ACS Rømer Algorithms Verification and Validation

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1. Introduction

1.1 Scope

The scope of this document is the algorithm verification and validation of the attitude control system for Rømer. This includes unit tests, integration tests, system tests, and acceptance tests, as it is specified in the ESA standards [1]. Since the tests are planned at different stages in the design, the current version only includes the integration testing. Following versions of the document will include the unit tests, which are planned in the detailed design phase. The system and acceptance tests are deliverables of Terma, hence they will not be included in this document.

The present version of this document specifies the procedure of the integration tests required for algorithm verification and validation as specified in [1]. The tests are conducted in Simulink. The test plan describes the process of assembling the ACS modules in a given sequence, in order to perform intermediate testing.

The design of the integration test is done in parallel with the architectural design. Changes in the architectural design, or elaborations, will spawn new version of this document also.

1.2 Contract Relations

This document constitutes part of the deliverable 3 from Aalborg University for the work described under work package 3620 in [2].

1.3 Definitions, Acronyms and Abbreviations

ACS	Attitude Control System
ASR	ACS System Requirement
ADD	Architectural Design Document
FD	Fault Detection
SRD	System Requirements Document
AVVP/IT	Algorithm Verification and Validation Integration Test
TBD	To Be Determined
TBC	To Be Confirmed

1.4 References

[1] Guide to software verification and validation. Technical Report ESA-PSS-05-10, ESA, 1994.

[2] Peter Hoffmeyer. RØMER Detailed Design Phase Project Management Plan. Technical Report RØMER/TEB/MAN/PLN/0007(3), Terma, October 2001.

[3] Thomas Bak. Detailed architectural design document. Technical Report roemer/iesp/sus/dd/0001(1), Aalborg University, 2001.

[4] Ron Noteborn. System requirements document. Technical Report roemer/teb/sus/rs/0002(2), Terma, 2001.

[5] Ron Noteborn. Acs user requirements document. Technical Report roemer/teb/sus/rs/0001(1), Terma, 2000.

Part I

Integration Tests

2. Test Plan

This document describes the test plan for the integration procedure, conforming to ESA's document development standards, given in [1], and shown in Figure 2.1.

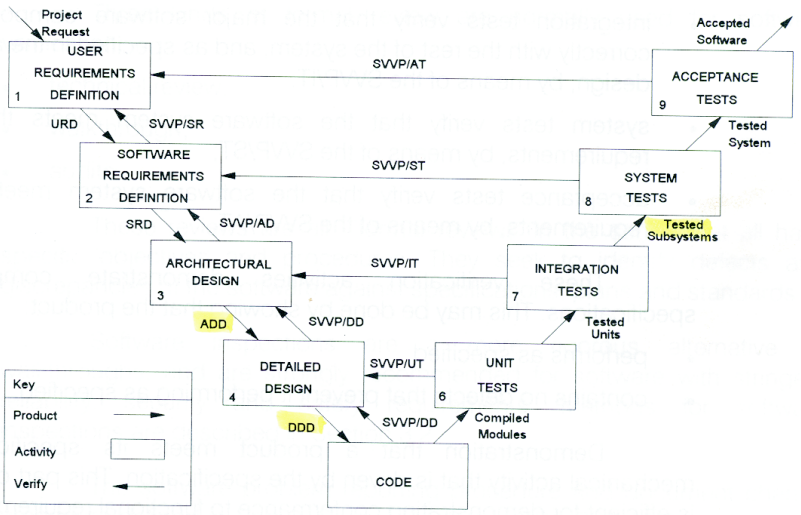

Fig. 2.1: Life cycle verification approach. [1]

2.1 Introduction

This test plan provides the procedure for integrating the unit blocks of the ACS to form the top level sub-systems in the ADD. Hence the inputs of the test are the tested unit blocks, and the outputs are the tested subsystems, which are internally connected in the top-level architectural design.

The integration tests of the ACS subsystem are related to those of ASR's which can be validated by a selection of unit blocks. The tests are not specified in detail, e.g. initial conditions, due to the early stage of the ACS development. This documentation should instead be found in the actual test report, which are done in the actual test phase.

The integration testing is limited to verifying the interfacing of blocks, and functionality of a collection of unit blocks. These tests do not necessarily include range tests on inputs to blocks, since this is already done in unit testing. The important task of the integration testing, is the logical assembly of the ACS with intermediate testing. The intermediate testing is mainly for confirmation of the functionality of the new subset of unit blocks for easy isolation of any problems that may arise.

The assembly of the ACS subsystem is done by connecting the interfaces of the unit blocks as specified in the architectural design. The architectural design is documented in [3]. Figure 2.2 outlines the architectural design.

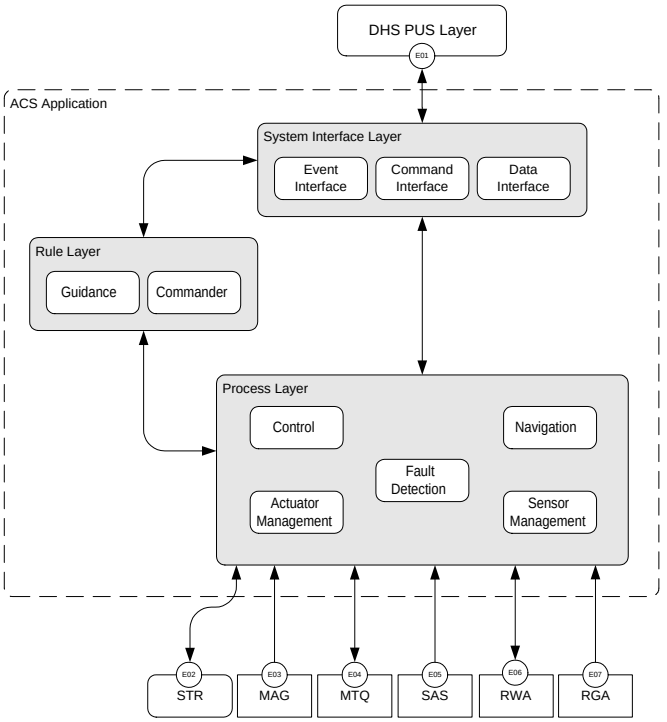

Fig. 2.2: Autonomous controller functional architecture. The top level of the architecture is composed of three basic layers or components, the *Process Layer*, the *Rule Layer*, and the *System Interface Layer*. [3]

At this time the [3] defines two levels (disregarding the ACS block itself), all visible in Figure 2.2. The top level components are:

– Process Layer

– Rule Layer

– System Layer

2.2 Features to be tested

The features to be tested in the AVVP/IT are interfaces between blocks, and the subsystems formed by assembling blocks. The interface testing is done mainly through inspection, since the unit test should test inputs and outputs thoroughly.

The main challenge of the AVVP/IT document is the design of the block assembling procedure with intermediate testing, in order to isolate software errors efficiently.

2.3 Features not to be tested

Features not tested in the integration tests are tests system and acceptance tests which are done after, and unit tests which should already be completed. This means that external interfaces to the ACS system are not tested. This should be done in the system test.

The unit tests are assumed to include the stress of inputs and outputs to blocks, hence the integration test needs only to confirm the compatibility of two blocks, with no need to stress the interfaces between blocks.

2.4 Approach

The integration testing will be designed such that each individual functionality of the unit blocks are expanded by adding a minimum of other unit blocks, yielding a new functionality subsystem, which is tested. When the integration test is complete, a minimum of new blocks are added and the new subsystem is tested. This is repeated until all blocks have been integrated.

Adding a minimum of new blocks, makes it easier to isolate errors observed during testing.

2.5 Item pass/fail criteria

The pass criteria of the integration test is the successful completion of all intermediate tests. The item fails if not.

2.6 Suspension criteria and resumption requirements

TBD.

2.7 Test deliverables

The deliverable of the test will be an ACS subsystem Simulink block. Tests which fail will result in an error correction and/or re-design. The delivered ACS subsystem must pass all tests described in this document.

2.8 Environmental needs

The tests are done on the software development platform, i.e. Matlab.

2.9 Responsibilities

AUC is responsible for tests of the process layer. Terma is responsible for tests of the system interface layer and rule layer. Any anomalous behavior detected in system/integration tests is a shared responsibility between those who are interfacing.

2.10 Staffing and training needs

None.

2.11 Risks and contingencies

TBD.

2.12 Approvals

The test reports and plans are approved by AUC.

3. Test Design

3.1 Process Layer Assembly

The tests in this section form the process layer component. Individual test are executed for all internal interfaces. External interfaces to the Rule Layer and System Interface Layer are assembled and tested in Section 3.2.

3.1.1 Process Layer Integration Tests

The tests verify the internal interfaces in the Process Layer specified in [3] and validates the related requirements from [4]. The interfaces and blocks of the Process Layer is shown in Figure 3.1.

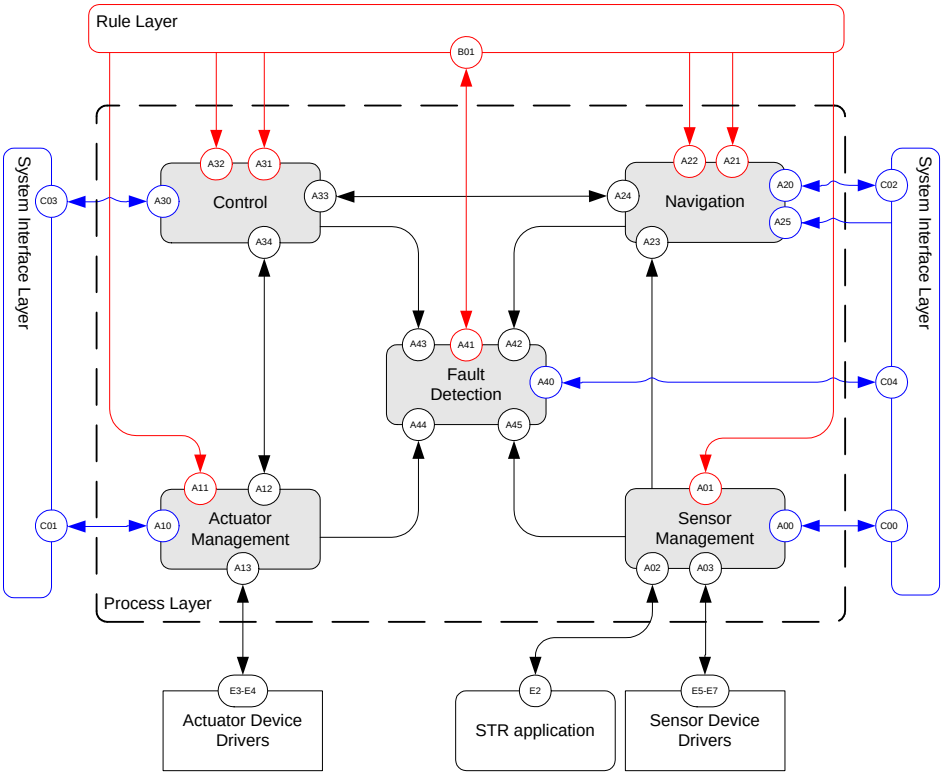

Fig. 3.1: Process Layer architecture. Interfaces to System Interface Layer and Rule Layer are indicated. [3]

3.1.2 Features to be tested

The features that should be tested are given by the SRD, and are listed in Table 3.1. Table 3.1 includes only the system requirements that involve the interfaces defined in the Process Layer, which can be identified in Figure 3.1 by the predecessor “A”, e.g. A23.

The tests in this section will validate the system requirements which can be tested by interfacing to the Process Layer only, or internally within the Process Layer. During the validation, the verification of the interfaces involved in the tests are executed through inspection.

Table 3.1: System Requirements which can be validated using the Process Layer, given in [4].

ASR	Interfaces	Description
2.1	A42, A44, A42	The ACS shall collect information that is relevant to Fault Detection from the following sources: – sensors – actuators – attitude estimation module – position estimation module – controller
2.2	A42, A44, A45	The ACS shall be able to sample FD information at different frequencies for different sources of information.
3.3.1.1	A03, A12, A13, A23, A24, A33, A34	The ACS shall be able to handle de-tumbling of the satellite.
3.3.1.1a	A03, A12, A13, A23, A24, A33, A34	The ACS shall be able to de-tumble from a maximum of 2 deg/sec rate about any axis to 0.1 deg/sec.
3.3.1.2a	A03, A12, A13, A23, A24, A33, A34	The ACS shall be able to perform the sun acquisition from a tumbling state within one hour after activation.
3.3.1.2b	A03, A12, A13, A23, A24, A33, A34	The ACS shall perform the sun acquisition with an accuracy of 15 degrees, 95% of the time.
4.2	A03, A23	The ACS shall measure the attitude of the satellite.
4.2.2	A23	The attitude sensors shall transmit the results of the measurements.
4.2.4	A45	The attitude sensors shall transfer health data.
4.4.1	A12, A24, A33, A34	The ACS shall have the possibility to process actuator information in its attitude determination.
4.4.2.2a	A03, A23	Coarse precision attitude estimation shall have an accuracy of 3 degrees about all axes, 95% of the time that it can be used.
4.4.2.3	A03, A23	In fine pointing, the ACS shall be able to handle a period of maximum 1 minute without stellar attitude data where the satellite shall remain three axis stabilized without loosing the target, but shall not necessarily be within requirements.

3.1.3 Approach Refinements

The strategy of assembly, is to start with the producing blocks, then add the consuming blocks on at a time. Hence the Sensor Management block will be connected to the Navigation block. Then the Control block and the actuator block. Finally the Fault Detection block is added. This will enable the testing of internal interfaces first. For this reason the Process Layer assembly is divided into three phases:

1. Connection of Navigation to Sensor Management through interface A23.
2. Connection of Control and Actuator Management through interface A12, A24, A33, and A34.
3. Connection of Fault Detection through interfaces A42, A44, and A45.

3.1.4 Test Case Identification

The tests of each Process Layer Assembly Phase is given in Table 3.2. The tests validate the system requirements (ASR) which can be tested using only the functionality of blocks

in the Process Layer. The interfaces into the Process Layer are simulated as necessary. It is important to note that the system requirement including functionality from other layers, will not be included at this stage. These test are given in Section 3.2.

Table 3.2: Process Layer Assembly Tests.

Phase:	1
Test No:	1
Interfaces Connected:	A23
ASR Tested:	4.2
Blocks Included:	Sensor Management, Navigation
Interfaces Simulated:	A03
Pass/Fail Criteria:	The attitude of the satellite must be available on interface A33.
Phase:	1
Test No:	2
Interfaces Connected:	A23
ASR Tested:	4.4.2.2a
Blocks Included:	Sensor Management, Navigation
Interfaces Simulated:	A03
Pass/Fail Criteria:	The attitude of the satellite must must have an accuracy of 3 degrees about all axes, 95% of the time in coarse mode.
Phase:	1
Test No:	3
Interfaces Connected:	A23
ASR Tested:	4.4.2.3
Blocks Included:	Sensor Management, Navigation
Interfaces Simulated:	A03
Pass/Fail Criteria:	The satellite must remain three axis stabilized without stellar measurements in the duration of one minute, without loosing its target.
Phase:	2
Test No:	4
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.1
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management
Interfaces Simulated:	A03, A13
Pass/Fail Criteria:	The ACS must de-tumble the satellite.
Phase:	2
Test No:	5
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.1a
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management
Interfaces Simulated:	A03, A13
Pass/Fail Criteria:	The ACS must de-tumble the satellite from 2 deg/sec to 0.1 deg/sec about all axes.
Phase:	2
Test No:	6
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.2a
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management
Interfaces Simulated:	A03, A13
Pass/Fail Criteria:	Sun acquisition must be performed from a tumbling state within one hour.
Phase:	2
Test No:	7
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.2b

Blocks Included:	Sensor Management, Navigation, Control, Actuator Management
Interfaces Simulated:	A03, A13
Pass/Fail Criteria:	Sun acquisition with an accuracy of 15 degrees, 95% of the time.
Phase:	2
Test No:	8
Interfaces Connected:	A12, A33, A24, A34
ASR Tested:	4.4.1
Blocks Included:	Navigation, Control, Actuator Management
Interfaces Simulated:	A12, A13
Pass/Fail Criteria:	Actuator information must be used in attitude determination.
Phase:	3
Test No:	9
Interfaces Connected:	A42, A44, A45
ASR Tested:	2.1
Blocks Included:	Sensor Management, Navigation, Actuator Management, Fault Detection
Interfaces Simulated:	A03, A23, A13
Pass/Fail Criteria:	Fault Detection data must be collected.
Phase:	3
Test No:	10
Interfaces Connected:	A42, A44, A45
ASR Tested:	2.1
Blocks Included:	Sensor Management, Navigation, Actuator Management, Fault Detection
Interfaces Simulated:	A03, A23, A13
Pass/Fail Criteria:	Fault Detection information must be sampled at different frequencies for different sources.

3.2 ACS Assembly

Due to the simplicity of the Rule Layer and System Interface Layer, these are not assembled separately. Instead the blocks within each layer are connected to the Process Layer individually, in order to improve the integration testing.

3.2.1 ACS Integration Tests

The tests verify the internal interfaces in the ACS specified in [3] and validates the related requirements from [4]. The interfaces and blocks of the Rule Layer is shown in Figure 3.2, and the System Interface Layer is shown in Figure 3.3

3.2.2 Features to be tested

The features that should be tested are given by the SRD, and are listed in Table 3.3. Table 3.3 includes the system requirements not already covered by the Process Layer assembly, and requirements which are assumed to be tested in unit tests or system tests.

As in the previous section, verification of the interfaces involved in the tests are executed through inspection.

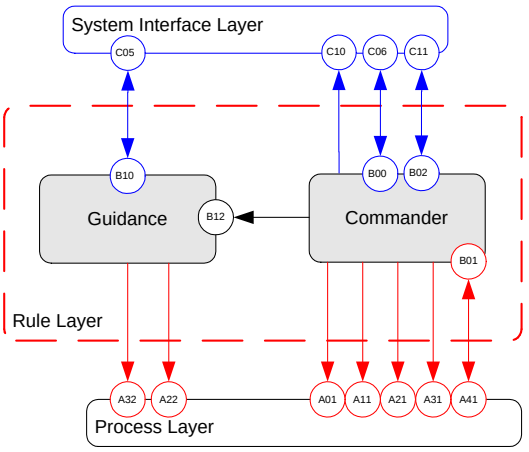

Fig. 3.2: Rule Layer architecture. Interfaces to System Interface Layer and Process Layer are indicated. [3]

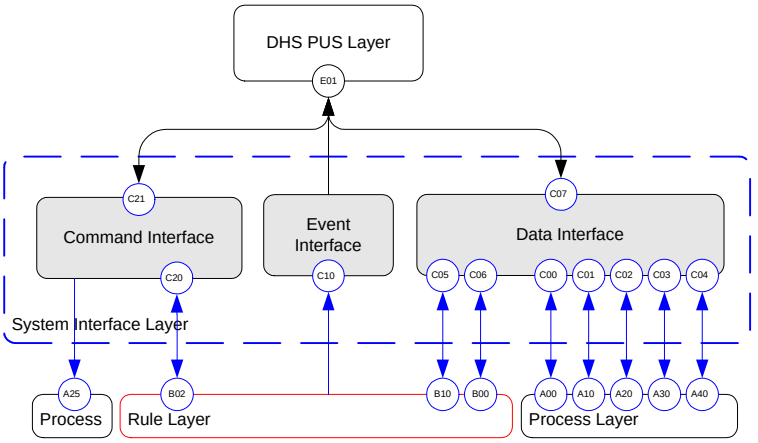

Fig. 3.3: System Interface Layer architecture. Interfaces to Rule Layer and Process Layer are indicated. [3]

Table 3.3: System Requirements which are validated in the ACS assembly, specified in [4].

ASR	Interfaces	Description
1.1	TBD	The ACS shall initialize itself before starting to control the satellite's attitude.
1.2.2	A42, A44, A45, B01	The ACS shall be able to process fault alarms.
1.2.3	B01, B02	The ACS shall be able to apply logic on alarms and commands.
1.3	B01, B02	The ACS shall decide on configuration changes on the basis of results of commands and alarms.
1.3.1	A11, B01	The ACS shall be able to reconfigure itself to use different type of actuators.
1.3.3	A31, B01	The ACS shall be able to reconfigure itself to use different types of controllers.
1.3.4	A01, B01	The ACS shall be able to reconfigure itself to use different types of sensors.
1.3.6	A21, B01	The ACS shall be able to reconfigure itself to use different kinds of attitude determinators.
1.3.7	A41, B01	The ACS shall be able to reconfigure itself to change fault detection.
1.3.8	A00, A10, A20, A30, A40, B00, B10, C07	The ACS shall be able to change internal parameters, ideally all parameters, but as minimum: – the set point of a controller in inertial coordinates. – the setpoint of a controller relative to the last set point. – the parameters that model the system internally.
1.5	A01, A11, A21, A31, A41, B01	The ACS shall be able to reconfigure itself autonomously.
1.6	C10	The ACS shall report on the decisions it takes autonomously on changes in its activities.
1.8	B00, B02, C06	The ACS shall feature the possibility to switch any autonomous actions off and transfer to ground.
2.5.6	A01, A11, A21, A31, A41, B01	The ACS shall raise a FD alarm to trigger state change of the supervisor for execution of specific tasks.
2.6	A42, A44, A45, B01, B02	The ACS shall be able to switch off and on alarms and subsequently also not perform associated analysis for alarms that are off.
2.7	B01, C10	The ACS shall report a detection of a fault to the external world.
3.2.2	B01, C10	The ACS shall make it known that it has reached the steady state condition.
3.3.1.3a	A03, A12, A13, A22, A23, A24, A32, A33, A34	The ACS shall be able to reorient the satellite about an angle of 180 degrees in 10 minutes.
3.3.1.3b	A03, A12, A13, A22, A23, A24, A32, A33, A34	After the reorientation, the ACS shall be able to reach steady state in fine pointing within 3 minutes (if fine pointing is the succeeding mode of operation).
3.3.1.4a	A03, A12, A13, A22, A23, A24, A32, A33, A34	The Absolute Pointing Error for the payload boresight axis in Fine Pointing satellite with respect to the set-point, shall be less that 2 arcmin in pitch yaw, and 60 arcmin about roll, 95% of the time.
3.3.1.4b	A03, A12, A13, A22, A23, A24, A32, A33, A34	The Relative Pointing Error for the payload boresight axis in Fine Pointing shall be better than specified in URD AUR-7.1.
3.3.1.5a	A03, A12, A13, A22, A23, A24, A32, A33, A34	The Absolute Pointing Error for the ACS reference for coarse control frame shall be less than 15 degrees about all axes, 95% of the time.

3.7	TBD	The ACS shall report on the torque applied to the satellite.
4.3	C00	The ACS shall collect data from from the sensors.
4.4.2.4	B01, C10	When the ACS is without stellar attitude data in fine pointing mode, this shall be reported to the rest of the system.
4.4.4a	A25	The position knowledge must be accurate enough to allow reconstruction of the magnetic field vector with the desired accuracy for altitudes lower than 1,000 km.
4.4.5	A25	The ACS shall be able to predict the inertial position of the Sun as a function of time with an accuracy of 0.34 degrees, 95% of the time.
4.4.6	A25	The ACS shall be able to predict the inertial position of Earth with respect to the orbital position with an accuracy of 2 degrees, 95% of the time.
4.4.8	A25	The ACS shall be able to predict the magnetic field vector (intensity and direction) in the inertial frame with respect to the orbital position, with an accuracy of 1.6 degrees, 95% of the time.
4.5	C02	The ACS shall make the attitude, rates, and position of the satellite available to the sub systems that need this data.
5.1	A00, A10, A20, A30, A40, B00, B10	It shall be possible to configure the ACS in any desired state by commanding parameters and state machine states.
5.3	C00, C01, C02, C03, C04, C05, C06	It shall be possible to monitor the activities and state of the ACS closely via telemetry.
TBD	B12, A22	The ACS shall have the ability to perform a search pattern.

3.2.3 Approach Refinements

The strategy of assembly, is to connect the components of the Rule Layer and System Interface Layer to the Process Layer in a logical sequence, which allows effective integration testing.

The System Interface Layer will be connected last, since the only interface to the Process Layer, involves data interfacing. This is for get/set parameter routines. These have no dependencies on other blocks, so this will be tested separately on the assembled ACS.

The sequence of assembly is given by the following phases:

1. The Guidance block is connected to the Process Layer through interface A22, A32, B11.
2. The Commander is connected to the Process Layer through interfaces A01, A11, A21, A31, A41, B01, and to Guidance through B03, B12.
3. The Command Interface and Event Interface are connected to the Rule Layer through interfaces B02, C10, and C20.
4. The Data Interface is connected to the Rule Layer through interfaces B00, B10, C05, and C06, and to the Process Layer through interfaces A00, A10, A20, A30, A40, C00, C01, C02, C03, and C04.

3.2.4 Test Case Identification

The tests of each ACS assembly Phase is given in Table 3.4. The external interfaces to the ACS are simulated as necessary.

Table 3.4: Process Layer Assembly Tests.

Phase: 1

Test No:	11
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.3a
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management, Guidance
Interfaces Simulated:	A03, A13, A22, A32
Pass/Fail Criteria:	Reorientation about an angle of 180 degrees must be performed within one hour.
Phase:	1
Test No:	12
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.3b
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management, Guidance
Interfaces Simulated:	A03, A13, A22, A32
Pass/Fail Criteria:	After reorientation the satellite must reach steady state in fine pointing within three minutes.
Phase:	1
Test No:	13
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.4a
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management, Guidance
Interfaces Simulated:	A03, A13, A22, A32
Pass/Fail Criteria:	Absolute Pointing Error must be less than 2 arcmin in pitch yaw, and 60 arcmin about roll, 95% of the time in Fine Pointing.
Phase:	1
Test No:	14
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.4b
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management, Guidance
Interfaces Simulated:	A03, A13, A22, A32
Pass/Fail Criteria:	Relative Pointing Error in Fine Pointing must be within the specification in URD AUR-7.1 [5].
Phase:	1
Test No:	15
Interfaces Connected:	A12, A23, A24, A33, A34
ASR Tested:	3.3.1.5a
Blocks Included:	Sensor Management, Navigation, Control, Actuator Management, Guidance
Interfaces Simulated:	A03, A13, A22, A32
Pass/Fail Criteria:	Absolute Pointing Error in coarse mode must be less than 15 degrees about all axes, 95% of the time.
Phase:	1
Test No:	16
Interfaces Connected:	A25
ASR Tested:	4.4.4a
Blocks Included:	Navigation, Command Interface
Interfaces Simulated:	C21
Pass/Fail Criteria:	The position must be accurate enough to reconstruct the magnetic field vector in altitudes below 1,000 km, with an accuracy less than TBD.
Phase:	1
Test No:	17
Interfaces Connected:	A25
ASR Tested:	4.4.5
Blocks Included:	Navigation, Command Interface

Interfaces Simulated:	C21
Pass/Fail Criteria:	The inertial position of the Sun as a function of time, must be estimated with an accuracy of 0.34 degrees, 95% of the time.
Phase:	1
Test No:	18
Interfaces Connected:	A25
ASR Tested:	4.4.6
Blocks Included:	Navigation, Command Interface
Interfaces Simulated:	C21
Pass/Fail Criteria:	The inertial position of Earth with respect to the orbital position, must be estimated with an accuracy of 2 degrees, 95% of the time.
Phase:	1
Test No:	19
Interfaces Connected:	A25
ASR Tested:	4.4.8
Blocks Included:	Navigation, Command Interface
Interfaces Simulated:	C21
Pass/Fail Criteria:	The magnetic vector must be reconstructed with a pointing accuracy of 1.6 degrees and magnitude accuracy of TBD, 95% of the time.
Phase:	2
Test No:	20
Interfaces Connected:	B01
ASR Tested:	1.2.2
Blocks Included:	Fault Detection, Commander
Interfaces Simulated:	A42, A44, A45
Pass/Fail Criteria:	The generated fault alarms must be handled by the processed by the Command block.
Phase:	2
Test No:	21
Interfaces Connected:	B01, B02
ASR Tested:	1.2.3
Blocks Included:	Fault Detection, Commander, Command Interface
Interfaces Simulated:	A42, A44, A45, C21
Pass/Fail Criteria:	Logic must be applied on faults and telecommands.
Phase:	2
Test No:	22
Interfaces Connected:	B01, B02
ASR Tested:	1.3
Blocks Included:	Fault Detection, Commander, Command Interface
Interfaces Simulated:	A42, A44, A45, C21
Pass/Fail Criteria:	Configuration changes must be decided based on faults and telecommands.
Phase:	2
Test No:	23
Interfaces Connected:	A11
ASR Tested:	1.3.1
Blocks Included:	Actuator Management, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	Commander must reconfigure Actuator Management.
Phase:	2
Test No:	24
Interfaces Connected:	A31
ASR Tested:	1.3.3
Blocks Included:	Control, Commander
Interfaces Simulated:	B01

Pass/Fail Criteria:	Commander must reconfigure Control.
Phase:	2
Test No:	25
Interfaces Connected:	A01
ASR Tested:	1.3.4
Blocks Included:	Sensor Management, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	Commander must reconfigure Sensor Management.
Phase:	2
Test No:	26
Interfaces Connected:	A21
ASR Tested:	1.3.6
Blocks Included:	Navigation, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	Commander must reconfigure Navigation.
Phase:	2
Test No:	27
Interfaces Connected:	A41
ASR Tested:	1.3.7
Blocks Included:	Fault Detection, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	Commander must reconfigure Fault Detection.
Phase:	2
Test No:	28
Interfaces Connected:	A01, A11, A21, A31, A41
ASR Tested:	1.5
Blocks Included:	Process Layer, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	Commander must reconfigure ACS autonomously.
Phase:	2
Test No:	29
Interfaces Connected:	A01, A11, A21, A31, A41
ASR Tested:	2.5.6
Blocks Included:	Process Layer, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	The fault alarm must trigger a state change.
Phase:	3
Test No:	30
Interfaces Connected:	C10
ASR Tested:	1.6
Blocks Included:	Commander, Event Interface
Interfaces Simulated:	B01
Pass/Fail Criteria:	Autonomous changes must be reported.
Phase:	3
Test No:	31
Interfaces Connected:	B00, B02, C06
ASR Tested:	1.8
Blocks Included:	Commander, Command Interface
Interfaces Simulated:	B01
Pass/Fail Criteria:	Ground must have the ability to override autonomy, and take over control.
Phase:	3
Test No:	32
Interfaces Connected:	B00, B02, C06
ASR Tested:	2.6
Blocks Included:	Commander, Command Interface
Interfaces Simulated:	B01

Pass/Fail Criteria:	Ground must have the ability to override autonomy, and take over control.
Phase:	3
Test No:	33
Interfaces Connected:	A01, A11, A21, A31, A41, B02
ASR Tested:	2.6
Blocks Included:	Process Layer, Commander
Interfaces Simulated:	B01
Pass/Fail Criteria:	Alarms must be turned on and off, and the Commander must not handle alarms turned off.
Phase:	3
Test No:	34
Interfaces Connected:	C10
ASR Tested:	2.7
Blocks Included:	Commander, Event Interface
Interfaces Simulated:	B01
Pass/Fail Criteria:	Alarms must be reported externally.
Phase:	3
Test No:	35
Interfaces Connected:	C10
ASR Tested:	3.2.2
Blocks Included:	Commander, Event Interface
Interfaces Simulated:	B01
Pass/Fail Criteria:	Steady state must be reported externally.
Phase:	3
Test No:	36
Interfaces Connected:	C10
ASR Tested:	4.4.2.4
Blocks Included:	Commander, Event Interface
Interfaces Simulated:	B01
Pass/Fail Criteria:	Unavailability of stellar measurements must be reported externally.
Phase:	4
Test No:	37
Interfaces Connected:	A00, A10, A20, A30, A40, B00, B10
ASR Tested:	1.3.8
Blocks Included:	Process Layer, Rule Layer, Data Interface
Interfaces Simulated:	C07
Pass/Fail Criteria:	All parameters in the Process Layer and Rule Layer can be changed externally.
Phase:	4
Test No:	38
Interfaces Connected:	C00
ASR Tested:	4.3
Blocks Included:	Sensor Management, Data Interface
Interfaces Simulated:	A03
Pass/Fail Criteria:	Sensor data must be available externally.
Phase:	4
Test No:	39
Interfaces Connected:	C02
ASR Tested:	4.5
Blocks Included:	Navigation, Data Interface
Interfaces Simulated:	A23, A25
Pass/Fail Criteria:	Attitude, rates, and position data must be available externally.
Phase:	4
Test No:	40
Interfaces Connected:	A00, A10, A20, A30, A40, B00, B10

ASR Tested:	5.1
Blocks Included:	Process Layer, Rule Layer, Data Interface
Interfaces Simulated:	C07
Pass/Fail Criteria:	All states in the ACS must be configurable externally.
Phase:	4
Test No:	41
Interfaces Connected:	C00, C01, C02, C03, C04, C05, C06
ASR Tested:	5.3
Blocks Included:	Process Layer, Rule Layer, Data Interface
Interfaces Simulated:	C07
Pass/Fail Criteria:	All states and activities in the ACS must be readable externally.

Part II

Unit Tests