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Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
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VERY LARGE TELESCOPE

Auxiliary Telescope Control System

Liège Test Plan

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ONLY FOR INTERNAL USE!

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TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

This document defines the software-related tests to be performed in the integration test phase at AMOS in Liège. The first parts of the tests, up to and including tuning of altitude and azimuth control loops, are done with a dummy M1 mirror in the telescope, but the rest of the tests are done on the complete, assembled telescope, including optics and all electronics.

1.2 Applicable Documents

The following document is applicable and forms part of this document:

AD- 1 VLT-SPE-ESO-15151-1712, Issue 2.2, 2000-07-11; AT Control Software, Requirements Specification

1.3 Reference Documents

The following documents are referenced in this document

RD- 1 VLT-SPE-ESO-15151-1795, Issue 3.0, 2001-07-10; AT Control Software, System Design Specification

RD- 2 VLT-MAN-ESO-11670-1870, Issue 1.1, 2000-05-15, STRAP Software User Manual

RD- 3 VLT-TRE-ESO-11320-1012, Issue 2, 8. Jan 1997, POSITION LOOP CONTROL ALGORITHM FOR ALTITUDE AND AZIMUTH AXES.

RD- 4 VLT-PRO-ESO-11321-1013, Draft 1.1, 16. Sept 1997, Main structure Local Control System, Alt and Az servo tuning procedure

RD- 5 VLT-TRE-ESO-10000-0469, Issue 2, 20. Oct 1994, Influence of mechanical eigenfrequencies on the tracking.

RD- 6 VLT-ICD-ESO-11670-1288, Issue 3.0 30. May 2000, APD Tilt Loop Interface Control Document.

RD- 7 VLT-MAN-ESO-117001775, Issue 2.1 06. Dec 2000, Technical CCD System Operation Manual

RD- 8 VLT-ICD-ESO-15100-1528, Issue 4.3 15 May 2001, Interface control document between the Electro-Mechanical Hardware and the Control System of the ATS

1.4 List of Abbreviations/Acronyms

The following abbreviations and acronyms are used in this document.

CCS Central Control Software

GPS	General Positioning System
I/O	Input/Output
N/A	Not Applicable
TBC	To Be Confirmed
TBD	To Be Defined
TBSL	To Be Specified Later
TBDB	Time Bus Distribution Box
Tcl/Tk	Tool Command Language/Tool Kit
TCS	Telescope Control Software

2. OVERVIEW

2.1 General

The purpose of the Integration test in Liège is to test the telescope with all its devices, as delivered by AMOS, with the control software and the electronics delivered by ESO. The emphasis is on testing what has not been tested in Garching, but of course also all the detailed hw and sw tests done in Garching will be done also in Liège.

Since the AT control system to a large extent is re-using VLT TCS software, it is not necessary to make tests of functionality that is exactly the same as for VLT. For this reason, the test cases defined here are concentrating on things that are different or new, and on functions directly related to the hardware.

2.2 Test activities.

The Liège integration test period will be used to:

- test the installation of LCUs and WS on AT #1
- test the connection of I/O signals between LCU boards and screw terminals in cabinets
- test the connection of I/O signals from field hardware to cabinet screw terminals and to LCU software
- tune control loops
- test all LCU software functionality
- test all WS software functionality
- test all Use Cases defined in Requirements specification; see

It is assumed that when the tests start

- all LCUs for AT #1 are installed and connected to a local LAN
- field hardware is installed and all signals connected to LCU cabinets
- the WS for AT #1 is installed and connected to a local LAN
- the latest VLTSW release is installed
- ATCS software is installed, and all WS and LCU environments generated

2.3 Summary of test sequence

The tests are composed of a number of ‘test blocks’ (with one chapter per block in this document). The test blocks are divided in smaller test sets, and finally, a number of individual test cases are defined. Each test case has a unique identifier.

The test sequence can be summarised as follows:

1. Check LCU I/O: signals, serial lines, field hw
2. Check telescope safety (interlocks, limits etc)
3. Tune axes control loops
4. Test functions on LCU level
5. Module tests of ws modules
6. Integration test cases
7. Tests of Use Cases

2.4 Computer configuration

A Local TIME generator is inserted in the Azimuth LCU
Other LCU's have the standard configuration

2.5 System configuration.

The local time is distributed to Sensor and to Altitude LCU via the cable wrap using the DB9 electrical I/O connector.

3. PLANNING

Detailed planning for the first part (3 weeks) of the tests in Liège is done, and the corresponding MS Project sheets distributed. In this first period, the test activities as described in the chapters 4 –6 below are to be done. Ideally, this planning should be integrated in this document, but for "technical reasons" this is not done; for the remaining test period(-s) it might be done.

The remaining test periods will be planned in detail when the dates for the test period are fixed.

4. CHECK LCU I/O

Purpose: Test that all IO-signals are correctly defined and connected, all the way from Field hardware up to LCU software panels; check all serial lines and PLC connections

Pre-requisite: WS and LCUs installed; ATCS sw installed

Duration:

Requires:

The activities have test IDs as follows:

- **IO0:** Check LCU connections
- **IO1:** connect and test all signals of alt LCU
- **IO2:** connect and test all signals of az LCU
- **IO3:** connect and test all signals of detector LCU
- **IO4:** check serial line connections
- **IO5:** Test handset for alt and az
- **IO6:** Test drive polarities of alt and az
- **IO7:** Test handset for MACCON small function units
- **IO8:** APD cable tests

4.1 General

Signals are as far as possible tested by using the actual field hardware devices and checking status using the Inducer tools of LCC. Where this is not possible, signals are tested "indirectly" by testing the device functionality. Also check that the signal appears correctly in the corresponding axis Gui panel, i.e. **ataltazAltGui** or **ataltazAzGui**.
Special care must be taken to check safety relevant interlock signals before any telescope motion is done. To test the effect of a particular interlock signal, all other interlocks must be inactive! The test procedure shall be an "end-to-end"-test, i.e. for **each** interlock signal:

- set all interlocks OFF
- generate the interlock signal on the field hardware
- check that the signal appears correctly in the LCU **acroxInducer** panel and in the **ataltazAltGui**/ **ataltazAzGui**
- check that whichever interlock signal is set, INTERLOCKI gets set also.
- check that power amplifiers get disabled and that brakes get engaged if an interlock signal becomes active during axis motion.

4.2 Check LCU connections

4.2.1 Description

The connections from field hardware to the interface terminals are tested by AMOS at sub system level, therefore the ESO tests are limited to the safety relevant connections which are: the protective earth, the main voltage supply lines and low voltage supply lines. These are checked before a connection is made.

4.2.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO0-1	Test Altitude VME connections; see list in 14.1			
IO0-2	Test Signal cabinet connections; see list in 14.2			
IO0-3	Test Hub/Lan connections; see list in 14.3			
IO0-4	Test Cable wrap connections; see list in 14.4			
IO0-5	Test Service panel connections; see list in 14.5			
IO0-6	Test Azimuth VME connections; see list in 14.6			
IO0-7	Test Sensor VME connections; see list in 14.7			
IO0-8	Test M6 cabinet connections; see list in 14.8			
IO0-9	Test Auxiliary VME connections; see list in 14.9			
IO0-10	Test TCCD connections; see list in 14.10			
IO0-11	Test APD head connections; see list in 14.11			

4.3 Connect and test all signals of the alt LCU

4.3.1 Description

Not nice, but until we have something better: The analogue board is normally used from the slave CPU and is not defined on the master side. For test purposes, however, one can temporarily make the aioxInducer usable by patching the bootScript to define the board there.

All digital signals are tested with both values generated and analogue values are tested for min, max and in-between values. Also check names, addresses and polarity for all signals.
See also the test case in 5.3.2 (tests that signals appear in the panel "ataltazAltGui").

4.3.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO1-1	Test ALAZ digital signals; see list in 12.2			
IO1-2	Test ALAZ analogue signals; see list in 12.1			

4.4 Connect and test all signals of the azimuth LCU

4.4.1 Description

See also the test case in 6.2.2 (tests that signals appear in the panel "ataltazAzGui").

4.4.2 Actions/test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO2-1	Test digital signals; see list in 12.4			
IO2-2	Test analogue signals; see list in 12.3			

4.5 Connect and test all signals of the detector LCU

4.5.1 Description

4.5.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO3-1				

4.6 Check serial connection lines

4.6.1 Description

This is the basic test of the serial ports; the check is done by connecting a terminal directly to each side of a serial connection (LCU serial port and device side serial port), except for PLC side connections which are tested in the chapter below.

4.6.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO4-1	M2 connection (alt LCU)	Communication In and OUT OK.	19FEB	OK
2	Cab. temp connection (alt LCU)	Communication In and OUT OK.	20FEB	OK but was set to 19200 baud
3	1st Beacon connection (alt LCU)	Communication In and OUT OK.	21FEB	OK
4	2nd Beacon connection (alt LCU)	Communication In and OUT OK.	21FEB	OK
5	M10 connection (az LCU)	Communication In and OUT OK.	19FEB	OK
6	Siemens PLC connection (aux LCU)	Communication In and OUT OK.		N/A
7	Sauter PLC connection (aux LCU)	Communication In and OUT OK.		N/A

4.7 Test handset for alt and az

4.7.1 Description

A handset can be connected directly to the alt and/or az LCUs resp. When connected there is a hardware interlock, which can be overridden by a button on the handset, thus allowing motion commands to the connected axis (only one axis per handset).
Use the **acroxInducer** panel and the **ataltazAltGui**/**ataltazAzGui** panels to check signals.

4.7.2 Actions/Test cases alt

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO5-1	Connect handset	ILMANUALI is set ("Handset" on ataltazXxxGui)		
2	Push OVERRIDE	ILOVERRIDEI is set		
3	Check all interlock signals displayed on the handset, without moving the telescope			
4	Check telescop[e motion using handset			
5	Check all buttons on handset; incl. correct display on the ataltazXxxGui.			

4.8 Test drive polarities of alt and az

4.8.1 Description

Use the hand set to feed a positive torque reference to the drive. The axis should turn positive according to telescope definitions; the tacho signal and encoder counts should be positives. Use the **ikonxInducer** panel and the **ataltazAltGui**/**ataltazAzGui** panels to check signals.

4.8.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO6-1	Check positive Torque polarity	Altitude moves from Horizon toward zenith		
2		Azimuth moves from South to East		
3	Check Tacho polarity	Positive voltage when positive move		
4	Check Encoder polarity	Count is positive when move is positive		

4.9 Test handset for MACCON small function units

4.9.1 Description

A handset can be connected directly to the drive amplifier (VME4SA) of the MACCON controller. It allows a check of the limits and the motor/tacho functionality.
Use the **motei** panel to check signals and encoder function.

4.9.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO7-1	Altitude / Nasmyth Wheel		20FEB 25FEB	NOK: wheel went in OK: limits and encoder swap
2	Azimuth / TADC	N/A		
3	Azimuth / Coudé Beam Switching Device		18FEB	OK
4	Sensor / FSS Field Diaphragm	N/A		Not cabled yet
5	Sensor / FSS Filter Wheel		19FEB	NOK: Reference switch seen always active by MACCON #0 Replaced VME4SA backplane did not fix the problem.
6	Sensor / FSS Translation Stage X		20FEB	OK: limits and encoder swap Sense to be checked against direction conventions
7	Sensor / FSS Translation Stage Y		20FEB	Idem dito

4.10 APD cables tests

4.10.1 Description

Check for isolation impedance between signal lines and shield / housing.

4.10.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
IO8-1	Signal cable	≥1MOhm		
2	Control cable	≥1MOhm		
3	High voltage cable	≥1MOhm		
4	Field Diaphragm	≥1MOhm		

5. LCU FUNCTIONS - ALTITUDE

Purpose: Systematic check through all altitude LCU application functionality in a bottom- up approach.

Pre-requisite: IO-signals OK

Duration:

Requires:

The activities have test IDs as follows:

- **ALT0**: Check/set configuration data
- **ALT1**: velocity controller (tac/rtc)
- **ALT2**: Startup sequence
- **ALT3**: alt axis control
- **ALT4**: alt tracking
- **ALT5**: monitoring
- **ALT6**: M2 functions
- **ALT7**: Nasmyth Focus Device functions
- **ALT8**: Altitude Services

5.1 Check/set configuration data

Test Id	Command/Action	Expected Result/Status	Test date	Test result
ALT0-1	Check/set configuration data see 15.1			

5.2 Velocity controller (tac/rtc)

Do we need the notch-filters that we had for UTs? If yes: where are they? If no: why not?

5.2.1 Description

Before any tests involving axes motions can be done, a first iteration of velocity loop tuning must be done. The control parameters must be set to allow a safe motion; perhaps slow, but without oscillations. This is done without involving the position control at all; this means that the normal axis start-up sequence cannot be used, since that involves motion of the axis.

Use the panel **tacgui** to send commands to the velocity controller and to monitor its behaviour.

The power amplifier is enabled/disabled by setting/clearing the signal **DRIVEENABLEO** using the acroxInducer panel.

Configuration and database data involved in control loop tuning: see 15.3.

The alt LCU shall be re-booted just before the start of the tests.

This test is just of the basic behaviour of the velocity controller. The integrated test with axis control, including position control, is done in 5.4.

5.2.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
ALT1-1	Set alt axis to approx. 70 deg, using handset			
2	Check configuration data: see 15.1			
3	Enable amplifier			
4	INIT ONLINE	tac state/substate becomes ONLINE initialised/ ACTIVE		
5	Check Kp, Ki and Kd in tacgui	Kp=0.1 Ki=0 Kd=0		
6	set ref vel = 0 V	alt axis standing still Check in tacgui: Speed ref=0 Speed feedback=0 PID output=0 torque ref=0		
7	set ref. vel. =1V	axis moves. Check step response! actual values of ref and feedback are updated Check that Speed ref = 0.4 deg/s Speed fbk=0.4 deg/s		
8	Adjust Kp as appropriate. Keep switching vel. ref between 0V and 1 V and adjusting Kp and Ki until step response is OK			
9	Make steps between –5V, 0V, +5V and adjust Kp and Ki until steps are OK			
10	**Update ataltazAlt.tac with the new values of Kp and Ki.**			
11	**Update the db attributes propGain**			

	diffGain **integGain** **in point** **:trackingAxis:vta:alt:POS LOOP:DIGVCTRL** **with the new Kp,Kd,Ki**			

5.3 Startup sequence

5.3.1 Description

This test section is a test of the software that runs the axis Startup sequence, and also of some hardware logic involved in Startup, as well as tests of the hardware related axis dependant panel **ataltazAltGui**.
The hardware test switches and the Inducer panels are used to control and monitor hardware signals, and the **ataltazAltGui** panel is used to send commands and to check signals.
Digital signals are checked for both values, and analogue signals with a few representative values.

5.3.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
ALT2-1	Check all I/O signals in panel ataltazAltGui	All signals correctly displayed		
2	Set DRIVEENABLEO (using Inducer panel)			
	set tac ONLINE			
	set velocity reference =1	motor turns		
	Clear DRIVEENABLEO while motor turning	motor stops		
	set velocity ref=0			
3	Normal Startup:			
	INIT (on **ataltazAltGui**)	Motor makes init sequence and stops Signals set during INIT: ILENABLE_DIOO DRIVEENABLEO TACHOHIGHSENSO VCCVLO P24ONO Signals cleared during INIT: INTERLOCKI		
4	Clear P400VOKI			
5	INIT	Rejected. Error log Setting and clearing signals as in previous case is not done.		
6	Set P400VOKI Clear TACHOOKI			
7	INIT	Rejected, Error log		
8	Set TACHOOKI Clear MOTPOWEREDI			
9	INIT	Rejected, Error log		
10	Set MOTPOWEREDI Clear BRAKE1DISI			
11	INIT	Rejected, Error log.		
12	Set BRAKE1DISI Clear BRAKE2DISI			
13	INIT	Rejected, Error log.		
14	STOP			

5.4 Alt axis control

5.4.1 Description

These tests shall verify the following functionality:

- good position step response for small, medium and BIIIG steps
- good position stability at low speed (tracking speed)
- the global and general behaviour

Tuning of the position servo is done by measuring step responses. The procedure is described in **RD- 4** chapter "Position loop". When the step response tuning has been done for one alt axis position, it shall be verified in a few more positions.
When the servo parameters are adjusted for optimum response in PRESET control, fine-tuning might be necessary in order optimise performance in tracking. If needed, settling time in positioning is sacrificed if that improves tracking.

This section tests the basic states and state transitions of the axis control, as well as axis motion on lowest level.
It is assumed that the basic test of the tac velocity controller is done, and that the normal axis Startup case is OK!

Test start conditions:

- tac ONLINE
- velocity reference=0
- altServer state Loaded, Encoder initialised, Simulation Off

Configuration and database data involved in control loop tuning: see 15.3.

Use the panel **ataltazAltGui** or ccseiMsg to send commands to **altServer** and check that the panel is updated as applicable. Use sampCtrl to configure and start plotting of position and position error.

5.4.2 Actions/test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
ALT3-1	Basic step response tuning, with alt ~ 60 deg. See RD- 4.	NOTE: save plots of step responses when tuning is ready.		
2	MOVE square,0.000278,10,600	clean square wave with 1" amplitude		
3	MOVE square,0.00278,10,600	clean square wave with 10" amplitude		
4	MOVE square,0.0278,10,600	clean square wave with 100" amplitude		
5	Basic step response tuning, with alt ~ 89 deg. See RD- 4.			
6	Basic step response tuning, with alt ~ 30 deg. See RD- 4.			

7	MOVE consp,0.00000278,1,300	The axis moves at 0.01"/s for 5 minutes Fine tune if the error curve shows limit cycles.		
8	MOVE consp,0.0000278,1,300	The axis moves at 0.1"/s for 5 minutes Fine tune if necessary.		
9	Set signal OVERSPEEDI on the switch panel, to simulate "any interlock" condition.	(This is not a test of the interlock chain, but a check that the software properly handles the interlock condition.)		
10	INIT while interlock exist	INIT rejected with proper error message.		
11	Clear signal INTERLOCKI			
12	INIT	Motor moves to init point and then stops		
13	STATUS	Encoder initialised		
14	ONLINE	State becomes Online		
15	OFF from panel	State becomes Loaded		
16	INIT from panel	Encoder initialised		
17	ONLINE from panel	State becomes Online		
18	PRESET abs,30,100	Check with STATUS command that the motor moves to position 30 degrees		
19	PRESET rel,-30,100	Rejected, setpoint out of range		
20	Set signal ILFAULTI to check "interlock appears while in position control"	Error log with the correct signal name. Also: INTERLOCKI is set (by hw).		
21	Clear ILFAULTI			
22	INIT			
23	ONLINE			
24	VANTOC 0.5,40,60	motor moves from 30 to 40 deg in 20 sec		
25	VANTOC -0.5,30,60	motor moves from 40 to 30 deg in 20 sec		
26	STANDBY	INTERLOCKI gets active DRIVEENABLEO cleared State becomes STANDBY		

5.5 Alt tracking

5.5.1 Description

The tracking functionality is exactly the same as for the UTs, so there is no need to repeat all that functionality. Here are defined just a few cases to verify that the interface between tracking and axis control is OK.

Test start condition:

- the alt axis is ONLINE

Use ccseiMsg to send commands and get status to **alttrkServer**.

5.5.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
ALT4-1	INIT	state becomes Loaded		
ALT4-2	ONLINE	state becomes ONLINE		
ALT4-3	OBJFIX 40,50	motor moves to 40 deg		
ALT4-4	OFFSAA 3600,3600	motor moves to 41 deg		
ALT4-5	OFFSAD 10,20	rejected (not tracking)		
ALT4-6	OBJSTAR 101112,-880000	Motor presets and then starts tracking		
ALT4-7	STATUS	Substate TRACKING		
ALT4-8	OFFSAA 50,60	Rejected, while tracking		
ALT4-9	OFFSAD 3600,3600	OK		

5.6 Monitoring

5.6.1 Description

Temperature monitoring.

5.6.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result

5.7 M2 functions

5.7.1 Description

Use panel **atm2gui** or ccseiMsg to send commands and get status.

5.7.2 Actions/Test cases

When the tests start, no M2 commands have been issued since last reboot of the LCU.

Test Id	Command/Action	Expected Result/Status	Test date	Test result
ALT6-1	VERSION	OK reply with correct version and date	23FEB	OK with atm2HW=0 (no motion command sent to M2)
2	SIMULAT	OK		
3	GETSIM	On		
4	STOPSIM	OK	27FEB	OK: Homing done (improved reply parser)
5	GETSIM	Off		
7	STATE	Loaded		
8	STATUS	Loaded- Not init		
9	INIT	Loaded-init-Idle		
10	ONLINE	OK		
11	STATUS	Loaded, substate Idle, M2 idle, beacon #0 off	23FEB 27FEB 28FEB	NOK: Beacon must be selected first (to be fixed in code) NOK: bug in reply parser leading to math error (NaN). Fixed on line OK: M2 position available. M2 Temperature = 19.8C
12	GETCPOS	Returns actual center position	28FEB	OK (see STATUS)
13	GETFPOS	Returns actual focus pos		
14	GETINIT	On	28FEB	OK
15	GETPBCN	All beacons are off	28FEB	NOK: see STATUS
16	GETTILT	alpha=0, beta=0		OK (see STATUS)
17	SETCPOS 0.1,0.2	X=0.1; Y=0.2	28FEB	OK
18	SETFPOS 0.5	Z=0.5		
19	SETPBCN ON	Beacon #0 is on at 10%	28FEB	OK
20	SETPBLV 78	Beacon #0 is on at 78%		
21	SETTILT 0.1,-0.2	alpha=0.1, beta=-0.2	28FEB	OK
	STANDBY	STANDBY	28FEB	OK
	SETFPOS 2	Rejected, not ONLINE	28FEB	OK
	OFF	Status to Loaded	28FEB	OK

Overall reliability problem: lost control over M2 on LVDT error message (#1 and #5) which then become "Excessive actuator difference" message (#1 was at about 18000, #5 at 53000 and the other 4 at approx. 32000). This failure raised after a Homing. It disappeared a while later, the re-initialization show the values of the LVDT #1 and #5 slowly converging towards 32000.

The M2 firmware was still the one used for acceptance Unit #1. The joint ESO-CSEM version shall be retro-fitted to Units #1 and #2 after Acceptance Unit #3.

5.8 Nasmyth Focus Device functions

5.8.1 Description

In addition to ccseiMsg the panel **atnfdgui** is used to send commands and check status.

5.8.2 Actions/Test cases

Test id	Command/Action	Expected Result/Status	Test date	Test result
ALT7-1	Tune motor and encoder parameters, using **motei.** Save config		24FEB	OK
	align nfd wheel positions. Save config.			
	VERSION			
	SIMULAT	OK		
	GETSIM	On		
	STOPSIM			
	STATE	Loaded		
	STATUS			
	INIT			
	STATUS	Loaded		
	ONLINE	ONLINE IDLE		
	STATUS			
	Set path to FREE	Position is FREE		
	RETRO	RETRO		
	TOOL1	TOOL1		
	TOOL2	TOOL2		
	SETNBCN 1,on	Beacon #1 On		
	SETNBLV 50	Beacon #1 at 50%		
	Check beacon visually	Beacon i1 s on		
	SETNBCN 1,off	Beacon #1 off		
	Check beacon visually	Beacon 1 is OFF		
	SETNBLV 50	Beacon #1 at 0%		
	SETNBCN 2,on	Beacon #2 On		
	SETNBLV 50	Beacon #2 at 50%		
	Check beacon 2 visually	Beacon 2 is ON		
	SETNBCN 2,off	Beacon 2 is off		
	Check beacon visually	Beacon 2 is OFF		
	Check "beacon cross talk" between nfd and M2		24FEB	Partially OK: upgrade according to SPR to be submitted.

The wheel is mounted 180degrees offset wrt the limit switches: some positions are not reachable! To be fixed by AMOS for Beacon installation on Wednesday 06MAR by SLE .
Range measured 252.7 deg compared to the 260deg indicated on drawingVLT-FIS-DWG-151136-01
Some position might also be too close to the limit switch: overshoot in motion might end into the limit.
5th position (#4 on drawing) not known by SW team until test. Please check assignments and inform SW.

5.9 Altitude Services functions

5.9.1 Description

In addition to ccseiMsg the panel **ataltsrvgui** is used to send commands and check status.

5.9.2 Actions/Test cases

Test id	Command/Action	Expected Result/Status	Test date	Test result
ALT8-1	Telescope Temperature monitoring		21FEB 24FEB	NOK: Missing power supply on the 4-20mA signal conditioners TopRing signal is inverted, the voltage read is negative. CR in ICD needed for consistency. OK The FITS logs shall be modified to indicate the name of the measured quantity.
ALT8-2	Altitude Cabinet Cooling		01MAR	OK: Temperature given with 0.1C resolution. Alarms to be checked on Control Model. AMOS to test the interlock when door open, a variable in PKC shall indicate this status; Fan shall stop when door opened. PKC address set to 23 (for all ATs); How easy to change it? Shall be in DB configuration.

AMOS to deliver the final design report on Altitude Cabinet Cooling. It is questionable whether the power supply of the fans shall be UPS.
No non-UPS supply in Cabinet. It is desirable to have a 230V socket for external appliances like laptop, oscilloscope…

6. LCU FUNCTIONS - AZIMUTH

Purpose: Systematic check through all azimuth LCU application functionality in a bottom- up approach.

Pre-requisite: IO-signals OK

Duration:

Requires:

The activities have been assigned test IDs as follows:

- **AZ1**: velocity controller (tac/rtc)
- **AZ2**: Startup sequence
- **AZ3**: az axis control
- **AZ4**: az path selection
- **AZ5**: az tracking
- **AZ6**: M10 functions
- **AZ7**: Coudé Focus Device functions

6.1 Velocity controller (tac/rtc)

Do we need the notch-filters that we had for UTs? If yes: where are they? If no: why not?

6.1.1 Description

Before any tests involving axes motions can be done, a first iteration of velocity loop tuning must be done. The control parameters must be set to allow a safe motion; perhaps slow, but without oscillations. This is done without involving the position control at all; this means that the normal axis start-up sequence cannot be used, since that involves motion of the axis.

Use the panel **tacgui** to send commands to the velocity controller and to monitor its behaviour.

The power amplifier is enabled/disabled by setting/clearing the signal **DRIVEENABLEO** using the acroxInducer panel.

Configuration and database data involved in control loop tuning: see 15.3.

The alt LCU shall be re-booted just before the start of the tests.

This test is just of the basic behaviour of the velocity controller. The integrated test with axis control, including position control, is done in 6.3.

6.1.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
	Set alt axis to approx. 89 deg, using handset Set az axis to approx 0 deg			
	Check configuration data: see15.2			
	Enable amplifier			
	INIT ONLINE	tac state/substate becomes ONLINE initialised/ ACTIVE		
	Check Kp, Ki and Kd in tacgui	Kp=0.1 Ki=0 Kd=0		
	set ref vel = 0 V	alt axis standing still Check in tacgui: Speed ref=0 Speed feedback=0 PID output=0 torque ref=0		
	set ref. vel. =1V	axis moves. Check step response! actual values of ref and feedback are updated Check that Speed ref = 0.4 deg/s Speed fbk=0.4 deg/s		
	Adjust Kp as appropriate. Keep switching vel. ref between 0V and 1 V and adjusting Kp and Ki until step response is OK			
	Make steps between –5V, 0V, +5V and adjust Kp and Ki until steps are OK			
	Update ataltazAz.tac with the new values of Kp and Ki.			
	Update the db attributes propGain diffGain integGain in point :trackingAxis:vta:az:POS LOOP:DIGVCTRL with the new Kp,Kd,Ki			

6.2 Startup sequence

6.2.1 Description

This test section is a test of the software that runs the axis startup sequence, and also of some hardware logic involved in startup, as well as tests of the hardware related axis dependant panel **ataltazAzGui**.
The hardware test switches and the Inducer panels are used to control and monitor hardware signals, and the **ataltazAzGui** panel is used to send commands and to check signals.
Digital signals are checked for both values, and analogue signals with a few representative values.

6.2.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
AZ2-1	Check all I/O signals in panel ataltazAzGui	All signals correctly displayed		
-2	Set DRIVEENABLEO (using Inducer panel)			
	set tac ONLINE			
	set velocity reference =10	motor turns		
	Clear DRIVEENABLEO while motor turning	motor stops		
	set velocity ref=0			
-4	Normal Startup:			
	INIT (on **ataltazAzGui**)	Motor makes init sequence and stops. Signals set during INIT: ILENABLE_DIOO DRIVEENABLEO TACHOHIGHSENSO VCCVLO P24ONO Signals cleared during INIT: INTERLOCKI		
-5	Clear P400VOKI			
	INIT	Rejected. Error log Setting and clearing signals as in previous case is not done.		
-6	Set P400VOKI Clear TACHOOKI			
	INIT	Rejected, Error log		
-7	Set TACHOOKI Clear MOTPOWEREDI			
	INIT	Rejected, Error log		
-8	Set MOTPOWEREDI Clear BRAKE1DISI			
	INIT	Rejected, Error log		
-9	Set BRAKE1DISI Clear BRAKE2DISI			
	INIT	Rejected, Error log..		
	STOP			

6.3 Azimuth axis control

6.3.1 Description

These tests shall verify the following functionality:

- good position step response for small, medium and BIIIG steps
- good position stability at low speed (tracking speed)
- the global and general behaviour

Tuning of the position servo is done by measuring step responses. The procedure is described in **RD- 4** chapter "Position loop". When the step response tuning has been done for one alt axis position, it shall be verified in a few more positions.
When the servo parameters are adjusted for optimum response in PRESET control, fine-tuning might be necessary in order optimise performance in tracking. If needed, settling time in positioning is sacrificed if that improves tracking.

This section tests the basic states and state transitions of the axis control, as well as axis motion on lowest level.
It is assumed that the basic test of the tac velocity controller is done, and that the normal axis Startup case is OK!

Test start conditions:

- tac ONLINE
- velocity reference=0
- azServer state Loaded, Encoder initialised, Simulation Off

Configuration and database data involved in control loop tuning: see 15.3.

Use the panel **ataltazAltGui** or ccseiMsg to send commands to **azServer** and check that the panel is updated as applicable. Use sampCtrl to configure and start plotting of position and position error.

6.3.2 Actions/test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
AZ3-1	Basic step response tuning, with alt ~ 60 deg. See RD- 4.	NOTE: save plots of step responses when tuning is ready.		
	MOVE square,0.000278,10,600	clean square wave with 1" amplitude		
	MOVE square,0.00278,10,600	clean square wave with 10" amplitude		
	MOVE square,0.0278,10,600	clean square wave with 100" amplitude		
	Basic step response tuning, with alt ~ 89 deg. See RD- 4.			
	Basic step response tuning, with alt ~ 30 deg. See RD- 4.			

	MOVE consp,0.00000278,1,300	The axis moves at 0.01"/s for 5 minutes Fine tune if the error curve shows limit cycles.		
	MOVE consp,0.0000278,1,300	The axis moves at 0.1"/s for 5 minutes Fine tune if necessary.		
	Set signal OVERSPEEDI on the switch panel, to simulate "any interlock" condition.	(This is not a test of the interlock chain, but a check that the software properly handles the interlock condition.)		
	INIT while interlock exist	INIT rejected with proper error message.		
	Clear signal INTERLOCKI			
	INIT	Motor moves to init point and then stops		
	STATUS	Encoder initialised		
	ONLINE	State becomes Online		
	OFF from panel	State becomes Loaded		
	INIT from panel	Encoder initialised		
	ONLINE from panel	State becomes Online		
	PRESET abs,30,100	Check with STATUS command that the motor moves to position 30 degrees		
	PRESET rel,-30,100	Rejected, setpoint out of range		
	Set signal ILFAULTI to check "interlock appears while in position control"	Error log with the correct signal name. Also: INTERLOCKI is set (by hw).		
	Clear ILFAULTI			
	INIT			
	ONLINE			
	VANTOC 0.5,40,60	motor moves from 30 to 40 deg in 20 sec		
	VANTOC -0.5,30,60	motor moves from 40 to 30 deg in 20 sec		
	STANDBY	INTERLOCKI gets active DRIVEENABLEO cleared State becomes STANDBY		

6.4 Azimuth path selection

6.4.1 Description

The azimuth axis can move in the range (-180,360) degrees. This means that for azimuth angles in the range (-180,0)=(180,360) degreees there are two possible positions of the axis.

The terminology used here is:
- the DIRECTION in which azimuth is'looking' is called 'direction azimuth', DAZ, and is in the range (0,360) degrees
- the absolute POSITION angle of the axis is called 'position azimuth' PAZ, and is in the range (-180,+360) degrees.

So, for a given 'direction azimuth' in the range (180,360) degrees there are two possible 'position azimuth'. These tests shall verify that the az axis control, including handling of the encoder, moves in the correct way; when moving to a new position in the ambigous range, the 'position azimuth' that is closest should be selected.

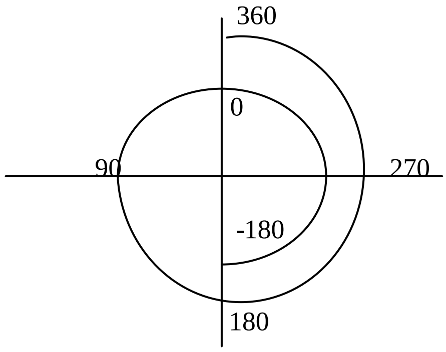

Figure 1 Azimuth angles

6.4.2 Actions/Test cases

Use commands to aztrkServer.
It is assumed that the azimuth range is defined in the database to be (-180,360) deg

Test Id	Command/Action	Expected Result/Status	Test date	Test result
AZ4-1	set azServer ONLINE			
2	set aztrkServer ONLINE			
3	OBJFIX 89,10	az axis moves to 10 deg		
4	OBJFIX 89,350	axis moves clock-wise to PAZ=-10, DAZ=350		
5	OBJFIX 89,185	axis moves clockwise to PAZ=-175, DAZ=185		
6	OBJFIX 89,179.999	axis moves clockwise to PAZ=-179.99 DAZ=180.01		
7	OBJFIX 89,175	counterclockwise to PAZ=175, DAZ=175		
8	OBJFIX 89,185	counterclockwise to PAZ=185 DAZ=185		
9	OBJFIX 89,350	counterclockwise to PAZ=350, DAZ=350		

10	OBJFIX 89,359.9	counterclockwise to PAZ=359.9,DAZ=359.9		
11	OBJFIX 89,10	clockwise to PAZ=10, DAZ=10		
12	OBJFIX 89,90	clockwise to PAZ=90,DAZ=90		
13	STANDBY			

6.5 Azimuth tracking

6.5.1 Description

The tracking functionality is exactly the same as for the UTs, so there is no need to repeat all that functionality. Here are defined just a few cases to verify that the interface between tracking and axis control is OK.

Test start condition:

- the az axis is ONLINE

Use ccseiMsg to send commands and get status to **aztrkServer**.

6.5.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
AZ5-1	INIT	state becomes Loaded		
AZ5-2	ONLINE	state becomes ONLINE		
AZ5-3	OBJFIX 40,50	motor moves to 50 deg		
AZ5-4	OFFSAA 3600,3600	motor moves to 51 deg		
AZ5-5	OFFSAD 10,20	rejected (not tracking)		
AZ5-6	OBJSTAR 101112,-880000	Motor presets and then starts tracking		
AZ5-7	STATUS	Substate TRACKING		
AZ5-8	OFFSAA 50,60	Rejected, while tracking		
AZ5-9	OFFSAD 3600,3600	OK		

6.6 M10 control

6.6.1 Description

In addition to ccseiMsg the panel **atm10gui** is used to send commands and check status.

6.6.2 Actions/Test cases

Whern the test starts, no M10 commands have been sent since last reboot of the LCU.

Test Id	Command/Action	Expected Result/Status	Test date	Test result
AZ6-1	Check controller tuning (speed,acc, etc) Save config		01MAR	OK on beta axis. Alpha not yet tuned. AMOS to provide parameters. Overall position accuracy is low. Missing conversion function for alpha axis.
2	Check Init sequence Save config			OK AMOS to provide encoder values of the optical center position.
3	VERSION	OK reply with correct version and date		OK
4	SIMULAT	OK		
5	GETSIM	On		
6	STOPSIM	OK		
7	GETSIM	Off		
8	STATE	Loaded		
9	STATUS	Loaded, simulation off		
10	INIT	OK		
11	STATUS	Loaded, substate IDLE, initialised		
12	ONLINE	ONLINE, Idle		
13	GETTILT	Returns alpha and beta		Functionally OK but scaling not correct yet. ESO to implement.
14	SETTILT 1.2,3.4	OK		
15	GETTILT	alpha=1.2, beta=3.4		
16	CENTER			
17	STOP			OK
18	OFF			

6.7 Coudé Focus Device functions

6.7.1 Description

In addition to ccseiMsg the panel **atcfdgui** is used to send commands and check status.

6.7.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
AZ7-1	Check controller tuning (speed,acc, etc) Save config		18FEB	OK
2	Align wheel positions. Save config			Relative positions defined according to drawing but not calibrated wrt LHW/REF
3	VERSION			OK
4	SIMULAT	OK		
5	GETSIM	On		
6	STOPSIM			
7	GETSIM			
8	STATE	Loaded		
9	STATUS			
10	INIT			
11	STATUS	Loaded, Substate Idle, Beam SPLIT		
12	ONLINE	OK		
13	SETBEAM stop	OK		
14	GETBEAM	Light Stop		
15	SETBEAM mirror	OK		
16	GETBEAM	Mirror		
17	SETBEAM split	OK		
18	GETBEAM	Beam splitter		
19	SETBEAM hole	OK		
20	GETBEAM	Hole		
21	STOP			
22	OFF			

The maximum speed of 2mm/s could only be achived (FISBA claims 5mm/s mec.). The position accuracy could be reached down to 2 Enc = approx. 0.35micrometers. Is this sufficient? Relaxing this constraint could allow to increase the max. speed.
Added new element “Pupil Field Viewer” as not known by SW team. Elements separated by 47mm nominal acc. To drawing. Range between limits is 200mm.
Question for ESO: what is the position accuracy (not specified yet)? Especially for the Pupil field viewer.

7. LCU FUNCTIONS - AUX

Purpose: Systematically check through all LCU application functionality in a bottom-up approach.

Pre-requisite: IO-signals OK

Duration:

Requires:

The activities have been assigned test IDs as follows:

- **AUX1**: Siemens PLC functions (ecs,ros,srv,trl)
- **AUX2**: Sauter PLC functions (acs)

7.1 Siemens PLC functions

7.1.1 Description

7.1.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result

7.2 Sauter PLC functions

7.2.1 Description

Actions/test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result

8. LCU FUNCTIONS - DCS

Purpose: Systematic check of all LCU application functionality in a bottom-up approach.

Pre-requisite: IO-signals OK

Duration:

Requires:

The activities have test IDs as follows:

- **DCS1**: Check utility I/O signals
- **DCS2**: FSS device (STRAP)
- **DCS3**: FAS device (TCCD)
- **DCS4**: XY-table functions
- **DCS5**: M6 functions
- **DCS6**: NDF + AFD functions
- **DCS7**: probe tracking

8.1 Check utility I/O signals

8.1.1 Description

This section is testing some special utility functions that are controlled via digital I/O signals. The functions are tested using the panel **atdcssrvgui**.

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS1-1	INIT,ONLINE	Status goes ONLINE	20FEB	OK ACE powered On
DCS1-2	switch on TCCD	ACE box of TCCD is switched on	20FEB	OK
DCS1-3	switch off TCCD	ACE box switched off	20FEB 25FEB	NOK Bound all ground lines on Y31 OK
DCS1-4	switch on M6 amplifier	M6 amplifier switched on		
DCS1-5	switch off M6 amplifier	M6 amplifier switched off		
DCS1-6	M6 in position	Signal active when M6 on target		
DCS1-7	M6 overflow	Signal active on overflow		
DCS1-8	STRAP Gate	STRAP counting when active	21FEB	LCU function OK, but not tested electrically on STRAP input
DCS1-9	Reset STRAP	STRAP reset Led goes On for a fraction of a second	21FEB 22FEB	NOK: Reset line is always active OK after reversed logic in I/F board LCU output signal is active High, STRAP input signal is active Low
DCS1-10	check flow meter reading	Act on cooling pump to see the flow meter reading. Stop the pump, flow meter shall read ZERO.		Not mounted in cooling circuit yet.

8.2 FSS device (STRAP)

8.2.1 Description

This section is testing the basic commands and the basic motions of the STRAP. Some performance tests have been done prior to the integration tests, and these will not be re-done here. These performance tests are listed in the table below, for completeness, and the results will be made available as part of the integration tests report.

Use the panel **atfssgui** to send commands and to monitor STRAP.

It is assumed that the basic configuration and setting of SETUP parameters of STRAP has been done before these tests start. For info how to do these things, see RD- 2

8.2.2 Actions/Test cases

The LCU latxdcs shall be re-booted just before start of the tests.

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS2-1	Generate STRAP interaction matrix See RD- 2			
DCS2-2	Save the new interaction matrix			
DCS2-3	**Check that STRAP is counting**			
	put XY-table in center position			
	INIT		01MAR	OK
	ONLINE	Current values of temp and High Voltages becomes = the SETUP values	01MAR	OK after the coolant had a temperature below 10C (hardcoded in the STRAP SW).
	SETTHR 0	Threshold=0		
	Switch on a Nasmyth beacon			
	Start Open loop	The APD counts starts counting	01MAR	OK (with cap on STRAP head) Counts were (samples): Cts: 200; 322; 312; 418; 264; 209 RMS: 13; 17.6; 17; 18.8; 16.2; 13.2 RMS = approx sqrt(Counts)
	Change beacon level until at least 1 APD count gets > 1000000	at least 1 of the APDs gets a high count		
DCS2-4	**Check Closed Loop**			
	Close loop	STRAP outputs corrections to M6 (M6 might go to end pos!)		
	Open loop			
	Move XY-table such that the max count is in another APD			
	Close loop	M6 corrections changed direction		

Perform the XY-table tests, incl. centering XY-table on star, and the TCCD tests before proceeding with the following STRAP tests

DCS2-5	**Check Closed loop behaviour**			
	Put XY-table in center-of-star pos. Have sequential exposures running on TCCD See test 8.4.2			
	Close STRAP loop	small centroids ($<10^{-4}$) small M6 corr. (<0.1")		
	Offset XY-table in X 165 µ (=0.5")	M6 is corrected by 0.5" Star moves 0.5" on TCCD		
	Offset XY-table in Y 165 µ (=0.5")	M6 is corrected 0.5" , 90 deg rotated to previous		

		D:o star motion on TCCD		
	Offset XY-table in X -165µ	M6 going back		
	Offset XY-table in Y -165µ	M6 going back		
	Set XY-table X velocity to 0.1"/s	M6 moving 0.1"/s Centroids always small		
	Open loop			
	Stop XY-table			
	STRAP INIT			
DCS2-6	**Check STRAP linearity**	See coming Test Report		

8.3 FAS device (TCCD)

8.3.1 Description

The TCCD head is mounted "before" the XY-table and STRAP but "after" M6. That is to say that M6 motions will move the star on the TCCD but XY-table/STRAP head motions will NOT.
The CCD stand-alone control panel is used to control the TCCD and images are displayed using the tcscam/rtd.

8.3.2 Actions/test cases

The LCU is just booted before the tests start.
STRAP should be in LOADED or ONLINE/Open loop.
M6 amplifier is switched on.

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS3-1	Start the TCCD panel: ccdStartFas	The panel comes up	22FEB	OK
DCS3-2	Start tcscam/rtd: rtdStartFas		22FEB	OK
DCS3-3	SHUTDOWN the CCD	State goes to OFF	22FEB	OK
DCS3-4	Startup TCCD	State goes to ONLINE	22FEB 27FEB	NOK: discontinuity in optical fibers OK with direct ESO fibers The optical mergers in the ROS were found in opposite direction. Tested all fibers from LCU to ACE Found discontinuity in socked #1 Used fiber #3 instead OK
DCS3-5	Start Sequential exposures, with exp. time 0.1 sec	Exposure active, exposure counting starts	27FEB	OK
DCS3-6	in rtd panel: attach the camera	green transmission indicator starts blinking	27FEB	OK
DCS3-7	switch on the "star" and adjust voltage	the "star" is approx. in the center of the image	27FEB	No “star” available yet, but dark image correct, no visible patterns Dark level correct.
DCS3-8	change exposure time	display brightness changes		
DCS3-9	SHUTDOWN		27FEB	

The color assignment for the fiber bound LCU-GIS is: #1 Black; #2 Red; #3 Orange; #4 Yellow; #5 Green; #6 Blue.

AMOS: it is essential that the continuity tests are made from the LCU to the ACE. The continuity test performed from the GIS socket down to the mergers is in no way sufficient.

AMOS: The GIS socket #1 shall be checked. The GIS fiber sockets must be labelled.

8.4 XY-table functions

8.4.1 Description

This section is testing the basic commands and the basic motions of the XY-table. Some XY-table performance tests have been done prior to the integration tests, and these will not be re-done here. These performance tests are listed in the table below, for completeness, and the results will be made available as part of the integration tests report.

Tracking is tested in section 8.7 below.

Use the panel **atxytgui** to send commands and get status from the XY-table, or use **ccseiMsg** for commands not implemented in the panel. Commands are sent to **atxytServer**.
At start of the test the LCU is newly re-booted.

8.4.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS4-1	Check accuracy of offset steps	In spec See the coming Test Report!		
-2	Check of absolute position reproducibility	In spec See the coming Test Report!		
-3	Check position hysteresis	none See the coming Test Report!		
-4	Check the position accuracy during tracking	In spec See the coming Test Report!		
-5	VERSION		20FEB	OK (see comments below)
-6	STATE	Loaded		
-7	STATUS	State Loaded, substate Idle		
-8	INIT	both axes initialise, State stays Loaded, substate gets INITIALISED position is x=y=0		
-9	ONLINE	State becomes ONLINE		
-10	Set x=5.001,y=6.002, push PRESET → command SETXYP	XY table moves to x/y=(5.001,6.002), panel updated		
-11	Set x=11,y=5, push PRESET	command rejected, log message		
-12	Set x=9.8,y=-9.8, push PRESET	XY table moves to (9.8,-9.8)		
-13	Click “Pos” under TRACKING, set x=-7 y=8 push TRACKING → command SETXYTP	XY table moves to (-7,8) , panel updated		
-14	Click “Vel” under TRACKING, set Vx=0.1Vy=-0.1 mm/s push TRACKING → command SETXYTV	XY table moves with 0.1 mm/s.		
-15	Stop after 20 sec, by setting velocities=0 Send STOP	XY table stops at approx. (0.0,0.0)		
-16	Set offsets = 5.0,-5.0 push OFFSET → command SETXYR	XY table makes offset step to (5.0,-5.0)		
-17	**Align XY-table on the star**			
	Move XY-table to make STRAP centroids smaller, and APD readings more balanced			
	Close STRAP loop			

	If M6 goes into limit, Open loop and go back to step 1			
	If M6 is not in limit, fine-adjust the XY-table position so that STRAP output to M6 is small (|tilt|<0.1") Take note of this XY-pos, and use it as XY-table offset!			
-18	STANDBY	State → STANDBY	20FEB	OK
-19	OFF	State → Loaded	20FEB	OK

The bouncing already observed in Garching was still present on the Lower Limits of both axes. Not tested on the Upper limits.
The measured range is 46.58mm in X and 46.45mm in Y instead of the 50mm announced by FISBA.
Decreasing the speed down to 0.5mm/s instead of the 1.5mm/s used so far could reduce the bouncing. An additional delay of 5s has been introduced prior to move to center.

The Initialization Sequence for both axes is now:

- Find LHW @ 0.5mm/s
- Delay 5s
- Calibrate ABS –25mm
- Move ABS 0mm @ 1.5mm/s

Special Positions:

- UHW=LHW+45.5mm

Software Limits set as:

- LSW=LHW+0.1mm
- USW=UHW-0.1mm

8.5 NDF + AFD Functions

8.5.1 Description

These two motorized axes are controlling the Neutral Density Filter wheel (for STRAP flux limitation) and the Aperture Field Diaphragm (inside the STRAP head).

8.5.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS5-1	NDF axis		19FEB	NOK (see comment below)
DCS5-2	AFD axis			N/A (cabling not done by AMOS yet)

The Reference Switch is seen always active by the MACCON board. After replacement of the VME4SA back-plane, is has been OK for some time then failed again. The switch is correctly working and the problem seems to be lying in the MACCON board (TTL levels). ESO TEC HW team to solve.

8.6 M6

8.6.1 Description

The M6 is controlled by STRAP; there is no way to move M6 except doing it via STRAP. In fact, testing STRAP also requires M6, so the two are very much integrated.
The interaction matrix, that relates a STRAP error vector with the corresponding M6 correction, is measured and calculated using a dedicated STRAP functionality; see RD- 2.
The coefficients for the M6 controller in STRAP have been determined before these tests. This operation is described in the coming *Integration Test Report*.

8.6.2 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS6-1				

8.7 Probe tracking

8.7.1 Description

The objective of this test section is to demonstrate that the "guide probe" of the ATs can be positioned and can track according to spec. The LCU tracking module itself is completely inherited from VLT, and needs not be tested in this context; it is the implementation of the XY-table as a guide probe, i.e. the autoguiding related positioning and tracking that is to be tested. For this reason, it is mainly the commands to **probeServer** that are to be tested, whereas prbtrkServer is "only" used to set up the relevant test cases.

The Use Cases Tests, see chapter 10, of course includes the complete chain involved in presetting, tracking and offsetting of the XY-table, i.e. also the tracking parts!

Use the panel **atguiGA** to send commands and monitor status of the probe, and use ccseiMsg for the basic commands (not available on the panel).

Conditions at start of tests:

- the XY-table is ONLINE
- probetrkServer is ONLINE
- ccdfas is ONLINE

8.7.2 Actions/Test cases

Commands are sent to **probeServer** except where other receiver explicitly mentioned.

Test Id	Command/Action	Expected Result/Status	Test date	Test result
DCS7-1	STATE	Loaded		
-2	STATUS	Loaded No GS selected Diff trk on RecalcRef No		
-3	DIFTOFF	DiffTrk off		
-4	DIFTON	Diff trk on		
-5	INIT, ONLINE	state ---> ONLINE		
-6	Set xy-table in pos (3.0,4.0)			
	PRCNT	Probe moves to center position		
	Change center position in database!	:probe:data:atp:xyt:con-fig.xOffset		
	UPDATE			
	PRCNT	Probe moves to new center pos		
-7	PRPARK	probe moves to Park position		
-8	Start tracking. send to probetrkServer: OBJSTAR 181920.1,-883344.2	probetrkServer to sub-state TRACKING		
-9	PRABS AD,181920.1, -883334.2,,,,,,,,540	probe moves approx. 3 mm, gs wavelength 540 nm		
-10	PRCHK 0,0,0,190000,-883344,,,567	Rejected. Position out of range		
	OFFSAD 1800,-1800	probe moves to position 182120.1,-880344.2		
	PRSOFF 30,-30			

-11	PROBJ	probe moves to position 181920.1,-88334 This is the local effect of this command at probeServer level. Other actions, on higher level, are not tested here!4.2		
	STANDBY			

9. MODULE TESTS OF WORKSTATION MODULES

Purpose: Run the module tests for all workstation modules.

Pre-requisite:

Duration:

Requires:

The activities have been assigned test IDs as follows:

- **MT01**:

9.1 Description

The modules tests are run on the target machine, with the ATCS system fully installed and the environment running. In this case, the sequence of testing is not important. (***TRUE ????***)

9.2 Actions/Test cases

Test Id	Module	Version	Result	Test result
MT01-1	agws			
-2	atagws			
-3	atact			
-4	atcsmon			
-5	atecsws			
-6	astgui			
-7	atosf			
-8	msw			
-9	atmsw			
-10	prs			
-11	atprs			
-12	chopws			
-13	fsws			
-14	pom			
-15	pomgui			
-16	tcs			
-17	tcscam			
-18	tcsmon			
-19	tif			
-20	trkws			

10. USE CASES

Purpose:

Pre-requisite: WS module tests passed, LCU function tests passed

Duration:

Requires:

Use Cases are defined in **AD- 1**, and the tests of Use Cases on AT #1 in Liège are documented in the internal document "ATCS- Tests of Use Cases, AT #1", which is supplied as a separate attachment to this document.

11. INTEGRATION TEST SCENARIOS

Purpose: **-** to test more cases, in particular more error cases, than defined in the Use Cases
- to test parallel activities that are usually not defined in Use cases

Pre-requisite: UC tests passed

Duration:

Requires:

The activities have test IDs as follows:

- INT1: startup and shutdown
- INT2: Presetting
- INT3: Tracking
- INT4: Guiding, Field Stabilisation
- INT5: Chopping

11.1 Startup and shutdown

11.1.1 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result
INT1-1	start atguiStatus			
-2	Check commands INIT, ONLINE, STANDBY for all modules			
-3	Check that actual STATE is OK for all modules			
-4	Check that IGNORE button works correctly for all modules			

11.2 Presetting

11.2.1 Presets and offsets

Use **ccseiMsg** to send commands to **prsControl**. and **trkwsControl** .

Test Id	Command/Action	Expected Result/Status		Test result
INT2-1	Set TCS ONLINE			
2	PRSALAZ 60,90			
3	PRSNAME zenith			
4	PRSALAZ 50,350			
5	PRSNAME PARK			
6	PRSALAZ 10,350	Rejected (alt low)		
7	PRSALAZ 50,350			
8	OFFSAD 10,10	Rejected (not allowed in this mode)		
9	OFFSAA 30,0	Offset step in alt only		
10	OFFSAA 0,60	Offset step in az only		
11	OFFSAA –1,-2			
12	PRSCOOR <HA~0>, -450000	OK		
13	GETREM	>= 6 hours		
14	PRSCOOR <HA~0>, -450000			
15	PRSCOOR <HA~0>, -850000			
16	PRSCOOR <HA~-1h>, -600000 **When moving do**: PRSCOOR <HA~+1h>, -600000 **When moving do:** PRSCOOR <HA~-1h>, -600000	Telescope starts moving Starts moving to new target Starts moving to new target		
17	OFFSAA 10,20	Rejected (not tracking)		
18	OFFSAD 60,0	The change in RA actual position =60/(15*cos(60))=8 sec		

11.3 Tracking

11.3.1 Tracking into limits/Calculation of remaining tracking time

This is a set of tests where the telescope is preset to a position close to a limit and then left tracking until it reaches the limit. At that point, tracking shall be stopped by the alt axis. The workstation module (trkws) stops all tracking axes by sending a STOP command to them. All tracking LCUs and also trkws stay ONLINE, IDLE.
Before the telescope reaches the limit, the handling of 'remaining tracking time' shall be checked and verified:
- cyclical calculation and update in ws database
- the ws command GETREM (without parameters) to get actual value
- alarm when the actual value is < 'remaining tracking time limit'

Test Id	Command/Action	Expected Result/Status	Test date	Test result
INT3-1	SETRLIM 120	'rem. track time limit' set to 2 minutes		
2	'STAR object' <HA~-0.25>, -243700	Limit is reached when HA=-000213		
3	when HA~-10 min.: GETREM (no params)	8 minutes		
4	when HA~-5 min.: GETREM (no params)	3 minutes		
5	When HA ~-4 min.	ALARM 'Rem. track time low'		
6	when HA~2min13sec	Tracking stopped Check that the behaviour is as described above		
7	'STAR object' <HA~+5h20min>, -400000	Limit is reached when HA~053600		
8	when HA~:5h25 GETREM (no params)	11 minutes		
9	when HA~5h30m GETREM (no params)	6 minutes		
10	when HA ~5h34m	ALARM 'Rem. track time low'		
11	when HA~5h36m	Tracking stopped Check that the behaviour is as described above.		
12	preset to named object ZENITH			

11.3.2 Tracking error cases

These tests shall verify that the complete tracking system is stopped correctly in the following error cases:

- LCU failed:
  - it unexpectedly left state ONLINE
  - unexpected power off
- an interlock signal was asserted

The correct behaviour for these errors is:

- LCU failed

  The ws process trkws is event triggered. When triggered it sends command STOP to all other tracking LCUs (i.e. azimuth and xy-table), which then go to state ONLINE/IDLE.

- interlock signal ASSERTED
  - a log message is generated, giving the name of the interlock signal
  - the position loop is opened
  - the velocity reference is set to 0
  - the velocity loop is opened
  - the power amplifiers are disabled
  - set state to STANDBY

For each of the simulated error test cases, the correct and complete set of actions as described above shall be checked. In the case of Interlocks, it shall also be checked that the telescope remains switched off and standing still when the interlock signal is NEGATED.
Sending command OFF to aztrkServer or alttrkServer simulates the error 'LCU failed'. Use the switches to simulate interlocks. Since all interlock signals cause the same set of actions, it is enough to test on the signal INTERLOCKI, which is asserted hardware-wise whenever ANY interlock signal is asserted (this latter fact was tested in the hardware sections above!).
Before the tests start, alt and az LCUs shall be rebooted. Use panels **atguiStatus** and **atguiTCS** to send commands.

Test Id	Command/Action	Expected Result/Status		Test result
INT3-13	Set tracking LCUs and WS ONLINE	All ONLINE		
14	Preset to object HA~3h, dec=-450000	Telescope presets and starts tracking		
15	OFF to altServer	alt LCU goes ONLINE,IDLE Check actions; see above		
16	set all ONLINE again			
17	Preset to object HA~3h, dec=-450000	Telescope presets and starts tracking		
18	set INTERLOCKI =TRUE	Check actions; see above		
19	set INTERLOCKI=FALSE	no reaction on telescope or any module		

11.4 Guiding, Field Stabilization

Test various error cases:
loosing guide star
tracking stopped
TCCD/STRAP not ONLINE
…..

11.4.1 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result

11.5 Chopping

- *various choppping params*
- *chopping +FS*
- *chopping + AG*
- *errors while chopping*

11.5.1 Actions/Test cases

Test Id	Command/Action	Expected Result/Status	Test date	Test result

12. APPENDIX 1: SIGNAL CONFIGURATION FILES

12.1 Altitude analogue signals

```
#*************************************************************************
# E.S.O. - VLT project
#
# "@(#) $Id: ataltazAltAnalog.config,v 1.30 2002/01/22 13:41:24 vltsccm Exp $"
#
# who       when      what
# --------  --------  ----------------------------------------------
# kwirenst 2001-04-03 Based on Signal List Draft 2
# atcsmgr 2000-11-23 created
#

#*******************************************************************
#   NAME
#
#   SYNOPSIS
#
#   DESCRIPTION
#
#   FILES
#
#   ENVIRONMENT
#
#   RETURN VALUES
#
#   CAUTIONS
#
#   EXAMPLES
#
#   SEE ALSO
#
#   BUGS
#
#------------------------------------------------------------------------

# name             device      number      conv  range
# ---------------------------------------------------------
###TELTEMP1I        /aio0   0       1.0     -10.0 +10.0 1 0.0
###TELTEMP2I        /aio0   1       1.0     -10.0 +10.0 1 0.0
###TELTEMP3I        /aio0   2       1.0     -10.0 +10.0 1 0.0
###TELTEMP4I        /aio0   3       1.0     -10.0 +10.0 1 0.0
###TELTEMP5I        /aio0   4       1.0     -10.0 +10.0 1 0.0
###TELTEMP6I        /aio0   5       1.0     -10.0 +10.0 1 0.0
###TELTEMP7I        /aio0   6       1.0     -10.0 +10.0 1 0.0
###TELTEMP8I        /aio0   7       1.0     -10.0 +10.0 1 0.0
###TELTEMP9I        /aio0   8       1.0     -10.0 +10.0 1 0.0
###TACHOFI          /aio0   9       1.0     -10.0 +10.0 1 0.0
###VCCVLO           /aio0   10      1.0     -10.0 +10.0 1 0.0
###TREFINI          /aio0   11      1.0     -10.0 +10.0 1 0.0
###PHASEMONITORI    /aio0   12      1.0     -10.0 +10.0 1 0.0
###A00CWI           /aio0   13      1.0     -10.0 +10.0 1 0.0
###EXTREF           /aio0   14      1.0     -10.0 +10.0 1 0.0
###TP7I             /aio0   15      1.0     -10.0 +10.0 1 0.0
###TREFOUTO         /aio0   0       1.0     -10.0 +10.0 1 0.0
###AUXOUTO          /aio0   1       1.0     -10.0 +10.0 1 0.0
# ___oOo___
```

12.2 Altitude digital signals

```
#*******************************************************************************
# E.S.O. - VLT project
#
# "@(#) $Id: ataltazAltDigital.config,v 1.30 2002/01/22 13:41:25 vltsccm Exp $"
#
# who       when      what
# --------  --------  ----------------------------------------------
# kwirenst 2001-09-10 OPDOORI deleted, BRAKEnDISI set active high.
# kwirenst 2001-04-03  Based on Signal List Draft 2
# atcsmgr 2000-11-23 created
#

#************************************************************************
#   NAME
#     ataltazAltDigital.config - ALT digital signals configuration file
#
#   SYNOPSIS
#
#   DESCRIPTION
#
#   FILES
#
#   ENVIRONMENT
#
#   RETURN VALUES
#
#   CAUTIONS
#     NEVER remove the "info" field or leave one of the fields empty.
#     The software won't tell you, it will let you search the error
#     for hours!
#
#   EXAMPLES
#
#   SEE ALSO
#
#   BUGS
#
#------------------------------------------------------------------------

# name            device      bit   width sim   info
# ------------------------------------------------------
### was used on lat0alt
### DRENABO*        /acro0  32      1       0       DriveEnable
##
##
ILENDSTOPSAI    /acro0  14      1       0       ?
ILENDSTOPSBI    /acro0  15      1       0       ?
TIM1_HWG4O      /acro0  16      1       0       ?
TIM1_HWG5O      /acro0  17      1       0       ?
TIM1_TOUT0I     /acro0  18      1       0       ?
TIM1_TOUT1I     /acro0  19      1       0       ?
P24VOKI*        /acro0  20      1       0       ?
NEGVMOKI*       /acro0  21      1       0       ?
POSVMOKI*       /acro0  22      1       0       ?
VXOKI*          /acro0  23      1       0       ?
WDTMTI          /acro0  27      1       0       ?
SPAREOUTO       /acro0  28      1       0       ?
```

```
SPAREINI        /acro0  29      1       0       ?
VCCVLO*         /acro0  30      1       0       ?
### used form AT1 on
ILMOTIONSTOPI   /acro0  32      1       0       ?
BRAKE2DISI      /acro0  33      1       0       ?
BRAKE1DISI      /acro0  34      1       0       ?
ILOVERRIDEI*    /acro0  35      1       0       ?
MOTPOWEREDI     /acro0  37      1       0       ?
ILENABLEO_DIOO  /acro0  38      1       0       ?
P400VOKI        /acro0  39      1       0       ?
ILOVERSPEEDI    /acro0  40      1       0       ?
ILFAULTI        /acro0  41      1       0       ?
ENCODEROKO      /acro0  42      1       0       ?
TACHOHIGHSENSI  /acro0  43      1       0       ?
ILMANUALI       /acro0  44      1       0       ?
VICINITYNEGI*   /acro0  45      1       0       ?
VICINITYPOSI*   /acro0  46      1       0       ?
HOME1I          /acro0  47      1       0       ?
ILRELOCATIONI   /acro0  48      1       0       ?
ILLOCKPIN1I     /acro0  49      1       0       ?
ILPOSLIMI       /acro0  50      1       0       ?
ILNEGLIMI       /acro0  51      1       0       ?
TACHOHIGHSENSO  /acro0  52      1       0       ?
TACHOOKI        /acro0  53      1       0       ?
RESETI*         /acro0  55      1       0       ?
ILLOCKPIN2I     /acro0  56      1       0       ?
INTERLOCKI      /acro0  57      1       0       ?
SPAREOPTO       /acro0  58      1       0       ?
SPEEDMODEI      /acro0  59      1       0       ?
### used form AT1 on
DRIVEENABLEO*   /acro0  60      1       0       ?
ILRESETO*       /acro0  61      1       0       ?
ILBRAKEMANI*    /acro0  62      1       0       ?
P24VONO         /acro0  63      1       0       ?
# ___oOo___
```

12.3 Azimuth analogue signals

```
#*******************************************************************************
# E.S.O. - VLT project
#
# "@(#) $Id: ataltazAzAnalog.config,v 1.30 2002/01/22 13:41:25 vltsccm Exp $"
#
# who       when      what
# --------  --------  ----------------------------------------------
# kwirenst 2001-04-03  Based on Signal List Draft 2
# atcsmgr 2000-11-23 created
#

#************************************************************************
#   NAME
#
#   SYNOPSIS
#
#   DESCRIPTION
#
#   FILES
#
#   ENVIRONMENT
#
#   RETURN VALUES
#
#   CAUTIONS
#
#   EXAMPLES
#
#   SEE ALSO
#
#   BUGS
#
#------------------------------------------------------------------------

# name            device      number      conv  range
# ----------------------------------------------------------
###TACHOFI          /aio0   9       1.0     -10.0 +10.0 1 0.0
###VCCVLO           /aio0   10      1.0     -10.0 +10.0 1 0.0
###TREFINI          /aio0   11      1.0     -10.0 +10.0 1 0.0
###PHASEMONITORI    /aio0   12      1.0     -10.0 +10.0 1 0.0
###A00CWI           /aio0   13      1.0     -10.0 +10.0 1 0.0
###EXTREF           /aio0   14      1.0     -10.0 +10.0 1 0.0
###TP7I             /aio0   15      1.0     -10.0 +10.0 1 0.0
###TREFOUTO         /aio0   0       1.0     -10.0 +10.0 1 0.0
###AUXOUTO          /aio0   1       1.0     -10.0 +10.0 1 0.0

# ___oOo___
```

12.4 Azimuth digital signals

```
#******************************************************************************
# E.S.O. - VLT project
#
# "@(#) $Id: ataltazAzDigital.config,v 1.30 2002/01/22 13:41:23 vltsccm Exp $"
#
# who       when      what
# --------  --------  ----------------------------------------------
# pduhoux  2001-10-26 STATIONIDI simVal=114=0x72 = Station 'G2'
# kwirenst 2001-09-10 BRAKEnDISI set active high
# kwirenst 2001-04-23 Added missing signal DIRSWITCH2I
# atcsmgr 2001-04-09 shorten name of DIRECTIONSWITCH1I
# kwirenst 2001-04-03 Based on Signal List Draft 2
# atcsmgr  2000-11-23 created
#

#************************************************************************
#   NAME
#     ataltazAzDigital.config - AZ digital signals configuration file
#
#   SYNOPSIS
#
#   DESCRIPTION
#
#   FILES
#
#   ENVIRONMENT
#
#   RETURN VALUES
#
#   CAUTIONS
#     NEVER remove the "info" field or leave one of the fields empty.
#     The software won't tell you, it will let you search the error
#     for hours!
#
#   EXAMPLES
#
#   SEE ALSO
#
#   BUGS
#
#------------------------------------------------------------------------

# name            device      bit   width sim   info
# -----------------------------------------------------
STATIONIDI*     /acro0  0       8       114     ?
ILCWFAULTI      /acro0  11      1       0       ?
ILCWNEGLIMI     /acro0  12      1       0       ?
ILCWPOSLIMI     /acro0  13      1       0       ?
ILGISDOORI      /acro0  14      1       0       ?
ILEWAI          /acro0  15      1       0       ?
TIM1_HWG4O      /acro0  16      1       0       ?
TIM1_HWG5O      /acro0  17      1       0       ?
TIM1_TOUT0I     /acro0  18      1       0       ?
TIM1_TOUT1I     /acro0  19      1       0       ?
P24VOKI*        /acro0  20      1       0       ?
NEGVMOKI*       /acro0  21      1       0       ?
POSVMOKI*       /acro0  22      1       0       ?
```

```
VXOKI*          /acro0  23      1       0       ?
WDTMTI          /acro0  27      1       0       ?
SPAREOUTO       /acro0  28      1       0       ?
SPAREINI        /acro0  29      1       0       ?
VCCVLO*         /acro0  30      1       0       ?
ILMOTIONSTOPI   /acro0  32      1       0       ?
BRAKE2DISI      /acro0  33      1       0       ?
BRAKE1DISI      /acro0  34      1       0       ?
ILOVERRIDEI*    /acro0  35      1       0       ?
MOTPOWEREDI     /acro0  37      1       0       ?
ILENABLEO_DIOO  /acro0  38      1       0       ?
P400VOKI        /acro0  39      1       0       ?
ILOVERSPEEDI    /acro0  40      1       0       ?
ILFAULTI        /acro0  41      1       0       ?
ENCODEROKO      /acro0  42      1       0       ?
TACHOHIGHSENSI  /acro0  43      1       0       ?
ILMANUALI       /acro0  44      1       0       ?
VICINITYNEGI*   /acro0  45      1       0       ?
VICINITYPOSI*   /acro0  46      1       0       ?
DIRSWITCH1I     /acro0  47      1       0       ?
ILRELOCATIONI   /acro0  48      1       0       ?
ILPOSLIMI       /acro0  50      1       0       ?
ILNEGLIMI       /acro0  51      1       0       ?
TACHOHIGHSENSO  /acro0  52      1       0       ?
TACHOOKI        /acro0  53      1       0       ?
DIRSWITCH2I     /acro0  54      1       0       ?
RESETI*         /acro0  55      1       0       ?
ILSPARE1I       /acro0  56      1       0       ?
INTERLOCKI      /acro0  57      1       0       ?
SPEEDMODEI      /acro0  59      1       0       ?
DRIVEENABLEO*   /acro0  60      1       0       ?
ILRESETO*       /acro0  61      1       0       ?
ILBRAKEMANI*    /acro0  62      1       0       ?
P24VONO         /acro0  63      1       0       ?

# ___oOo___
```

12.4.1 Detector LCU analogue signals

12.4.2 Detector LCU digital signals

13. APPENDIX 2: PANELS

Should we include copies of some/ALL/none of the referenced panels????????

14. APPENDIX 3: HW CONNECTIONS

14.1 Altitude VME connections

See RD- 8 and annex01 for detail of connections listed herebelow

14.1.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	230V VME			
	230V Fans			
	Protective Earth			
	TIME synchro	RS485 during tests to Sensor and Altitude via cable wrap test or fibre C17ESO		
	Control LAN	Optic fibre C16ESO		
	Temperature	J6		
	Nasmyth wheel	Z3		
	Altitude Encoder	X1		
	Field & PHASE amplifier	Z1		
	24V supply PHASE amplifier	Z1 31, 24V Z1 32 GND		
	Amplifier analogue	J4		
	PHASE serial link	W13 Z11		
	M2 controller	JMACH1, JMACH2, JS1, J8		
	Field supplies	J7, J8, Y1		
	Thermal controller	W12		
	CPU console port	W10, W11, Z11		

14.2 Signal cabinet connections

14.2.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	230V UPS to strip supply			
	230V NUPS to Fans strip supply			
	Protective Earth			
	230V Thermal exchanger NUPS			

14.3 Hub/Lan connections

See annex01of RD- 8 and for detail of connections listed herebelow

14.3.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	Fiber 1 to 12 from AT Station plug	C1ESO/X206/OP1		
	Fibber 1 to 8 from cable wrapp	C3 ESO/OP2/X200		
	Fibber 1 to 8 from cable wrapp	C4 ESO/OP2/X200		
	230V UPS			

14.4 Cable wrap connections

14.4.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	Motion stop and Relocation interlock	Z21 / Z5		
	Motion stop and Relocation interlock	Z11 / Z1		
	Altitude CPU0&CPU1 console ports	Z11/ W10, & W11		
	Altitude CPU0&CPU1 console ports at service panel	Z21/ W10’, & W11’		
	Other connetions			

14.5 Service panel connections

14.5.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	Altitude CPU0 console	W10’		
	Altitude CPU1 console	W11’		

14.6 Azimuth VME connections

See annex01 of RD- 8 for detail of connections listed below

14.6.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	TIME synchro	RS485 during tests to Sensor and Altitude via cable wrap		
	Control LAN	Optic fibre Hub 2T-Rx		
	Coudé Beam	Z10		
	TADC	Y20		
	Azimuth Encoder Head 1	X1 X3		
	Azimuth Encoder Head 2	X1 X3		
	Field & PHASE amplifier	Z5		
	24V supply PHASE amplifier	Z5 31, 24V Z5 32 GND		
	Amplifier analogue	J4		
	PHASE serial link	V13 Z31		
	Field supplies	J7, J8, Y2		
	M10 controller	V14 Z31		
	Azimuth CPU0 console	W20		
	Altitude CPU1 console	W23		

14.7 Sensor VME connections

See annex01 of RD- 8 for detail of connections listed herebelow

14.7.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	TIME synchro	RS485 for test		
	Control LAN	Optic fibre Hub 4T-Rx		
	FSS Field diaphragm	Y34		
	FSS Filter wheel	Z12		
	FSS Translation stage X	Z16		
	FSS Translation stage Y	Z17		
	Field & PHASE amplifier	Z5		
	Amplifier analogue	J4		
	PHASE serial link	V13 Z31		
	TCCD Field supplies	Lemo4a Lemo4b Y31		
	TCCD fibber	Y301 -308		
	STRAP/APD	Y32CL Y32SG Y32HV		
	Sensor CPU0 console	V30		
	M6 Signal cabinet	Y33		
	Cooling flow sensor	Y35		

14.8 M6 cabinet connections

See annex01 of RD- 8 for detail of connections listed below

14.8.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	230V UPS	X71		
	Protective earth	X71		
	Cooling supply	inlet outlet		
	M6 control Signal	X72 Y333		
	Control Optic fibre	X204 ST 20		

14.9 Auxiliary VME connections

See annex01 of RD- 8 for detail of connections listed below

14.9.1 Connection/Test cases

Test Id	connection	Expected Result/Status	Test date	Test result
	Control LAN	Optic fibre Hub 5T-Rx		
	Air conditioning Sauter	W41 Z31		
	Transporter Siemens PLC	W42 Z31		
	Sensor CPU0 console	V30		

14.10 TCCD connections

See RD- 7for detailed connections scheme

14.10.1 ACE box Connection/Test cases

Test Id	Connection	Expected Result/Status	Test date	Test result
	Fiber links 1 to 6	Fiber optic 1 to 6 (SMA)		
	Control supply	P21		
	Peltier supply	P22		
	Cooling pipe	Inlet outlet		

14.10.2 TCCD Head Connection/Test cases

Test Id	Connection	Expected Result/Status	Test date	Test result
	J01	Cable 1 to P11		
	J02	Cable 2 to P12		
	J03	Cable 3 to P13		
	Cooling pipe	Inlet outlet		

14.11 APD head connections

See RD- 6 for detailed connections scheme

14.11.1 Connection/Test cases

Test Id	Connection	Expected Result/Status	Test date	Test result
	Signal	Fisher 16 poles yellow		
	High voltage	Fischer 5 poles red		
	Control	Fischer 19 poles blue		
	Field diaphragm	LEMO 10 poles white		

14.12 Servo loop

14.12.1 Velocity loop

The speed loop uses the tac (Tool for advanced Control); the implemented algorithm is shown here below

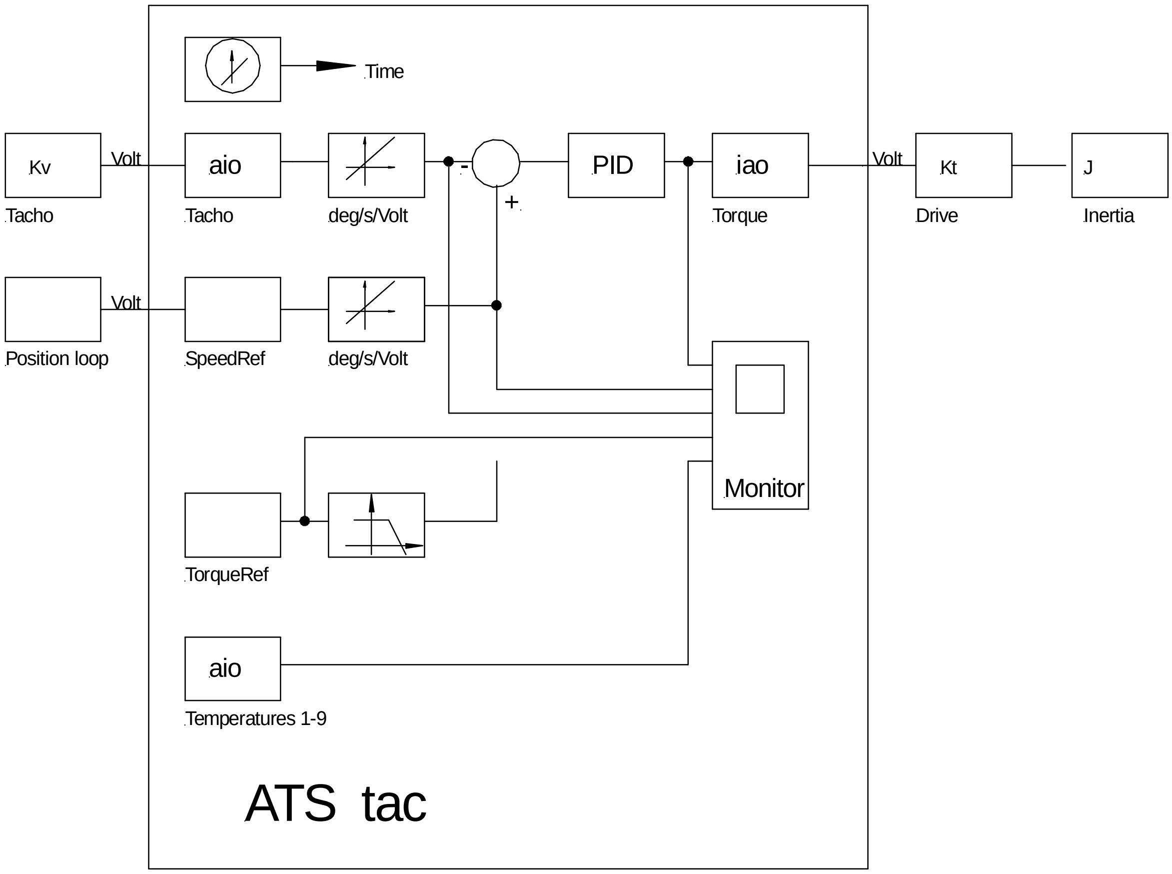

Figure 2 tac speed loop controller

Note: the temperature reading is implemented only in the Altitude tac, not in the Azimuth one.

Parameter values

Parameter	Altitude	Azimuth
Sampling ime	2 ms	2 ms
Tacho scale Kv	0.5*11.72 V*s/° 335.5 V*s/rad	0.5*8.92 V*s/° 255.5 V*s/rad
Max speed	2 °/s	1.5 °/s
Tacho input max.[1]	+/-10V	+/-10V
Torque output max.	+/-10V	+/-10V
Amplifier scale	0.74 A/V	0.74 A/V
Motor constant	125 Nm/A	150Nm/A
Drive Torque scale = Kt	92.5 Nm/V	110Nm/V
Torque output max.	+/-10V	+/-10V

[1] The tacho full scale ranges is +/-20V at PHASE outputs; it is divide by two in the dico2 interface card

Load Inertia = J	5600 kg.m2	9560 kg.m2

The calculated velocity loop gain P I for the specified closed loop bandwidth of 8 Hz are: see also RD- 4

Parameter	Altitude	Azimuth
D	0	0

Tuning the speed loop

Make sure to limit the output torque of the DICO2 by mean of 1V zener diodes across the Trefin signal.
NOTE: the Tacho feedback signal has to be divided by 2 (compared to Garching configuration) on the DICO2 board.

Tune the PI parameters for optimised step response.
Note: keep parameter D=0

14.12.2 Position loop

Encoder parameters

Parameter	Altitude	Azimuth
Type	RON905	LIDA 4 heads
Number of signal period Nsp	36000	122520
Measuring step (IK320)	8.79E-3 arcsec	2.582E-3 arcsec

The calculated position loop gains Kp and Ki for the specified closed loop bandwidth of 2 Hz are: see also RD- 4
Calculated values assuming encoder position in rad and velocity command in rad/s

Parameter	Altitude	Azimuth

15. APPENDIX 4: DATABASE CONFIGURATION

This appendix lists some database attrributes that need special care before start of testing or during testing in Liège; either because the value must be set different than in Garching or because they are involved in the servo loops tuning process.

15.1 Check/set before start test - altitude

attribute name	Garching value	Liège value	explanation
:trackingAxis:vta:alt:POSLOOP:ABSENCODER:CONTROL.configOpmode	1	1	using 1 Head, 1 Board (see iklidaInternal.h)
:trackingAxis:vta:alt:POSLOOP:ABSENCODER:CONTROL.initSpeed	e.g. 3.0	0.03491	axis init velocity, rad/sec
:trackingAxis:vta:alt:POSLOOP.max_velocity		0.03491	max vel. rad/sec
:trackingAxis:vta:alt:POSLOOP.max_acceleration			
:trackingAxis:vta:alt:POSLOOP:VELLOOP.convFactor	2.53	335.5	velocity scale, V/(rad/s)
in file ataltazDigVelBlksAlt.tac: block name TachoScale bloch Name SpeedRefScale block name PID2	 22.582,-0.24592 22.582,0 1.0,1.0,0.1,0,0	 0.17064846,0 0.17064846,0 1.0,1.0,0.1,0,0	
in file /vltdata/ENVIRONMENTS/lat1alt/iklidaEnc.config: params 5.1 and 5.2	 36000	 ???	

15.2 Check/set before start test - azimuth

attribute name	Garching value	Liège value	explanation
:trackingAxis:vta:az:POSLOOP:ABSENCODER:CONTROL.configOpmode	1	7	using 4 Heads, 2 Boards (see iklidaInternal.h)
:trackingAxis:vta:az:POSLOOP:ABSENCODER:CONTROL.initSpeed	e.g. 3.0	0.02618	axis init velocity, rad/sec
:trackingAxis:vta:az:POSLOOP.max_velocity		0.02618	max vel. rad/sec
:trackingAxis:vta:az:POSLOOP.max_acceleration			
:trackingAxis:vta:az:POSLOOP:VELLOOP.convFactor	2.53	255.5	velocity scale, V/(rad/s)
in file ataltazDigVelBlksAz.tac: block name TachoScale bloch Name SpeedRefScale block name PID2	 22.582,-0.24592 22.582,0 1.0,1.0,0.1,0,0	 0.22421525,0 0.22421525,0 1.0,1.0,0.1,0,0	Tacho scale, (deg/sec)/V
in file /vltdata/ENVIRONMENTS/lat1az/iklidaEnc.config: params 5.1 and 5.2	 36000	 ???	

15.3 Parameters involved in control loop tuning

The table below lists attributes for azimuth; the corresponding attributes and the same start values are used also for altitude.

attribute name	Start value	Final value	explanation
:trackingAxis:vta:az:POSLOOP:DIGVCTRL.propGain	0.1	as tuned	
:trackingAxis:vta:az:POSLOOP:DIGVCTRL.integGain	0	as tuned	
:trackingAxis:vta:az:POSLOOP:DIGVCTRL.diffGain	0	as tuned	
:trackingAxis:vta:az:POSLOOP.Alg_switch(0:1)	0.035,0.005	0.0035,0.00005	
:trackingAxis:vta:az:POSLOOP.Kp	2	as tuned	
:trackingAxis:vta:az:POSLOOP.Ki	0	as tuned	
:trackingAxis:vta:az:POSLOOP.Kb	0.5	as tuned	

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