SIROM

D2.14: OG5-D2_Interface Control Document

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DOCUMENT CHANGE RECORD

REVISION	DATE	SECTION / PARAGRAPH AFFECTED	REASON OF CHANGE/ REMARKS
0	20-06-2017	All	Initial release
1	06-09-2017	5.4 (F/4/2)	Reference to OG2 deleted
		5.2 (D/1/3, D/1/4)	Second requirements D/1/1 and D/1/2 renumbered to D/1/3 and D/1/4 respectively
			Revised version according to PDR RIDs
		5.4 (M/2/1)	RID 2: OG5-212
		5.4 (F/4/5)	RID 3: OG5-211
		5.4 (M/2/2)	RID 4: OG5-213
		5.2 (D/1/4)	RID 5: OG5-214
		5.4 (D/3/1)	RID 8: OG5-220
		5.4 (F/3/1 and D/1/1)	RID 11: OG5-223
		5.4 (F/7/1 and F/7/2)	RID 12: OG5-224
		5.4 (O/1/1)	RID 13: OG5-225
		5.4 (O/5/1 and M/1/1)	RID 15: OG5-227
		4.3	RID 17: OG5-230
		Done in D 2.3	RID 18: OG5-231
		Done in D 2.3	RID 19: OG5-232
		Done in D 2.18	RID 21: OG5-235
		5.3 (T/1/0)	RID 22: OG5-236. For thermal (Note: data and power lines fixed connectors are in the lower plate of the SIROM. See section 11 in DDF D2.9)
		5.4 (F/3/1)	D 2.4 RID 5: OG5-280

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1. INTRODUCTION AND SCOPE

This document is provided as the inputs from SIROM OG5 for the compilation of an Interface Control Document with all of the Operational Grants (OG) that have been awarded in Call 1 of the SRC.

These OGs develop basic building blocks that, at later stage in the SRC, will be assembled into application solutions and finally fly as part of the In-Orbit Demonstration (IOD) in the timeframe 2023-2024.

Though it is not intended to integrate the results (intermediate and final) of the OGs as part of the current activities, it is important that these building blocks are designed to be intrinsically compatible.

This is the fundamental purpose of this document: describing the interfaces and interactions needed between the OGs so that one day they can seamlessly work together.

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2. REFERENCES

2.1 Applicable Documents

AD	Title	Reference
[AD01]	-	-
[AD02]	-	-
[AD03]	-	-

Table 2-1 Applicable Documents

2.2 Reference Documents

RD	Title	Reference
[RD01]	H2020 OG6 - FACILITATOR_SRD	D1.2_Issue 2.0_SEN1_DFKI
[RD02]	Call1_Template_Integrated_ICD	[H2020 Space Robotics SRC] ICD consolidation; E-mail dated on 25.04.2017
[RD03]	-	-

Table 2-2 Reference Documents

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3. ACRONYMS LIST

Acronyms	Meaning
API	Application Programming Interface
APM	Active Payload Module
CAD	Computer Aided Design
CDR	Critical Design Review
DH	Denavit Hartenberg
HMI	Human Machine Interface
ICD	Interface Control Document
IF	Interface
IMU	Inertial/Internal Measurement Unit
OBC	On Board Computer
OG	Operational Grant
PDR	Preliminary Design Review
SCR	Strategic Research Cluster
SRR	System Requirements Review
SIROM	Standard Interface for Robotic Manipulators
TBC	To Be Confirmed
TBD	To Be Defined
TC	Telecommand
TM	Telemetry

Table 3-1 Acronyms list

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4. CONVENTIONS, SYSTEM BREAKDOWN AND DEFINITIONS

4.1 Conventions

The following conventions are established to name uniquely interfaces

Fields names->	BETWEEN	TYPE	Major sequence	Minor sequence	version.revision
Field spec. ->	OGx-OGy	L	nnn	mmm	V i.j
Example ->	OG1-OG6/s/001/001/V0.1				

- The BETWEEN field establishes the placement of the interface. In the spec. x,y correspond to the numerals of the OGs and so x,y ∈[1-6] and always x<y
- The TYPE literal defines the nature of interfaces and is defined as:
  - D data
  - F functional
  - P power
  - O operational/procedural
  - S software
  - M mechanical
  - T thermal
- The two sequence numbers (Major and Minor) are meant to provide further categorization of the interface in 2 levels
- The version.revision field is to provide for the ability to evolve the interface.

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4.2 System Breakdown

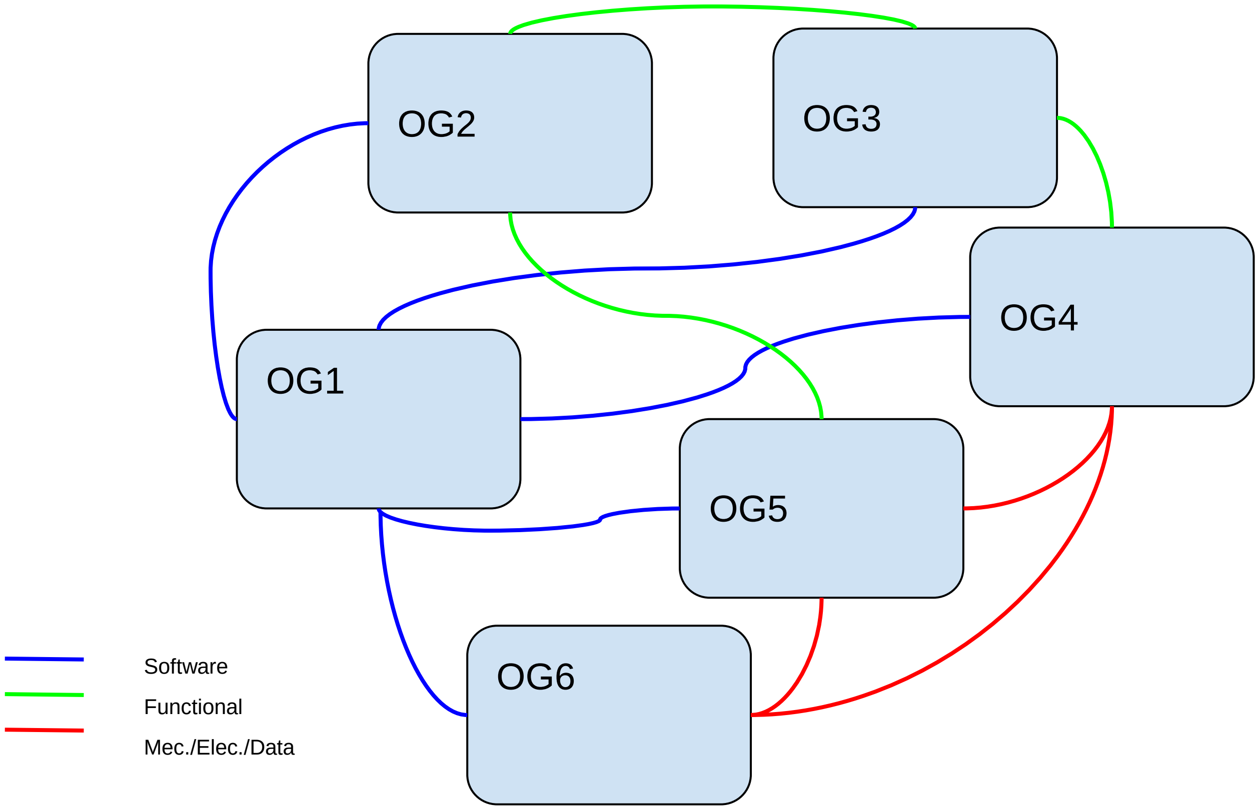

Figure 4-1. I/Fs between OGs.

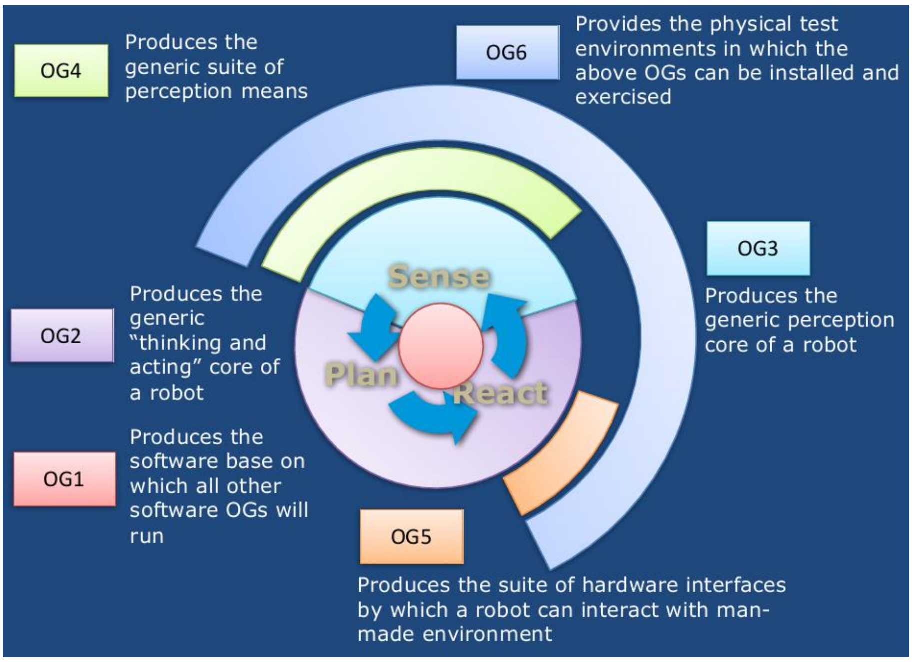

Figure 4-2. Global picture and relations between OGs.

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4.3 OG5 product definitions

OG5 produces an androgynous interconnect (the SIROM interconnect). Two SIROM interconnect can be connected together to allow transfer between them of force/torque, data, power and heat flux.

The interfaces between two SIROM interconnect are "Internal Interfaces" and are not relevant for this document.

The interfaces that allow coupling SIROM to other devices are "external Interfaces" and are described in the following.

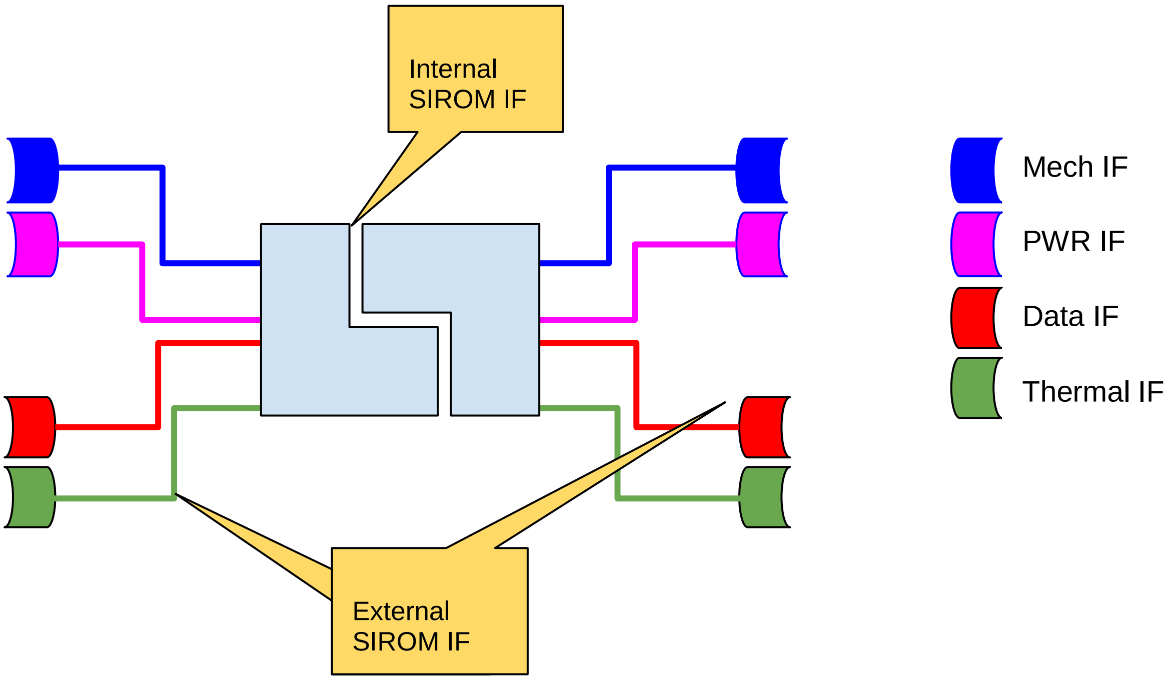

Figure 4-3. Coupling IFs

The SIROM working principle is based on a staged connection as follows:

- First stage (latching) includes guiding from the manipulator misalignments to controlled and reduced misalignments using a capture mechanism to reduce the separation distance between SIROMs. Capture range is defined to allow capture before the contact of the guides occurs to be able to use the positioning mode of the manipulator. This stage starts when the Ready-to-capture status is detected by the manipulator and ends when the Latched status is detected by the SIROM.

- The second stage (connecting Control, Data, PWR and thermal) is done by a second mechanism that provides the functional connection from a position driven by the design of the previous stage. This stage starts when the Latched status is detected by the SIROM and ends when the Connected status is detected by the SIROM.

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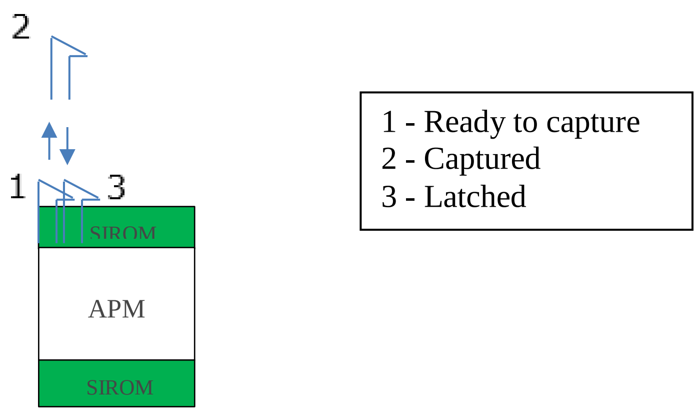

Figure 4-4. First stage (latching) for SIROM connection

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5. RELATIONS OF SIROM WITH OTHER OGS

5.1 OG1-OG5

BETWEEN	TYPE	Major sequence	Minor sequence	version.revision	Title	Description
OG1-all	S	1	0	V0.1		OG1 shall model the provided core robotics functions and tools in TASTE, so that they can be interfaced by any software component modelled in TASTE and using the set of provided ASN.1 types. The software provided by other OGs may be in the form of TASTE models that can be directly imported in the model of an application, or in the form of software libraries that can be invoked from TASTE code. In order to facilitate the integration, the software should make use of the ASN.1 data types provided by ESROCOS.
OG1-all	S	1	0	V0.1		OG1 shall provide to the application developer with the autoproj system to manage package dependencies and builds. In order to benefit from the package and build management capabilities, other OGs may distribute the software products as autoproj packages.
OG1-all	S	1	0	V0.1		OG1 shall provide monitoring and command services based on PUS to operate a robotic application from a control workstation. The following services shall be provided (TBC): · TC verification · Housekeeping TM · Event management · Function management · Time management · Connection test · Timeline command scheduling · Event-action table management · OBCP · Parameter management · File management
OG1-OG5	D	1	0	V0.1		OG1 shall provide an ASN.1 type to configure a SpaceWire connection in TASTE.
OG1-OG5	S	1	0	V0.1		OG1 shall provide a SpaceWire driver for RTEMS and AIR in the selected reference board (TBC), and shall provide the bus driver model in TASTE for use by the applications.
OG1-OG5	S	1	0	V0.1		OG1 shall provide a CAN bus driver for RTEMS and AIR in the selected reference board (TBC), and shall provide the bus driver model in TASTE for use by the applications.

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5.2 OG2-OG5

BETWEEN	TYPE	Major sequence	Minor sequence	version.revision	Title	Description
OG2-OG5	F	1	1	V0.1		OG2 shall communicate with SIROM through two data and control interfaces: ● SPACEWIRE (Data) ● CANbus (Control)
OG2-OG5	F	1	2	V0.1		OG2 shall provide API functions that through the CAN bus interface can discover and identify all SIROM interconnects attached to the CAN bus. CANOpen protocol must be used.
OG2-OG5	F	1	3	V0.1		OG2 shall provide API functions that through the CAN bus interface send commands to a SIROM interconnect and poll telemetry from a SIROM interconnect. CANOpen protocol must be used.
OG2-OG5	F	2	1	V0.1		SIROM Controller TM messages to be provided by OG2 shall include, at least (the following list is TBC): - SIROM Controller Operating Status: [Ok - Error - etc] - Sensors Data: - - o Latched Status: [Unlatched o Latched] o o Connected: [Connected o Disconnected] o - PWR IF Status: [Ok - Unavailable - Error] - Data IF Status: [Ok - Unavailable - Error] - Thermal IF Status: [Ok - Unavailable - Error]
OG2-OG5	F	2	2	V0.1		SIROM Controller TC messages to be provided by OG2 shall include, at least (the following list is TBC): - Command to Latch/Unlatch and Connect/Disconnect: o Command to Latch sent to SIROM B shall be performed after manipulator detects that SIROM B has arrived in the Ready-to-capture position. NOTE: Command to Latch sent to SIROM A shall be performed by the APM1 and is not commanded through SIROM. o Command to Connect sent to SIROM A/B shall be performed after SIROM A/B sensors detect that they are in Latched status. o Command to Unlatch sent to SIROM D shall be performed after SIROM A/B sensors detect that they are in Connected status. o Command to Disconnect sent to SIROM C/D shall be performed after SIROM D sensor detect that it is in Ready-to-capture status. o Command to Unlatch sent to SIROM C shall be performed after SIROM C sensor detect that it is in Disconnected status. - Commands to initiate the PWR IF. - Commands to initiate the Data IF. - Commands to initiate the Thermal IF.
OG2-OG5	F	3	1	V0.1		OG2 shall provide to OG5 ready-to-capture status when the robotic arm arrives to the ready-to-capture position of SIROM interfaces according to OG5-OG6/F/004/003/V0.1.
OG2-OG5	F	4	1	V0.1		The APM provided by OG5 shall be controllable to connect or disconnect to/from its SIROM I/Fs through a simple command delivered by OG2. NOTE: During demonstration tests, an application developed by OG6 and running on the OG6 OBC will perform control of the APM only. But the connect/disconnect tasks or any M&C command on the SIROM I/F will be performed by OG5 EGSE.
OG2-OG5	D	1	1	V0.1	Data protocol:	The SIROM Data communication will be through SPACEWIRE-PnP protocol as defined in the ECSS-E-50-12C.

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OG2-OG5	D	1	2	V0.1	Data harness and connector:	The SIROM SPACEWIRE lines are in form of cable assemblies as defined in the ECSS-E-50-12C §4.2 with male/female connector, here recalled to be nine contact micro-miniature D-type ESA/SCC 3401/029-01B 9P.
OG2-OG5	D	1	3	V1.1	Data protocol:	The SIROM Control communication to discover and identify all SIROM interconnects will be through CANbus protocol interface as defined in the ECSS-E-ST-50-15C – CANbus extension protocol.
OG2-OG5	D	1	4	V1.1	Data harness and connector:	The SIROM CANbus lines are in form of cable assembly that shall comply to sections 5 and 10 of ECSS-E-ST-50-15C.As described in section 5, connectors can be selected (or not) from the following ones (described in section clause 10): Circular Connector: MIL-C D38999 configuration D-type: Single CAN Network male/female connectors *CAN is preferred over SpW due to the following aspects: CAN allows automatic address; with CAN there may or may not be a central control node, and nodes may be added at any time, even while the network is operating (hot-plugging). This is an advantage with respect to SpW.* *CANopen is a set of higher level protocols and profile specifications that include services for device monitoring (heartbeat), error signalling and network management. SIROM interface will have scenarios that require ad-hoc connections and the need for higher level functionality provided by CANopen is essential.* *'ECSS-E-ST-50-15C – CANbus extension protocol' covers the standard CAN protocol and also the CANopen protocol.* *The elements in the architecture that will act as a CANOpen master and as CANOpen slaves shall be defined. SIROMs and secondary APMs will be CANOpen slaves.* *Note: OG1 and OG2 are frameworks. They don't provide an application to monitor and control the SIROM. Instead, they provide the means for the final user to build such application: OG1 by providing the CAN drivers inside TASTE so that they can be used in the system models, and OG2 by defining the interface that allows functional layer components to be used by an agent.*

OG2-OG5/F/002/002/V0.1

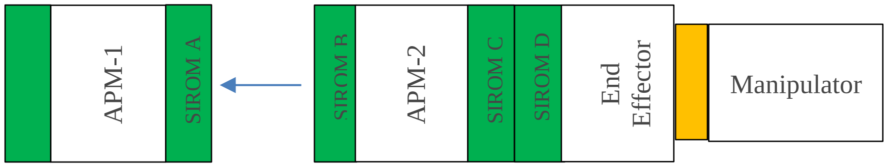

Figure 5-1. Example showing Connection between SIROM A and B.

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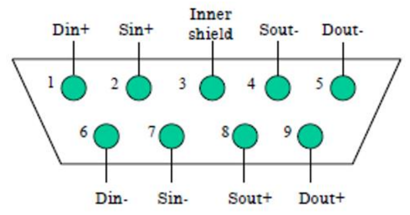
OG2-OG5/D/001/001/V0.1



Viewed from rear of receptacle or front of plug

Contact number	Signal name
1	Din+
2	Sin+
3	Inner shield
4	Sout-
5	Dout-
6	Din-
7	Sin-
8	Sout+
9	Dout+

OG2-OG5/D/001/003/V1.1

- Circular Connector: MIL-C D38999 configuration D: Single CAN Network male/female connectors:

Table 10-3: Pin function for MIL-C D38999 configuration D

Pin No	Function
1	CAN_H
2	CAN_L
3	Reserved

- Sub-miniature or Micro-miniature D-type ESA/SCC 3401/029 male/female connectors:

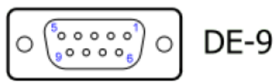


Figure 10-1: Illustration of a 9-pin D-Sub connector

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Table 10-4: Pin function for sub D-type with CAN Network

Pin No	Signal Name	Function
1	-	Reserved
2	CAN_L	CAN_L bus line dominant low
3	CAN_GND	CAN Ground (OPTIONAL)
4	-	Reserved
5	(CAN_SHLD)	CAN Shield (OPTIONAL)
6	(GND)	Ground (OPTIONAL)
7	CAN_H	CAN_H bus line dominant high
8	-	Reserved (Some commercial systems may use pin 8 as an error line, to indicate an error on the net).
9	(CAN_V+)	CAN_V+ - CAN external supply (OPTIONAL)

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5.3 OG4-OG5

BETWEEN	TYPE	Major sequence	Minor sequence	version.revision	Title	Description
OG4-OG5	E	1	0	V0.1		OG5 routes the electrical interfaces either between the ICU and the platform or between the sensors and the ICU.
OG4-OG5	E	2	0	V0.1		OG5 SIROM interconnect provides pass through data interfaces which maintain the signal integrity of the applicable electrical standard: SpaceWire (N+R) CAN Bus (TBD) SpaceFibre (N+R) (TBD) 1553 (TBD) Analog Thermistor interfaces
OG4-OG5	E	3	0	V0.1		The SIROM SPACEWIRE lines are in form of cable assemblies as defined in the ECSS-E-50-12 Â§4.2 with female connector plug, here recalled to be nine contact micro-miniature D-type 340102901B 9P as defined in ESA SCC Detailed Specification No. 3401 29
OG4-OG5	M	1	0	V0.1		OG5 mechanical interface shall be compatible with OG4 mechanical interface: at ICU level or sensor level.
OG4-OG5	M	2	0	V0.1		OG5 provides a mechanical model of their SIROM interface.
OG4-OG5	P	2	0	V0.1		OG5 provides a flexible power cable arrangement (N+R) to enable peripherals in the range 10W to 300W and bus voltages in the range 5V to 100V to be specified.
OG4-OG5	P	3	0	V0.1		OG5 specifies that the destination device shall use isolating power supplies to reduce common mode voltage differences between source and destination
OG4-OG5	P	4	0	V0.1		OG5 specifies a non-current carrying 0 V reference signal to establish a 0V reference between both sides of the interface.
OG4-OG5	P	5	0	V0.1		OG5 provides a separate power cables (N+R) for survival heaters.
OG4-OG5	T	1	0	V1.1		OG5 provides thermal transfer path that can be used by OG4 APM. The IF between the SIROM thermal connectors and the APM will be defined,

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5.4 OG5-OG6

BETWEEN	TYPE	Major sequence	Minor sequence	version.revision	Title	Description
OG5-OG6	F	1	1	V0.1	Orbital:	OG6 facility shall include a robotic arm on which OG5 end-effector shall be mounted.
OG5-OG6	F	1	2	V0.1	Planetary	OG6 facility shall include a rover provided with a robotic arm on which OG5 end-effector shall be mounted.
OG5-OG6	F	2	1	V0.1	Orbital:	Orbital: OG6 facility shall provide 3 M6 (TBC) I-F threaded holes for attaching each of the two non-active I/F elements (provided by OG5) onto which the OG5 APM's SIROM I-F can be accommodated. These threaded holes shall be equally distributed (at 120º) over a 200 mm (TBC) diameter circumference.
OG5-OG6	F	2	2	V0.1	Planetary	Planetary:OG6 facility shall provide: - For the auxiliary APM (positioned on the upper side of the carrying rover): 3x M6 (TBC) I/F (provided by OG5) and 3 M6 (TBC) I/F threaded holes for attaching one non-active I/F element (provided by OG5) onto which the OG5 APM's SIROM I/F can be accommodated. These threaded holes shall be equally distributed (at 120º) over a TBC mm diameter circumference. - For the primary APM (positioned on the underside of the carrying rover): Holding means for this APM. The I/F between the primary APM and OG5 is TBD.
OG5-OG6	F	3	1	V1.1		Orbital: OG6 facility shall include an on-board computer (OBC). The OBC shall host the M&C (monitoring and control) application for communication with the APM. The OBC shall also retrieve the APM's measurement data. Data will be transmitted between the APM and the computer through the robotic arm. NOTE: OG5 will include an EGSE for communication with the SIROM. No interfaces are foreseen between OG6 OBC and OG5 EGSE (TBC). Planetary: Not applicable. In planetary scenario communication with the APM will be provided by EGSE (OG5)
OG5-OG6	F	3	2	V0.1		The OG6 robot arm shall be able to grasp, detach and relocate an APM from an initial to a final operational location.
OG5-OG6	F	3	3	V0.1		The robotic arm provided by OG6 shall be capable to hold and transport one APM. NOTE: The estimated dimensions of the APMs are the following: - Orbital primary APM: (HxWxL) 250 x 150 x 150 mm (TBC) - Orbital secondary APM: (HxWxL) 250 x 150 x 150 mm (TBC) - Planetary primary APM: (HxWxL) 400 x 600 x 600 mm (TBC) --> Not movable by arm - Planetary secondary APM: (HxWxL) 250 x 150 x 150 mm (TBC)
OG5-OG6	F	4	1	V0.1		The OG6 robot shall be controlled in position and in impedance control modes. The OG6 robot will be controlled in position mode till close to contact (i.e. till ready-to-capture identified by OG6) and then in impedance mode (after captured state identified by SIROM) for the contact operations. No change in robot position shall occur when switching from position to impedance mode.

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OG5-OG6	F	4	2	V1.1		The OG6 shall provide the following control option of the robot used to manipulate the APMs: 1. An open-loop control, where the positions of both the base of the robot and APMs are pre-defined and hard-coded into the controller. This is referred to as position control mode. NOTE; In this setting, no external inputs are needed but any relative movement of the components of the system (i.e. the base of the robot and APMs) during the experiments are to be excluded. As an alternative, which feasibility should be first confirmed with OG4, the following control option could be investigated: 2. A closed-loop control, where the positions of both the base of the robot and APMs are detected by a visual system provided by OG4. NOTE; In this setting, a more realistic scenario is represented since the positions of the component of the system are not hard-coded into the controller. But this would require visual detection by OG4.
OG5-OG6	F	4	3	V0.1		The OG6 robot in position control mode shall have a position accuracy at SIROM interface coordinate frame of: - +/-5 mm in any direction - +/- 1º in any axis
OG5-OG6	F	4	4	V0.1		The OG6 robot shall be able to be controlled in closed-loop impedance control mode after SIROM identifies captured state.
OG5-OG6	F	4	5	V1.1		The OG6 robot in impedance control mode shall limit the resistance torques and forces at SIROM interface coordinate frame to: - Less than 10 N in any direction (static value) - Less than 0,5 Nm in any axis (static value) NOTE: OG6 robot shall provide the force-torque sensor because the SIROM's end-effector is just an adaptor (between the SIROM and the robot flange) without any force-torque sensor to enable the mentioned control mode (i.e. the impedance control mode).
OG5-OG6	F	5	1	V0.1		For orbital scenario, the OG6 robot manipulator minimum load capacity shall be 10.5 kg (quasi-static) (TBC).
OG5-OG6	F	5	2	V0.1		For planetary scenario, the OG6 manipulator shall have a minimum payload capacity of 7.5 kg. The indicated value is determined by the weight of the end-effector (2 kg with its SIROM) and the secondary APM (5.5 kg with its 2 SIROMs). *NOTE: In the SRR, it was mentioned that SherpaTT robotic system will be used. Thus, the capacity of SherpaTT shall be higher than 7.5 kg.*
OG5-OG6	F	6	1	V0.1		The OG6 robot controller shall include a collision avoidance functionality to ensure that during the relocation of the APM no collisions occur with the experimental mock-up. The world model used to allow this functionality shall be updated after relocation of APM.
OG5-OG6	F	6	2	V0.1		The OG5 shall provide envelope constraints (static and dynamic) of the APMs and end effector
OG5-OG6	F	7	1	V1.1		The robotic arm shall be able to mount the EE safely. Either with brakes when the robotic arm is unpowered or by any other means.
OG5-OG6	F	8	1	V0.1		OG6 shall provide to OG5 ready-to-capture status when the robotic arm arrives to the ready-to-capture position of SIROM interfaces according to OG5-OG6/F/4/3/V0.1.
OG5-OG6	O	1	1	V1.1		The manipulator shall be equipped with sensors to measure their pose (i.e. IMUs) to be provided by OG6 in order to get relative position and orientation w.r.t. the target of the manipulator. *NOTE: In this setting, the visual feedback is not needed, therefore it is assumed that the manipulator is controlled in the open-loop position control mode. If this is not true, then a visual feedback is needed as described in OG5-OG6/F/4/2/V0.1.*

OG5-OG6	O	1	2	V0.1		6 DOF tip force/torque sensor data during testing shall be provided by OG6. This is required to verify that the requirement OG5-OG/6F/4/5/V0.1 is fulfilled.
OG5-OG6	O	1	3	V0.1		Data about the robotic arm tip position and orientation shall be provided by OG6.
OG5-OG6	O	2	1	V0.1		The analogue test site shall feature planetary surface analogue environmental conditions (dust, temperature variations, low visibility). To prove that SIROM I F will remain functional in environmental conditions analogue to those found on Mars or Moon.
OG5-OG6	O	3	1	V0.1		For open-loop manipulator control, the exact geometries of the test setup shall be provided by OG6. Exact position of APMs relative to robot is needed for open-loop picking.
OG5-OG6	O	4	1	V0.1		The OG6 facility ICD (lay-out) shall be provided to OG5 by CDR. OG6 orbital and planetary Manipulators ICD shall be available before PDR.
OG5-OG6	O	5	1	V1.1		Step flies, drawings, a kinematic description (e.g. DH parameters), and data sheets from the robotic arm and rover platform shall be provided by OG6 for orbital and planetary.
OG5-OG6	M	1	1	V1.1		The OG6 manipulator shall include a suitable mechanical interface to mount the end effector provided by OG5. OG6: Detailed information about the mapping of the output flange of this IF is required. Step files and drawings are required. Note: The mechanical interface between the end-effector produced by OG5 (SIROM) and the Light-Weight Robot used by OG6 for the OG5 validation is described in Figure 2. Refer to figure 2, FWA 50 (right). DLR provides this flange. The OG5 device should comply to DIN ISO-9409, as shown in the figure. It needs to have four threaded holes (pcd 50, M6, 8mm depth) (see 33), the 6 mm H7 hole (8mm depth for orienting pin) (see 73) and the 31.5 h7centering stud (maximum length 3mm) (see 78). The pin (see 73) is directed in the +ve x-direction. The z-axis is the axis of symmetry, +ve inwards into your device (into the page for given figure).
OG5-OG6	M	2	1	V1.1		The output flange of the Robotic Arm used in the simulated environment (either Planetary or Orbital one) shall be able to exert a force of 150 N in any direction.
OG5-OG6	M	2	2	V1.1		The output flange of the Robotic Arm used in the simulated environment (either Planetary or Orbital one) shall be able to exert a torque of 25 Nm along any direction.
OG5-OG6	M	3	1	V0.1		The Robotic Arm used in the simulated environment (either Planetary or Orbital one) shall offer one or more attaching points to sustain the cables of the SIROM End Effector EGSE harness within 30 cm max from the output flange of the Robotic Arm itself. This shall be valid for any attitude of any Robotic Arm's joint.
OG5-OG6	P	1	1	V0.1		Not applicable (TBC). NOTE: Powering of SIROM I F and APM shall be provided by OG5 EGSE (TBC).
OG5-OG6	P	2	1	V0.1		The two power interfaces between the OG5 Standard Interfaces (IF) produced by OG5, i.e. at the end-effector and at the Active Payload Module (APM), and the power supply provided by OG6 consists of external cables. These are sustained by the Robotic Arm itself. The cables are fixed along the Robotic Arm with glued fixtures and Velcro stripes (see Figure 1).The cables are provided by OG5.
OG5-OG6	T	1	1	V0.1		The thermal environmental conditions shall be laboratory conditions.
OG5-OG6	D	1	1	V1.1		Orbital: The OG6 OBC shall provide SpW-PnP communication protocol used for data interface with the APM. Necessary to retrieve the APM's measurement data (e.g., an image from its camera). Harness and connectors shall be provided by OG6 to connect the OBC with the SIROM (the APM data harness passes through the SIROM). NOTE: For details see OG2-OG5/D/1/1/V0.1.

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						Planetary: Not applicable. In planetary scenario communication with the APM will be provided by EGSE (OG5)
OG5-OG6	D	1	2	V0.1		The OG6 OBC shall have a CANOpen communication protocol used for control interface with the APM controller. Harness and connectors shall be provided by OG6 to connect the OBC with the SIROM (the APM controller harness passes through the SIROM). NOTE: For details see OG2-OG5/C1/1/V0.1.
OG5-OG6	D	2	1	V0.1		Real time measurements data of rover and robot arm control in relative and absolute position and orientation shall be provided by OG6. To verify the compliance of requirement OG5-OG6/F/4/3/V0.1 by OG6.
OG5-OG6	D	3	1	V1.1		Orbital: A monitoring interface (HMI) capability to control the APM M&C Application shall be provided by OG6. Planetary: HMI will be provided by OG5 EGSE.
OG5-OG6	D	4	1	V0.1		The data transfer interface (Ethernet connection) between the OG5 end-effector (SIROM) and the OG5 Active Payload Module (APM) produced by OG5 and the on-board computer (OBC) provided by OG6 at the orbital facility consists of external cables. These are sustained by the Robotic Arm itself. The cables are fixed along the Robotic Arm with glued fixtures and Velcro stripes (see Figure 1). The cables are provided by OG5.
OG5-OG6	S	1	0	V0.1		OG6 provides, for the planetary scenario validation, software to compute a manipulator trajectory based on the relative positions of manipulator and the mock-up payload provided by OG5
OG5-OG6	S	2	0	V0.1		OG6 provides, for the planetary scenario validation, software to compute a manipulator trajectory using sensor data from sensors integrated in the OG5 STD/IF (if available)

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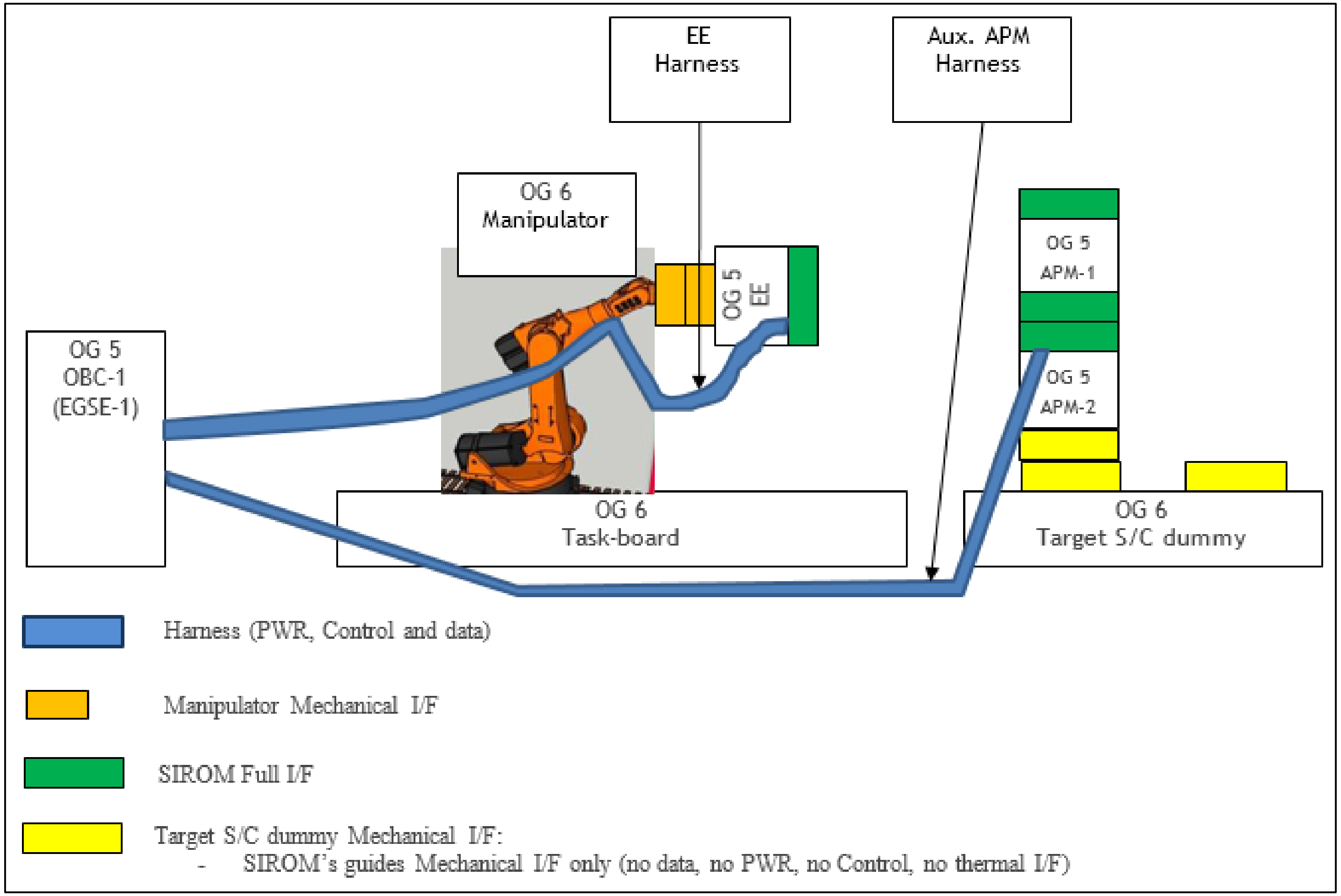

Figure 5-2. Orbital track test configuration.

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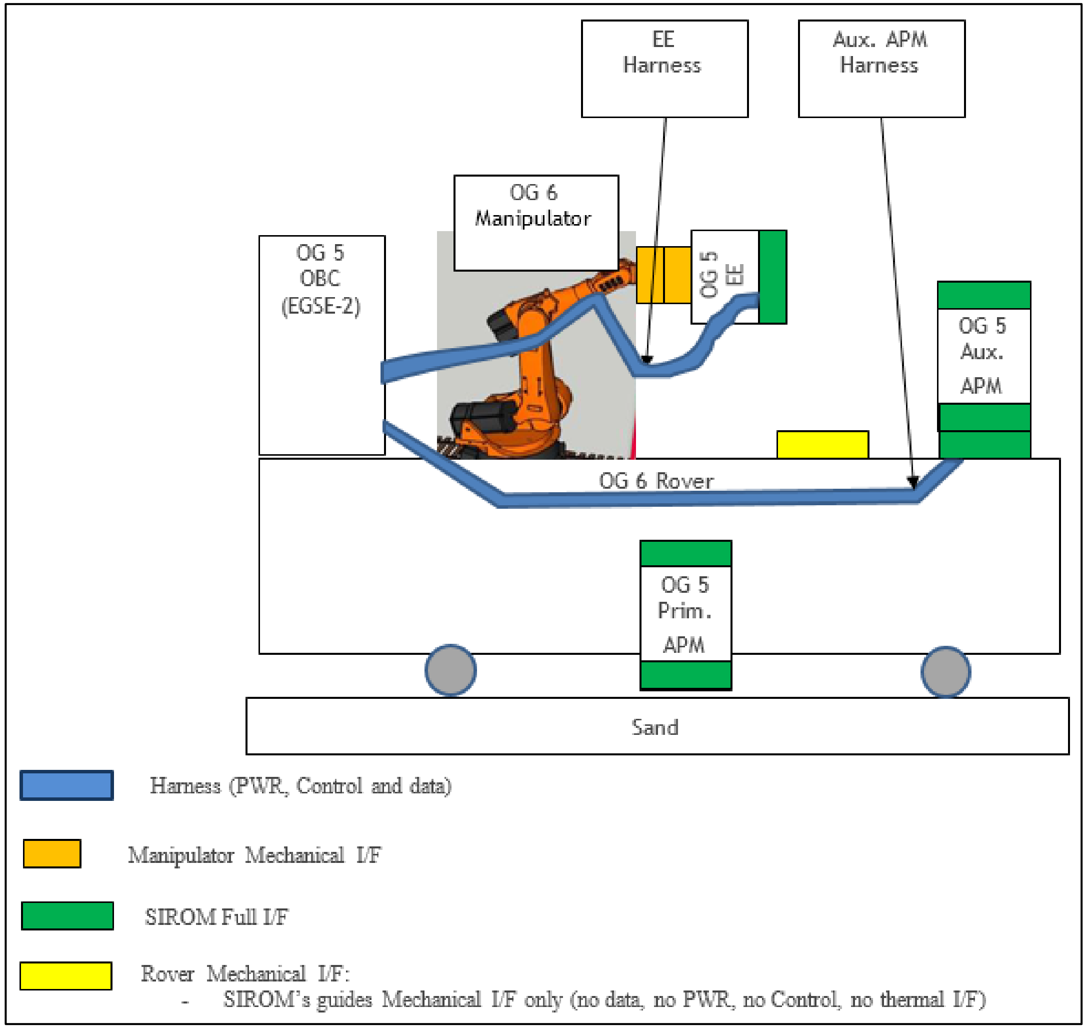

Figure 5-3. Planetary track test configuration.

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