 11.2.5.1    | General description                        | 59        |
| 11.2.5.2    | Coordinate systems                         | 59        |
| 11.2.5.3    | Parameters                                 | 60        |
| <b>11.3</b> | <b>STAR TRACKER</b>                        | <b>61</b> |
| 11.3.1      | <u>Introduction</u>                        | 61        |
| 11.3.2      | <u>STR-A</u>                               | 62        |
| 11.3.2.1    | General description                        | 62        |
| 11.3.2.2    | Coordinate systems                         | 62        |
| 11.3.2.3    | Parameters                                 | 63        |
| 11.3.3      | <u>STR-B</u>                               | 64        |

|          |                                  |    |
|----------|----------------------------------|----|
| 11.3.3.1 | General description .....        | 64 |
| 11.3.3.2 | Coordinate systems .....         | 64 |
| 11.3.3.3 | Parameters .....                 | 65 |
| 11.4     | NAVCAM .....                     | 66 |
| 11.4.1   | <u>Introduction</u> .....        | 66 |
| 11.4.2   | <u>NAVCAM-A</u> .....            | 67 |
| 11.4.2.1 | General description .....        | 67 |
| 11.4.2.2 | Coordinate systems .....         | 67 |
| 11.4.2.3 | Parameters .....                 | 68 |
| 11.4.3   | <u>NAVCAM-B</u> .....            | 69 |
| 11.4.3.1 | General description .....        | 69 |
| 11.4.3.2 | Coordinate systems .....         | 69 |
| 11.4.3.3 | Parameters .....                 | 70 |
| 12.      | <u>OTHER UNITS</u> .....         | 71 |
| 12.1     | SSP .....                        | 71 |
| 12.1.1   | <u>General description</u> ..... | 71 |
| 12.1.2   | <u>Coordinate systems</u> .....  | 71 |
| 12.1.3   | <u>Parameters</u> .....          | 72 |
| 12.2     | MGA-S .....                      | 73 |
| 12.2.1   | <u>General description</u> ..... | 73 |
| 12.2.2   | <u>Coordinate systems</u> .....  | 73 |
| 12.2.3   | <u>Parameters</u> .....          | 73 |
| 12.3     | MGA-X .....                      | 74 |
| 12.3.1   | <u>General description</u> ..... | 74 |
| 12.3.2   | <u>Coordinate systems</u> .....  | 74 |
| 12.3.3   | <u>Parameters</u> .....          | 74 |
| 12.4     | LGA-1 .....                      | 75 |
| 12.4.1   | <u>General description</u> ..... | 75 |
| 12.4.2   | <u>Coordinate systems</u> .....  | 75 |
| 12.4.3   | <u>Parameters</u> .....          | 75 |
| 12.5     | LGA-2 .....                      | 76 |
| 12.5.1   | <u>General description</u> ..... | 76 |
| 12.5.2   | <u>Coordinate systems</u> .....  | 76 |
| 12.5.3   | <u>Parameters</u> .....          | 76 |

## TABLE OF FIGURES

|                                                                                     |    |
|-------------------------------------------------------------------------------------|----|
| Figure 1: Spacecraft assembly .....                                                 | 11 |
| Figure 2: Spacecraft mechanical reference system .....                              | 14 |
| Figure 3: SA+Y overview and unit frame .....                                        | 15 |
| Figure 4: SA-Y overview and unit frame .....                                        | 18 |
| Figure 5: Overview and rotation axes .....                                          | 21 |
| Figure 6: APM and rotation axes .....                                               | 21 |
| Figure 7: HGAROT1 unit system .....                                                 | 23 |
| Figure 8: HGAROT2 unit system .....                                                 | 26 |
| Figure 9: Corner point positions .....                                              | 28 |
| Figure 10: Reaction wheels overview .....                                           | 30 |
| Figure 11: Reaction wheel spin axis .....                                           | 30 |
| Figure 12: Thruster locations and orientations, view 1 .....                        | 32 |
| Figure 13: Thruster locations and orientations, view 2 .....                        | 33 |
| Figure 14: Definition of thruster plume direction and resulting thrust vector ..... | 34 |
| Figure 15: ALICE unit system .....                                                  | 35 |
| Figure 16: MIRO unit system .....                                                   | 37 |
| Figure 17: OSIRIS-NAC unit system .....                                             | 39 |
| Figure 18: OSIRIS-WAC unit system .....                                             | 41 |
| Figure 19: VIRTIS unit system .....                                                 | 43 |
| Figure 20: IMU overview .....                                                       | 45 |
| Figure 21: IMU-A unit system .....                                                  | 46 |
| Figure 22: IMU-B unit system .....                                                  | 48 |
| Figure 23: IMU-C unit system .....                                                  | 50 |
| Figure 24: SAS overview .....                                                       | 52 |
| Figure 25: SAS-1 unit system .....                                                  | 53 |
| Figure 26: SAS-2 unit system .....                                                  | 55 |
| Figure 27: SAS-3 unit system .....                                                  | 57 |
| Figure 28: SAS-4 unit system .....                                                  | 59 |
| Figure 29: STR overview .....                                                       | 61 |
| Figure 30: STR-A unit system .....                                                  | 62 |
| Figure 31: STR-B unit system .....                                                  | 64 |
| Figure 32: NAVCAM overview .....                                                    | 66 |
| Figure 33: NAVCAM-A unit system .....                                               | 67 |
| Figure 34: NAVCAM-B unit system .....                                               | 69 |
| Figure 35: Lander unit system .....                                                 | 71 |
| Figure 36: MGA-S overview .....                                                     | 73 |
| Figure 37: MGA-X overview .....                                                     | 74 |
| Figure 38: LGA-1 boresight axis .....                                               | 75 |
| Figure 39: LGA-2 boresight axis .....                                               | 76 |

## 1. SCOPE

The purpose of this technical note is twofold:

- To define the various co-ordinate systems which are relevant for the definition of alignment data.
- To serve as a reference document for generation of the Flight Dynamics Database.

In this document the reference to the satellite data tables (T\_SAT or T\_UL\_) and to the satellite data queries (Q\_SAT or Q\_UL) are given in the tables of "General Description" in lines "RFDDDB-table / query". For alignment queries the returned data are extracted from the T\_SAT\_Unit\_FNC\_SC\_MEAS.

## 2. APPLICABLE DOCUMENTS

| Reference | Document Identifier    | Description                                                                                                                                       |
|-----------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| AD1       | RO-DSS-IS-1001         | System Interface Requirements Specification.<br>This document specifies the basic alignment requirements.                                         |
| AD2       | RO-DSS-TN-1020         | ROSETTA Pointing and Alignment Definition.<br>This document describes the requirements in more detail and defines some of the measurement frames. |
| AD3       | RO-DSS-IF-1201 issue 2 | Spacecraft Mechanical / Thermal Interface Control Document PFM Build Status                                                                       |

## 3. REFERENCE DOCUMENTS

| Reference | Document Identifier | Description                 |
|-----------|---------------------|-----------------------------|
| RF1       | RO-DSS-TN-1087      | RFDDDB Parameter Definition |
| RF2       | RO-MMT-1164/99      |                             |
| RF3       | RO-DSS-CR-1026      |                             |
| RF4       | RO-MMT-0473/00      | SAS Numbering               |

## 4. ACRONYMS

|        |                                                   |
|--------|---------------------------------------------------|
| AOCMS  | Attitude and Orbit Control and Measurement System |
| APM    | Antenna Pointing Mechanism                        |
| HGA    | High Gain Antenna                                 |
| IMU    | Inertial Measurement Unit                         |
| LGA    | Low Gain Antenna                                  |
| MGA    | Medium Gain Antenna                               |
| NAVCAM | Navigation Camera                                 |
| RCS    | Reaction Control System                           |
| RFDDDB | Rosetta Flight Dynamics Database                  |
| RSDB   | Rosetta System Database                           |
| RUM    | Rosetta User's Manual                             |
| RW     | Reaction Wheel                                    |
| SAS    | Sun Acquisition Sensor                            |
| SSP    | Surface Science Package                           |
| STR    | Star tracker                                      |

## 5. ABBREVIATIONS

|                 |                                                    |
|-----------------|----------------------------------------------------|
| N/A             | not applicable                                     |
| §               | paragraph                                          |
| ref.            | reference                                          |
| tbc             | to be confirmed                                    |
| $X_U, Y_U, Z_U$ | (local or currently concerned) unit reference axes |

## 6. PARAMETER NAME DEFINITION IN THE RFDDB

All parameters found in this document shall be stored in the RFDDB. The link between the parameters defined in this document and their placeholders in the RFDDB is the RFDDB Parameter Definition Document (RF1).

## 7. DEFINITIONS

### 7.1 TRANSFORMATION MATRIX

Transformation Matrix  $M_{AtoB}$  from reference frame A to reference frame B:

$$V_B = M_{AtoB} * V_A$$

The vector  $V$  in reference frame B ( $V_B$ ) is given by the product of the matrix  $M_{AtoB}$  and the vector  $V$  in reference frame A ( $V_A$ ).

### 7.2 SPACECRAFT MECHANICAL AXES ( $X_{SC}$ , $Y_{SC}$ , $Z_{SC}$ )

The spacecraft mechanical build axes are fixed relative to the spacecraft geometry and shall be used during spacecraft design and integration for the positioning of spacecraft items.

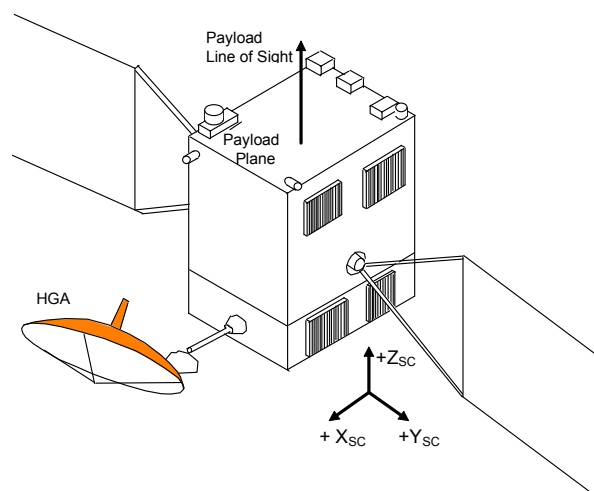
The spacecraft axes are named  $X_{SC}$ ,  $Y_{SC}$ ,  $Z_{SC}$  and form a right-hand orthogonal coordinate system, with the origin at the centre of the spacecraft / launcher separation plane.

$Z_{SC}$  is perpendicular to this interface plane, with positive sense towards the upper (payload) plane, and is nominally coincident with the payload line of sight.

$X_{SC}$  is defined by a mechanical reference on the spacecraft structure, and is nominally orientated with its positive sense towards the High Gain Antenna (HGA) mounting plane.

$Y_{SC}$  is right-hand perpendicular to the plane spanned by the  $X_{SC}$  /  $Z_{SC}$  axes, mainly parallel to the direction of the Solar Arrays.

When the spacecraft is integrated with the launch vehicle, the  $+Z_{SC}$  axis is aligned with the launch vehicle longitudinal (+X) axis. The  $X_{SC}$  axis will be positioned relative to the launch vehicle by the adapter and umbilical link / pyro connectors key ways.



**Figure 1: Spacecraft assembly**

## 7.3 UNIT MECHANICAL AXES ( $X_U$ , $Y_U$ , $Z_U$ )

This unit-fixed right hand orthogonal set of axes represents the reference system for each spacecraft item. The origin is located at the centre of the reference hole in the item mounting plane. The  $+Z_U$  axis is normal to the mounting plane and in the direction from the mounting plane to the item. The other two axes lie in the mounting plane.

The unit reference axes shall be identified on the item by mechanical or optical (mirror) references for measurement or adjustment.

## 7.4 DIRECTION COSINE MATRIX

For all units, direction cosine data are provided in the following form:

| Direction cosines | $X_{SC}$ | $Y_{SC}$ | $Z_{SC}$ |
|-------------------|----------|----------|----------|
| $X_U$             | $a_{11}$ | $a_{12}$ | $a_{13}$ |
| $Y_U$             | $a_{21}$ | $a_{22}$ | $a_{23}$ |
| $Z_U$             | $a_{31}$ | $a_{32}$ | $a_{33}$ |

This is to be interpreted as follows:

$$\begin{bmatrix} X_U \\ Y_U \\ Z_U \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} X_{SC} \\ Y_{SC} \\ Z_{SC} \end{bmatrix}$$

## 7.5 UNITS AND FRAMES

### 7.5.1 General

In order to describe, systematically, the geometrical properties of ROSETTA, the spacecraft is broken down into units. The position and orientation of each unit (with the exception of the central body) is given in relation to its "parent unit". For instance, for a sun sensor located on a solar array, this solar array is the parent unit. In the same way, the parent unit of the solar array is the central body. The central body is at the root of the tree and thus has no parent unit.

For each unit, a "local frame" is defined. Firstly, this local frame is defined by its relation to the geometry of the unit. The unit mass and inertia properties and the unit geometry or shape (e.g. corner points of a box) are defined with respect to its local frame. The definition of these parameters is not within the scope of this document. The measurement directions of each instrument are also defined with respect to its local frame.

Secondly, the relation between the local frame and its parent frame is defined, i.e. a transformation matrix between local frame and parent frame is given and the origin of the local frame is given in the parent frame.

The definition of the relation between local frame and parent frame depends on whether the unit is "fixed" or "articulated". Fixed units are all units which have a rigid connection with their parent unit, e.g. the array-mounted SASs with the solar array. Here, the orientation of the local frame and the position of its origin are fixed within the parent frame.



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 13

The articulated units of Rosetta are the solar array wings and the high gain antenna. The articulated units of Rosetta are specifically "rotating", i.e. the solar arrays rotate with respect to the central body, the HGA arm rotates with respect to the central body and the HGA dish rotates with respect to the HGA arm. (The HGA arm is later denoted "HGAROT1" and the HGA dish "HGAROT2").

For a rotating unit, the rotation axis is defined in the parent frame by its direction (expressed as a unit vector given in the parent frame) and by specifying the position of a point on the rotation axis within the parent frame. Commonly, the position of the "attachment point" is provided. While the "attachment point" must be on the rotation axis, there is no firm a priori definition of its location along the axis. To comply with intuition, the location along the axis is selected within the bearing or hinge.

In addition to the rotation axis direction and attachment point, in the case of rotating units the orientation of the local frame and the location of its origin with respect to the parent frame are provided for zero rotation angle, corresponding to the reference orientation of the rotating unit. The limiting angles of rotation in positive and negative direction of rotation are also provided.

## 7.5.2 Units overview

| Units overview             |                 |              |          |                     |
|----------------------------|-----------------|--------------|----------|---------------------|
| Group                      | Unit            | Parent unit  | Type     | Remark              |
| Relevant geometrical units | Central body    | N/A          | Fixed    | Without parent unit |
|                            | SA+Y            | Central body | Rotating |                     |
|                            | SA-Y            | Central body | Rotating |                     |
|                            | HGAROT1         | Central body | Rotating |                     |
|                            | HGAROT2         | HGAROT1      | Rotating |                     |
| Actuators                  | Reaction wheels | Central body | Fixed    |                     |
|                            | RCS             | Central body | Fixed    |                     |
| Sensors                    | IMU-A           | Central body | Fixed    |                     |
|                            | IMU-B           | Central body | Fixed    |                     |
|                            | IMU-C           | Central body | Fixed    |                     |
|                            | SAS-1           | Central body | Fixed    |                     |
|                            | SAS-2           | Central body | Fixed    |                     |
|                            | SAS-3           | SA+Y         | Fixed    |                     |
|                            | SAS-4           | SA-Y         | Fixed    |                     |
|                            | STR-A           | Central body | Fixed    |                     |
|                            | STR-B           | Central body | Fixed    |                     |
|                            | NAVCAM-A        | Central body | Fixed    |                     |
|                            | NAVCAM-B        | Central body | Fixed    |                     |
| Payload instruments        | ALICE           | Central body | Fixed    |                     |
|                            | MIRO            | Central body | Fixed    |                     |
|                            | OSIRIS-NAC      | Central body | Fixed    |                     |
|                            | OSIRIS-WAC      | Central body | Fixed    |                     |
|                            | VIRTIS          | Central body | Fixed    |                     |
| Other units                | SSP             | Central body | Fixed    |                     |
|                            | MGA             | Central body | Fixed    |                     |
|                            | LGA             | Central body | Fixed    |                     |

## 8. RELEVANT GEOMETRICAL UNITS

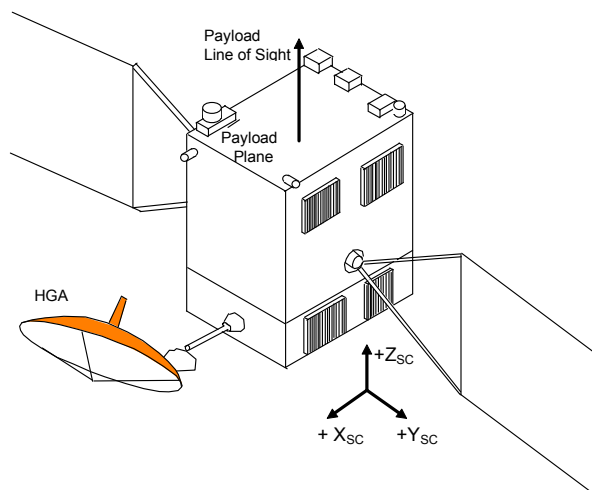
### 8.1 CENTRAL BODY

#### 8.1.1 General description

| Central Body       |                                                                  |
|--------------------|------------------------------------------------------------------|
| Identification     | Central body                                                     |
| Type of unit       | Fixed                                                            |
| Parent unit        | -                                                                |
| Coordinate systems | Spacecraft mechanical reference frame (central body unit system) |

#### 8.1.2 Coordinate systems

| Central Body Coordinate Systems                                       |        |                                                                                                                                                    |
|-----------------------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Spacecraft reference mechanical frame (central body reference system) | Origin | Centre of the spacecraft / launcher interface.                                                                                                     |
|                                                                       | Z-axis | Perpendicular to the spacecraft / launcher interface plane, pointing towards the upper (payload) panel. Nominally along the payload line of sight. |
|                                                                       | X-axis | Normal to the HGA mounting plane pointing outward from the spacecraft body.                                                                        |
|                                                                       | Y-axis | Completing a right handed orthogonal system. Nominally parallel to the solar array longitudinal axis.                                              |



**Figure 2: Spacecraft mechanical reference system**

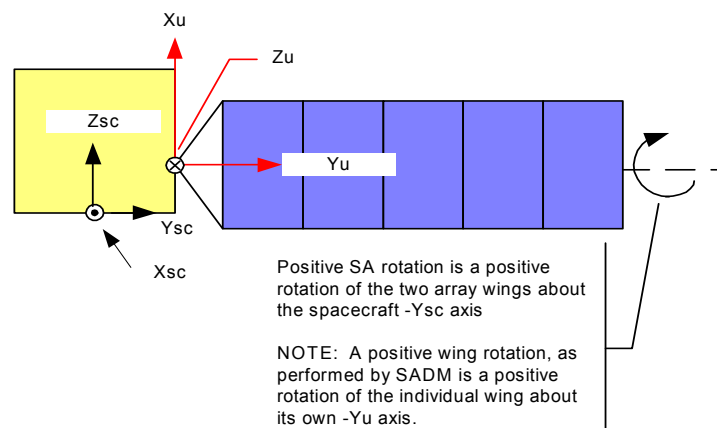
The faces of the box-shaped central body can be identified by the direction of the normal unit vector (e.g. +Y side, -Y side)

## 8.2 SOLAR ARRAY +Y

### 8.2.1 General description

| SA+Y                       |                                                                                                                                              |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Identification             | Solar array at the +Y side of the central body                                                                                               |
| RFDDDB-table / query       | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_UL_SA / Q_SAT_SA_ALIGN                                                                  |
| Product tree               | B18C                                                                                                                                         |
| CONFIG_Id<br>(from RFDDDB) | USAYP000                                                                                                                                     |
| Type of unit               | Rotating                                                                                                                                     |
| Parent unit                | Central body system                                                                                                                          |
| Coordinate systems         | Central body system.<br>Solar array +Y unit system.                                                                                          |
| Parameters                 | Position of SA+Y attachment point.<br>Direction of SA+Y rotation axis.<br>Orientation of SA+Y unit system to the spacecraft reference frame. |
| Variables                  | Solar array rotation angle                                                                                                                   |

### 8.2.2 Coordinate systems



**Figure 3: SA+Y overview and unit frame**



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 16

## SA+Y coordinate systems

|                                                           |                        |                                                                                                 |
|-----------------------------------------------------------|------------------------|-------------------------------------------------------------------------------------------------|
| SA+Y<br>Parent frame:<br>Central body<br>reference system | See § 8.1 Central Body |                                                                                                 |
| SA+Y unit<br>reference system                             | Origin                 | Attachment point.                                                                               |
|                                                           | $X_U$                  | Completing a right handed orthogonal system.                                                    |
|                                                           | $Y_U$                  | In solar array plane, along longitudinal symmetry axis of array, pointing away from spacecraft. |
|                                                           | $Z_U$                  | Perpendicular to solar array. The normal to the active cell face is in the $-Z_U$ direction.    |

## 8.2.3 Parameters

### Position of SA+Y attachment point

|                                              |                                                                  |                             |                                  |
|----------------------------------------------|------------------------------------------------------------------|-----------------------------|----------------------------------|
| RFDDDB-table / query                         | T SAT_UNIT_MECH_SC_NOM / Q SAT_UNIT_MECH_SC_NOM                  |                             |                                  |
| Parameter description                        | Position of the attachment point of the SA+Y to the central body |                             |                                  |
| Provided in<br>(reference coordinate system) | Central body system                                              |                             |                                  |
| Provided as                                  | Three vector components                                          |                             |                                  |
| Physical units                               | m                                                                |                             |                                  |
| Nominal values                               | RFDDDB-ref.:<br>Figure-ref.:                                     | UNIT_POS_x<br>$X_{sc}$<br>0 | UNIT_POS_y<br>$Y_{sc}$<br>1.0645 |
|                                              |                                                                  |                             | UNIT_POS_z<br>$Z_{sc}$<br>1.3211 |

### Direction of SA+Y rotation axis

|                                              |                                                    |                             |                             |
|----------------------------------------------|----------------------------------------------------|-----------------------------|-----------------------------|
| RFDDDB-table / query                         | T_UL_SA / Q SAT_SA_ALIGN                           |                             |                             |
| Parameter description                        | Direction of the SA+Y or rotation axis unit vector |                             |                             |
| Provided in<br>(reference coordinate system) | Central body system                                |                             |                             |
| Provided as                                  | Three vector components                            |                             |                             |
| Physical units                               | Dimensionless                                      |                             |                             |
| Nominal values                               | RFDDDB-ref.:<br>Figure-ref.:                       | A_SA_ROT_x<br>$X_{sc}$<br>0 | A_SA_ROT_y<br>$Y_{sc}$<br>1 |
|                                              |                                                    |                             | A_SA_ROT_z<br>$Z_{sc}$<br>0 |

### Orientation of SA+Y frame to the spacecraft reference frame

|                                              |                                                                                                                     |          |          |          |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------|----------|----------|
| RFDDDB-table / query                         | T SAT_UNIT_MECH_SC_NOM / Q SAT_UNIT_MECH_SC_NOM                                                                     |          |          |          |
| Parameter description                        | Transformation matrix (§ 7.1) from the central body system to the SA+Y unit reference system at zero rotation angle |          |          |          |
| Provided in<br>(reference coordinate system) | Central body system                                                                                                 |          |          |          |
| Provided as                                  | 3 * 3 matrix according to § 7.4                                                                                     |          |          |          |
| Physical units                               | Dimensionless                                                                                                       |          |          |          |
| Nominal values                               | Direction cosines                                                                                                   | $X_{sc}$ | $Y_{sc}$ | $Z_{sc}$ |
| RFDDDB-identification :                      | $X_U$                                                                                                               | 0        | 0        | 1        |
| A_MECH_SC_1x to                              | $Y_U$                                                                                                               | 0        | 1        | 0        |
| A_MECH_SC_3z                                 | $Z_U$                                                                                                               | -1       | 0        | 0        |



## 8.2.4 Variables

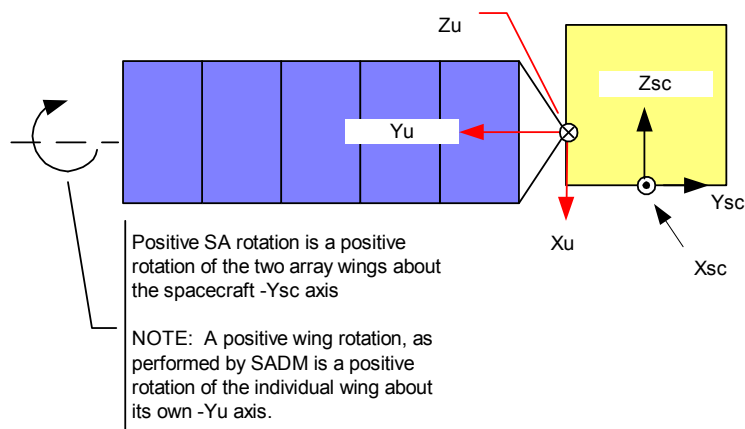
| SA+Y rotation angle                          |                                                                                                                                                                                                                                                    |  |                 |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------|
| RFDDDB-table / query                         | T_UL_SA / Q_UL_SA_PERF                                                                                                                                                                                                                             |  |                 |
| Variable description                         | Rotation angle around the SA+Y rotation axis.                                                                                                                                                                                                      |  |                 |
| Provided in<br>(reference coordinate system) | Central body system                                                                                                                                                                                                                                |  |                 |
| Provided as                                  | Angle with sign in mathematical sense (positive about the direction of the rotation axis unit vector)                                                                                                                                              |  |                 |
| Physical units                               | deg                                                                                                                                                                                                                                                |  |                 |
| Reference position                           | Implicitly defined by the transformation matrix from central body to SA+Y unit frame, which provides the transformation at zero rotation angle. Nominally, at zero rotation angle, the $-Z_U$ axis of SA+Y is aligned with the spacecraft +X axis. |  |                 |
| Physical range:                              | RFDDDB-ref.:                                                                                                                                                                                                                                       |  |                 |
|                                              | P_SA_ROT_MIN_HW                                                                                                                                                                                                                                    |  | P_SA_ROT_MAX_HW |
|                                              | Min                                                                                                                                                                                                                                                |  | Max             |
|                                              | -180°                                                                                                                                                                                                                                              |  | +180°           |

## 8.3 SOLAR ARRAY -Y

### 8.3.1 General description

| SA-Y                       |                                                                                                                                              |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Identification             | Solar array at the -Y side of the central body                                                                                               |
| RFDDDB-table / query       | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_UL_SA / Q_UL_SA_PERF / Q_SAT_SA_ALIGN                                                   |
| Product tree               | B18C                                                                                                                                         |
| CONFIG_Id<br>(from RFDDDB) | USAYM000                                                                                                                                     |
| Type of unit               | Rotating                                                                                                                                     |
| Parent unit                | Central body system                                                                                                                          |
| Coordinate systems         | Central body system.<br>SA-Y unit system.                                                                                                    |
| Parameters                 | Position of SA-Y attachment point.<br>Direction of SA-Y rotation axis.<br>Orientation of SA-Y unit system to the spacecraft reference frame. |
| Variables                  | Solar array rotation angle                                                                                                                   |

### 8.3.2 Coordinate systems



**Figure 4: SA-Y overview and unit frame**



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 19

## SA-Y coordinate systems

|                                                           |                        |                                                                                                 |
|-----------------------------------------------------------|------------------------|-------------------------------------------------------------------------------------------------|
| SA-Y<br>Parent frame:<br>Central body<br>reference system | See § 8.1 Central Body |                                                                                                 |
| SA-Y unit<br>reference system                             | Origin                 | Attachment point.                                                                               |
|                                                           | $X_U$                  | Completing a right handed orthogonal system.                                                    |
|                                                           | $Y_U$                  | In solar array plane, along longitudinal symmetry axis of array, pointing away from spacecraft. |
|                                                           | $Z_U$                  | Perpendicular to solar array. The normal to the active cell face is in the $-Z_U$ direction.    |

### 8.3.3 Parameters

#### Position of SA-Y attachment point

|                                              |                                                                  |                             |                                   |
|----------------------------------------------|------------------------------------------------------------------|-----------------------------|-----------------------------------|
| RFDDDB-table / query                         | T SAT UNIT MECH SC NOM / Q SAT UNIT MECH SC NOM                  |                             |                                   |
| Parameter description                        | Position of the attachment point of the SA-Y to the central body |                             |                                   |
| Provided in<br>(reference coordinate system) | Central body system                                              |                             |                                   |
| Provided as                                  | Three vector components                                          |                             |                                   |
| Physical units                               | m                                                                |                             |                                   |
| Nominal values                               | RFDDDB-ref.:<br>Figure-ref.:                                     | UNIT_POS_x<br>$X_{sc}$<br>0 | UNIT_POS_y<br>$Y_{sc}$<br>-1.0645 |
|                                              |                                                                  |                             | UNIT_POS_z<br>$Z_{sc}$<br>1.3211  |

#### Direction of SA-Y rotation axis

|                                              |                                                    |                             |                              |
|----------------------------------------------|----------------------------------------------------|-----------------------------|------------------------------|
| RFDDDB-table / query                         | T UL SA / Q SAT SA ALIGN                           |                             |                              |
| Parameter description                        | Direction of the SA-Y or rotation axis unit vector |                             |                              |
| Provided in<br>(reference coordinate system) | Central body system                                |                             |                              |
| Provided as                                  | Three vector components                            |                             |                              |
| Physical units                               | Dimensionless                                      |                             |                              |
| Nominal values                               | RFDDDB-ref.:<br>Figure-ref.:                       | A_SA_ROT_x<br>$X_{sc}$<br>0 | A_SA_ROT_y<br>$Y_{sc}$<br>-1 |
|                                              |                                                    |                             | A_SA_ROT_z<br>$Z_{sc}$<br>0  |

#### Orientation of SA-Y frame to the spacecraft reference frame

|                                              |                                                                                                                     |          |          |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------|----------|
| RFDDDB-table / query                         | T SAT UNIT MECH SC NOM / Q SAT UNIT MECH SC NOM                                                                     |          |          |
| Parameter description                        | Transformation matrix (§ 7.1) from the central body system to the SA-Y unit reference system at zero rotation angle |          |          |
| Provided in<br>(reference coordinate system) | Central body system                                                                                                 |          |          |
| Provided as                                  | 3 * 3 matrix according to § 7.4                                                                                     |          |          |
| Physical units                               | Dimensionless                                                                                                       |          |          |
| Nominal values                               | Direction cosines                                                                                                   | $X_{sc}$ | $Y_{sc}$ |
| RFDDDB-identification :                      | $X_U$                                                                                                               | 0        | 0        |
| A_MECH_SC_1x to                              | $Y_U$                                                                                                               | 0        | -1       |
| A_MECH_SC_3z                                 | $Z_U$                                                                                                               | -1       | 0        |



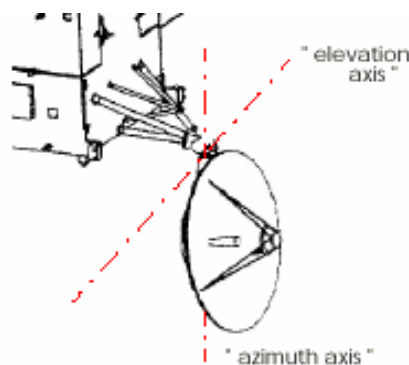
## 8.3.4 Variables

| SA-Y rotation angle                          |                                                                                                                                                                                                                                                    |                 |                 |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_UL_SA / Q_UL_SA_PERF                                                                                                                                                                                                                             |                 |                 |
| Variable description                         | Rotation angle around the SA-Y rotation axis.                                                                                                                                                                                                      |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                                                                                                                                                                                                                |                 |                 |
| Provided as                                  | Angle with sign in mathematical sense (positive about the direction of the rotation axis unit vector)                                                                                                                                              |                 |                 |
| Physical units                               | deg                                                                                                                                                                                                                                                |                 |                 |
| Reference position                           | Implicitly defined by the transformation matrix from central body to SA-Y unit frame, which provides the transformation at zero rotation angle. Nominally, at zero rotation angle, the $-Z_U$ axis of SA-Y is aligned with the spacecraft +X axis. |                 |                 |
| Physical range:                              | RFDDDB-ref.:                                                                                                                                                                                                                                       | P_SA_ROT_MIN_HW | P_SA_ROT_MAX_HW |
|                                              |                                                                                                                                                                                                                                                    | Min             | Max             |
|                                              |                                                                                                                                                                                                                                                    | -180°           | +180°           |

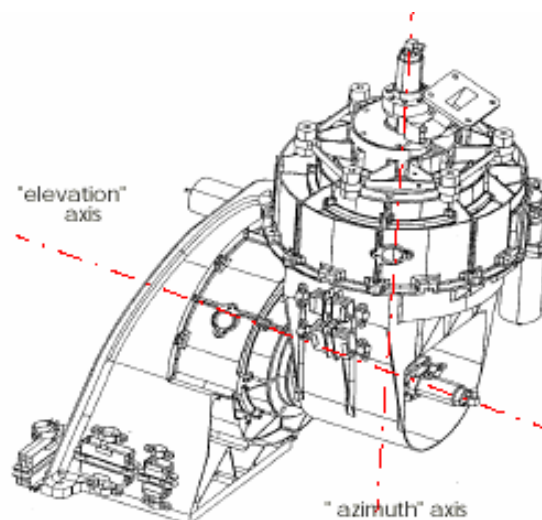
## 8.4 HGAROT1

### 8.4.1 Introduction

The HGA system is split into two units. The first unit "HGAROT1", (the HGA arm), is attached to the central body through a rotation axis. The degree of freedom around this axis is the HGA elevation (see Figure 5: Overview and rotation axes). It comprises all the elements that can rotate directly about this axis, i.e. the part of the antenna pointing mechanism that is neither fixed to the central body nor rotates about the HGA azimuth rotation (see Figure 6: APM and rotation axes).



**Figure 5: Overview and rotation axes**



**Figure 6: APM and rotation axes**

Note that the APM tripod support structure and the fixed part of the APM are considered part of the central body.



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

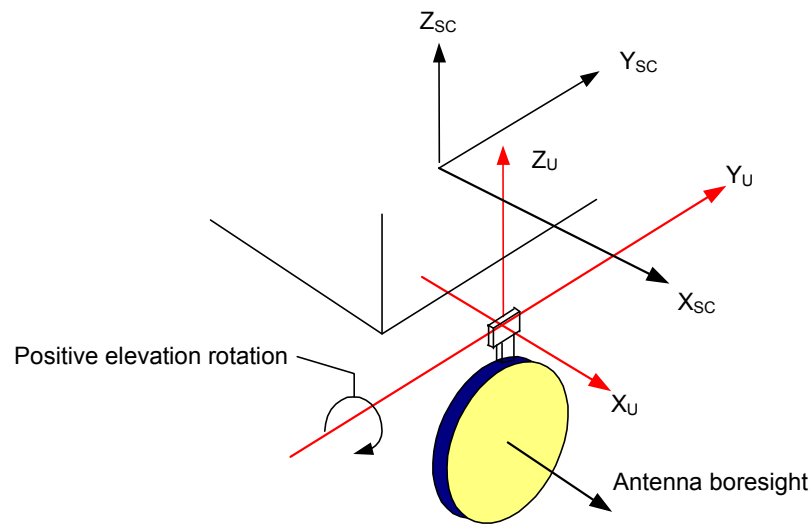
Sheet: 22

## 8.4.2 General description

| HGAROT1                    |                                                                                                                                                          |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification             | Part of the HGA pointing mechanism that rotates around the HGA elevation axis i.e. the part neither fixed to the central body nor fixed to the HGA dish. |
| RFDDDB-table / query       | T_UL_HGA / Q_SAT_HGA_ALIGN, Q_UL_HGA_PERF                                                                                                                |
| Product tree               | B19C                                                                                                                                                     |
| CONFIG_Id<br>(from RFDDDB) | UHGHHGAROT1 (tbc)                                                                                                                                        |
| Type of unit               | Rotating                                                                                                                                                 |
| Parent unit                | Central body system                                                                                                                                      |
| Coordinate systems         | Central body system.<br>HGAROT1 nominal unit system.                                                                                                     |
| Parameters                 | Position of HGAROT1 attachment point.<br>Direction of HGAROT1 rotation axis.<br>Orientation of HGAROT1 nominal unit frame to spacecraft reference frame. |
| Variables                  | HGAROT1 rotation angle                                                                                                                                   |

## 8.4.3 Coordinate systems

| HGAROT1 coordinate systems                                   |                        |                                                                                                                                                                 |
|--------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HGAROT1<br>Parent frame:<br>Central body<br>reference system | See § 8.1 Central Body |                                                                                                                                                                 |
| HGAROT1 reference<br>system                                  | Origin                 | Attachment point.                                                                                                                                               |
|                                                              | X <sub>U</sub>         | Completing a right handed orthogonal system.                                                                                                                    |
|                                                              | Y <sub>U</sub>         | Along the elevation axis of the APM, in the same direction as the spacecraft Y-axis.                                                                            |
|                                                              | Z <sub>U</sub>         | Along the projection of the "azimuth" axis onto the plane perpendicular to the "elevation" axis, pointing away from the HGA dish to the spacecraft center body. |



**Figure 7: HGAROT1 unit system**

Positive elevation rotation is a positive rotation about  $Y_u$ .

#### 8.4.4 Parameters

| Position of HGAROT1 attachment point      |                                                                                                                                                                                       |           |           |           |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|
| RFDDDB-table / query                      | T_UL_HGA / Q_SAT_HGA_ALIGN                                                                                                                                                            |           |           |           |
| Parameter description                     | Position of the attachment point of the HGAROT1 to the central body, at the intersection of the rotation axis with the interface plane between the fixed and rotary parts of the APM. |           |           |           |
| Provided in (reference coordinate system) | Central body system                                                                                                                                                                   |           |           |           |
| Provided as                               | Three vector components                                                                                                                                                               |           |           |           |
| Physical units                            | m                                                                                                                                                                                     |           |           |           |
| Nominal values                            | RFDDDB-ref.:                                                                                                                                                                          | HGA_POS_x | HGA_POS_y | HGA_POS_z |
|                                           | Figure-ref.:                                                                                                                                                                          | $X_{sc}$  | $Y_{sc}$  | $Z_{sc}$  |
|                                           |                                                                                                                                                                                       | 2.1515    | 0         | 0.0800    |

| Direction of HGAROT1 rotation axis        |                                                     |             |             |             |
|-------------------------------------------|-----------------------------------------------------|-------------|-------------|-------------|
| RFDDDB-table / query                      | T_UL_HGA / Q_SAT_HGA_ALIGN                          |             |             |             |
| Parameter description                     | Direction of the HGAROT1 rotation axis unit vector. |             |             |             |
| Provided in (reference coordinate system) | Central body system                                 |             |             |             |
| Provided as                               | Three vector components                             |             |             |             |
| Physical units                            | Dimensionless                                       |             |             |             |
| Nominal values                            | RFDDDB-ref.:                                        | A_HGA_ROT_x | A_HGA_ROT_y | A_HGA_ROT_z |
|                                           | Figure-ref.:                                        | $X_{sc}$    | $Y_{sc}$    | $Z_{sc}$    |
|                                           |                                                     | 0           | 1           | 0           |



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 24

## Orientation of HGAROT1 nominal unit frame to the spacecraft reference frame

|                                              |                                                                                                                                  |                 |                 |                 |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_UL_HGA / Q_SAT_HGA_ALIGN                                                                                                       |                 |                 |                 |
| Parameter description                        | Transformation matrix (§ 7.1) from the central body system to the HGAROT1 nominal unit reference system, at zero rotation angle. |                 |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                                                                                              |                 |                 |                 |
| Provided as                                  | 3 * 3 matrix according to § 7.4                                                                                                  |                 |                 |                 |
| Physical units                               | Dimensionless                                                                                                                    |                 |                 |                 |
| Nominal values                               | Direction cosines                                                                                                                | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
| RFDDDB-identification:                       | X <sub>U</sub>                                                                                                                   | 1               | 0               | 0               |
| A_HGA_ALI_1x to                              | Y <sub>U</sub>                                                                                                                   | 0               | 1               | 0               |
| A_HGA_ALI_3z                                 | Z <sub>U</sub>                                                                                                                   | 0               | 0               | 1               |

### 8.4.5 Variables

#### HGAROT1 rotation angle

|                                              |                                                                                                                                                                                                                                                                                                              |                  |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| RFDDDB-table / query                         | T_UL_HGA / Q_UL_HGA_PERF                                                                                                                                                                                                                                                                                     |                  |
| Variable description                         | Rotation angle about the HGAROT1 rotation axis.                                                                                                                                                                                                                                                              |                  |
| Provided in<br>(reference coordinate system) | Central body system                                                                                                                                                                                                                                                                                          |                  |
| Provided as                                  | Angle with sign in mathematical sense (positive around the direction of the rotation axis unit vector)                                                                                                                                                                                                       |                  |
| Physical units                               | deg                                                                                                                                                                                                                                                                                                          |                  |
| Reference position                           | Implicitly defined by the transformation matrix from central body to HGAROT1 unit frame, which provides the transformation at zero rotation angle. Nominally, at zero rotation angle, the HGAROT1 X-axis is aligned with the spacecraft X-axis and the HGAROT1 Z-axis is aligned with the spacecraft Z-axis. |                  |
| Operational range:                           | RFDDDB-ref.:                                                                                                                                                                                                                                                                                                 | P_HGA_ROT_MIN_HW |
|                                              |                                                                                                                                                                                                                                                                                                              | Min              |
|                                              |                                                                                                                                                                                                                                                                                                              | -165°            |
|                                              |                                                                                                                                                                                                                                                                                                              | P_HGA_ROT_MAX_HW |
|                                              |                                                                                                                                                                                                                                                                                                              | Max              |
|                                              |                                                                                                                                                                                                                                                                                                              | +30°             |



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 25

## 8.5 HGAROT2

### 8.5.1 Introduction

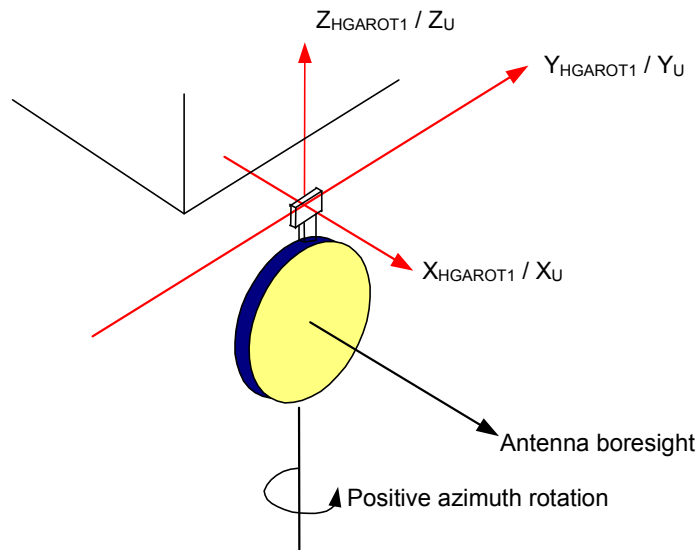
HGAROT2 comprises the HGA dish with all rigid attachments. It is attached to the HGAROT1 through a rotation axis (corresponding to the so called HGA azimuth rotation).

### 8.5.2 General description

| HGAROT2                    |                                                                                                                                                 |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification             | Group of elements that can rotate about the HGA "azimuth" axis.                                                                                 |
| RFDDDB-table / query       | T_UL_HGA / Q_SAT_HGA_ALIGN, Q_UL_HGA_PERF                                                                                                       |
| Product tree               | B19C                                                                                                                                            |
| CONFIG_Id<br>(from RFDDDB) | UHGHHGAROT2 (tbc)                                                                                                                               |
| Type of unit               | Rotating                                                                                                                                        |
| Parent unit                | HGAROT1                                                                                                                                         |
| Coordinate systems         | HGAROT1 nominal unit system.<br>HGAROT2 nominal unit system.                                                                                    |
| Parameters                 | Position of HGAROT2 attachment point.<br>Direction of HGAROT2 rotation axis.<br>Orientation of HGAROT2 nominal unit frame to the HGAROT1 frame. |
| Variables                  | HGAROT2 rotation angle                                                                                                                          |

### 8.5.3 Coordinate systems

| HGAROT2 coordinate systems                                   |                 |                                                                                                                  |
|--------------------------------------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------|
| HGAROT2<br>Parent frame:<br>HGAROT1 unit<br>reference system | See 8.4 HGAROT1 |                                                                                                                  |
| HGAROT2 unit<br>reference system                             | Origin          | Attachment point.                                                                                                |
|                                                              | X <sub>U</sub>  | Parallel to the direction of the antenna boresight.                                                              |
|                                                              | Y <sub>U</sub>  | Completing a right handed orthogonal system.                                                                     |
|                                                              | Z <sub>U</sub>  | Along the so called azimuth axis of the APM, pointing away from the HGA dish towards the spacecraft center body. |



**Figure 8: HGAROT2 unit system**

Positive azimuth rotation is a positive rotation about  $Z_U$ .

## 8.5.4 Parameters

| Position of HGAROT2 attachment point      |                                                                 |           |           |
|-------------------------------------------|-----------------------------------------------------------------|-----------|-----------|
| RFDDDB-table / query                      | T_UL_HGA / Q_SAT_HGA_ALIGN                                      |           |           |
| Parameter description                     | Position of the attachment point of the HGAROT2 to the HGAROT1. |           |           |
| Provided in (reference coordinate system) | HGAROT1 system                                                  |           |           |
| Provided as                               | Three vector components                                         |           |           |
| Physical units                            | m                                                               |           |           |
| Nominal values                            | RFDDDB-ref.:                                                    | HGA_POS_x | HGA_POS_y |
|                                           | Figure-ref.:                                                    | X_HGAROT1 | Y_HGAROT1 |
|                                           |                                                                 | 0         | 0         |
|                                           |                                                                 |           | HGA_POS_z |
|                                           |                                                                 |           | Z_HGAROT1 |
|                                           |                                                                 |           | 0         |

| Direction of HGAROT2 rotation axis        |                                                     |             |             |
|-------------------------------------------|-----------------------------------------------------|-------------|-------------|
| RFDDDB-table / query                      | T_UL_HGA / Q_SAT_HGA_ALIGN                          |             |             |
| Parameter description                     | Direction of the HGAROT2 rotation axis unit vector. |             |             |
| Provided in (reference coordinate system) | HGAROT1 system                                      |             |             |
| Provided as                               | Three vector components                             |             |             |
| Physical units                            | Dimensionless                                       |             |             |
| Nominal values                            | RFDDDB-ref.:                                        | A_HGA_ROT_x | A_HGA_ROT_y |
|                                           | Figure-ref.:                                        | X_HGAROT1   | Y_HGAROT1   |
|                                           |                                                     | 0           | 0           |
|                                           |                                                     |             | A_HGA_ROT_z |
|                                           |                                                     |             | Z_HGAROT1   |
|                                           |                                                     |             | 1           |



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 27

## Orientation of HGAROT2 nominal unit frame to the HGAROT1 reference frame

|                                              |                                                                                                                                                   |                      |                      |                      |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|
| RFDDDB-table / query                         | T_UL_HGA / Q_SAT_HGA_ALIGN                                                                                                                        |                      |                      |                      |
| Parameter description                        | Transformation matrix (§ 7.1) from the HGAROT1 nominal unit reference system to the HGAROT2 nominal unit reference system at zero rotation angle. |                      |                      |                      |
| Provided in<br>(reference coordinate system) | HGAROT1 system                                                                                                                                    |                      |                      |                      |
| Provided as                                  | 3 * 3 matrix according to § 7.4                                                                                                                   |                      |                      |                      |
| Physical units                               | Dimensionless                                                                                                                                     |                      |                      |                      |
| Nominal values                               | Direction cosines                                                                                                                                 | $X_{\text{HGAROT1}}$ | $Y_{\text{HGAROT1}}$ | $Z_{\text{HGAROT1}}$ |
| RFDDDB-identification:                       | $X_U$                                                                                                                                             | 1                    | 0                    | 0                    |
| A_HGA_ALI_1x to                              | $Y_U$                                                                                                                                             | 0                    | 1                    | 0                    |
| A_HGA_ALI_3z                                 | $Z_U$                                                                                                                                             | 0                    | 0                    | 1                    |

### 8.5.5 Variables

#### HGAROT2 rotation angle

|                                              |                                                                                                                                                                                                                                                                                                               |                  |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| RFDDDB-table / query                         | T_UL_HGA / Q_UL_HGA_PERF                                                                                                                                                                                                                                                                                      |                  |
| Variable description                         | Rotation angle about the HGAROT2 rotation axis.                                                                                                                                                                                                                                                               |                  |
| Provided in<br>(reference coordinate system) | HGAROT1 system                                                                                                                                                                                                                                                                                                |                  |
| Provided as                                  | Angle with sign in mathematical sense (positive around the direction of the rotation axis unit vector)                                                                                                                                                                                                        |                  |
| Physical units                               | deg                                                                                                                                                                                                                                                                                                           |                  |
| Reference position                           | Implicitly defined by the transformation matrix from HGAROT1 unit frame to HGAROT2 unit frame, which provides the transformation at zero rotation angle. Nominally, at zero rotation angle, the HGAROT2 X-axis is aligned with the HGAROT1 X-axis, and the HGAROT2 Z-axis is aligned with the HGAROT1 Z-axis. |                  |
| Operational range:                           | RFDDDB-ref.:                                                                                                                                                                                                                                                                                                  | P_HGA_ROT_MIN_HW |
|                                              |                                                                                                                                                                                                                                                                                                               | Min              |
|                                              |                                                                                                                                                                                                                                                                                                               | -260°            |
|                                              |                                                                                                                                                                                                                                                                                                               | P_HGA_ROT_MAX_HW |
|                                              |                                                                                                                                                                                                                                                                                                               | Max              |
|                                              |                                                                                                                                                                                                                                                                                                               | +80°             |

## 8.6 CORNER POINT POSITIONS

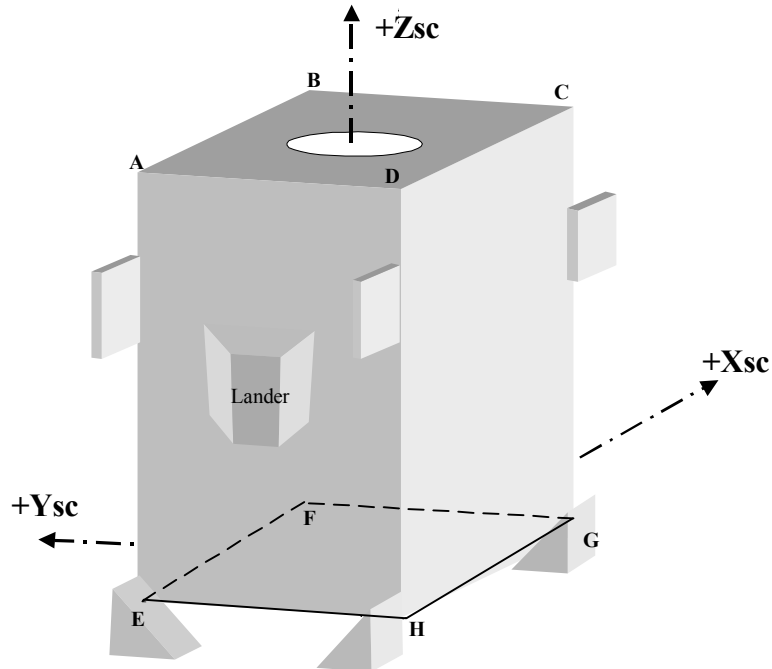


Figure 9: Corner point positions

| Corner point positions |                                 |          |          |
|------------------------|---------------------------------|----------|----------|
| Corner point           | Reference point coordinates [m] |          |          |
|                        | $X_{sc}$                        | $Y_{sc}$ | $Z_{sc}$ |
| A                      | -1.0500                         | 1.0000   | 2.6550   |
| B                      | 1.0500                          | 1.0000   | 2.6550   |
| C                      | 1.0500                          | -1.0000  | 2.6550   |
| D                      | -1.0500                         | -1.0000  | 2.6550   |
| E                      | -1.0500                         | 1.0000   | 0.0800   |
| F                      | 1.0500                          | 1.0000   | 0.0800   |
| G                      | 1.0500                          | -1.0000  | 0.0800   |
| H                      | -1.0500                         | -1.0000  | 0.0800   |



## 9. ACTUATORS

### 9.1 REACTION WHEELS

#### 9.1.1 Introduction

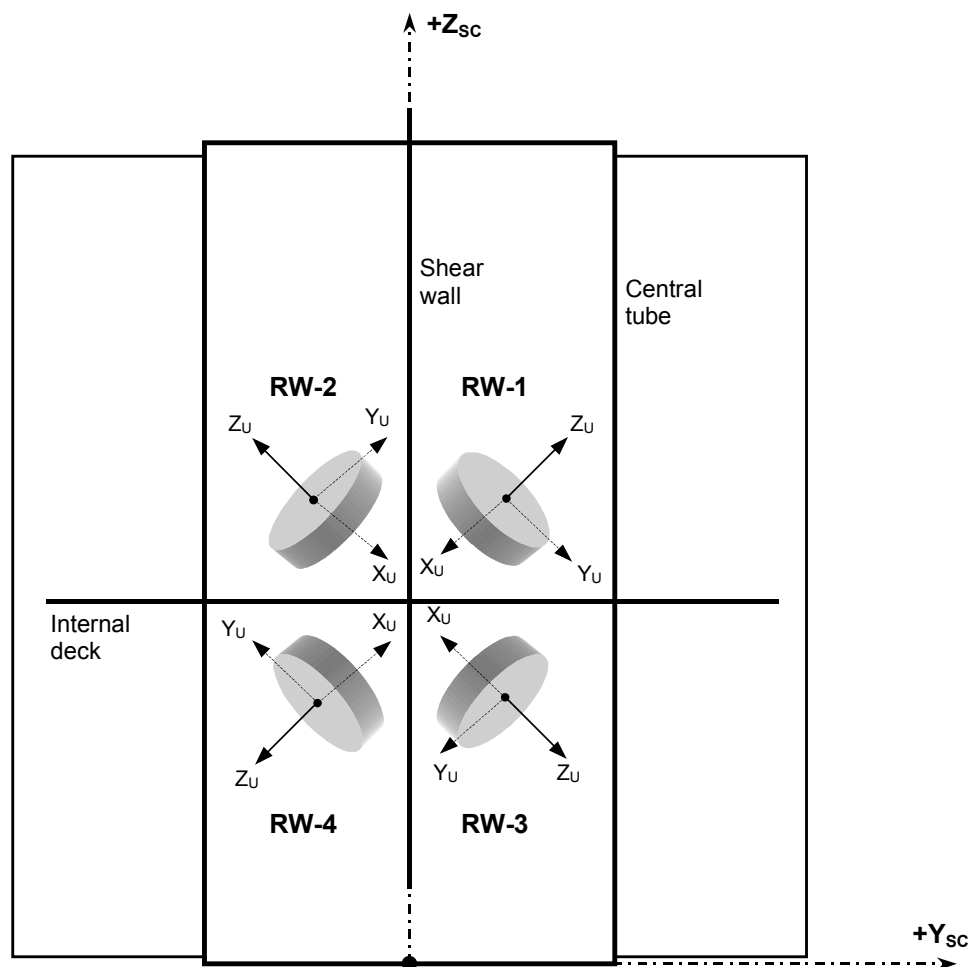
Four wheels are defined and located symmetrically on the internal deck and +X shear wall. The nomenclature is according to the Avionics and Spacecraft Mechanical / Thermal ICD:

#### **W1, W2, W3, W4**

The direction of the spin axis ( $Z_U$ ) of each wheel is defined by the unit vectors in the spacecraft coordinate frame - see Section 9.1.3. Rotary orientation on the bracket is given by the unit X-axis.

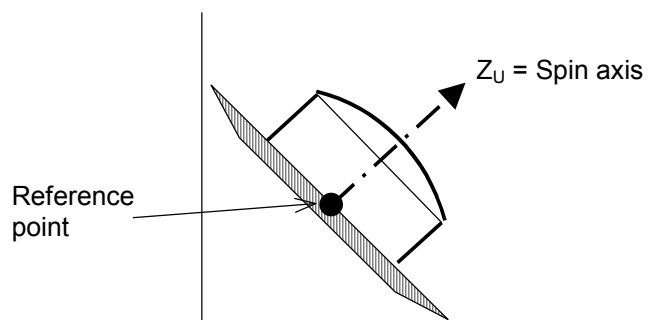
#### 9.1.2 General description

| Reaction Wheel          |                                                                                                                                                                       |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification          | RW                                                                                                                                                                    |
| RFDDDB-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM                                                                |
| Product tree            | B22BA                                                                                                                                                                 |
| CONFIG_Id (from RFDDDB) | UACRWA01, UACRWA02, UACRWA03, UACRWA04                                                                                                                                |
| Parent unit             | Central body                                                                                                                                                          |
| Coordinate systems      | Central body system.<br>RW mirror system (one mirror per wheel along boresight direction).                                                                            |
| Parameters              | Nominal direction of RW rotation axes to spacecraft frame.<br>Direction of RW mirrors to spacecraft frame.<br>Functional direction of RW rotation axes to RW mirrors. |



**Figure 10: Reaction wheels overview**

The reference point for each wheel is the origin of the unit coordinate system on the mounting bracket – see scheme below:



**Figure 11: Reaction wheel spin axis**



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 31

## 9.1.3 Parameters

| Position of Reaction Wheel attachment point      |                                                                            |                 |                 |                 |
|--------------------------------------------------|----------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                             | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                            |                 |                 |                 |
| Parameter description                            | Position of the attachment point of the Reaction Wheel to the central body |                 |                 |                 |
| Provided in<br>(reference coordinate system)     | Central body system                                                        |                 |                 |                 |
| Provided as                                      | Three vector components                                                    |                 |                 |                 |
| Physical units                                   | m                                                                          |                 |                 |                 |
| Nominal values      RFDDDB-ref.:<br>Figure-ref.: | Reaction Wheel                                                             | UNIT_POS_x      | UNIT_POS_y      | UNIT_POS_z      |
|                                                  |                                                                            | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                  | RW-1                                                                       | 0.72            | 0.18            | 1.265           |
|                                                  | RW-2                                                                       | 0.72            | -0.18           | 1.265           |
|                                                  | RW-3                                                                       | 0.72            | 0.18            | 0.935           |
|                                                  | RW-4                                                                       | 0.72            | -0.18           | 0.935           |

| Direction of Reaction Wheel rotation axes to spacecraft reference frame |                                                                     |                 |                 |                 |
|-------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                    | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM                 |                 |                 |                 |
| Product tree                                                            |                                                                     |                 |                 |                 |
| Parameter description                                                   | Nominal direction of RW rotation axes to spacecraft reference frame |                 |                 |                 |
| Provided in                                                             | Central body system                                                 |                 |                 |                 |
| Provided as                                                             | Direction cosine vector                                             |                 |                 |                 |
| Nominal values      RFDDDB-ref.:<br>Figure-ref.:                        | Direction cosines                                                   | BSIGHT_SC_x     | BSIGHT_SC_y     | BSIGHT_SC_z     |
|                                                                         |                                                                     | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                         | W1 (Z <sub>u</sub> )                                                | 0.612372        | 0.5             | 0.612372        |
|                                                                         | W2 (Z <sub>u</sub> )                                                | 0.612372        | -0.5            | 0.612372        |
|                                                                         | W3 (Z <sub>u</sub> )                                                | 0.612372        | 0.5             | -0.612372       |
|                                                                         | W4 (Z <sub>u</sub> )                                                | 0.612372        | -0.5            | -0.612372       |

## 9.2 REACTION CONTROL SYSTEM (THRUSTERS)

### 9.2.1 Introduction

Twelve thrusters are necessary for attitude and orbit control. Two sets of twelve thrusters are provided for redundancy purposes. They are spread over the spacecraft structure for highest effectivity.

The nomenclature for the main units is URCTR01A, URCTR02A, ...URCTR12A. The nomenclature for the redundant units is URCTR01B, URCTR02B, ... URCTR12B.

### 9.2.2 General description

The following two sketches show the locations. The A units have the larger lever arm.

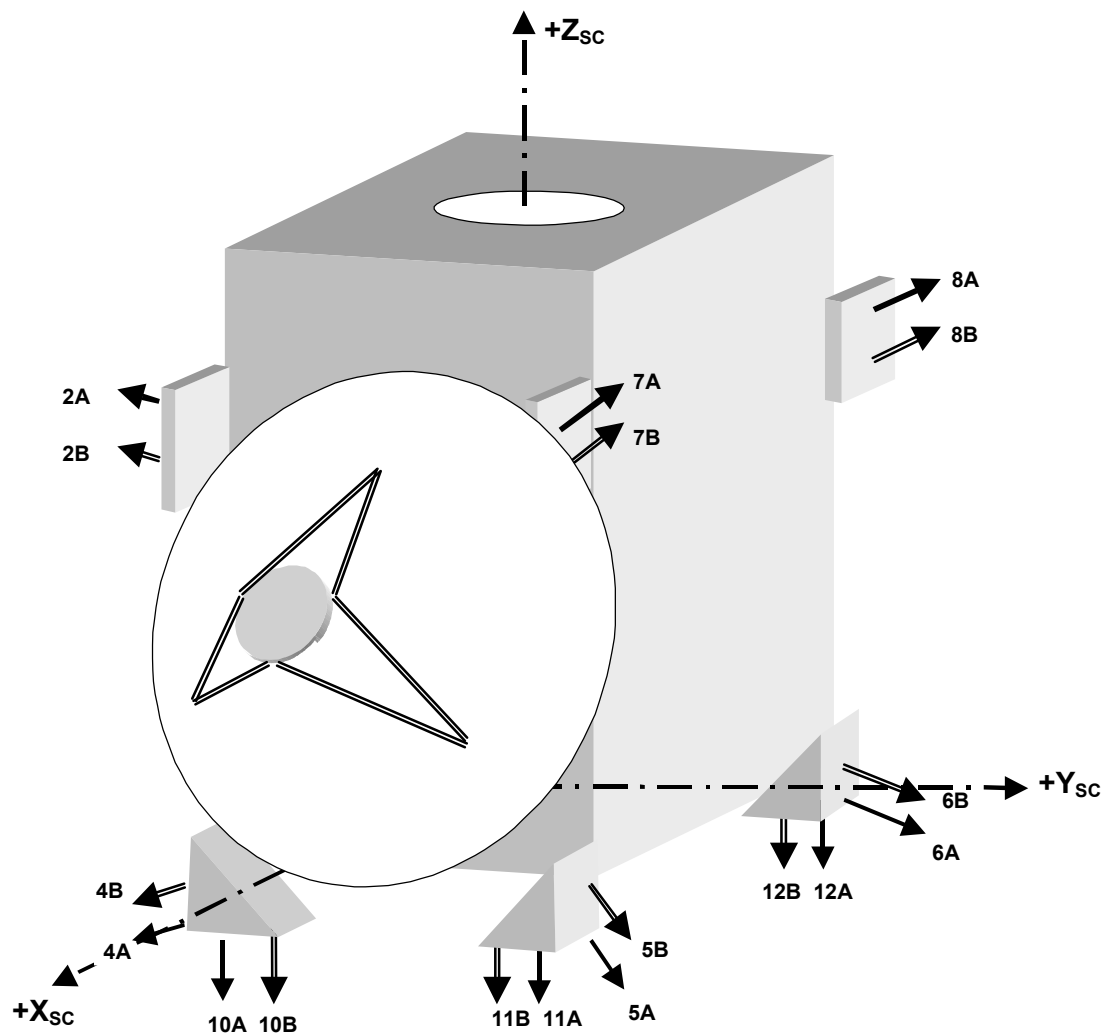
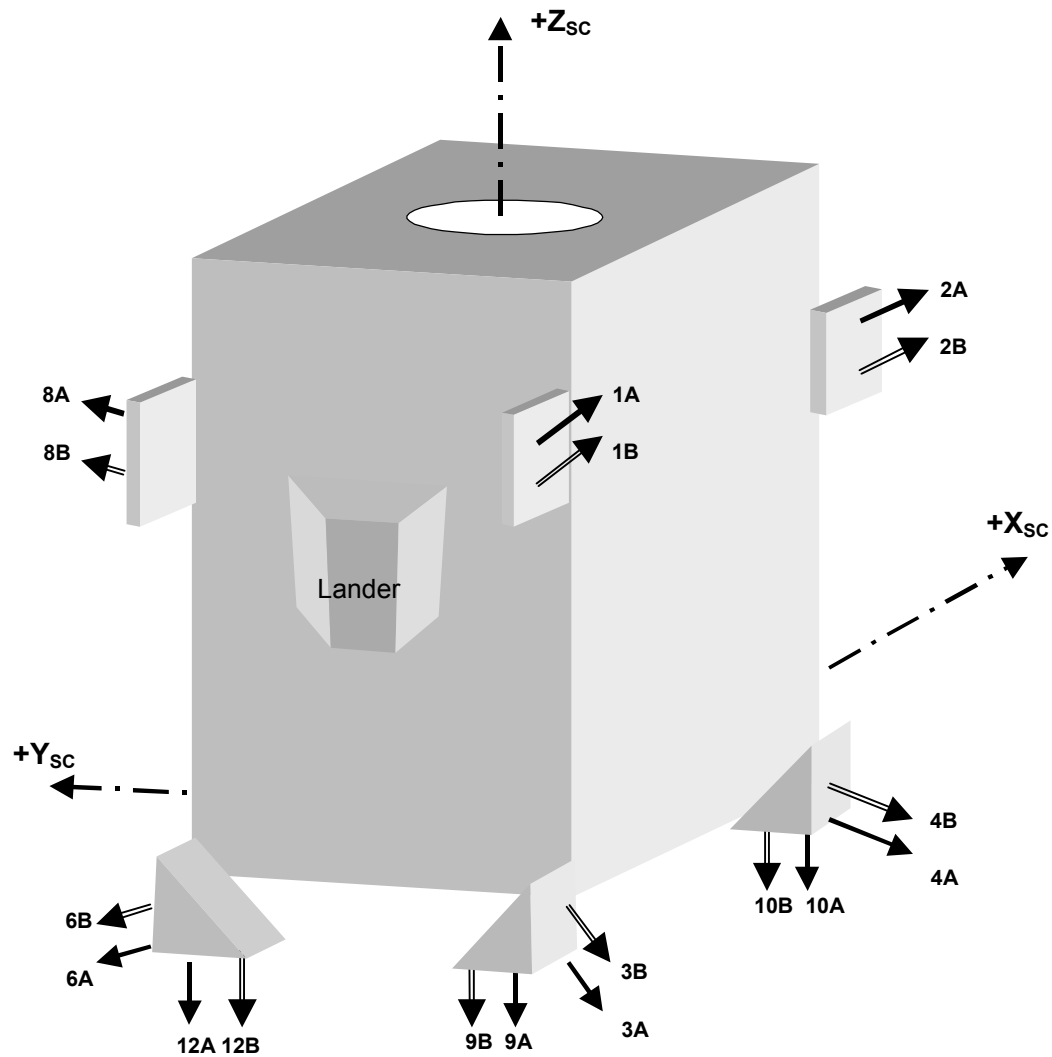


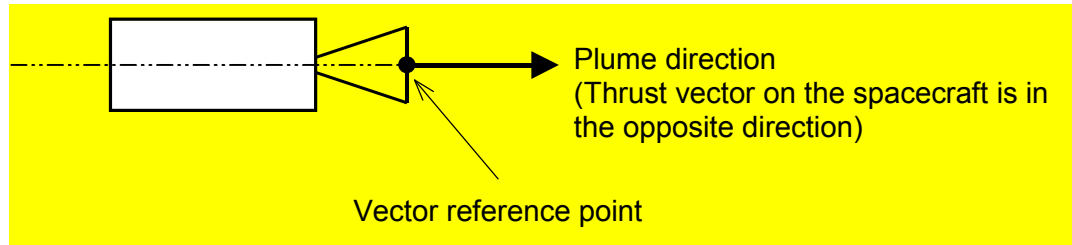
Figure 12: Thruster locations and orientations, view 1



**Figure 13: Thruster locations and orientations, view 2**

| Thrusters                 |                                                 |
|---------------------------|-------------------------------------------------|
| Identification            | 24 reaction control thrusters                   |
| RFDDb-table / query       | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM |
| Product tree              | B14A                                            |
| CONFIG_Id<br>(from RFDDb) | URCTR1A to URCTR12B                             |
| Type of unit              | Fixed                                           |
| Parent unit               | Central body                                    |
| Coordinate systems        | Central body system                             |
| Parameters                | Direction of thruster boresight axis            |

## 9.2.3 Parameters



**Figure 14: Definition of thruster plume direction and resulting thrust vector**

| Location and direction cosines                                          |                                                 |                 |                 |                                      |                 |                 |
|-------------------------------------------------------------------------|-------------------------------------------------|-----------------|-----------------|--------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                                                    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM |                 |                 |                                      |                 |                 |
| Location of vector reference point (end of nozzle)<br>Physical units: m |                                                 |                 |                 | Direction cosines of plume direction |                 |                 |
| RFDDDB-ref.:                                                            | UNIT_POS_x                                      | UNIT_POS_y      | UNIT_POS_z      | A_MECH_SC_1x                         | A_MECH_SC_1y    | A_MECH_SC_1z    |
| Figure-ref.:                                                            | X <sub>SC</sub>                                 | Y <sub>SC</sub> | Z <sub>SC</sub> | X <sub>SC</sub>                      | Y <sub>SC</sub> | Z <sub>SC</sub> |
| URCTR01A                                                                | -1.2319                                         | -1.1395         | +2.1768         | -0.469846                            | -0.866025       | +0.171010       |
| URCTR01B                                                                | -1.2381                                         | -1.1509         | +2.1019         | -0.469846                            | -0.866025       | +0.171010       |
| URCTR02A                                                                | +1.2319                                         | -1.1395         | +2.1768         | +0.469846                            | -0.866025       | +0.171010       |
| URCTR02B                                                                | +1.2381                                         | -1.1509         | +2.1019         | +0.469846                            | -0.866025       | +0.171010       |
| URCTR03A                                                                | -1.2319                                         | -1.1395         | -0.0843         | -0.469846                            | -0.866025       | -0.171010       |
| URCTR03B                                                                | -1.2381                                         | -1.1509         | -0.0094         | -0.469846                            | -0.866025       | -0.171010       |
| URCTR04A                                                                | +1.2319                                         | -1.1395         | -0.0843         | +0.469846                            | -0.866025       | -0.171010       |
| URCTR04B                                                                | +1.2381                                         | -1.1509         | -0.0094         | +0.469846                            | -0.866025       | -0.171010       |
| URCTR05A                                                                | +1.2319                                         | +1.1395         | -0.0843         | +0.469846                            | +0.866025       | -0.171010       |
| URCTR05B                                                                | +1.2381                                         | +1.1509         | -0.0094         | +0.469846                            | +0.866025       | -0.171010       |
| URCTR06A                                                                | -1.2319                                         | +1.1395         | -0.0843         | -0.469846                            | +0.866025       | -0.171010       |
| URCTR06B                                                                | -1.2381                                         | +1.1509         | -0.0094         | -0.469846                            | +0.866025       | -0.171010       |
| URCTR07A                                                                | +1.2319                                         | +1.1395         | +2.1768         | +0.469846                            | +0.866025       | +0.171010       |
| URCTR07B                                                                | +1.2381                                         | +1.1509         | +2.1019         | +0.469846                            | +0.866025       | +0.171010       |
| URCTR08A                                                                | -1.2319                                         | +1.1395         | +2.1768         | -0.469846                            | +0.866025       | +0.171010       |
| URCTR08B                                                                | -1.2381                                         | +1.1509         | +2.1019         | -0.469846                            | +0.866025       | +0.171010       |
| URCTR09A                                                                | -1.1600                                         | -0.9030         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR09B                                                                | -1.1600                                         | -0.8270         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR10A                                                                | +1.1600                                         | -0.9030         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR10B                                                                | +1.1600                                         | -0.8270         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR11A                                                                | +1.1600                                         | +0.9030         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR11B                                                                | +1.1600                                         | +0.8270         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR12A                                                                | -1.1600                                         | +0.9030         | -0.1992         | 0.0                                  | 0.0             | -1.0            |
| URCTR12B                                                                | -1.1600                                         | +0.8270         | -0.1992         | 0.0                                  | 0.0             | -1.0            |

## 10. PAYLOAD UNIT REFERENCE FRAMES

### 10.1 ALICE

#### 10.1.1 General description

| ALICE                  |                                                                                                                                                                                                                                                                  |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | ALICE                                                                                                                                                                                                                                                            |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                          |
| Product tree           | A11A                                                                                                                                                                                                                                                             |
| CONFIG_Id (from RFDDb) | UALALICE                                                                                                                                                                                                                                                         |
| Coordinate systems     | Central body system.<br>ALICE nominal unit system.<br>ALICE mirror system.<br>ALICE functional unit system.                                                                                                                                                      |
| Parameters             | Position of ALICE unit reference hole.<br>Orientation of ALICE nominal unit frame to the spacecraft reference frame.<br>Orientation of ALICE mirror frame to the spacecraft reference frame.<br>Orientation of ALICE functional frame to the ALICE mirror frame. |

#### 10.1.2 Coordinate systems

The reference point is taken as the origin and the direction cosines as the axes of the local frame.

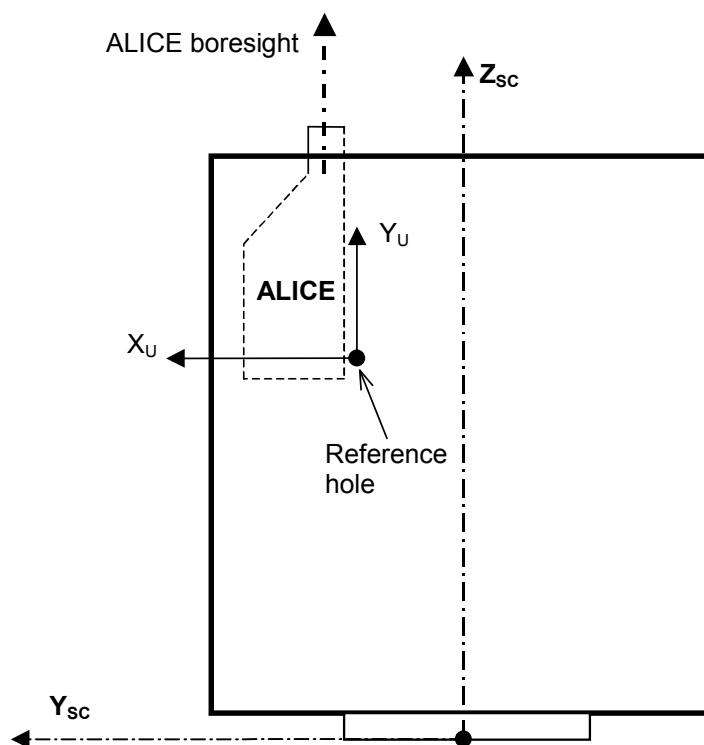


Figure 15: ALICE unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 36

## 10.1.3 Parameters

| Position of ALICE reference hole                                       |                                                                 |                 |                 |
|------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |
| Parameter description                                                  | Position of the reference hole of the ALICE to the central body |                 |                 |
| Provided in<br>(reference coordinate system)                           | Central body system                                             |                 |                 |
| Provided as                                                            | Coordinates in spacecraft reference frame                       |                 |                 |
| Physical units                                                         | m                                                               |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>UNIT_POS_X to UNIT_POS_Z) | X <sub>SC</sub>                                                 | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                        | -1.0244                                                         | 0.6900          | 2.3000          |

| Orientation of ALICE nominal unit reference frame to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                               | Transformation matrix (§ 7.1) from the central body system to the ALICE nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                        | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units                                                                      | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)       | Direction cosines                                                                                     | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                     | X <sub>U</sub>                                                                                        | 0               | 1               | 0               |
|                                                                                     | Y <sub>U</sub>                                                                                        | 0               | 0               | 1               |
|                                                                                     | Z <sub>U</sub>                                                                                        | 1               | 0               | 0               |

| Orientation of ALICE mirror frame to the spacecraft reference frame                     |                                                                                      |                 |                 |                 |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                      |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the ALICE mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                  |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                      |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                        |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                    | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                  | 0               | 1               | 0               |
|                                                                                         | Y <sub>mirror</sub>                                                                  | 0               | 0               | 1               |
|                                                                                         | Z <sub>mirror</sub>                                                                  | 1               | 0               | 0               |

| Orientation of ALICE functional frame to the ALICE mirror frame                           |                                                                                            |                     |                     |                     |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                          |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from ALICE mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                         |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                            |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                              |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                          | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                            | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                            | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                            | 0                   | 0                   | 1                   |

## 10.2 MIRO

### 10.2.1 General description

| MIRO                   |                                                                                                                                                                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | MIRO                                                                                                                                                                                                                                                        |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                     |
| Product tree           | A11B                                                                                                                                                                                                                                                        |
| CONFIG_Id (from RFDDb) | UMRMIRO0                                                                                                                                                                                                                                                    |
| Coordinate systems     | Central body system.<br>MIRO nominal unit system.<br>MIRO mirror system.<br>MIRO functional unit system.                                                                                                                                                    |
| Parameters             | Position of MIRO unit reference hole.<br>Orientation of MIRO nominal unit frame to the spacecraft reference frame.<br>Orientation of MIRO mirror frame to the spacecraft reference frame.<br>Orientation of MIRO functional frame to the MIRO mirror frame. |

### 10.2.2 Coordinate systems

The reference point is taken as the origin and the direction cosines as the axes of the local frame.

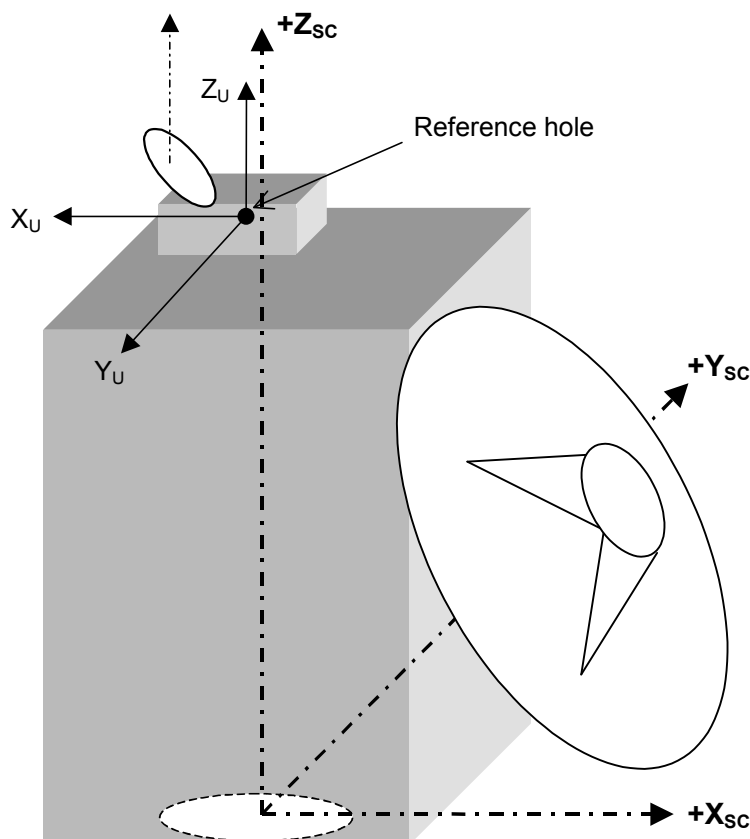


Figure 16: MIRO unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 38

## 10.2.3 Parameters

### Position of MIRO reference hole

|                                                                        |                                                                |          |          |
|------------------------------------------------------------------------|----------------------------------------------------------------|----------|----------|
| RFDDDB-table / query                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                |          |          |
| Parameter description                                                  | Position of the reference hole of the MIRO to the central body |          |          |
| Provided in<br>(reference coordinate system)                           | Central body system                                            |          |          |
| Provided as                                                            | Coordinates in spacecraft reference frame                      |          |          |
| Physical units                                                         | m                                                              |          |          |
| Nominal values<br>(RFDDDB-identification:<br>UNIT_POS_X to UNIT_POS_Z) | $X_{sc}$                                                       | $Y_{sc}$ | $Z_{sc}$ |
|                                                                        | -0.1100                                                        | 0.9236   | 2.6550   |

### Orientation of MIRO nominal reference frame to the spacecraft reference frame

|                                                                               |                                                                                              |          |          |          |
|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------|----------|----------|
| RFDDDB-table / query                                                          | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                              |          |          |          |
| Parameter description                                                         | Transformation matrix (§ 7.1) from the central body system to the MIRO unit reference system |          |          |          |
| Provided in<br>(reference coordinate system)                                  | Central body system                                                                          |          |          |          |
| Provided as                                                                   | Direction cosine matrix according to § 7.4                                                   |          |          |          |
| Physical units                                                                | Dimensionless                                                                                |          |          |          |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z) | Direction cosines                                                                            | $X_{sc}$ | $Y_{sc}$ | $Z_{sc}$ |
|                                                                               | $X_u$                                                                                        | -1       | 0        | 0        |
|                                                                               | $Y_u$                                                                                        | 0        | -1       | 0        |
|                                                                               | $Z_u$                                                                                        | 0        | 0        | 1        |

### Orientation of MIRO mirror frame to the spacecraft reference frame

|                                                                                         |                                                                                     |          |          |          |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------|----------|----------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                     |          |          |          |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the MIRO mirror frame |          |          |          |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                 |          |          |          |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                     |          |          |          |
| Physical units                                                                          | Dimensionless                                                                       |          |          |          |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                   | $X_{sc}$ | $Y_{sc}$ | $Z_{sc}$ |
|                                                                                         | $X_{mirror}$                                                                        | -1       | 0        | 0        |
|                                                                                         | $Y_{mirror}$                                                                        | 0        | -1       | 0        |
|                                                                                         | $Z_{mirror}$                                                                        | 0        | 0        | 1        |

### Orientation of MIRO functional frame to MIRO mirror frame

|                                                                                           |                                                                                               |              |              |              |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------|--------------|--------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                             |              |              |              |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from the MIRO mirror system to unit functional reference system |              |              |              |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                            |              |              |              |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                               |              |              |              |
| Physical units                                                                            | Dimensionless                                                                                 |              |              |              |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                             | $X_{mirror}$ | $Y_{mirror}$ | $Z_{mirror}$ |
|                                                                                           | $X_{fu}$                                                                                      | 1            | 0            | 0            |
|                                                                                           | $Y_{fu}$                                                                                      | 0            | 1            | 0            |
|                                                                                           | $Z_{fu}$                                                                                      | 0            | 0            | 1            |

## 10.3 OSIRIS-NAC

### 10.3.1 General description

| OSIRIS-NAC             |                                                                                                                                                                                                                                                                                           |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | OSIRIS-NAC                                                                                                                                                                                                                                                                                |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                                   |
| Product tree           | A11DB                                                                                                                                                                                                                                                                                     |
| CONFIG_Id (from RFDDb) | USRNAC00                                                                                                                                                                                                                                                                                  |
| Coordinate systems     | Central body system.<br>OSIRIS-NAC nominal unit system.<br>OSIRIS-NAC mirror system.<br>OSIRIS-NAC functional unit system.                                                                                                                                                                |
| Parameters             | Position of OSIRIS-NAC unit reference hole.<br>Orientation of OSIRIS-NAC nominal unit frame to the spacecraft reference frame.<br>Orientation of OSIRIS-NAC mirror frame to the spacecraft reference frame.<br>Orientation of OSIRIS-NAC functional frame to the OSIRIS-NAC mirror frame. |

### 10.3.2 Coordinate systems

The reference point is taken as the origin and the direction cosines as the axes of the local frame.

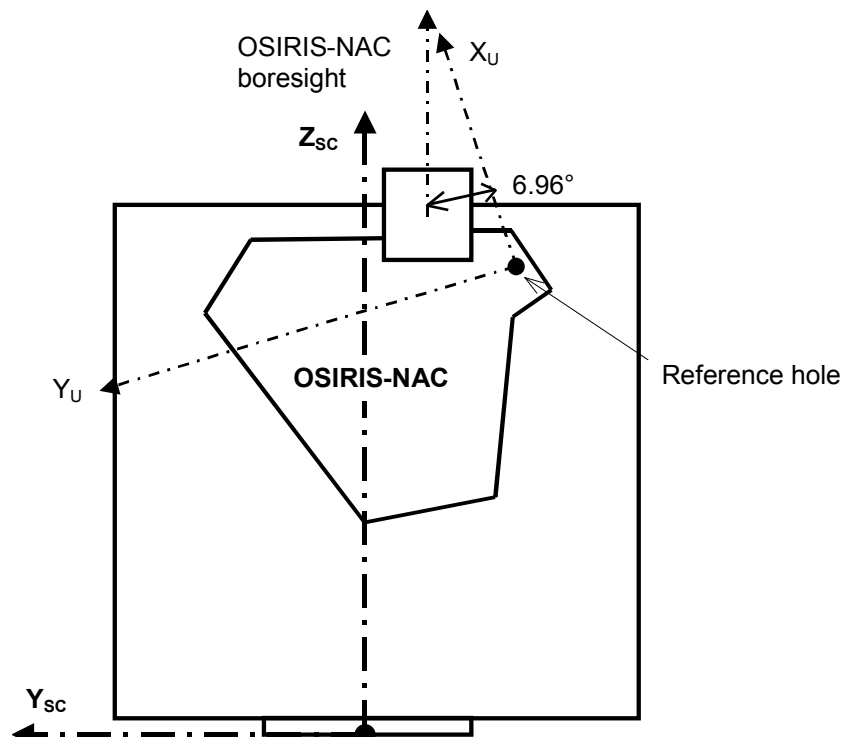


Figure 17: OSIRIS-NAC unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 40

## 10.3.3 Parameters

### Position of OSIRIS-NAC reference hole

|                                                                        |                                                                      |                            |                           |
|------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------|---------------------------|
| RFDDDB-table / query                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                      |                            |                           |
| Parameter description                                                  | Position of the reference hole of the OSIRIS-NAC to the central body |                            |                           |
| Provided in<br>(reference coordinate system)                           | Central body system                                                  |                            |                           |
| Provided as                                                            | Coordinates in spacecraft reference frame                            |                            |                           |
| Physical units                                                         | m                                                                    |                            |                           |
| Nominal values<br>(RFDDDB-identification:<br>UNIT_POS_X to UNIT_POS_Z) | X <sub>SC</sub><br>-1.0520                                           | Y <sub>SC</sub><br>-0.3250 | Z <sub>SC</sub><br>2.4291 |

### Orientation of OSIRIS-NAC nominal unit reference frame to the spacecraft reference frame

|                                                                               |                                                                                                    |                 |                 |                 |
|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                          | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                    |                 |                 |                 |
| Parameter description                                                         | Transformation matrix (§ 7.1) from the central body system to the OSIRIS-NAC unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                  | Central body system                                                                                |                 |                 |                 |
| Provided as                                                                   | Direction cosine matrix according to § 7.4                                                         |                 |                 |                 |
| Physical units                                                                | Dimensionless                                                                                      |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z) | Direction cosines                                                                                  | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                               | X <sub>U</sub>                                                                                     | 0               | 0.1211764       | 0.9926310       |
|                                                                               | Y <sub>U</sub>                                                                                     | 0               | 0.9926310       | -0.1211764      |
|                                                                               | Z <sub>U</sub>                                                                                     | -1              | 0               | 0               |

### Orientation of OSIRIS-NAC mirror frame to the spacecraft reference frame

|                                                                                         |                                                                                           |                 |                 |                 |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                           |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the OSIRIS-NAC mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                       |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                           |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                             |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                         | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | Xmirror                                                                                   | 0               | 0               | 1               |
|                                                                                         | Ymirror                                                                                   | 0               | 1               | 0               |
|                                                                                         | Zmirror                                                                                   | -1              | 0               | 0               |

### Orientation of OSIRIS-NAC functional frame to OSIRIS-NAC mirror frame

|                                                                                           |                                                                                                 |         |         |         |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------|---------|---------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                               |         |         |         |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from OSIRIS-NAC mirror system to unit functional reference system |         |         |         |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                              |         |         |         |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                                 |         |         |         |
| Physical units                                                                            | Dimensionless                                                                                   |         |         |         |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                               | Xmirror | Ymirror | Zmirror |
|                                                                                           | Xfu                                                                                             | 1       | 0       | 0       |
|                                                                                           | Yfu                                                                                             | 0       | 1       | 0       |
|                                                                                           | Zfu                                                                                             | 0       | 0       | 1       |

## 10.4 OSIRIS-WAC

### 10.4.1 General description

| OSIRIS-WAC             |                                                                                                                                                                                                                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | OSIRIS-WAC                                                                                                                                                                                                                                                                                     |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                                        |
| Product tree           | A11DA                                                                                                                                                                                                                                                                                          |
| CONFIG_Id (from RFDDb) | USRWAC00                                                                                                                                                                                                                                                                                       |
| Coordinate systems     | Central body system.<br>OSIRIS-WAC nominal unit system.<br>OSIRIS-WAC mirror system.<br>OSIRIS-WAC functional unit system.                                                                                                                                                                     |
| Parameters             | Position of OSIRIS-WAC unit reference hole.<br>Orientation of OSIRIS-WAC nominal unit frame to the spacecraft reference frame.<br>Orientation of OSIRIS-WAC mirror frame to the spacecraft reference frame.<br>Orientation of OSIRIS-WAC functional unit frame to the OSIRIS-WAC mirror frame. |

### 10.4.2 Coordinate systems

The reference point is taken as the origin and the direction cosines as the axes of the local frame.

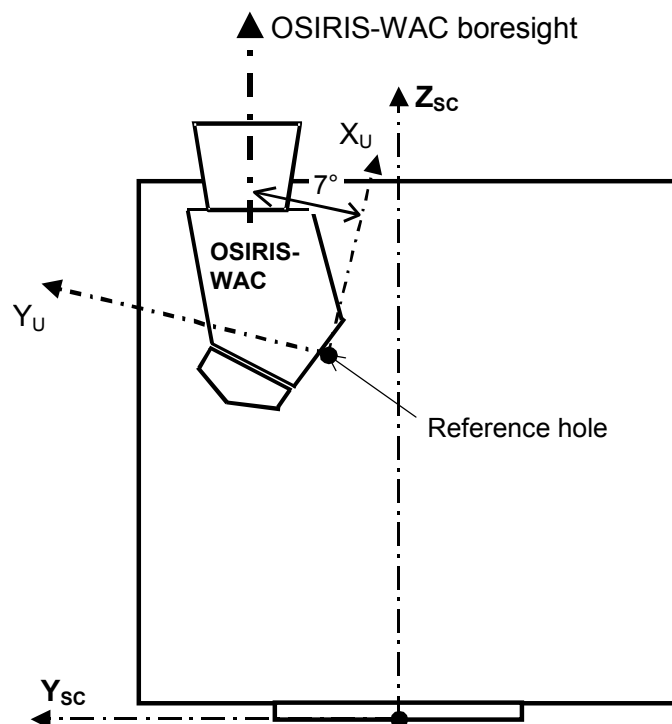


Figure 18: OSIRIS-WAC unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 42

## 10.4.3 Parameters

| Position of OSIRIS-WAC reference hole                                  |                                                                      |                 |                 |
|------------------------------------------------------------------------|----------------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                      |                 |                 |
| Parameter description                                                  | Position of the reference hole of the OSIRIS-WAC to the central body |                 |                 |
| Provided in<br>(reference coordinate system)                           | Central body system                                                  |                 |                 |
| Provided as                                                            | Coordinates in spacecraft reference frame                            |                 |                 |
| Physical units                                                         | m                                                                    |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>UNIT_POS_X to UNIT_POS_Z) | X <sub>SC</sub>                                                      | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                        | -1.0500                                                              | 0.2325          | 2.1139          |

| Orientation of OSIRIS-WAC reference frame to the spacecraft reference frame   |                                                                                                    |                 |                 |                 |
|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                          | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                    |                 |                 |                 |
| Parameter description                                                         | Transformation matrix (§ 7.1) from the central body system to the OSIRIS-WAC unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                  | Central body system                                                                                |                 |                 |                 |
| Provided as                                                                   | Direction cosine matrix according to § 7.4                                                         |                 |                 |                 |
| Physical units                                                                | Dimensionless                                                                                      |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z) | Direction cosines                                                                                  | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                               | X <sub>U</sub>                                                                                     | 0               | -0.1218693      | 0.9925462       |
|                                                                               | Y <sub>U</sub>                                                                                     | 0               | 0.9925462       | 0.1218693       |
|                                                                               | Z <sub>U</sub>                                                                                     | -1              | 0               | 0               |

| Orientation of OSIRIS-WAC mirror frame to the spacecraft reference frame                |                                                                                           |                 |                 |                 |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                           |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the OSIRIS-WAC mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                       |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                           |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                             |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                         | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                       | 0               | 0               | 1               |
|                                                                                         | Y <sub>mirror</sub>                                                                       | 0               | 1               | 0               |
|                                                                                         | Z <sub>mirror</sub>                                                                       | -1              | 0               | 0               |

| Orientation of OSIRIS-WAC functional frame to OSIRIS-WAC mirror frame                     |                                                                                                 |                     |                     |                     |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                               |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from OSIRIS-WAC mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                              |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                                 |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                                   |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                               | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                                 | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                                 | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                                 | 0                   | 0                   | 1                   |

## 10.5 VIRTIS

### 10.5.1 General description

| VIRTIS                 |                                                                                                                                                                                                                                                                        |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | VIRTIS                                                                                                                                                                                                                                                                 |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                |
| Product tree           | A11C                                                                                                                                                                                                                                                                   |
| CONFIG_Id (from RFDDb) | UVRVIRTIS000                                                                                                                                                                                                                                                           |
| Coordinate systems     | Central body system.<br>VIRTIS nominal unit system.<br>VIRTIS mirror system.<br>VIRTIS functional unit system.                                                                                                                                                         |
| Parameters             | Position of VIRTIS unit reference hole.<br>Orientation of VIRTIS unit reference axes to the spacecraft reference frame.<br>Orientation of VIRTIS mirror frame to the spacecraft reference frame.<br>Orientation of VIRTIS functional frame to the VIRTIS mirror frame. |

### 10.5.2 Coordinate systems

The reference point is taken as the origin and the direction cosines as the axes of the local frame.

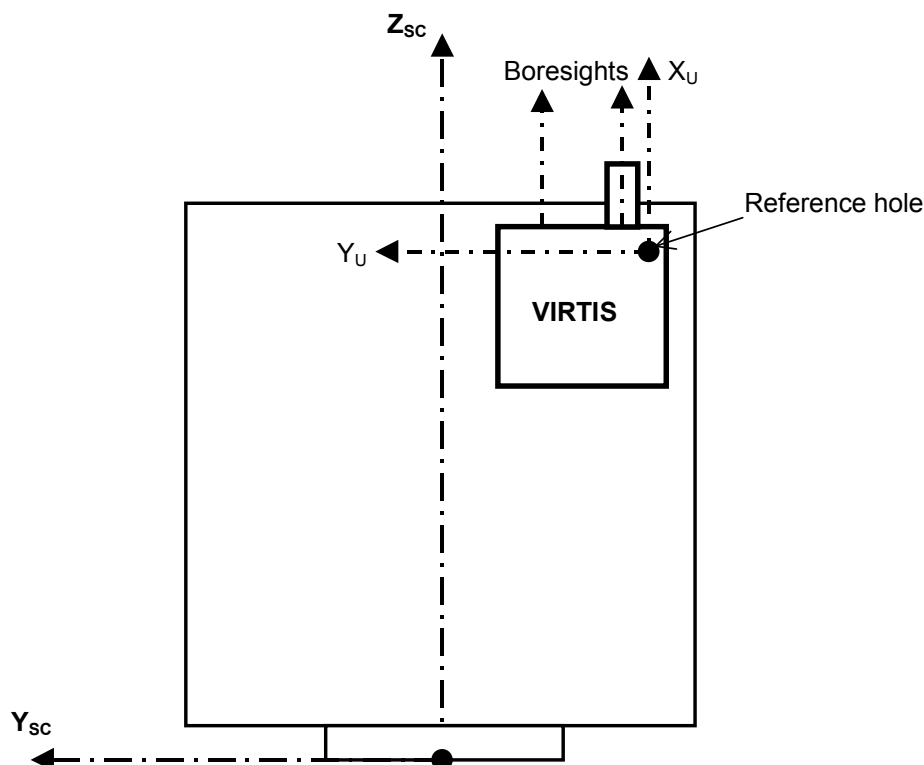


Figure 19: VIRTIS unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 44

## 10.5.3 Parameters

| Position of VIRTIS reference hole                                      |                                                                  |                 |                 |
|------------------------------------------------------------------------|------------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                  |                 |                 |
| Parameter description                                                  | Position of the reference hole of the VIRTIS to the central body |                 |                 |
| Provided in<br>(reference coordinate system)                           | Central body system                                              |                 |                 |
| Provided as                                                            | Coordinates in spacecraft reference frame                        |                 |                 |
| Physical units                                                         | m                                                                |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>UNIT_POS_X to UNIT_POS_Z) | X <sub>SC</sub>                                                  | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                        | -1.050                                                           | -0.8400         | 2.5462          |

| Orientation of VIRTIS nominal unit reference frame to the spacecraft reference frame |                                                                                                        |                 |                 |                 |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                 | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                        |                 |                 |                 |
| Parameter description                                                                | Transformation matrix (§ 7.1) from the central body system to the VIRTIS nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                         | Central body system                                                                                    |                 |                 |                 |
| Provided as                                                                          | Direction cosine matrix according to § 7.4                                                             |                 |                 |                 |
| Physical units                                                                       | Dimensionless                                                                                          |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)        | Direction cosines                                                                                      | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                      | X <sub>U</sub>                                                                                         | 0               | 0               | 1               |
|                                                                                      | Y <sub>U</sub>                                                                                         | 0               | 1               | 0               |
|                                                                                      | Z <sub>U</sub>                                                                                         | -1              | 0               | 0               |

| Orientation of VIRTIS mirror frame to the spacecraft reference frame                    |                                                                                       |                 |                 |                 |
|-----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                       |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the VIRTIS mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                   |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                       |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                     | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                   | 0               | 0               | 1               |
|                                                                                         | Y <sub>mirror</sub>                                                                   | 0               | 1               | 0               |
|                                                                                         | Z <sub>mirror</sub>                                                                   | -1              | 0               | 0               |

| Orientation of VIRTIS functional frame to VIRTIS mirror frame                             |                                                                                                 |                     |                     |                     |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                               |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from the VIRTIS mirror system to functional unit reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                              |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                                 |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                                   |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                               | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                                 | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                                 | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                                 | 0                   | 0                   | 1                   |

## 11. SENSOR UNIT REFERENCE FRAMES

### 11.1 IMU ASSEMBLY

#### 11.1.1 Introduction

Three units are mounted on a common bracket on the -Y BSM panel. The nomenclature for unit identification is IMU-A, IMU-B, IMU-C.

Two connectors on each unit define the relative orientation on the bracket. The reference point is the center of the datum plane on the bracket.

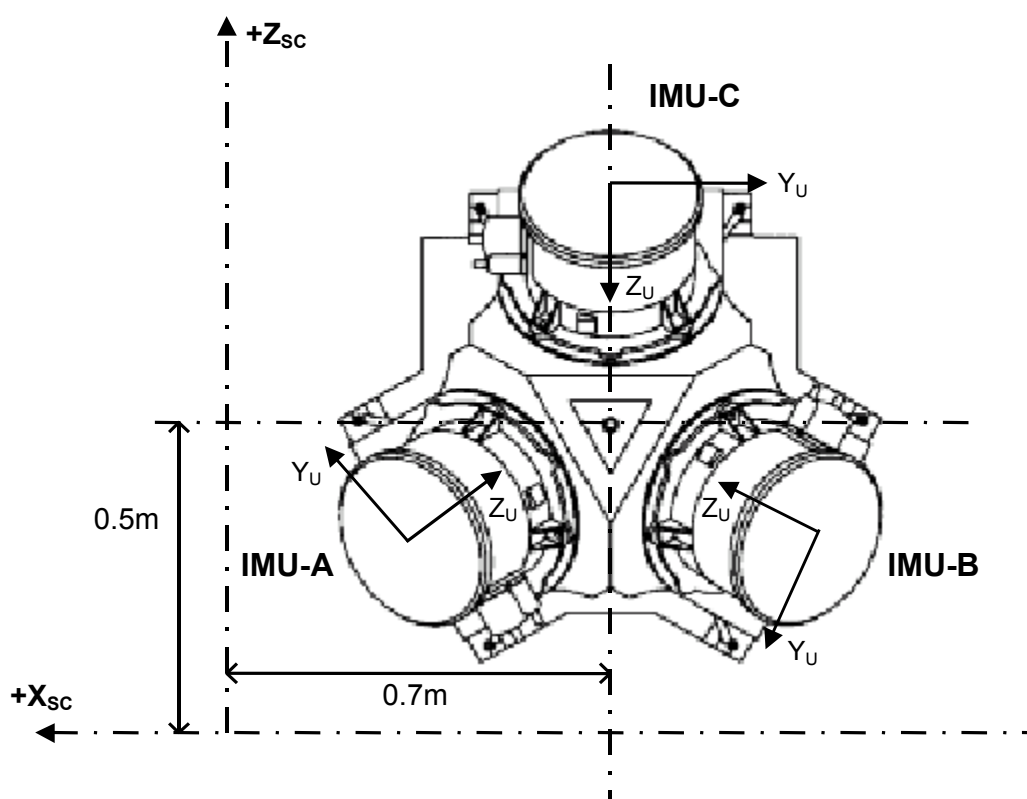


Figure 20: IMU overview

Remarks:

- $X_u$  axes are directed along the cylindrical axis, at  $45^\circ$  to the  $+Y_{sc}$  axis.
- $Y_u$  axes are in the  $X_{sc} Z_{sc}$  plane.

## 11.1.2 IMU-A

### 11.1.2.1 General description

| IMU-A               |                                                                                                                                                                                                                                                                  |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification      | IMU-A                                                                                                                                                                                                                                                            |
| RFDDb-table / query | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                          |
| Product tree        | B22C                                                                                                                                                                                                                                                             |
| CONFIG_Id           | UACIMP01                                                                                                                                                                                                                                                         |
| Type of unit        | Fixed                                                                                                                                                                                                                                                            |
| Parent unit         | Central body                                                                                                                                                                                                                                                     |
| Coordinate systems  | Central body system.<br>IMU-A nominal unit system.<br>IMU-A mirror system.<br>IMU-A functional unit system.                                                                                                                                                      |
| Parameters          | Position of IMU-A unit reference hole.<br>Orientation of IMU-A nominal unit frame to the spacecraft reference frame.<br>Orientation of IMU-A mirror frame to the spacecraft reference frame.<br>Orientation of IMU-A functional frame to the IMU-A mirror frame. |

### 11.1.2.2 Coordinate systems

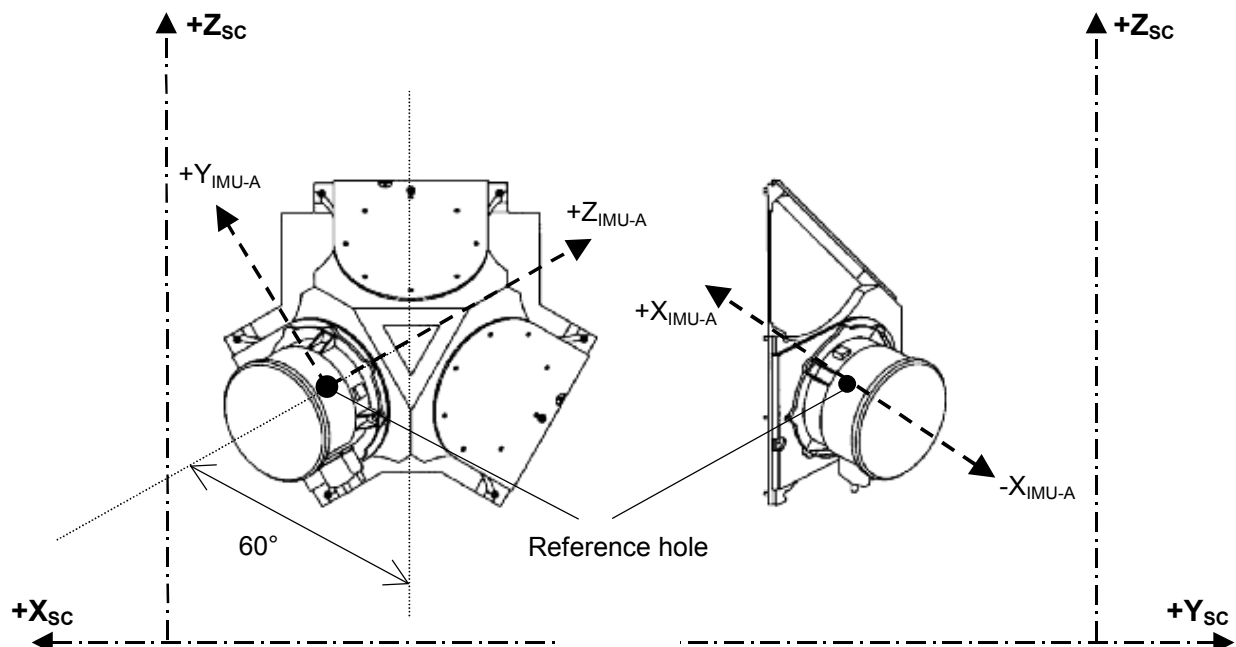


Figure 21: IMU-A unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 47

## 11.1.2.3 Parameters

| Position of IMU-A reference hole               |                                                                 |                 |                 |
|------------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                           | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |
| Parameter description                          | Position of the reference hole of the IMU-A to the central body |                 |                 |
| Provided in<br>(reference coordinate system)   | Central body system                                             |                 |                 |
| Provided as                                    | Coordinates in spacecraft reference frame                       |                 |                 |
| Physical units                                 | m                                                               |                 |                 |
| Nominal values<br>RFDDDB-ref.:<br>Figure-ref.: | UNIT_POS_x                                                      | UNIT_POS_y      | UNIT_POS_z      |
|                                                | X <sub>sc</sub>                                                 | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                | -0.5699                                                         | -0.8568         | 0.4249          |

| Orientation of IMU-A nominal unit reference frame to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                               | Transformation matrix (§ 7.1) from the central body system to the IMU-A nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                        | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units values                                                               | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)       | Direction cosines                                                                                     | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                     | X <sub>u</sub>                                                                                        | -0.612372       | -0.707107       | 0.353553        |
|                                                                                     | Y <sub>u</sub>                                                                                        | 0.5             | 0               | 0.866025        |
|                                                                                     | Z <sub>u</sub>                                                                                        | -0.612372       | 0.707107        | 0.353553        |
|                                                                                     |                                                                                                       |                 |                 |                 |

| Orientation of IMU-A mirror frame to the spacecraft reference frame                     |                                                                                      |                 |                 |                 |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                      |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the IMU-A mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                  |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                      |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                        |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                    | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                  | -0.612372       | -0.707107       | 0.353553        |
|                                                                                         | Y <sub>mirror</sub>                                                                  | 0.5             | 0               | 0.866025        |
|                                                                                         | Z <sub>mirror</sub>                                                                  | -0.612372       | 0.707107        | 0.353553        |
|                                                                                         |                                                                                      |                 |                 |                 |

| Orientation of IMU-A functional frame to IMU-A mirror frame                               |                                                                                            |                     |                     |                     |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                          |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from IMU-A mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                         |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                            |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                              |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                          | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                            | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                            | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                            | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                            |                     |                     |                     |

## 11.1.3 IMU-B

### 11.1.3.1 General description

| IMU-B                  |                                                                                                                                                                                                                                                                   |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | IMU-B                                                                                                                                                                                                                                                             |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                           |
| Product tree           | B22C                                                                                                                                                                                                                                                              |
| CONFIG_Id (from RFDDb) | UACIMP02                                                                                                                                                                                                                                                          |
| Type of unit           | Fixed                                                                                                                                                                                                                                                             |
| Parent unit            | Central body                                                                                                                                                                                                                                                      |
| Coordinate systems     | Central body system.<br>IMU-B nominal unit system.<br>IMU-B mirror system.<br>IMU-B functional unit system.                                                                                                                                                       |
| Parameters             | Position of IMU-B unit reference hole .<br>Orientation of IMU-B nominal unit frame to the spacecraft reference frame.<br>Orientation of IMU-B mirror frame to the spacecraft reference frame.<br>Orientation of IMU-B functional frame to the IMU-B mirror frame. |

### 11.1.3.2 Coordinate systems

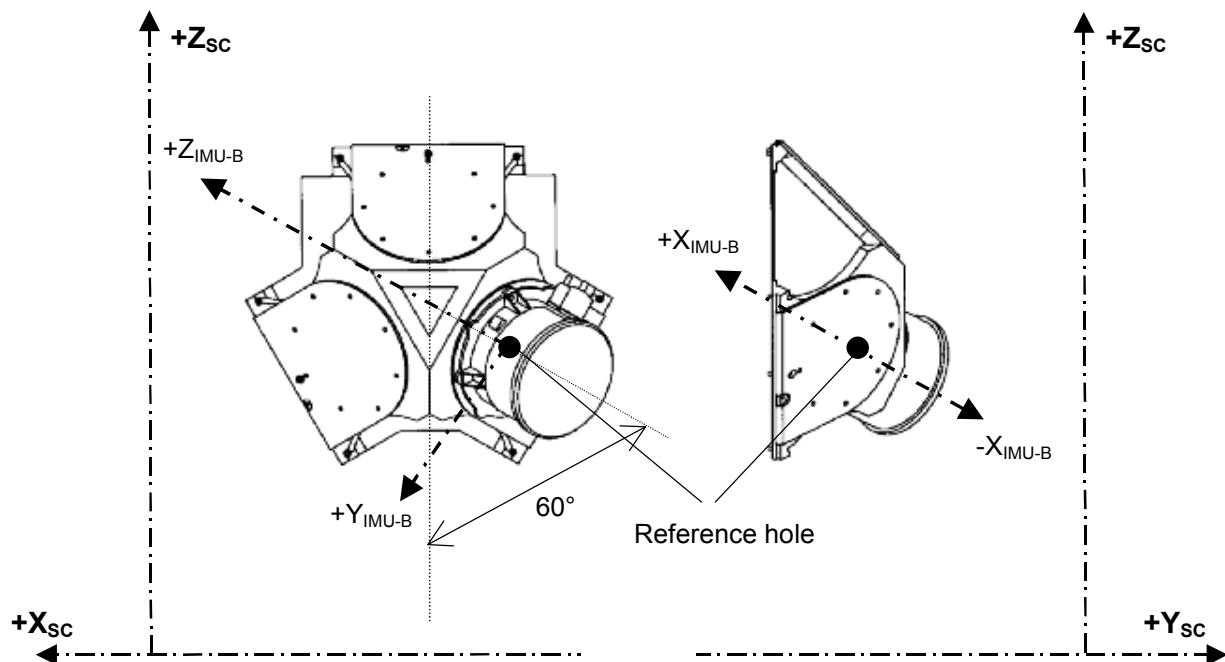


Figure 22: IMU-B unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 49

## 11.1.3.3 Parameters

| Position of IMU-B reference hole               |                                                                 |                 |                 |  |
|------------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|--|
| RFDDDB-table / query                           | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |  |
| Parameter description                          | Position of the reference hole of the IMU-B to the central body |                 |                 |  |
| Provided in<br>(reference coordinate system)   | Central body system                                             |                 |                 |  |
| Provided as                                    | Coordinates in spacecraft reference frame                       |                 |                 |  |
| Physical units                                 | m                                                               |                 |                 |  |
| Nominal values<br>RFDDDB-ref.:<br>Figure-ref.: | UNIT_POS_x                                                      | UNIT_POS_y      | UNIT_POS_z      |  |
|                                                | X <sub>sc</sub>                                                 | Y <sub>sc</sub> | Z <sub>sc</sub> |  |
|                                                | -0.8301                                                         | -0.8568         | 0.4249          |  |

| Orientation of IMU-B nominal unit reference axes to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                               | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                              | Transformation matrix (§ 7.1) from the central body system to the IMU-B nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                       | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                        | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units                                                                     | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)      | Direction cosines                                                                                     | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                    | X <sub>u</sub>                                                                                        | 0.612372        | -0.707107       | 0.353553        |
|                                                                                    | Y <sub>u</sub>                                                                                        | 0.5             | 0               | -0.866025       |
|                                                                                    | Z <sub>u</sub>                                                                                        | 0.612372        | 0.707107        | 0.353553        |
|                                                                                    |                                                                                                       |                 |                 |                 |

| Orientation of IMU-B mirror frame to the spacecraft reference frame                     |                                                                                      |                 |                 |                 |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                      |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the IMU-B mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                  |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                      |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                        |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                    | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                  | 0.612372        | -0.707107       | 0.353553        |
|                                                                                         | Y <sub>mirror</sub>                                                                  | 0.5             | 0               | -0.866025       |
|                                                                                         | Z <sub>mirror</sub>                                                                  | 0.612372        | 0.707107        | 0.353553        |
|                                                                                         |                                                                                      |                 |                 |                 |

| Orientation of IMU-B functional frame to IMU-B mirror frame                               |                                                                                            |                     |                     |                     |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                          |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from IMU-B mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                         |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                            |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                              |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                          | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                            | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                            | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                            | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                            |                     |                     |                     |

## 11.1.4 IMU-C

### 11.1.4.1 General description

| IMU-C                  |                                                                                                                                                                                                                                                                           |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | IMU-C                                                                                                                                                                                                                                                                     |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                   |
| Product tree           | B22C                                                                                                                                                                                                                                                                      |
| CONFIG_Id (from RFDDb) | UACIMP03                                                                                                                                                                                                                                                                  |
| Type of unit           | Fixed                                                                                                                                                                                                                                                                     |
| Parent unit            | Central body                                                                                                                                                                                                                                                              |
| Coordinate systems     | Central body system.<br>IMU-C nominal unit system.<br>IMU-C mirror system.<br>IMU-C functional unit system.                                                                                                                                                               |
| Parameters             | Position of IMU-C unit reference hole.<br>Orientation of IMU-C nominal unit reference axes to the spacecraft reference frame.<br>Orientation of IMU-C mirror frame to the spacecraft reference frame.<br>Orientation of IMU-C functional frame to the IMU-C mirror frame. |

### 11.1.4.2 Coordinate systems

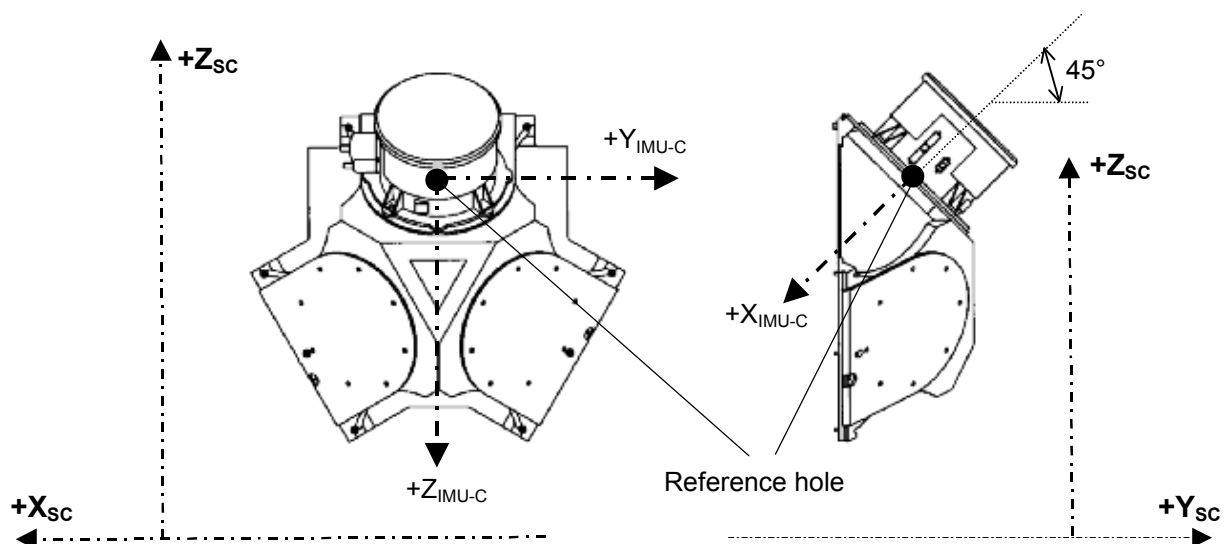


Figure 23: IMU-C unit system



## 11.1.4.3 Parameters

| Position of IMU-C reference hole               |                                                                 |                 |                 |  |
|------------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|--|
| RFDDDB-table / query                           | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |  |
| Parameter description                          | Position of the reference hole of the IMU-C to the central body |                 |                 |  |
| Provided in<br>(reference coordinate system)   | Central body system                                             |                 |                 |  |
| Provided as                                    | Coordinates in spacecraft reference frame                       |                 |                 |  |
| Physical units                                 | m                                                               |                 |                 |  |
| Nominal values<br>RFDDDB-ref.:<br>Figure-ref.: | UNIT_POS_x                                                      | UNIT_POS_y      | UNIT_POS_z      |  |
|                                                | X <sub>sc</sub>                                                 | Y <sub>sc</sub> | Z <sub>sc</sub> |  |
|                                                | -0.7000                                                         | -0.8568         | 0.6503          |  |

| Orientation of IMU C nominal reference frame to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                           | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                          | Transformation matrix (§ 7.1) from the central body system to the IMU-C nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                   | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                    | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units                                                                 | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)  | Direction cosines                                                                                     | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                | X <sub>u</sub>                                                                                        | 0               | -0.707107       | -0.707107       |
|                                                                                | Y <sub>u</sub>                                                                                        | -1              | 0               | 0               |
|                                                                                | Z <sub>u</sub>                                                                                        | 0               | 0.707107        | -0.707107       |
|                                                                                |                                                                                                       |                 |                 |                 |

| Orientation of IMU-C mirror frame to the spacecraft reference frame                     |                                                                                      |                 |                 |                 |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                      |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the IMU-C mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                  |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                      |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                        |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                    | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                  | 0               | -0.707107       | -0.707107       |
|                                                                                         | Y <sub>mirror</sub>                                                                  | -1              | 0               | 0               |
|                                                                                         | Z <sub>mirror</sub>                                                                  | 0               | 0.707107        | -0.707107       |
|                                                                                         |                                                                                      |                 |                 |                 |

| Orientation of IMU-C functional frame to IMU-C mirror frame                               |                                                                                            |                     |                     |                     |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                          |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from IMU-C mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                         |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                            |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                              |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                          | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                            | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                            | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                            | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                            |                     |                     |                     |

## 11.2 SAS

### 11.2.1 Introduction

Four sensors are required to provide sun direction information during any phase of the mission. Their locations, orientations and nomenclature are as follows:

SAS-1 boresight towards  $+X_{SC}$

SAS-2 boresight towards  $-X_{SC}/+Z_{SC}$ , tilted at  $45^\circ$

SAS-3 on SA+Y wing

SAS-4 on SA-Y wing

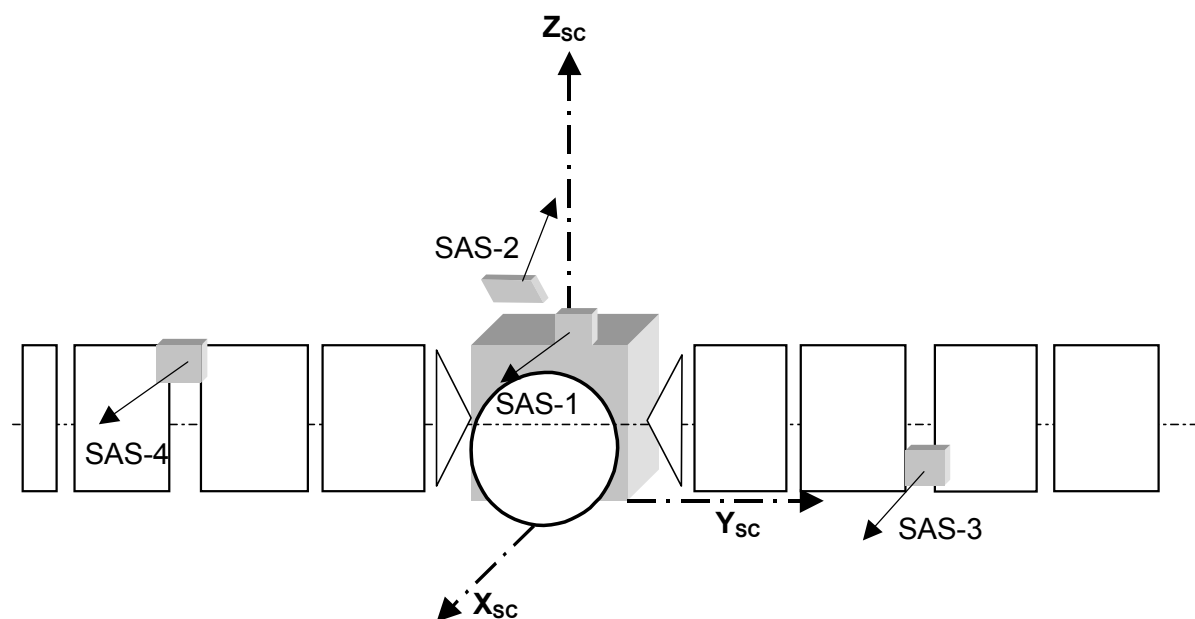


Figure 24: SAS overview

## 11.2.2 SAS-1

### 11.2.2.1 General description

| SAS-1                  |                                                                                                                               |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Identification         | SAS-1                                                                                                                         |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                                               |
| Product tree           | B22E                                                                                                                          |
| CONFIG_Id (from RFDDb) | UACSAS01                                                                                                                      |
| Type of unit           | Fixed                                                                                                                         |
| Parent unit            | Central body                                                                                                                  |
| Coordinate systems     | Central body system.<br>SAS-1 nominal unit system.                                                                            |
| Parameters             | Position of SAS-1 unit reference hole.<br>Orientation of SAS-1 nominal unit reference axes to the spacecraft reference frame. |

### 11.2.2.2 Coordinate systems

The unit is mounted on a bracket pointing towards  $+X_{SC}$ .

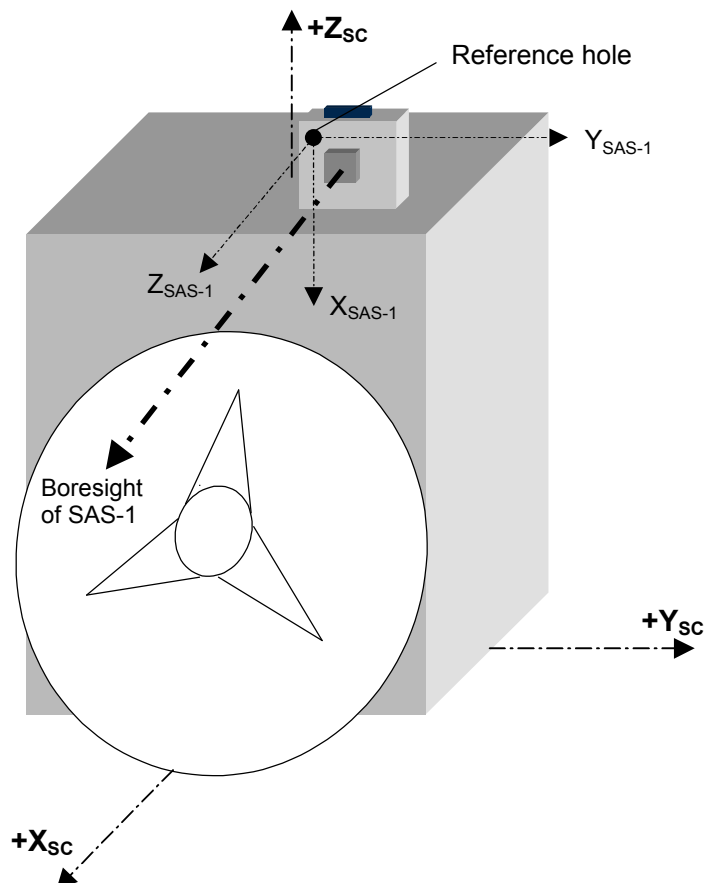


Figure 25: SAS-1 unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 54

## 11.2.2.3 Parameters

| Position of SAS-1 reference hole             |                                                                 |            |            |
|----------------------------------------------|-----------------------------------------------------------------|------------|------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |            |            |
| Parameter description                        | Position of the reference hole of the SAS-1 to the central body |            |            |
| Provided in<br>(reference coordinate system) | Central body system                                             |            |            |
| Provided as                                  | Coordinates in spacecraft reference frame                       |            |            |
| Physical units                               | m                                                               |            |            |
| Nominal values                               | RFDDDB-ref.: UNIT_POS-x                                         | UNIT_POS-y | UNIT_POS-z |
|                                              | Figure-ref.: $X_{SC}$                                           | $Y_{SC}$   | $Z_{SC}$   |
|                                              | 0.9400                                                          | 0.4500     | 3.0600     |

| Orientation of SAS-1 nominal unit reference frame to the spacecraft reference frame |                                                                                                       |          |          |          |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------|----------|----------|
| RFDDDB-table / query                                                                | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |          |          |          |
| Parameter description                                                               | Transformation matrix (§ 7.1) from the central body system to the SAS-1 nominal unit reference system |          |          |          |
| Provided in<br>(reference coordinate system)                                        | Central body system                                                                                   |          |          |          |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                                                            |          |          |          |
| Physical units                                                                      | Dimensionless                                                                                         |          |          |          |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)       | Direction cosines                                                                                     | $X_{SC}$ | $Y_{SC}$ | $Z_{SC}$ |
|                                                                                     | $X_U$                                                                                                 | 0        | 0        | -1       |
|                                                                                     | $Y_U$                                                                                                 | 0        | 1        | 0        |
|                                                                                     | $Z_U$                                                                                                 | 1        | 0        | 0        |

## 11.2.3 SAS-2

### 11.2.3.1 General description

| SAS-2                  |                                                                                                                       |
|------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Identification         | SAS-2                                                                                                                 |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                                       |
| Product tree           | B22E                                                                                                                  |
| CONFIG_Id (from RFDDb) | UACSAS02                                                                                                              |
| Type of unit           | Fixed                                                                                                                 |
| Parent unit            | Central body                                                                                                          |
| Coordinate systems     | Central body system.<br>SAS-2 nominal unit system.                                                                    |
| Parameters             | Position of SAS-2 unit reference hole.<br>Orientation of SAS-2 unit reference axes to the spacecraft reference frame. |

### 11.2.3.2 Coordinate systems

The sensor is mounted on a 45° tilted bracket pointing  $-X_{SC} / +Z_{SC}$ .

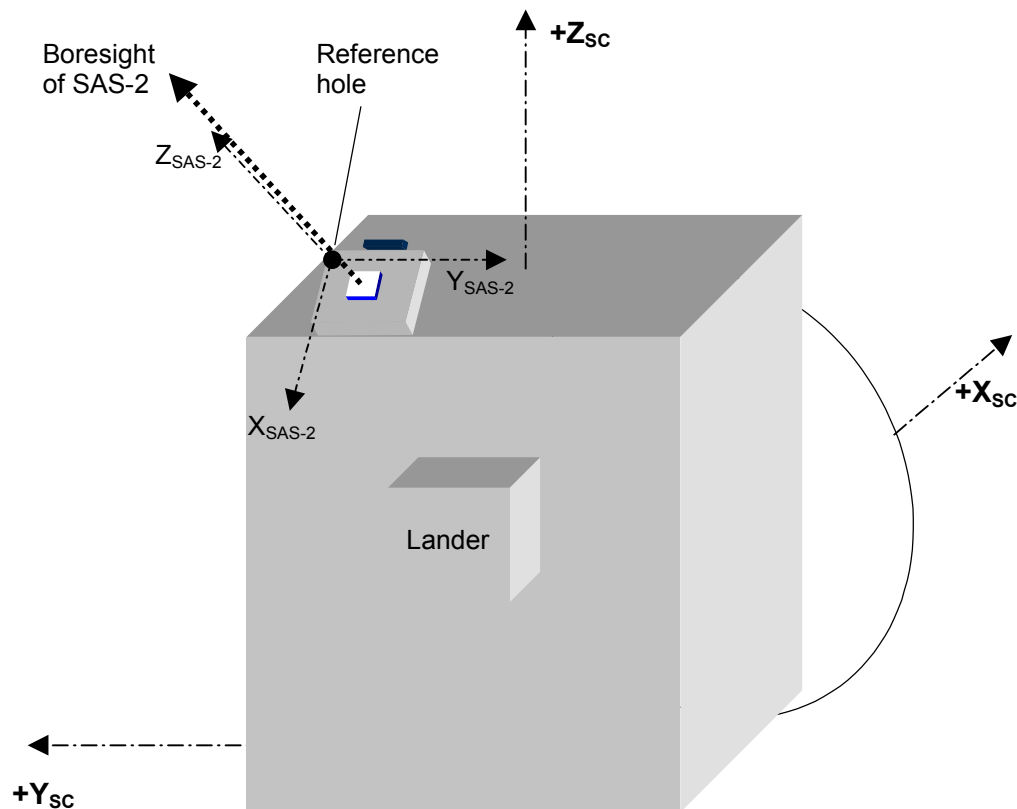


Figure 26: SAS-2 unit system



## 11.2.3.3 Parameters

| Position of SAS-2 reference hole             |                                                                 |                 |                 |
|----------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |
| Parameter description                        | Position of the reference hole of the SAS-2 to the central body |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                             |                 |                 |
| Provided as                                  | Coordinates in spacecraft reference frame                       |                 |                 |
| Physical units                               | m                                                               |                 |                 |
| Nominal values                               | RFDDDB-ref.: UNIT_POS_x                                         | UNIT_POS_y      | UNIT_POS_z      |
|                                              | Figure-ref.: X <sub>sc</sub>                                    | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                              | -1.2478                                                         | 0.1760          | 2.7593          |

| Orientation of SAS-2 nominal unit reference axes to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                               | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                              | Transformation matrix (§ 7.1) from the central body system to the SAS-2 nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                       | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                        | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units                                                                     | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)      | Direction cosines                                                                                     | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                    | X <sub>u</sub>                                                                                        | -0.707107       | 0               | -0.707107       |
|                                                                                    | Y <sub>u</sub>                                                                                        | 0               | -1              | 0               |
|                                                                                    | Z <sub>u</sub>                                                                                        | -0.707107       | 0               | 0.707107        |

## 11.2.4 SAS-3

### 11.2.4.1 General description

| SAS-3                     |                                                                                                              |
|---------------------------|--------------------------------------------------------------------------------------------------------------|
| Identification            | SAS-3                                                                                                        |
| RFDDb-table / query       | T_UL_MNT_SAS_SA_NOM / Q_UL_MNT_SAS_SA_NOM                                                                    |
| Product tree              | B22E                                                                                                         |
| CONFIG_Id<br>(from RFDDb) | UACSAS03                                                                                                     |
| Type of unit              | Fixed                                                                                                        |
| Parent unit               | SA+Y                                                                                                         |
| Coordinate systems        | SA+Y nominal system.<br>SAS-3 nominal unit system.                                                           |
| Parameters                | Position of SAS-3 unit reference hole.<br>Orientation of SAS-3 nominal unit frame to the SA+Y nominal frame. |

### 11.2.4.2 Coordinate systems

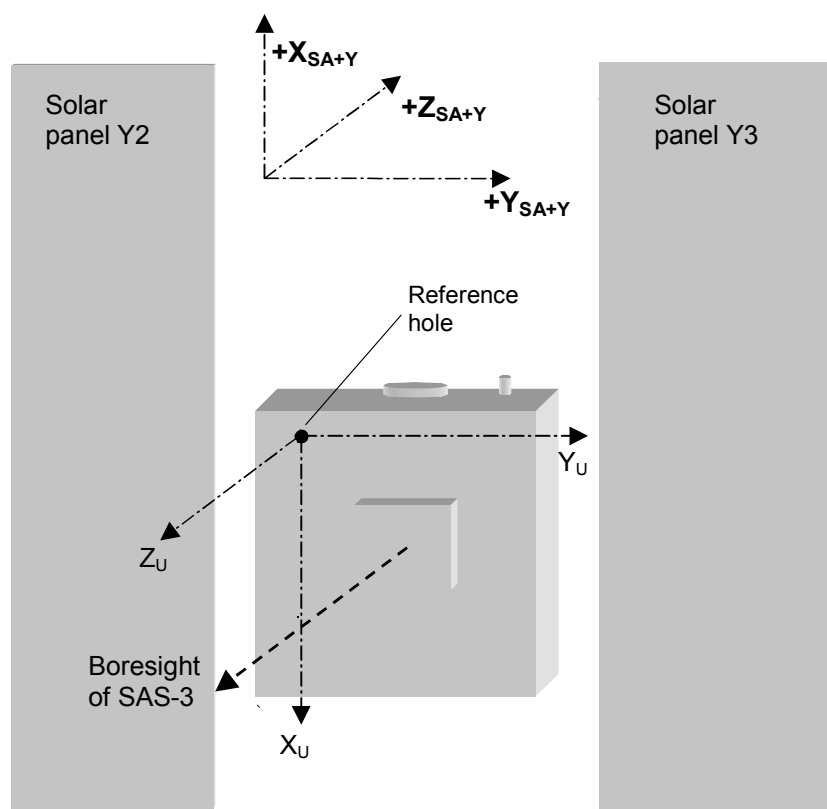


Figure 27: SAS-3 unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 58

## 11.2.4.3 Parameters

| Position of SAS-3 reference hole             |                                                                          |            |            |
|----------------------------------------------|--------------------------------------------------------------------------|------------|------------|
| RFDDDB-table / query                         | T_UL_MNT_SAS_SA_NOM / Q_UL_MNT_SAS_SA_NOM                                |            |            |
| Parameter description                        | Position of the reference hole of the SAS-3 to the SA+Y attachment point |            |            |
| Provided in<br>(reference coordinate system) | SA+Y                                                                     |            |            |
| Provided as                                  | Coordinates in SA+Y unit frame                                           |            |            |
| Physical units                               | m                                                                        |            |            |
| Nominal values                               | RFDDDB-ref.: SAS_POS_x                                                   | SAS_POS_y  | SAS_POS_z  |
|                                              | Figure-ref.: $X_{SA+Y}$                                                  | $Y_{SA+Y}$ | $Z_{SA+Y}$ |
|                                              | -0.337                                                                   | 6.909      | -0.009     |

| Orientation of SAS-3 nominal unit frame to the SA+Y frame                           |                                                                                  |            |            |            |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------------|------------|------------|
| RFDDDB-table / query                                                                | T_UL_MNT_SAS_SA_NOM / Q_UL_MNT_SAS_SA_NOM                                        |            |            |            |
| Parameter description                                                               | Direction cosine of SAS-3 nominal unit reference frame to the SA+Y nominal frame |            |            |            |
| Provided in<br>(reference coordinate system)                                        | SA+Y                                                                             |            |            |            |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                                       |            |            |            |
| Physical units                                                                      | Dimensionless                                                                    |            |            |            |
| Nominal values<br>(RFDDDB-identification:<br>A_MNT_SAS_SA_1x to<br>A_MNT_SAS_SA_3z) | Direction cosines                                                                | $X_{SA+Y}$ | $Y_{SA+Y}$ | $Z_{SA+Y}$ |
|                                                                                     | $X_U$                                                                            | -1         | 0          | 0          |
|                                                                                     | $Y_U$                                                                            | 0          | 1          | 0          |
|                                                                                     | $Z_U$                                                                            | 0          | 0          | -1         |

## 11.2.5 SAS-4

### 11.2.5.1 General description

| SAS-4                     |                                                                                                                      |
|---------------------------|----------------------------------------------------------------------------------------------------------------------|
| Identification            | SAS-4                                                                                                                |
| RFDDb-table / query       | T_UL_MNT_SAS_SA_NOM / Q_UL_MNT_SAS_SA_NOM                                                                            |
| Product tree              | B22E                                                                                                                 |
| CONFIG_Id<br>(from RFDDb) | UACSAS04                                                                                                             |
| Type of unit              | Fixed                                                                                                                |
| Parent unit               | SA-Y                                                                                                                 |
| Coordinate systems        | SA-Y system.<br>SAS-4 unit system.                                                                                   |
| Parameters                | Position of SAS-4 nominal unit reference hole.<br>Orientation of SAS-4 nominal unit frame to the SA-Y nominal frame. |

### 11.2.5.2 Coordinate systems

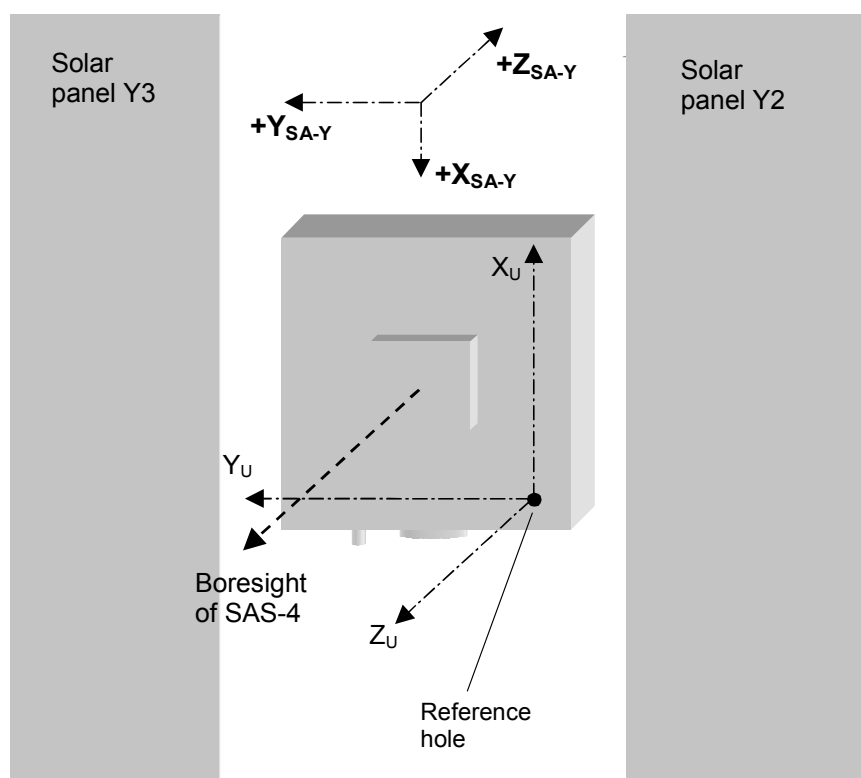


Figure 28: SAS-4 unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 60

## 11.2.5.3 Parameters

| Position of SAS-4 reference hole             |                                                                          |            |            |
|----------------------------------------------|--------------------------------------------------------------------------|------------|------------|
| RFDDDB-table / query                         | T_UL_MNT_SAS_SA_NOM / Q_UL_MNT_SAS_SA_NOM                                |            |            |
| Parameter description                        | Position of the reference hole of the SAS-4 to the SA-Y attachment point |            |            |
| Provided in<br>(reference coordinate system) | SA-Y                                                                     |            |            |
| Provided as                                  | Coordinates in SA-Y unit frame                                           |            |            |
| Physical units                               | m                                                                        |            |            |
| Nominal values                               | RFDDDB-ref.: SAS_POS_x                                                   | SAS_POS_y  | SAS_POS_z  |
|                                              | Figure-ref.: $X_{SA-Y}$                                                  | $Y_{SA-Y}$ | $Z_{SA-Y}$ |
|                                              | -0.337                                                                   | 6.909      | -0.009     |

| Orientation of SAS-4 nominal unit frame to the SA-Y frame                           |                                                                        |            |            |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------|------------|
| RFDDDB-table / query                                                                | T_UL_MNT_SAS_SA_NOM / Q_UL_MNT_SAS_SA_NOM                              |            |            |
| Parameter description                                                               | Direction cosine of SAS-4 nominal unit frame to the SA-Y nominal frame |            |            |
| Provided in<br>(reference coordinate system)                                        | SA-Y                                                                   |            |            |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                             |            |            |
| Physical units                                                                      | Dimensionless                                                          |            |            |
| Nominal values<br>(RFDDDB-identification:<br>A_MNT_SAS_SA_1x to<br>A_MNT_SAS_SA_3z) | Direction cosines                                                      | $X_{SA-Y}$ | $Y_{SA-Y}$ |
|                                                                                     | $X_U$                                                                  | -1         | 0          |
|                                                                                     | $Y_U$                                                                  | 0          | 1          |
|                                                                                     | $Z_U$                                                                  | 0          | -1         |

## 11.3 STAR TRACKER

### 11.3.1 Introduction

Two units are attached on tilted brackets onto the  $-X_{SC}$  shear walls. The boresights are located as follows:

STR-A: Oriented in the  $X_{SC} Y_{SC}$  plane, at  $15^\circ$  from the  $-X_{SC}$  axis towards the  $+Y_{SC}$  axis.

STR-B: First, consider a vector in the  $X_{SC} Y_{SC}$  plane, at  $15^\circ$  from the  $-X_{SC}$  axis towards the  $-Y_{SC}$  axis. The STR boresight is at an angle of  $-10^\circ$  to this vector, the  $10^\circ$  being measured out of the  $X_{SC} Y_{SC}$  plane towards the  $-Z_{SC}$  direction.

Unit identification is STR-A and STR-B.

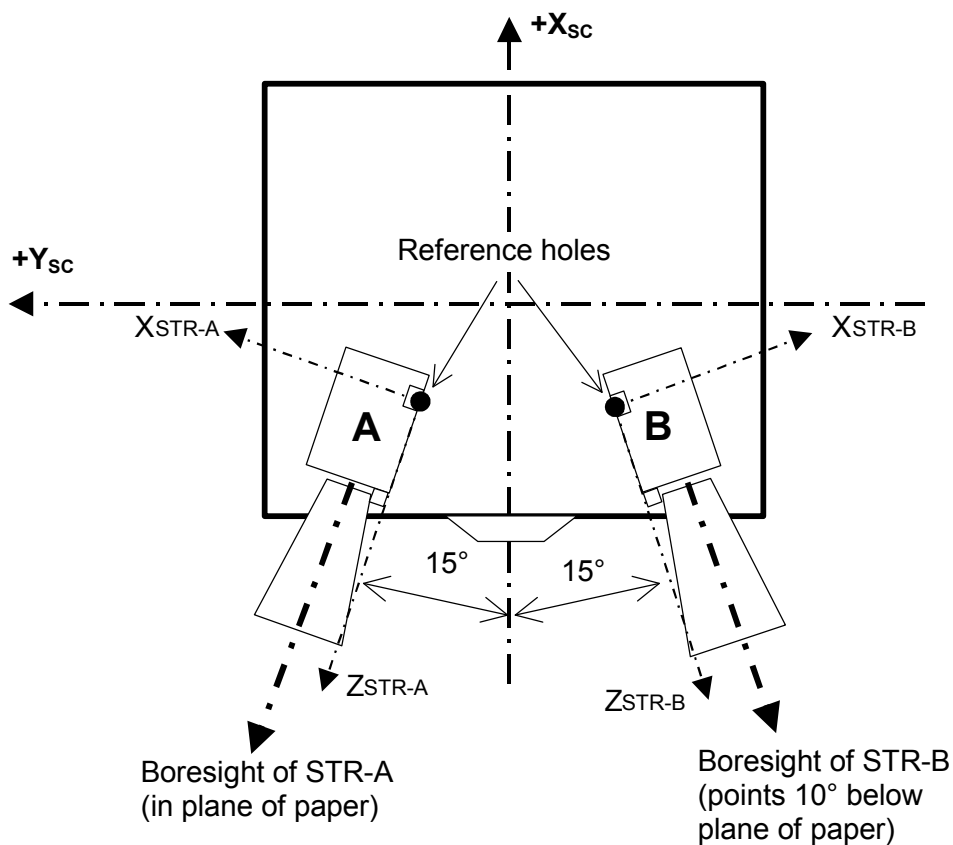


Figure 29: STR overview

## 11.3.2 STR-A

### 11.3.2.1 General description

| STR-A                  |                                                                                                                                                                                                                                                                           |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | STR-A                                                                                                                                                                                                                                                                     |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                   |
| Product tree           | B22DA                                                                                                                                                                                                                                                                     |
| CONFIG_Id (from RFDDb) | UACSTR1OHB00                                                                                                                                                                                                                                                              |
| Type of unit           | Fixed                                                                                                                                                                                                                                                                     |
| Parent unit            | Central body                                                                                                                                                                                                                                                              |
| Coordinate systems     | Central body system.<br>STR-A nominal unit system.<br>STR-A mirror system.<br>STR-A functional unit system.                                                                                                                                                               |
| Parameters             | Position of STR-A unit reference hole.<br>Orientation of STR-A nominal unit reference axes to the spacecraft reference frame.<br>Orientation of STR-A mirror frame to the spacecraft reference frame.<br>Orientation of STR-A functional frame to the STR-A mirror frame. |

### 11.3.2.2 Coordinate systems

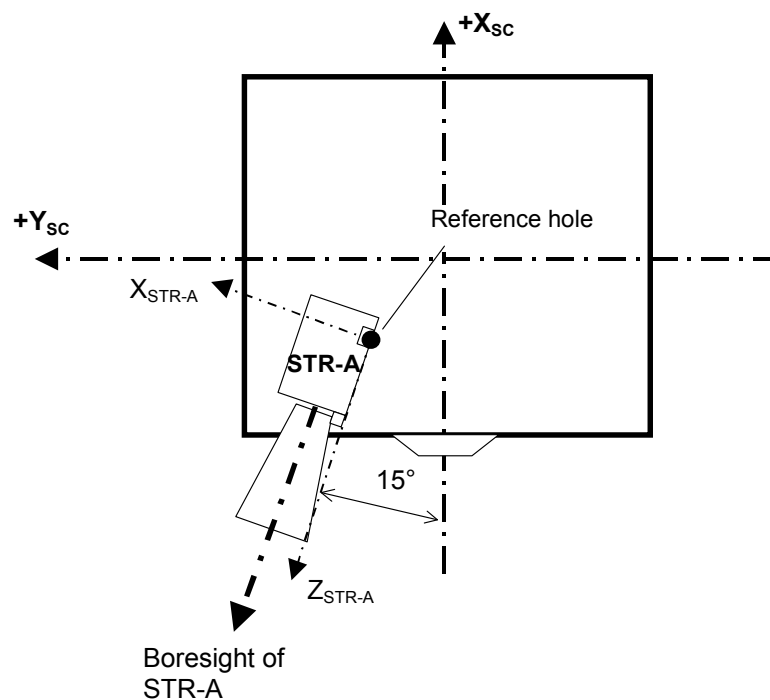


Figure 30: STR-A unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 63

## 11.3.2.3 Parameters

| Position of STR-A reference hole             |                                                                 |                 |                 |
|----------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |
| Parameter description                        | Position of the reference hole of the STR-A to the central body |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                             |                 |                 |
| Provided as                                  | Coordinates in spacecraft reference frame                       |                 |                 |
| Physical units                               | m                                                               |                 |                 |
| Nominal values<br>RFDDDB-ref.:               | X <sub>SC</sub>                                                 | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                              | UNIT_POS_x                                                      | UNIT_POS_y      | UNIT_POS_z      |
|                                              | -0.8539                                                         | 0.4509          | 1.8200          |

| Orientation of STR-A nominal unit reference frame to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                               | Transformation matrix (§ 7.1) from the central body system to the STR-A nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                        | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units                                                                      | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)       | Direction cosines                                                                                     | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                     | X <sub>U</sub>                                                                                        | 0.258819        | 0.965926        | 0               |
|                                                                                     | Y <sub>U</sub>                                                                                        | 0               | 0               | -1              |
|                                                                                     | Z <sub>U</sub>                                                                                        | -0.965926       | 0.258819        | 0               |
|                                                                                     |                                                                                                       |                 |                 |                 |

| Orientation of STR-A mirror frame to the spacecraft reference frame                     |                                                                                      |                 |                 |                 |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                      |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the STR-A mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                  |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                      |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                        |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                    | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                  | 0.258819        | 0.965926        | 0               |
|                                                                                         | Y <sub>mirror</sub>                                                                  | 0               | 0               | -1              |
|                                                                                         | Z <sub>mirror</sub>                                                                  | -0.965926       | 0.258819        | 0               |
|                                                                                         |                                                                                      |                 |                 |                 |

| Orientation of STR-A functional frame to STR-A mirror frame                               |                                                                                            |                     |                     |                     |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                          |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from STR-A mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                         |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                            |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                              |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                          | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                            | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                            | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                            | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                            |                     |                     |                     |

## 11.3.3 STR-B

### 11.3.3.1 General description

| STR-B                   |                                                                                                                                                                                                                                                                       |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification          | STR-B                                                                                                                                                                                                                                                                 |
| RFDDDB-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                               |
| Product tree            | B22DA                                                                                                                                                                                                                                                                 |
| CONFIG_Id (from RFDDDB) | UACSTR2OHB00                                                                                                                                                                                                                                                          |
| Type of unit            | Fixed                                                                                                                                                                                                                                                                 |
| Parent unit             | Central body                                                                                                                                                                                                                                                          |
| Coordinate systems      | Central body system.<br>STR-B unit system.<br>STR-B mirror system.<br>STR-B functional unit system.                                                                                                                                                                   |
| Parameters              | Position of STR-B unit reference hole.<br>Orientation of STR-B nominal unit frame to the spacecraft reference frame.<br>Orientation of STR-B mirror frame to the spacecraft reference frame.<br>Orientation of STR-B functional unit frame to the STR-B mirror frame. |

### 11.3.3.2 Coordinate systems

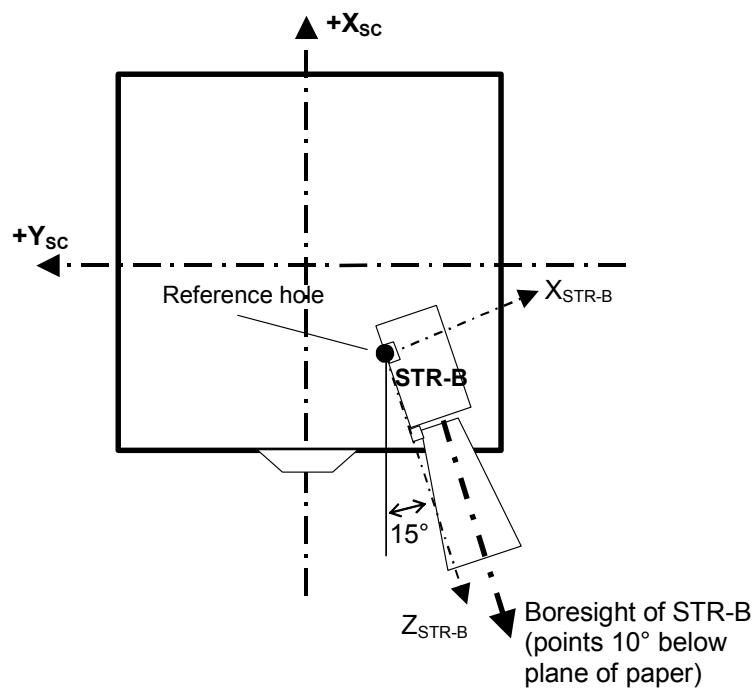


Figure 31: STR-B unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 65

## 11.3.3.3 Parameters

| Position of STR-B reference hole             |                                                                 |                 |                 |
|----------------------------------------------|-----------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                 |                 |                 |
| Parameter description                        | Position of the reference hole of the STR-B to the central body |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                             |                 |                 |
| Provided as                                  | Coordinates in spacecraft reference frame                       |                 |                 |
| Physical units                               | m                                                               |                 |                 |
| Nominal values<br>RFDDDB-ref.:               | X <sub>SC</sub>                                                 | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                              | UNIT_POS_x                                                      | UNIT_POS_y      | UNIT_POS_z      |
|                                              | -0,85388                                                        | -0,46019        | 2,03092         |

| Orientation of STR-B nominal unit reference frame to the spacecraft reference frame |                                                                                                       |                 |                 |                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                       |                 |                 |                 |
| Parameter description                                                               | Transformation matrix (§ 7.1) from the central body system to the STR-B nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                        | Central body system                                                                                   |                 |                 |                 |
| Provided as                                                                         | Direction cosine matrix according to § 7.4                                                            |                 |                 |                 |
| Physical units                                                                      | Dimensionless                                                                                         |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)       | Direction cosines                                                                                     | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                     | X <sub>U</sub>                                                                                        | 0,258819        | -0,9659258      | 0               |
|                                                                                     | Y <sub>U</sub>                                                                                        | -0,1677313      | -0,0449435      | 0,9848078       |
|                                                                                     | Z <sub>U</sub>                                                                                        | -0,9512512      | -0,254887       | -0,1736482      |
|                                                                                     |                                                                                                       |                 |                 |                 |

| Orientation of STR-B mirror frame to the spacecraft reference frame                     |                                                                                      |                 |                 |                 |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                      |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the STR-B mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                  |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                      |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                        |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                    | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                  | 0,258819        | -0,9659258      | 0               |
|                                                                                         | Y <sub>mirror</sub>                                                                  | -0,1677313      | -0,0449435      | 0,9848078       |
|                                                                                         | Z <sub>mirror</sub>                                                                  | -0,9512512      | -0,254887       | -0,1736482      |
|                                                                                         |                                                                                      |                 |                 |                 |

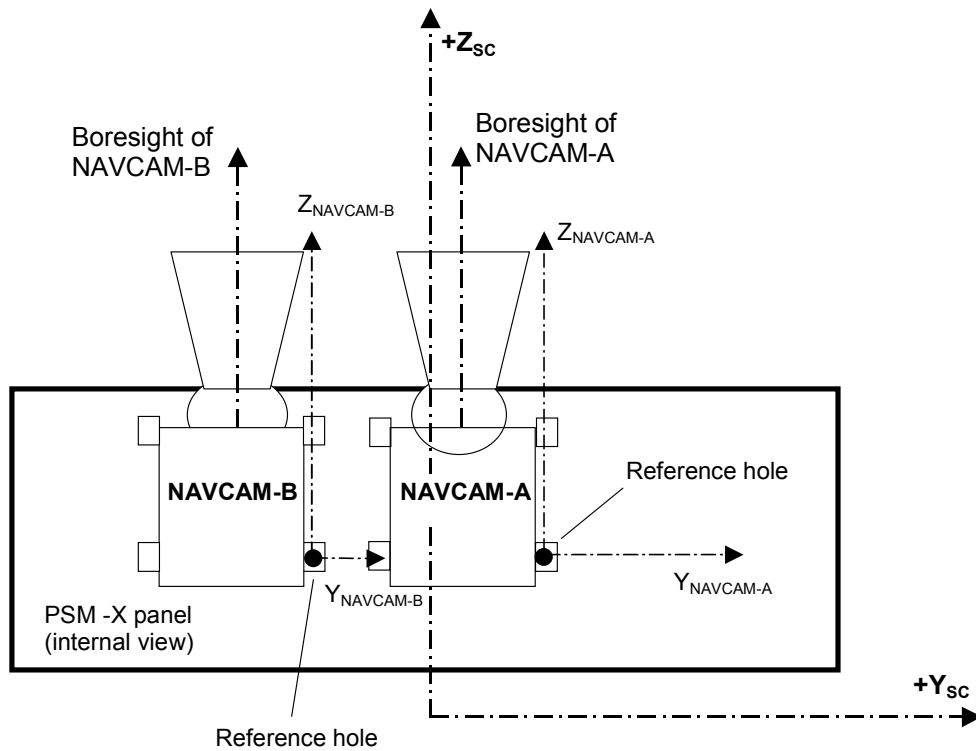
| Orientation of STR-B functional frame to STR-B mirror frame                               |                                                                                            |                     |                     |                     |
|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                          |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from STR-B mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                         |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                            |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                              |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                          | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                            | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                            | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                            | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                            |                     |                     |                     |

## 11.4 NAVCAM

### 11.4.1 Introduction

Two units are attached to the  $-X_{SC}$  PSM. The boresights are aligned with the  $+Z_{SC}$  axis.

Unit identification is NAVCAM-A and NAVCAM-B.



**Figure 32: NAVCAM overview**

## 11.4.2 NAVCAM-A

### 11.4.2.1 General description

| NAVCAM-A               |                                                                                                                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | NAVCAM-A                                                                                                                                                                                                                                                                             |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                              |
| Product tree           | B22BD                                                                                                                                                                                                                                                                                |
| CONFIG_Id (from RFDDb) | UACCAM10H000                                                                                                                                                                                                                                                                         |
| Type of unit           | Fixed                                                                                                                                                                                                                                                                                |
| Parent unit            | Central body                                                                                                                                                                                                                                                                         |
| Coordinate systems     | Central body system.<br>NAVCAM-A nominal unit system.<br>NAVCAM-A mirror system.<br>NAVCAM-A functional unit system.                                                                                                                                                                 |
| Parameters             | Position of NAVCAM-A unit reference hole.<br>Orientation of NAVCAM-A nominal unit frame to the spacecraft reference frame.<br>Orientation of NAVCAM-A mirror frame to the spacecraft reference frame.<br>Orientation of NAVCAM-A functional unit frame to the NAVCAM-A mirror frame. |

### 11.4.2.2 Coordinate systems

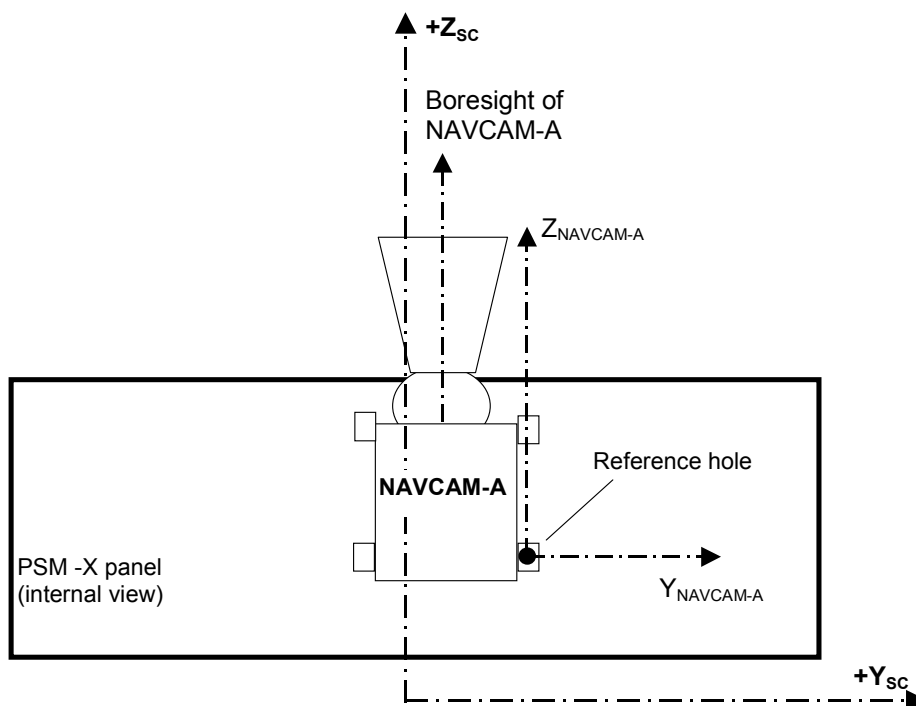


Figure 33: NAVCAM-A unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 68

## 11.4.2.3 Parameters

| Position of NAVCAM-A reference hole          |                                                                    |                 |                 |
|----------------------------------------------|--------------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                    |                 |                 |
| Parameter description                        | Position of the reference hole of the NAVCAM-A to the central body |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                                |                 |                 |
| Provided as                                  | Coordinates in spacecraft reference frame                          |                 |                 |
| Physical units                               | m                                                                  |                 |                 |
| Nominal values<br>RFDDDB-Ref.:               | X <sub>SC</sub>                                                    | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                              | UNIT_POS_x                                                         | UNIT_POS_y      | UNIT_POS_z      |
|                                              | -0.9734                                                            | 0.174           | 1.971           |

| Orientation of NAVCAM-A nominal unit reference frame to the spacecraft reference frame |                                                                                                          |                 |                 |                 |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                          |                 |                 |                 |
| Parameter description                                                                  | Transformation matrix (§ 7.1) from the central body system to the NAVCAM-A nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                           | Central body system                                                                                      |                 |                 |                 |
| Provided as                                                                            | Direction cosine matrix according to § 7.4                                                               |                 |                 |                 |
| Physical units                                                                         | Dimensionless                                                                                            |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)          | Direction cosines                                                                                        | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                        | X <sub>U</sub>                                                                                           | 1               | 0               | 0               |
|                                                                                        | Y <sub>U</sub>                                                                                           | 0               | 1               | 0               |
|                                                                                        | Z <sub>U</sub>                                                                                           | 0               | 0               | 1               |
|                                                                                        |                                                                                                          |                 |                 |                 |

| Orientation of NAVCAM-A mirror frame to the spacecraft reference frame                  |                                                                                         |                 |                 |                 |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                         |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the NAVCAM-A mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                     |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                         |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                           |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                       | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                     | -0.70711        | 0.70711         | 0               |
|                                                                                         | Y <sub>mirror</sub>                                                                     | -0.70711        | -0.70711        | 0               |
|                                                                                         | Z <sub>mirror</sub>                                                                     | 0               | 0               | 1               |
|                                                                                         |                                                                                         |                 |                 |                 |

| Orientation of NAVCAM-A functional frame to NAVCAM-A mirror frame                         |                                                                                               |                     |                     |                     |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                             |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from NAVCAM-A mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                            |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                               |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                                 |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                             | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                               | -0.70711            | -0.70711            | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                               | 0.70711             | -0.70711            | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                               | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                               |                     |                     |                     |

## 11.4.3 NAVCAM-B

### 11.4.3.1 General description

| NAVCAM-B               |                                                                                                                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | NAVCAM-B                                                                                                                                                                                                                                                                             |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                                              |
| Product tree           | B22DB                                                                                                                                                                                                                                                                                |
| CONFIG_Id (from RFDDb) | UACCAM2OH000                                                                                                                                                                                                                                                                         |
| Type of unit           | Fixed                                                                                                                                                                                                                                                                                |
| Parent unit            | Central body                                                                                                                                                                                                                                                                         |
| Coordinate systems     | Central body system.<br>NAVCAM-B nominal unit system.<br>NAVCAM-B mirror system.<br>NAVCAM-B functional unit system.                                                                                                                                                                 |
| Parameters             | Position of NAVCAM-B unit reference hole.<br>Orientation of NAVCAM-B nominal unit frame to the spacecraft reference frame.<br>Orientation of NAVCAM-B mirror frame to the spacecraft reference frame.<br>Orientation of NAVCAM-B functional unit frame to the NAVCAM-B mirror frame. |

### 11.4.3.2 Coordinate systems

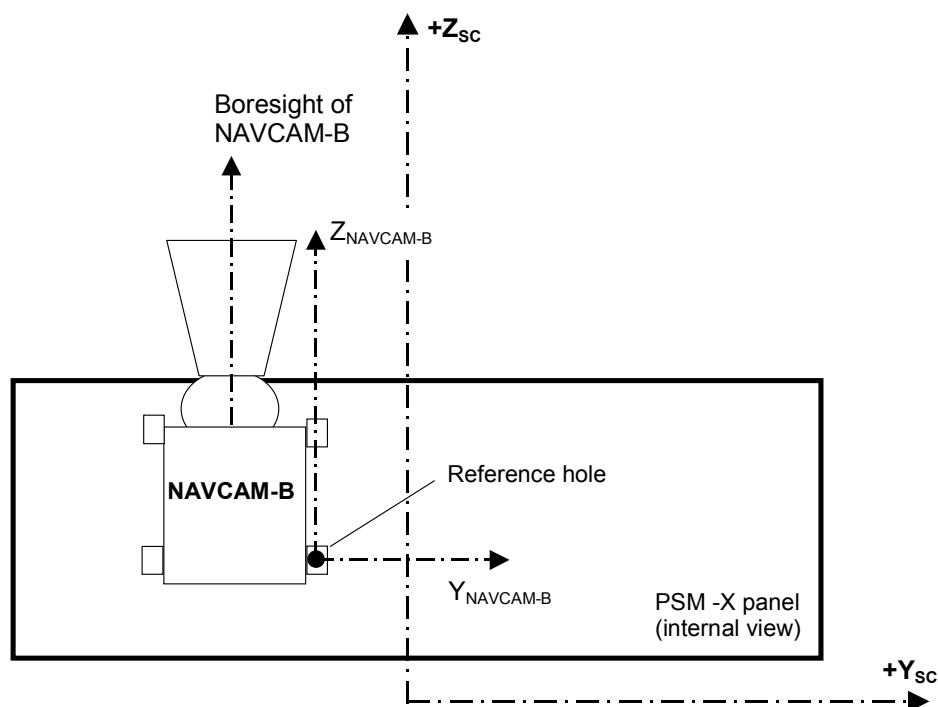


Figure 34: NAVCAM-B unit system



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 70

## 11.4.3.3 Parameters

| Position of NAVCAM-B reference hole          |                                                                    |                 |                 |
|----------------------------------------------|--------------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                    |                 |                 |
| Parameter description                        | Position of the reference hole of the NAVCAM-B to the central body |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                                |                 |                 |
| Provided as                                  | Coordinates in spacecraft reference frame                          |                 |                 |
| Physical units                               | m                                                                  |                 |                 |
| Nominal values<br>RFDDDB-ref.:               | X <sub>SC</sub>                                                    | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                              | UNIT_POS_x                                                         | UNIT_POS_y      | UNIT_POS_z      |
|                                              | -0.9734                                                            | -0.1460         | 1.9710          |

| Orientation of NAVCAM-B nominal unit reference frame to the spacecraft reference frame |                                                                                                          |                 |                 |                 |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                   | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                          |                 |                 |                 |
| Parameter description                                                                  | Transformation matrix (§ 7.1) from the central body system to the NAVCAM-B nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                           | Central body system                                                                                      |                 |                 |                 |
| Provided as                                                                            | Direction cosine matrix according to § 7.4.                                                              |                 |                 |                 |
| Physical units                                                                         | Dimensionless                                                                                            |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)          | Direction cosines                                                                                        | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                        | X <sub>U</sub>                                                                                           | 1               | 0               | 0               |
|                                                                                        | Y <sub>U</sub>                                                                                           | 0               | 1               | 0               |
|                                                                                        | Z <sub>U</sub>                                                                                           | 0               | 0               | 1               |
|                                                                                        |                                                                                                          |                 |                 |                 |

| Orientation of NAVCAM-B mirror frame to the spacecraft reference frame                  |                                                                                         |                 |                 |                 |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                         |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the NAVCAM-B mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                     |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                         |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                           |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                       | X <sub>SC</sub> | Y <sub>SC</sub> | Z <sub>SC</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                     | -0.70711        | 0.70711         | 0               |
|                                                                                         | Y <sub>mirror</sub>                                                                     | -0.70711        | -0.70711        | 0               |
|                                                                                         | Z <sub>mirror</sub>                                                                     | 0               | 0               | 1               |
|                                                                                         |                                                                                         |                 |                 |                 |

| Orientation of NAVCAM-B functional frame to NAVCAM-B mirror frame                         |                                                                                               |                     |                     |                     |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                             |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from NAVCAM-B mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                            |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                               |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                                 |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                             | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                               | -0.70711            | -0.70711            | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                               | 0.70711             | -0.70711            | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                               | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                               |                     |                     |                     |

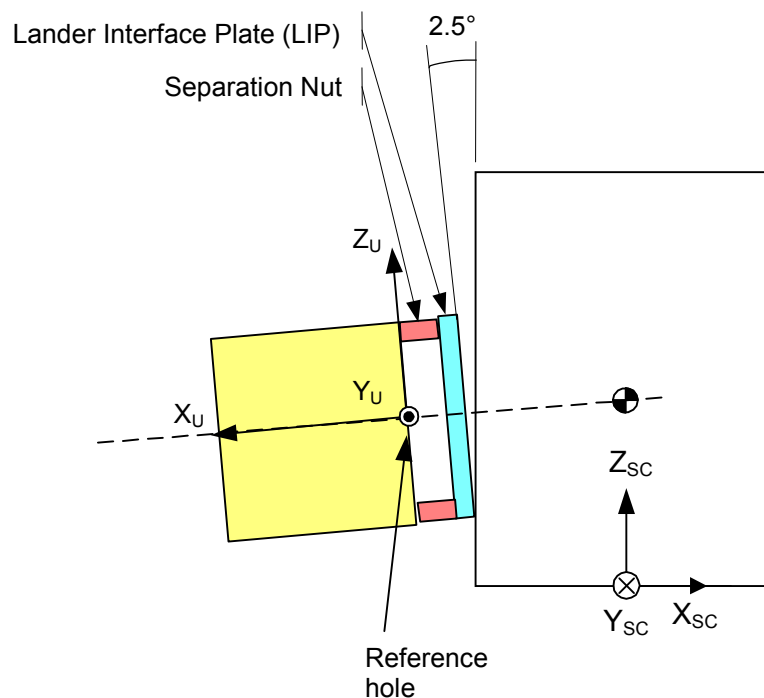
## 12. OTHER UNITS

### 12.1 SSP

#### 12.1.1 General description

| SSP                    |                                                                                                                                                                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Identification         | SSP                                                                                                                                                                                                                                                         |
| RFDDb-table / query    | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM<br>T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM<br>T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                                                                                     |
| Product tree           | A21                                                                                                                                                                                                                                                         |
| CONFIG_Id (from RFDDb) | USBLANDER000                                                                                                                                                                                                                                                |
| Type of unit           | Fixed                                                                                                                                                                                                                                                       |
| Parent unit            | Central body                                                                                                                                                                                                                                                |
| Coordinate systems     | Central body system.<br>SSP nominal unit system.<br>SSP mirror system.<br>SSP functional unit system.                                                                                                                                                       |
| Parameters             | Position of SSP unit reference hole.<br>Orientation of SSP nominal unit frame to the spacecraft reference frame.<br>Orientation of SSP mirror frame to the spacecraft reference frame.<br>Orientation of SSP functional unit frame to the SSP mirror frame. |

#### 12.1.2 Coordinate systems



**Figure 35: Lander unit system**



# ROSETTA

Doc. No: RO-DSS-TN-1081

Issue : 6d

Date: 17.09.2003

Sheet: 72

## 12.1.3 Parameters

| Position of SSP reference hole               |                                                               |                 |                 |
|----------------------------------------------|---------------------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                         | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM               |                 |                 |
| Parameter description                        | Position of the reference hole of the SSP to the central body |                 |                 |
| Provided in<br>(reference coordinate system) | Central body system                                           |                 |                 |
| Provided as                                  | Coordinates in spacecraft reference frame                     |                 |                 |
| Physical units                               | m                                                             |                 |                 |
| Nominal values<br>RFDDDB-ref.:               | X <sub>sc</sub>                                               | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                              | UNIT_POS_x                                                    | UNIT_POS_y      | UNIT_POS_z      |
|                                              | -0.8690                                                       | 0               | 1.3260          |

| Orientation of SSP nominal unit reference frame to the spacecraft reference frame |                                                                                                     |                 |                 |                 |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                              | T_SAT_UNIT_MECH_SC_NOM / Q_SAT_UNIT_MECH_SC_NOM                                                     |                 |                 |                 |
| Parameter description                                                             | Transformation matrix (§ 7.1) from the central body system to the SSP nominal unit reference system |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                      | Central body system                                                                                 |                 |                 |                 |
| Provided as                                                                       | Direction cosine matrix according to § 7.4                                                          |                 |                 |                 |
| Physical units                                                                    | Dimensionless                                                                                       |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_MECH_SC_1x to<br>A_MECH_SC_3z)     | Direction cosines                                                                                   | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                   | X <sub>u</sub>                                                                                      | -0.999048       | 0               | -0.043619       |
|                                                                                   | Y <sub>u</sub>                                                                                      | 0               | -1              | 0               |
|                                                                                   | Z <sub>u</sub>                                                                                      | -0.043619       | 0               | 0.999048        |
|                                                                                   |                                                                                                     |                 |                 |                 |

| Orientation of SSP mirror frame to the spacecraft reference frame                       |                                                                                    |                 |                 |                 |
|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|
| RFDDDB-table / query                                                                    | T_SAT_UNIT_MIRR_SC_NOM / Q_SAT_UNIT_MIRR_SC_NOM                                    |                 |                 |                 |
| Parameter description                                                                   | Transformation matrix (§ 7.1) from the central body system to the SSP mirror frame |                 |                 |                 |
| Provided in<br>(reference coordinate system)                                            | Central body system                                                                |                 |                 |                 |
| Provided as                                                                             | 3 * 3 matrix according to § 7.4                                                    |                 |                 |                 |
| Physical units                                                                          | Dimensionless                                                                      |                 |                 |                 |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_MIRR_SC_1x to<br>A_UNIT_MIRR_SC_3z) | Direction cosines                                                                  | X <sub>sc</sub> | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                                                                         | X <sub>mirror</sub>                                                                | -0.999048       | 0               | -0.043619       |
|                                                                                         | Y <sub>mirror</sub>                                                                | 0               | -1              | 0               |
|                                                                                         | Z <sub>mirror</sub>                                                                | -0.043619       | 0               | 0.999048        |
|                                                                                         |                                                                                    |                 |                 |                 |

| Orientation of SSP functional frame to SSP mirror frame                                   |                                                                                          |                     |                     |                     |
|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|
| RFDDDB-table / query                                                                      | T_SAT_UNIT_FNC_MIRR_NOM / Q_SAT_UNIT_FNC_MIRR_NOM                                        |                     |                     |                     |
| Parameter description                                                                     | Transformation matrix (§ 7.1) from SSP mirror system to unit functional reference system |                     |                     |                     |
| Provided in<br>(reference coordinate system)                                              | Unit mirror system                                                                       |                     |                     |                     |
| Provided as                                                                               | 3 * 3 matrix according to § 7.4                                                          |                     |                     |                     |
| Physical units                                                                            | Dimensionless                                                                            |                     |                     |                     |
| Nominal values<br>(RFDDDB-identification:<br>A_UNIT_FNC_MIRR_1x to<br>A_UNIT_FNC_MIRR_3z) | Direction cosines                                                                        | X <sub>mirror</sub> | Y <sub>mirror</sub> | Z <sub>mirror</sub> |
|                                                                                           | X <sub>fu</sub>                                                                          | 1                   | 0                   | 0                   |
|                                                                                           | Y <sub>fu</sub>                                                                          | 0                   | 1                   | 0                   |
|                                                                                           | Z <sub>fu</sub>                                                                          | 0                   | 0                   | 1                   |
|                                                                                           |                                                                                          |                     |                     |                     |

## 12.2 MGA-S

### 12.2.1 General description

| MGA-S                  |                                                     |
|------------------------|-----------------------------------------------------|
| Identification         | MGA-S                                               |
| RFDDb-table / query    | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |
| Product tree           | B17DA                                               |
| CONFIG_Id (from RFDDb) | UTTMGAS0                                            |
| Type of unit           | Fixed                                               |
| Parent unit            | Central body                                        |
| Coordinate systems     | Central body system.<br>MGA-S nominal unit system.  |
| Parameters             | Direction of MGA-S boresight axis                   |

### 12.2.2 Coordinate systems

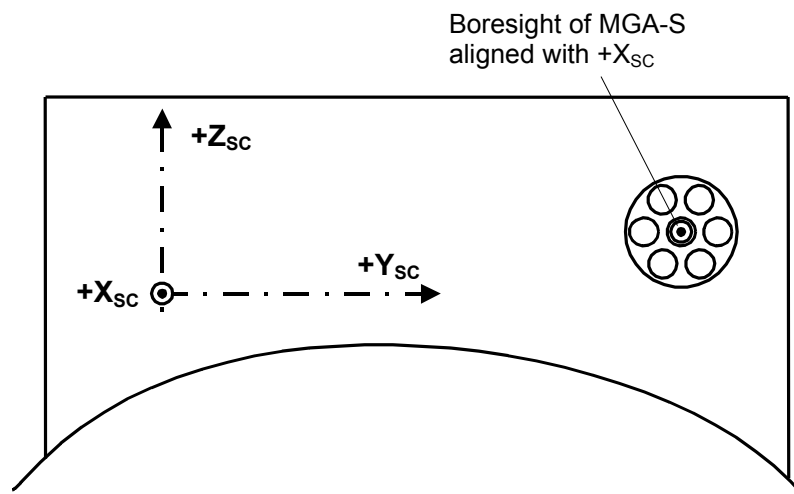


Figure 36: MGA-S overview

### 12.2.3 Parameters

| Direction of MGA-S boresight axis         |                                                     |             |             |
|-------------------------------------------|-----------------------------------------------------|-------------|-------------|
| RFDDb-table / query                       | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |             |             |
| Parameter description                     | Direction of the MGA-S boresight axis               |             |             |
| Provided in (reference coordinate system) | Central body system                                 |             |             |
| Provided as                               | Three vector components                             |             |             |
| Physical units                            | Dimensionless                                       |             |             |
| Nominal values<br>RFDDb-ref.:             | $X_{sc}$                                            | $Y_{sc}$    | $Z_{sc}$    |
|                                           | BSIGHT_SC_x                                         | BSIGHT_SC_y | BSIGHT_SC_z |
|                                           | 1                                                   | 0           | 0           |

## 12.3 MGA-X

### 12.3.1 General description

| MGA-X                   |                                                     |
|-------------------------|-----------------------------------------------------|
| Identification          | MGA-X                                               |
| RFDDDB-table / query    | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |
| Product tree            | B17DB                                               |
| CONFIG_Id (from RFDDDB) | UTTMGAX0                                            |
| Type of unit            | Fixed                                               |
| Parent unit             | Central body                                        |
| Coordinate systems      | Central body system.<br>MGA-X nominal unit system.  |
| Parameters              | Direction of MGA-X boresight axis                   |

### 12.3.2 Coordinate systems

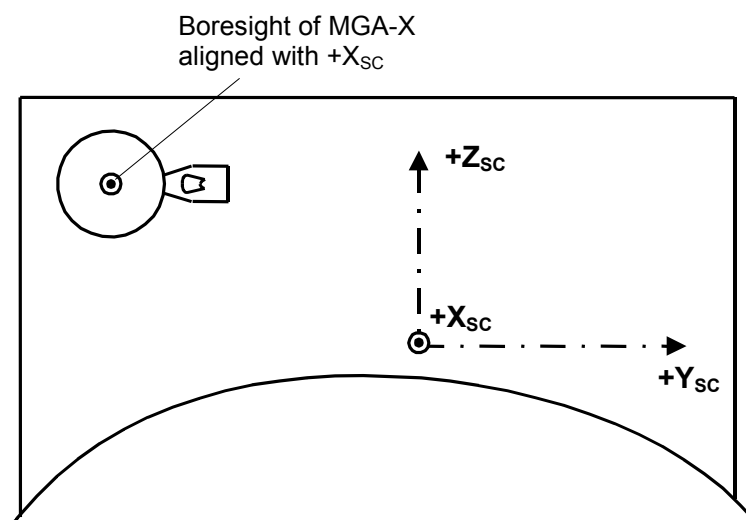


Figure 37: MGA-X overview

### 12.3.3 Parameters

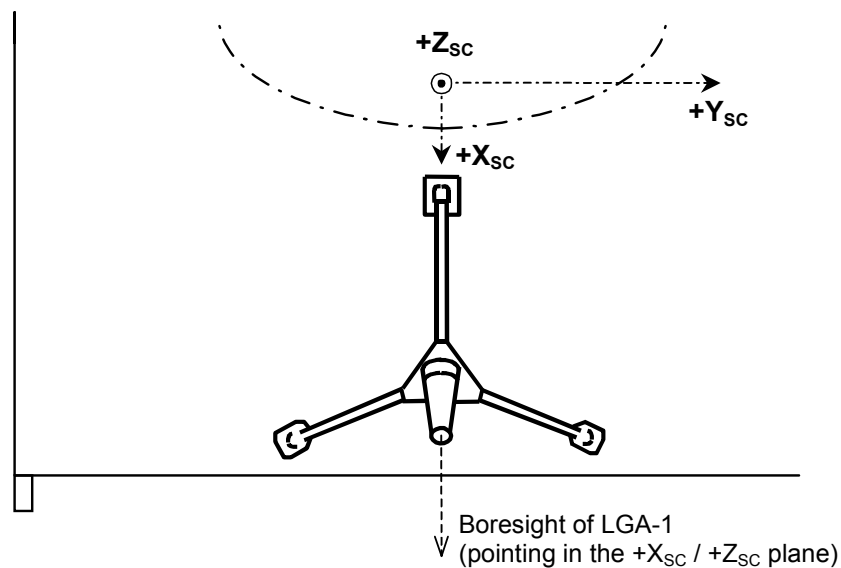
| Direction of MGA-X boresight axis         |                                                     |                 |                 |
|-------------------------------------------|-----------------------------------------------------|-----------------|-----------------|
| RFDDDB-table / query                      | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |                 |                 |
| Parameter description                     | Direction of the MGA-X boresight axis               |                 |                 |
| Provided in (reference coordinate system) | Central body system                                 |                 |                 |
| Provided as                               | Three vector components                             |                 |                 |
| Physical units                            | Dimensionless                                       |                 |                 |
| Nominal values<br>RFDDDB-ref.:            | X <sub>sc</sub>                                     | Y <sub>sc</sub> | Z <sub>sc</sub> |
|                                           | BSIGHT_SC_x                                         | BSIGHT_SC_y     | BSIGHT_SC_z     |
|                                           | 1                                                   | 0               | 0               |

## 12.4 LGA-1

### 12.4.1 General description

| LGA-1                   |                                                     |
|-------------------------|-----------------------------------------------------|
| Identification          | LGA-1                                               |
| RFDDDB-table / query    | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |
| Product tree            | B17E                                                |
| CONFIG_Id (from RFDDDB) | UTTLGA01                                            |
| Type of unit            | Fixed - front                                       |
| Parent unit             | Central body                                        |
| Coordinate systems      | Central body system.<br>LGA-1 unit system.          |
| Parameters              | Direction of LGA-1 boresight axis                   |

### 12.4.2 Coordinate systems



**Figure 38: LGA-1 boresight axis**

### 12.4.3 Parameters

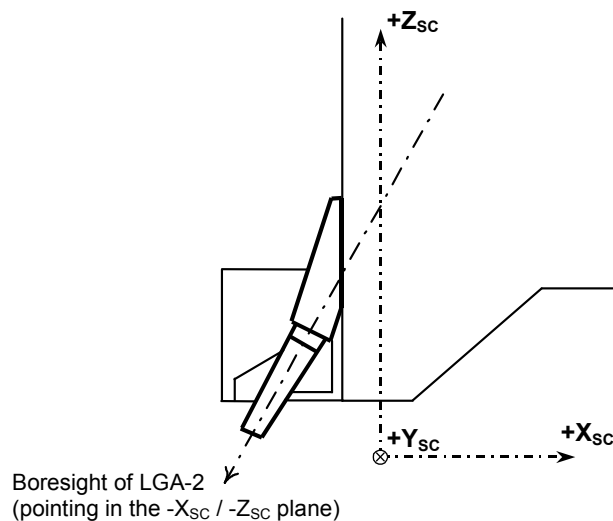
| Direction of LGA-1 boresight axis         |                                                     |             |             |
|-------------------------------------------|-----------------------------------------------------|-------------|-------------|
| RFDDDB-table / query                      | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |             |             |
| Parameter description                     | Direction of the LGA-1 boresight axis               |             |             |
| Provided in (reference coordinate system) | Central body system                                 |             |             |
| Provided as                               | Three vector components                             |             |             |
| Physical units                            | Dimensionless                                       |             |             |
| Nominal values<br>RFDDDB-ref.:            | $X_{sc}$                                            | $Y_{sc}$    | $Z_{sc}$    |
|                                           | BSIGHT_SC_x                                         | BSIGHT_SC_y | BSIGHT_SC_z |
|                                           | 0.5                                                 | 0           | 0.866025    |

## 12.5 LGA-2

### 12.5.1 General description

| LGA-2                   |                                                     |
|-------------------------|-----------------------------------------------------|
| Identification          | LGA-2                                               |
| RFDDDB-table / query    | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |
| Product tree            | B17E                                                |
| CONFIG_Id (from RFDDDB) | UTTLLGA02                                           |
| Type of unit            | Fixed - rear                                        |
| Parent unit             | Central body                                        |
| Coordinate systems      | Central body system.<br>LGA-2 unit system.          |
| Parameters              | Direction of LGA-2 boresight axis                   |

### 12.5.2 Coordinate systems



**Figure 39: LGA-2 boresight axis**

### 12.5.3 Parameters

| Direction of LGA-2 boresight axis         |                                                     |             |             |
|-------------------------------------------|-----------------------------------------------------|-------------|-------------|
| RFDDDB-table / query                      | T_SAT_UNIT_BSIGHT_SC_NOM / Q_SAT_UNIT_BSIGHT_SC_NOM |             |             |
| Parameter description                     | Direction of the LGA-2 boresight axis               |             |             |
| Provided in (reference coordinate system) | Central body system                                 |             |             |
| Provided as                               | Three vector components                             |             |             |
| Physical units                            | Dimensionless                                       |             |             |
| Nominal values<br>RFDDDB-ref.:            | $X_{sc}$                                            | $Y_{sc}$    | $Z_{sc}$    |
|                                           | BSIGHT_SC_x                                         | BSIGHT_SC_y | BSIGHT_SC_z |
|                                           | -0.5                                                | 0           | -0.866025   |