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Interface Control Document between the Electro-Mechanical Hardware and the Control System of the Auxiliary Telescope System

Doc. No.: VLT-ICD-ESO-15100-1528

Issue: 5

Date: 15/01/03

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CHANGE RECORD

ISSUE	DATE	SECTION/PAGE AFFECTED	REASON/INITIATION DOCUMENTS/REMARKS
1	081297	All	Issue for CFT.
Draft 1.1	9 sep 1998	All: Fig. 1a and 1b: All:	Font and format change. Global change, figure numbers changed Changes highlighted, covering: Letter 18feb1998, 5114/CP/LT/STJ-MAH, noted @@ VLT-VTE-98/0181, 30 jun 1998, noted: ** VLT-TRE-AMO-15100-0003, iss1, 30 jun 1998, noted: $$ VLT-VTE-98/0198, 14jul1998, noted: %% VLT-MIN-ESO-15100-1625, noted: ## Open issues: Station plug types. Interface with Nasm wheel, Coude beam sw., FSS filter, x, y. RS232 protocols. Heidenhain 11uA or 1V system Front space for ATS<>LCU connections Volume of workstation
2	21 oct 1998	All:	Validated revisions as of draft 1.1; Implemented changes as per att. 2 of VLT-MIN-ESO-15100-1669 (meeting 15-16 sep 1998); Interface to Nasmyth Wheel and FSS equipment as in Issue. 1 Implemented changes as per VLT-AMO-98/0030 (15oct1998) and answer VLT-VTE-98/0298
3 prep. 1	20 feb 1999	All:	Restructured paragraphs layout. Added all new interfaces as identified on SW Requirements Specification document VLT-SPE-ESO-15151-1712. Changed accordingly to AMOS Preliminary Design Review documents.
3 prep. 2	10 mar 1999	All	Updated according to AMOS comments on prep.1 Restructured all paragraphs for better readability Added Telescope Temperature Monitor to Azimuth LCU Moved Nasmyth Wheel device from Azimuth to Altitude LCU
3	15 mar 1999		Moved FSS Filter Wheel, Translation Stage to Sensor LCU Added FSS Field Diaphragm in Sensor LCU Foresee Atmospheric Dispersion Corrector on Azimuth LCU Added signal reference for brakes in Alt/Az drives Added PHASE encoder signals input
3.1	30 mar 1999		Updated according to AMOS Fax VLT-AMO-99/0017

4.0	30 jul 1999		Updated according to : AMOS Fax VLT-AMO-99/0037 ESO Fax VLT-VTE-98/0222, VLT-VTE-98/0279,VIF-99/0017 and VLT-VTE-99/0056 Minutes of meeting VLT-MIN-ESO-15100-1861 Added future subsystems M10DF, M6DM, TADC New Interlock System Motion Stop
4.1	10 Sep 1999		Updated according to : Minutes of meeting VLT-MIN-ESO-15100-1910 Fax VLT-AMO-99/0076
4.2	20 Sep 2000	Alt & Az	Include paragraph with co-ordinates conventions for Alt & Az axes Phase amplifier: §3.2.2 & 3.3.2 take into account the ICD AMOS/PHASE Issue 1 item 19 Convert 'Drive ready ' into 'Motor_Powered' merge 50 &70 overtemp item 17&18 into No_Fault signal, the origin of the fault is retrieved via serial link. Tacho OK: High = Tacho OK; encoder is used for commutation The torque is the monitored variable by default (tbc) p21&35 Item 4&5 Inhibit to ATS are accepted only when amplifier is in speed mode (i.e. maintenance or tests)

		Interlock ref: TEC-TES-99/038	chapter Altitude 3.2.2 & Azimuth3.3.2; add item 94 'BRAKE DISENGAGE' from LCU to ATS, active when contact closed. Description: activates the brake Electro-pneumatic valve to disengage the brakes. –chapter LCU Azimuth3.3.2; item 86 change the naming to 'Transporter relocation' from ATS to LCU, active when contact open. (already defined in 3.5.5 item 11) Description: action Az immobilized because AT not in station position , connection to X15_nn add chapter3.5.5; item 12'Motion Stop Status' from ATS to LCU description, give the list of Motion Stop buttons currently engaged via the RS232 link. Add chapter Altitude 3.2.2; item 83 and chapter 3.3.2 Azimuth Item 86 change the naming to 'Transporter relocation' from ATS to LCU, active when contact open. (already defined in 3.5.5 item 11) Description: action Alt immobilized because AT not in station position , connection to X11_nn Add chapter 3.3.2 Azimuth: item 88 'Enclosure area' from ATS to LCU, active when contact open. Description: Azimuth AND Enclosure interlocked while maintenance is being performed inside the enclosure. Chapter 3.3.2 Azimuth; item 83, 84 change naming 'AT Motion Stop' into 'Motion Stop' for consistency with item 80-81 of 3.2.2 Altitude. Chapter 4 Interlocks -add item number - 'Enclosure area' is preferred to 'Altitude Maintenance' Chapter 3.1.4 Station Plug item 13 Motion Stop, 1 contacts to Altitude, 1 contact to Azimuth, free of potential item 14 from: ATS to: LCU; Signal: Transporter relocation contact free of potential (the Carriage interlock; is AMOS internal Overview schematic p 13 -name: 'VLTI Motion Stop' instead of 'AT Motion Stop' -the VLTI Motion Stop goes to AMOS Motion Stop Chain -the carriage lock goes to Contractor carriage controller (Siemens PLC) P20 item 64 contact closed if Altitude Locking pin DISENGAGED P34 Azimuth direction switch item 62&63 add contact with opposite logicitem 62&63 §3.5.5 item 11 Relocation status two contacts instead of a single one; -Relocation to Altitude contact free of potential from ATS to LCU -Relocation to Azimuth contact free of potential from ATS to LCU §3.5.5 add item 12 Motion Stop status; two contacts -Motion Stop to Altitude: contact free of potential from ATS to LCU -Motion Stop Azimuth: contact free of potential from ATS to LCU the motion stop identification is done via the RS232 W42. p39 chap3.3.5add after'…the guide pin.': 'when the limit switch is active azimuth is interlocked ; a manual override is provided in case M7 is in front of the GIS door and prevent maintenance access to the azimuth cable wrap.'
		ICD	X naming of ICD terminals changed to Z

		Field Stabilisation System	Replace Strap TB Y32 by defined in AD03 connectors p45
		FSS Translation stage	'….and a negative lmit switch(NLS).' Add 'One of them is used as reference switch.
		M6	ICD requirements for the M6 drives (tip/tilt mirror and future AO) Electrical power: 230V UPS 0.75mm2 Electrical signals: 1 x WAGO interface module Cooling connections Fibre link to M6 and 12x2 electrical signals for control lines
		Enclosure	The two Young anemometers are configured with analog output, reading of UVW is via the Siemens PLC.
		Station plug	The detailed Station Plug connections are given in RD10 There 12 fibres 24 electrical contacts page 12 chap 3.1.4 §3.1.4 Item 13 is VLTI to ATS , Item 14 is ATS to ATS, Item 1&10 are Station Plug to ATS Updated drawing
		Azimuth Cable wrap	The azimuth axis shall be stopped whenever one of the proximity switches is activated. In case it stops the azimuth axis while M7 is blocking the access door; the cablewrap wrap can be manually dragged away. For that purpose the motorization drive is made reversible
		Mech. Int.	§6.5.2 Dual feed LCU the space required is defined in §6.1
	20/09/00	M10	Power ON/OFF command LCU to ATS OEM070 for reduced heat dissipation in the ROS. Digital
	19/01/01	Z11 Terminal block	§3.2.2 Include Z11 terminal block: Extension to Signal cabinmet via Az. Cable wrap
	19/01/01	Altitude Cabinet Temperature	§3.2.6 Include Temperature monitoring of Altitude cabinet via serial port W12
	19/01/01	Annex01	Detail drawings LCU's Electrical and optical connections §3.2.6 Include Temperature monitoring of Altitude cabinet via serial port W12
	19/01/01	comments	Included comments VLT-AMO-01/0006 §3.5.5 - replaced Station plugged in by 400V OK and EG-Cmd-Off, -removed Transporter Ground Seal inflated -status of pneumatic module replaced by Compressed air §3.5.2 -updated anemometer output -item 104 to 107 replaced by the position readout of the four enclosure shells actuators §3.2.6: Temperature signal is 4-20m; Full scale range is t.b.d. §3.3.2:added CW positive & negative switches items 71to 76 §3.5.3: Included Dew point §4: Updated interlock table §5: Electrical&Optical interface update §6: Mechanical interfaces update

4.3	14 May 2001	comments	-Updated PHASE interface definition: §3.2.2 Altitude drive and §3.3.2 Azimuth drive:added item 20 mode (torque/speed) updated item 30 Tacho signal, -§3.2.2 .1 Altitude Drive Z11 is ESO Only -§3.2.6: Telescope temperature sensors: item is Temperature Tube, item 7 is Temperature Center Piece -Harmonised ICD naming of Maccon controlled motors between ICD, annex 01 and FISBA design report VLT-TRE-FIS-15100-043 issue 4.1. in §3.2.5 Nasmyth wheel, §3.3.4 Coude beam switching device, §3.4.6 FSS Filter Wheel, §3.4.7 FSS Aperture Fiel Diaphragm, §3.4.8, FSS Translation stage -§3.3.2 cable wrap limit switches description item 71 to 76 moved to §3.3.5. Azimuth cable wrap; Switches are electro-mechanical type. -§3.4.6 FSS aperture corrected formatting; all is "ESO Only" -§3.5.2 .1Enclosure: item 100 to 103 the open commands and close commands are replaced by open/close and start/stop commands -§3.5.2, §3.5.4, §3.5.6 Siemens PLC serial link is RS422 with protocol RK512/3964R -§3.5.6 Service module: item 11 contact opens if battery NOT OK -§4.1.1.1 Interlock Altitude Locking pin is received by Altitude drive only -§6.1 added sentence for rear side access to Signal and Altitude cabinet
5	15 January 2003	comments	-§3.2.2. added description text; item 4 &5changed logic to active low; item 90-94 renamed Brake status -§3.2.5.1 added description text; -§3.3.1.1 corrected schematic -§3.3.2.1 added description text; item 4 &5changed logic to active low; -§3.3.3.1, -§3.3.4.1 -§3.4.5., -§3.4.7.1 added/corrected description text; -3.5.1.1 corrected schematic -§3.5.1& §3.5.3.2 added PKC Thermal controller for monitoring of Signal cabinet temperature -§3.5.5.1 item 10 &11 updated status list item 12 added list of motion stop -§4.1.1.1 Updated Interlock table -§6.1 added altitude VME ventilation requirements -§6.5.2.1 removed TBC sentence -§6.6.5 minor text correction

TABLE OF CONTENTS

1 Scope

This document describes the requirements and establishes the detailed specifications for the interface between the electro-mechanical hardware and the control system of the Auxiliary Telescope System.
For the sake of completeness, this document includes also interfaces between the Control Software and the Control Hardware developed under ESO responsibility.
In order to identify these interfaces internal to ESO, the associated section headers will be written in ***bold italic***, the section content will be framed and marked with a special margin.
The document covers now the basic configuration (4 LCUs) which will be first implemented. Requirements associated to further extensions (e.g. future Adaptive Optics or Dual Feed) as defined in the ATS Technical Specifications (RD 01) and further clarified in correspondence have been included.

2 Documents and Acronyms

2.1 Applicable Documents

The following documents, of the exact issue shown, form part of this ICD to the extend specified herein. In the event of conflict between the documents referenced herein and the content of this ICD, the content of this ICD shall be considered as a superseding requirement.

Reference	Document Number	Issue	Date	Title
[AD 01]	VLT-SPE-ESO-10000-0015	4		Electronic design specifications
[AD 02]	VLT-SPE-ESO-10000-0003	1	05/02/1992	Electromagnetic compatibility and power quality specifications, Part 2
[AD 03]	VLT-ICD-ESO-11670-1288	3.0	21/12/1998	APD Tilt Loop Interfaces Control Document
[AD 04]	VLT-MAN-ESO-11670-1754	1.0	31/01/1999	STRAP Software Maintenance Manual
[AD 05]	PHASE AX_V	3.0	07/01/1999	Main user manual
[AD 06]	VLT-TRE-AMO-151000-028	3.0	25/06/1999	ATS Safety Assessment Report
[AD 07]	Heidenhain GmbH	-	02/1996	IK 320 VME-Bus Interface Board User Manual
[AD 08]	VLT-SPE-ESO-15151-1795	1.0	20/07/1999	Auxiliary Telescope Control Software System Design Description

2.2 Reference Documents

The following documents contain additional information and are referenced in the text:

Reference	Document Number	Issue	Date	Title
[RD 01]	VLT-SPE-ESO-15400-0886	2.0	18/12/1996	VLTI Software Requirements Specifications
[RD 02]	VLT-SPE-ESO-15100-0338	2.1	19/05/1998	Technical Specifications for the ATS
[RD 03]	VLT-TRE-AMO-151800-082	2.0	28/05/1999	ATS AMOS Control System Final Design & Analysis Report

[RD 04]	VLT-TRE-FIS-151100-043	2.0	25/03/1999	ATS FISBA Package - Final Design Report
[RD 05]	VLT-MAN-ESO-17240-0672	1.5	19/11/1997	VLT Software - CCD Detector Control Software User Manual
[RD 06]	SIEI Peterlongo SpA	1.3	29/05/1995	S-Link 3 Protocol Specification
[RD 07]	VLT-MAN-ESO-11670-1870	1.0	in prep.	VLT Software - STRAP Control Software User Manual
[RD 08]	VLT-TRE-ESO-15154-1862	1.0	14/10/1999	Auxiliary Telescope System Control Hardware Design Specification Preliminary Design Report
[RD 09]	VLT-MAN-ESO-17210-0600	1.7	02/10/1998	VLT Software - Motor Control Software User Manual
[RD 10]	Sauter	-	04/92	EY-2400 Protocol Specification
[RD 11]	VLT-SCH-ESO-15154-2202	0	14/7/2000	AT Station Pit/Connection box internal wiring
[RD 12]	VLT-SPE-ESO-10000-0016	2	07/10/1992	Basic Telescope definitions
[RD 13]	VLT MAN DJO 11700-0001	1	02/12/1991	TCCD System User's manual
[RD 14]	VLT-CRE-AMO-151240-086	3.0	10/04/2000	Station Plug Interface
[RD 15]	VLT-CRE-AMO-151123-057	2.0	08/05/2000	M2 Pupil Beacon Interface
[RD 16]	VLT-CRE-AMO-151281-124	1.0	05/06/2000	Dew point sensor inside enclosure
[RD 17]	VLT-CRE-AMO-151800-145	2.0	08/08/2000	Installation of ESO cables
[RD 18]	VLT-ICD-AMO-151800-137	1.0	08/03/2000	Interface control Document for the M2 support
[RD 19]	VLT-TRE-AMO-151000-1225	1	12/12/2001	Altitude Cabinet Thermal Regulation Design

2.3 Annex Documents

The following documents contain detailed interface drawings and are referenced in the text:

Reference	Document Number	Issue	Date	Title
[AN 01]	VLT-TRE-ESO-15154- 2400	1.1	22/01/2001	Auxiliary Telescope System LCU's Electrical & Optical connections

2.4 Acronyms

This document employs several abbreviations and acronyms to refer concisely to an item, after it has been introduced. The following list is aimed to help the reader in recalling the extended meaning of each short expression:

ACE	Array Control Electronics
ADxx	Applicable Document #xx
ADC	Atmospheric Dispersion Corrector (Compensator)
AFD	Aperture Field Diaphragm
ALT	Altitude Axis
APD	Avalanche Photo-Diode
AT	Auxiliary Telescope unit
ATS	Auxiliary Telescope System
ATCS	Auxiliary Telescope Control System
CBSD	Coudé Beam Switching Device
DFM	Dual Feed Mirror
EMC	Electromagnetic Compatibility
ESO	European Southern Observatory
FAS	Field Acquisition System
FSS	Field Stabilization System
GIS	Ground Interface Structure
LAN	Local Area Network
LCM	Liquid Cooling Module
LCU	Local Control Unit
NDF	Neutral Density Filter
PE	Protective Earth
PLC	Programmable Logic Controller
ROS	Relay Optics Structure
RDxx	Reference Document #xx
STRAP	System for Tip-tilt Removal with APD
TADC	Transversal Atmospheric Dispersion Corrector (Compensator)
TCCD	Technical CCD System
TIM	Time Interface Module
WS	(Unix) Work Station

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3 Interface Definition

3.1 Deployment of sub-systems on the LCUs

3.1.1 Introduction

The interfaces between the Control Software of the ATS and the Electro-Mechanical Hardware are implemented at LCU level.
Typically one LCU is fully responsible for one or more sub-systems.

ESO	When mapping the interfaces for the sub-systems described in the following sections with the requirements captured in the Use Cases, take into account that every sub-system corresponds to an Actor in the Use Cases.

The Auxiliary Telescopes control system is distributed over 1 Workstation and 4 separate Local Control Units;
It is responsible for the control of 13 main and 5 auxiliary electro-mechanical functions, and 2 detectors.

- Altitude LCU
- Altitude drive
- M2 drives
- ***Pupil beacon***
- Nasmyth wheel
- Temperature Sensors
- Azimuth LCU
- Azimuth drive
- M10 (to be replaced by Dual Feed Mirror *M10DFM*)
- Coudé Beam Switching Device
- Azimuth cable wrap
- ***M10 Dual Feed Mirror***
- ***Transversal Atmospheric Dispersion Compensator***
- Sensor LCU
- ***Field Acquisition System*** *(FAS)*
- ***Field Stabilization System*** *(FSS)*
- ***M6*** (to be replaced by Deformable Mirror *M6DM*)
- FSS Filter Wheel
- ***FSS Aperture Field Diaphragm***
- FSS Translation Stage
- ***M6 Deformable Mirror***
- Auxiliary LCU
- Enclosure
- Air Conditioning
- Relay Optics Structure (ROS) Shutter
- Transporter
- Service modules:
- Auxiliary Power
- Hydraulic and Pneumatic systems
- Liquid Cooling Module

Each individual LCU is contained in an electronic cabinet and has a mechanical and an electronic interface. The mechanical interface is the location and fixation on the transporter. The electrical interface are the commands and monitoring signal lines necessary for the operation of the entire system under control of the central control workstation. The contractor is responsible for the low level specification (encoder resolution, friction, etc.) which are necessary to meet the performance requirements as defined in the Technical Specifications. Even though the final position control of

these elements is under ESO responsibility, the contractor shall verify performance requirements using his own verification control electronics, except for the azimuth and altitude loops.

3.1.2 Conventions

All Terminal Blocks and connectors referenced in this document have been labelled as described below:

Label	Connector Type	Description
Z	Terminal Block	Interface LCU to Contractor device
W	DB9 Connector	Any RS232, RS422, or RS485 interface
Y	Terminal Block	Interface LCU to ESO device

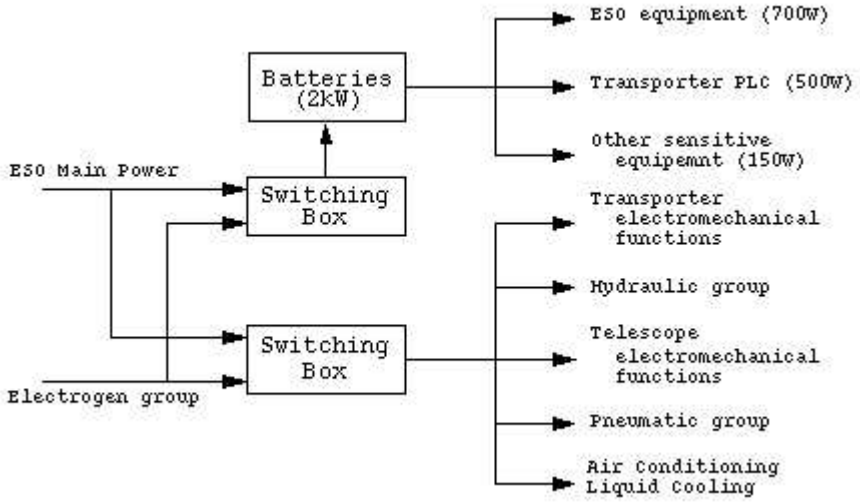
The signals are described as seen from the LCU.
The terminal blocks **Y*n*** and DB9 connectors **W*n*** have been indexed following the product tree numbering implemented in [RD 08]:

LCU	Index	LCU	Index
Altitude	1*n*	Azimuth	2*n*
Sensor	3*n*	Auxiliary	4*n*

The LCU console connectors are indexed **W*n*0**.

3.1.3 General requirements

These interfaces shall be compliant with the Electronic Design Specifications [AD 01] and the Electro-Magnetic Compatibility Specifications [AD 02].
These interfaces shall be identical for every AT unit.
The control racks shall be provided by the contractor (according to [AD 01]) and shall contain not only the power and drive electronics of the contractor but provide also the space for the ESO-LCUs.
All 4 LCUs are connected to station plugs for the power, the time bus, the control LAN and the Guide / Acquisition LAN.
All LCUs and other equipment supplied by ESO shall be powered by 230V via the battery system supplied by the contractor as shown in the following figure:



Power distribution schematics

The electrical power of all this equipment is specified in the ATS technical specifications.

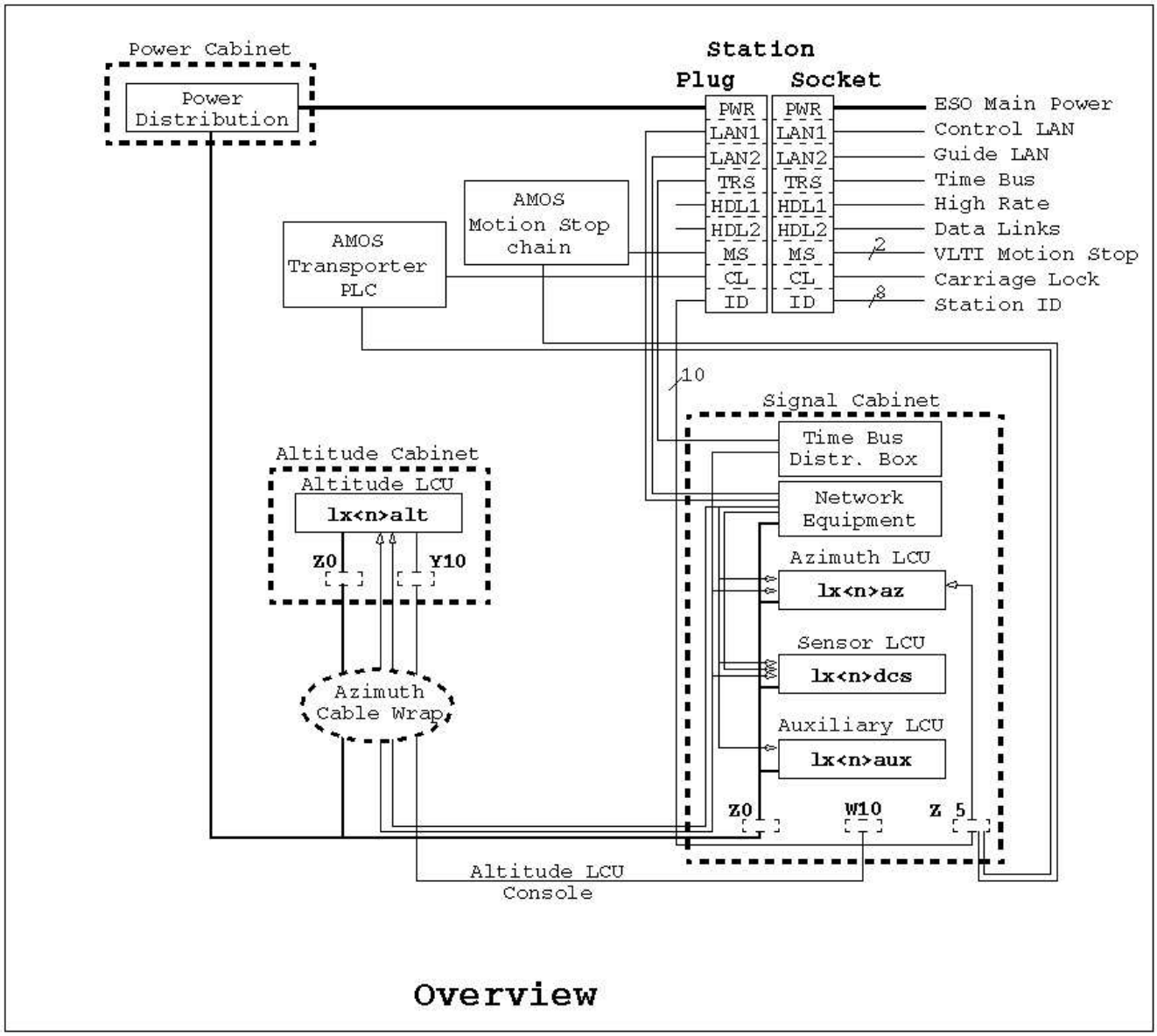
LCU will be connected to UPS main power supply via circuit breakers and intermediate terminal blocks up to distribution bars generically named Z0 on the drawing.

3.1.4 Station Plug

The connection layout and pin assignment is given in Annex [AN1] AT Station Pit/Connection box VLT-SCH-ESO-15154-2202

Item	From	To	Signal	Description
MAIN POWER:				
1	Station plug	ATS	400VAC, 3 phases	
2			Shield	PE
ELECTRICAL SIGNALS:				
10	ATS	Station plug	+24 VDC	
11			Shield	PE
STATION ID:				
12	ATS	LCU	Station Id code	8 Digital Input lines, pulled down to GND • upper 4-bit nipple *r* coding the rail=0x4*r* (in Hexadecimal: letters A to O) • lower nipple *s* coding the station=0x3*s* (in Hexadecimal: digits 0 to 9)
AT MOTION STOP:				
13	ATS	LCU	AT Motion Stop	Contact free of potential: to Azimuth to Altitude
OPTICAL FIBRES:				
20	ATS	LCU	Control LAN	1 fiber pair
21	ATS	LCU	Acquisition/Guide LAN	1 fiber pair
22	ATS	LCU	Time Bus	1 fiber pair
23	ATS	LCU	High Rate Data Links	2 fiber pairs
24	ATS	LCU	Spare	1 fiber pair

3.1.4.1 Overview Schematic:



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3.2 Altitude LCU

3.2.1 LCU Configuration

	Board	Supplier	Number
ESOnly	CPU	Motorola MVME 2604 (PowerPC, 333 MHz, 16MB)	1
	Time Interface	ESO TIM	1
	Encoder interface	Heidenhain IK 320	1
	Amplifier Interface	ESO TBD	1
	Interlock Interface	ESO TBD	1
	Digital I/O Interface	Acromag AVME 9481	1
	Analog I/O Interface	VMIC VMIVME 3111	1
	Serial Interface	ESD ISER8	1
	Motion Controller	MACCON MAC4-INC	1
	Servo Amplifier	ESO VME4SA-01	1
	Hexapod controller	Delta Tau PMAC	1

This ICD specifies to use the couple ESO VME4SA servo amplifier (supplied by AMOS) and MACCON MAC4 Motion controller (supplied by ESO) for the implementation of the control of the Nasmyth wheel.
The decision to assign the control of this wheel to this LCU was driven by the space requirement in the azimuth cable wrap.

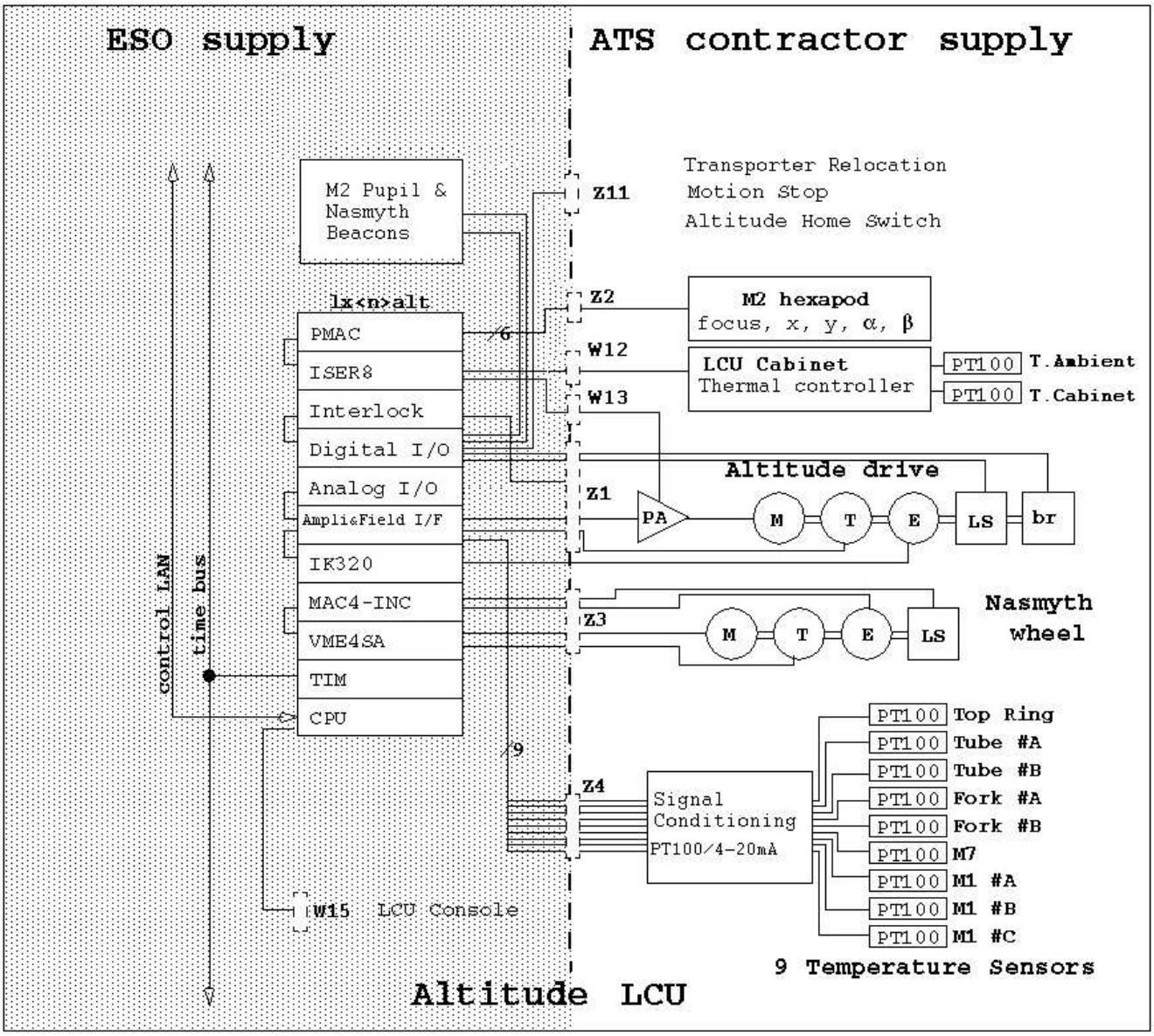
This LCU is responsible for:

Device	Terminal Block
Altitude drive	Z1, Z11, *W13*
M2 drives	Z2, *W14*
Pupil Beacon	*ESO Internal*
Nasmyth Wheel Nasmyth Beacon	Z3 *ESO Internal*
Telescope Temperature Sensors	Z4, *W12*

3.2.1.1 LCU Console

	The RS232 serial link is transiting via the Azimuth Cable Wrap to the Signal Cabinet on the DB9 Connector *W10*. see in Annex [AN01] VLT-DWG-ESO-15154-1769					
	Item	**From**	**To**	**Signal**	**Description**	**Pin**
	LCU CONSOLE:					
ESO	1	Altitude Cabinet ***Y10***	Signal Cabinet ***W10***	RS232 RX line	twisted pair	TBD
	2			RS232 TX line		
	3			RS232 GND line		
	4			Shield	PE	

3.2.1.2 Schematic:



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3.2.2 Altitude drive

- Position control of the telescope altitude axis, including motor, amplifier, tachometer, encoder, brakes and limit switches.
- The control is deployed on the Altitude LCU.
- The device is connected to the Terminal Blocks **Z1** & **Z11**, the later block being used to carry signals between Altitude and Signal cabinet via the Azimuth cable wrap
- The amplifier is connected to the Connector **W13**.

The coordinate convention is defined in: Telescope basic definitions [RD 12] . The telescope tube points to zenith when the altitude angle a=90º, to horizontal direction when a=0º;
The **PID controller** for the velocity of the Altitude drive will be included inside the LCU. It will provide an analogue signal as a reference with +-10Vdc maximum to the current loop, which belongs to the supply of the contractor and which may be included in his power amplifiers.
The **tachometer** shall provide an analog signal (+-10Vdc) proportional to the actual speed of the drive system to the LCU as an analog symmetrical signal via a screened twisted pair cable.
The connection between the **encoder** and the IK320 module in the LCU is defined in [AD 07].
The **limit switch** and **brake** status shall be connected to the ESO standard digital I/O board via the interlock system as defined in the Electronic Design Specification [AD 01]. The interlock system is supplied by ESO. The power 24VDC 0.6A for the PHASE drive is supplied by the LCU.

3.2.2.1 Altitude drive interfaces:

Proposed interface requirements according to the PHASE design using a fully digital amplifier, as in [AD 05].
The connection layout and pin assignment is given in [AN 01]Annex 1 VLT-DWG-ESO-15154-1769

Item	From	To	Signal	Description
COMMUNICATION:				
			PHASE Communication	RS485 Port - Protocol S-Link 3 [RD 06]
AMPLIFIER: Drive constant (amplifier+motor) Kt=92Nm/V				
1	LCU	ATS	Power On + Main power input relay	24VDC, 100mA supply to relay coil Digital output
2	LCU	ATS	Power On -	Common
3	LCU	ATS	Amplifier Enable	High = Enable Contact closed to enable the amplifier output stage Toggling that signal resets externally triggered faults .e.i. PTC overtemperatures, Overspeed, encoder fail signal. Digital
4	LCU	ATS	inhibit positive	Low = inhibit is asserted when positive vicinity limit is active. When the amplifier is in speed mode(manual only), the Positive velocity reference is clipped; the amplifier stop further motion in the corresponding direction. When the amplifier is in torque mode (nominal configuration) the ESO velocity speed loop sends apropriate command to stop further motion in the corresponding direction.

5	LCU	ATS	inhibit negative	Low = inhibit is asserted when negative vicinity limit is active. When the amplifier is in speed mode(manual only), the Negative velocity reference is clipped; the amplifier stop further motion in the corresponding direction. When the amplifier is in torque mode (nominal configuration) the ESO velocity speed loop sends apropriate command to stop further motion in the corresponding direction
6	ATS	LCU	Overspeed	High = no overspeed. The speed is sensed on the frequency of the Linear Hall Sensors, exceeding the limit will set the Overspeed alarm and keep it latched until the next enable cycle. Source Driver: 24V, 100mA max. Digital
7	ATS	LCU	DriveOK (no-fault)	High = DriveOK (no-fault). When negated (fault), the drive is disabled and latched until a reset is applied. Detailed fault information via the serial link. (Possible faults could be: tacho, hall sensor, over-under voltage, over current,, 50 &70 over temperature etc…) Source Driver: 24V, 100mA max. Digital
8	ATS	LCU	400VAC Power OK	High = the 400VAC Power is OK. Source Driver: 24V, 100mA max. Digital
9	LCU	ATS	Amplifier drive power +	+24VDC, 1.2A
10	LCU	ATS	Amplifier drive power -	GND
11			unused	PE
14	LCU	ATS	Torque command +	Analog differential +/-10V, Zin = 10kΩ Analog output
15	LCU	ATS	Torque command -	Analog differential +/-10V, Zin = 10kΩ Analog output
16			Shield	PE
18	LCU	ATS	Speed /Torque mode	High = Speed mode. The speed mode is used during manual operation for commissioning or maintenance, with a dedicated hand set. The torque mode is the nominal operation mode, the drive amplifier generates the tacho signal and uses the axis incremental encoder for improved ripple performances.
19	ATS	LCU	Motor Powered	High = 400V OK and Drive enabled Source Driver: 24V, 100mA max. Digital
TACHO: scale = 11.72V*s/deg; speed = 1.7 deg/s at Tacho out = 20V Tacho output is positive when tube moves from horizon towards zenith				
30	ATS	LCU	Tacho signal +	Analog symmetric +/-10V, 5mA Analog input
31	ATS	LCU	Tacho signal -	Analog input

33	LCU	ATS	Tacho Range 8x	High = Sensitivity is increased by factor 8. Contact status: 24VDC, 6.6kΩ to GND Digital
34	ATS	LCU	Tacho Range	High Sensitivity is increased by factor 8. Source Driver: 24V, 100mA max. Digital,
35	ATS	LCU	Tacho OK	High = Tacho OK; the tacho signal is ouput to ESO LCU. When Encoder OK is asserted, the drive amplifier uses the sine & cosine signals from the axis encoder for commutation and improved ripple performances. If coherency between the two signals is lost the tacho OK is negated. Source Driver: 24V, 100mA max. Digital,
ENCODER: 1 head RON 905, 11μA Heidenhain IK320 output : 1 V peak-to-peak, sine-cosine A,B signals				
40	LCU	ATS	A+	Output A+
41	LCU	ATS	A-	Output A-
42			Shield A	
43	LCU	ATS	B+	Output B+
44	LCU	ATS	B-	Output B-
45			Shield B	
46			Global Shield	Chassis GND
47	LCU	ATS	Encoder OK	High = Encoder OK and available, The encoder is powered and provides the sincos incremental signals. The drive amplifier performs a coherency check between the sine and cosine signals. 24VDC,Source Driver: 24V, 100mA max. Digital,
SWITCHES:				
50	ATS	LCU	Vicinity PLS +	Contact opens if positive vicinity limit is crossed Digital
51	ATS	LCU	Vicinity PLS -	Common
52			Shield	PE
53	ATS	LCU	Vicinity NLS +	Contact opens if negative vicinity limit is crossed Digital
54	ATS	LCU	Vicinity NLS -	Common
55			Shield	PE
56	ATS	LCU	Interlock PLS + (Positive Limit+)	Contact opens if positive interlock limit is crossed Digital
57	ATS	LCU	Interlock PLS - (Positive Limit-)	Common

58			Shield	PE
59	ATS	LCU	Interlock NLS + (Negative Limit+)	Contact opens if negative interlock limit is crossed Digital
60	ATS	LCU	Interlock NLS - (Negative Limit-)	Common
61			Shield	PE
62	ATS	LCU	Altitude Locking pinA +	10 to 30 VDC
63	ATS	LCU	Altitude Locking pinA -	Common
64	ATS	LCU	Altitude Locking pinA signal	High = Altitude Locking pin is disengaged. Open collector PNP, 200 mA max. Digital
65	ATS	LCU	Altitude Home switch +	24V logic Transition at about 5 degree Zenithal distance; open at Zenith, closed at Horizont
66	ATS	LCU	Altitude Home switch -	Common
67			Shield	
68	ATS	LCU	Altitude Locking pinB +	10 to 30 VDC
69	ATS	LCU	Altitude Locking pinB -	Common
70	ATS	LCU	Altitude Locking pinB signal	High = Altitude Locking pin is disengaged. Open collector PNP, 200 mA max. Digital
71	ATS	LCU	EndStopA +	On Nasmyth A side a Zenith or a Parking End Stop schock absorber is not in position Contact opens
72	ATS	LCU	EndStopA -	Common
73	ATS	LCU	EndStopB +	On Nasmyth A side a Zenith or a Parking End Stop schock absorber is not in position Contact opens
74	ATS	LCU	EndStopB -	Common
80	ATS	LCU	Motion Stop +	24VDC, 8W max.
81	ATS	LCU	Motion Stop -	Common
82			Shield	
83	ATS	LCU	Transporter relocation+	High = Transporter in station position. Low = Altitude immobilized because AT not in station position. See IfTransporter_RelocationStatus 1 Digital line, pulled down to GND
84	ATS	LCU	Transporter relocation-	
85			Shield	
BRAKES:				

90	ATS	LCU	Status B side +	8 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital input
91	ATS	LCU	Status B side -	8 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital input
92	ATS	LCU	Status A side +	8 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital input
93	ATS	LCU	Status A side -	8 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital input
94	LCU	ATS	Brake command	High = Enable Contact closes to disengage the brakes
95	LCU	ATS	Return	Common
MONITOR:				
100 101	ATS	LCU	Signal monitoring	Buffer amplifier output +/- 10V ,5mA differential for monitoring of internal amplifier variable selected via the serial communication link. <u>Relevant signals for monitoring:</u> • analog input • measured torque (default selection) • measured currents: phase 1, phase2, etc... • hall sensor signal • actual speed from the hall sensors • actual speed from the tacho • any signal specific to the amplifier/motor unit Analog input
110	LCU	ATS	Signal selection	<u>Saturation parameters:</u> • maximum torque: the output torque cannot go beyond the set value • maximum speed: the output speed cannot go beyond the set value <u>Controller parameters:</u> • P,I,D servo loop gain adjustable on the fly • integrator anti windup • integrator limitation

Z11 TERMINAL BLOCK:AZIMUTH CABLEWRAP

	Item	From	To	Signal	Description
ESO only	1	ATS	LCU	Motion Stop +	24VDC, 8W max.
	2	ATS	LCU	Motion Stop -	Common
	3	ATS	LCU	Relocation +	High = Transporter in station position. Low = Altitude immobilized because AT not in station position.
	4	ATS	LCU	Relocation -	
	5-23	SPARE	SPARE		
	24	LCU	LCU	PHASE R/TX+	PHASE RS485 communication link
	25	LCU	LCU	PHASE R/TX-	
	26	LCU	LCU	PHASE return R/TX+	
	27	LCU	LCU	PHASE return R/TX-	
	28			Ground	
	29			Ground	PMAC RS232 communication link
	30	LCU	LCU	PMAC TxD	
	31	LCU	LCU	PMAC RxD-	
	32	LCU	LCU	PMAC RTS	
	33	LCU	LCU	PMAC CTS	
	34	LCU	LCU	Ground	
	35	LCU	LCU	PMAC return TxD	
	36	LCU	LCU	PMAC return RxD	
	37	LCU	LCU	PMAC return RTS	
	38	LCU	LCU	PMAC return CTS	
	39	LCU	LCU	CPU0 RXD	RS232 communication link
	40	LCU	LCU	CPU0 TXD	
	41	LCU	LCU	Ground	
	42	LCU	LCU	Ground	
	43	LCU	LCU	CPU1 TXD	RS232 communication link
	44	LCU	LCU	CPU1 RXD	
	45-48			SPARE	

3.2.3 M2 drives

- Control of the focusing, centering and tilt mechanism (focus, x, y, α, β).
- The control is deployed on the Altitude LCU.
- The device is connected to the PMAC connectors J4, JS1, J8, JMACH1 & JMACH2.
- The M2 controller is connected to the Connector **W14**.

The M2 controller PMAC-VME is supplied by ESO.
The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-2217
The control of M2 shall be performed by a PMAC VME board. The control of the PMAC board shall be done through RS422 interface on the ISER board. AMOS provides the source code to be implemented on the CPU in order to transform high-level commands into low-level commands (individual actuator motions). These commands are sent to the PMAC board via the RS422 interface. The high-level commands are listed in the table below.
Important Note: The effective interface to the M2 drives is **not** on PMAC connectors J4, JS1, J8, JMACH1 & JMACH2. The contractor is responsible of the interface between the PMAC-VME output connector and the Terminal Block, while ESO is responsible of interfacing the PMAC-VME RS422 input port with a ESO standard serial ISER8 output port. see also the full description in RD 18 Interface control document for the M2 support.

3.2.3.1 M2 drives interfaces:

Item	From	To	Signal	Description	Pin
COMMUNICATION:					
1			M2 Communication	RS422 Port to PMAC Input port - Protocol details TBD	W14
GENERAL COMMANDS:					
10	LCU	ATS	Power On/Off	**M2_POWER_ON_OFF**	Software Command to W14
11	LCU	ATS	Stop all actuators	**M2_STOP**	
11.1	LCU	ATS	Execute set command	**M2_GO**	
12	LCU	ATS	Constraints for each degree of freedom (focus, tip, tilt, x, y)	**M2_PARAMETERS *min,max,velocity***	
13	LCU	ATS	Initialize all actuators (motion to Home position)	**M2_HOME**	
14	LCU	ATS	Request M2 status	**M2_STATUS_REQUEST** • ***M2_STATUS*** o ***M2_GLOBAL*: 4-bit value indicating *Power On/Off*, *home*, *moving* and *error*** o ***M2_FAULT_LOCATION*: On *error*, indicates the faulty actuator (1 to 6)** o ***M2_FAULT_DIAGNOSTIC*: On *error*, indicates the error type** • ***M2_TEMPERATURE_STATUS*** o ***SENSOR_TEMP*:**	

				temperature measured by the sensor	
MOTION COMMANDS:					
20	LCU	ATS	Set M2 absolute position	**M2_MOVE_ABS <axis> <absolute value>** • ***M2_DES_FOCUS* <z along Z axis in mm** • *M2_DES_TIP* <α around X axis in radians • *M2_DES_TILT* <β around Y axis in radians • *M2_DES_X* <*x* along X axis in mm • *M2_DES_Y* <*y* along Y axis in mm	Software Command to W14
21	LCU	ATS	Set M2 relative position	**M2_MOVE_REL <axis> <relative value>** • ***M2_DES_FOCUS*** <***z***> along Z axis in mm • ***M2_DES_TIP*** <α> around X axis in radians • *M2_DES_TILT* <β around Y axis in radians • *M2_DES_X* <*x* along X axis in mm • *M2_DES_Y* <*y* along Y axis in mm	
POSITION COMMANDS:					
22	LCU	ATS	Get M2 absolute position	**M2_MOVE_ABS <axis** • ***M2_DES_FOCUS* returns the position <z along Z axis in mm** • *M2_DES_TIP* returns the position <α around X axis in radians • *M2_DES_TILT* returns the position <β around Y axis in radians • *M2_DES_X* returns the position <*x* along X axis in mm • *M2_DES_Y* returns the position <*y* along Y axis in mm	Software Command to W14
LOW LEVEL ACTUATOR CONTROL:					
30	LCU	ATS	Set actuator absolute position	**M2_ACTUATOR_ABS <n=1..6 <absolute value** • ***M2_DES_ACTUATOR_n_POSITION* <*p* along its degree of freedom**	Software Command to W14
31	LCU	ATS	Set actuator relative position	**M2_ACTUATOR_REL <n=1..6 <relative value**	

				• ***M2_DES_ACTUATOR_n_POSITION*** **<*p* along its degree of freedom**	
32	LCU	ATS	Get actuator absolute position	**M2_ACTUATOR_ABS <n=1..6** • ***M2_DES_ACTUATOR_n_POSITION*** **returns the position <*p* of actuator #n along its degree of freedom**	

Last modified: Mon Oct 29 13:42:43 UTC 2001

3.2.4 Pupil Beacon

ESO Only

- Control of the 2 pupil beacon light sources, infrared and visible fed into one optical fibre to the M2 beacon.

- The control is deployed on the Altitude LCU.

3.2.4.1 Pupil Beacon interfaces:

Item	From	To	Signal	Description
PUPIL BEACON LIGHT SOURCES:				
1	LCU	ATS	Switch Pupil beacon visible light source on/off	contact closed to switch on visible light source Digital Output
2	ATS	LCU	Visible light source status	contact closed means visible light source switched on Digital Input
3	LCU	ATS	Switch Pupil beacon infrared light source on/off	contact closed to switch on infrared light source Digital Output
4	ATS	LCU	Infrared light source status	contact closed means infrared light source switched on Digital Input

Last modified: Wed Sep 20 15:24:25 METDST 2000

3.2.5 Nasmyth wheel

- Control of the position of the wheel, including motor, tachometer, encoder and limit switches. This 4-element device consists of a Flat Retro-Reflecting mirror, a Free Hole and 2 positions for dedicated Alignment Tools (2 light beacons, half-masks).

The motor and tacho are connected to the ESO standard VME4SA Servo Amplifier and the encoder to the MAC4 Motion Controller. The tacho generator is mounted on the motor. The velocity loop is closed in the amplifier. There are two switches: one of them is used as a reference switch.

ESO	
	• Control of the 2 Image Beacon Light Sources in one of the dedicated Alignment Tools (they are fed into a single optical fibre).

- The control is deployed on the Altitude LCU.
- The device is connected to the Terminal Block **Z3**.

ESO Only	
	The motor control is a pure SW interface: the target position and velocity are passed to the Motion Controller via the VME bus. The motor control software is provided by ESO. The functionalities to be provided are: Set absolute position of Nasmyth wheel axis • Set to Retro-Reflecting mirror • Set to free hole • Set 1st Alignment Tool position (Beacon) • Set 2nd Alignment Tool position (Halfmasks) • Chop Nasmyth wheel with a given stroke and frequency

3.2.5.1 Nasmyth wheel interfaces:

Item	From	Signal	Description
MOTOR: Minimotor DC Brush 3557-024CS 24VDC, 30W Gear 180:1			
1	LCU	Motor M+	VME4SA Servo Amplifier Channel #1
2	LCU	Motor M-	VME4SA Servo Amplifier Channel #1
3		Shield MSH	
TACHOGENERATOR: Minimotor 4.3 G60 4.3mV / rpm			
4	ATS	Tacho T+	VME4SA Servo Amplifier Channel #1
5	ATS	Tacho T-	VME4SA Servo Amplifier Channel #1
6		Shield TSH	

ENCODER: Minimotor Optical HP HEDL 5540-500 5 VDC - 500 lines/turn - Resolution in Quadrature = 1000 counts/degree = 3.6"/count			
7	LCU	Encoder 5V VCC	MAC4-INC Motion Controller Channel #1
8	LCU	Encoder GND	MAC4-INC Motion Controller Channel #1
10	ATS	Encoder A+	Differential line driver A+ MAC4-INC Motion Controller Channel #1
11	ATS	Encoder A-	Differential line driver A- MAC4-INC Motion Controller Channel #1
13	ATS	Encoder B+	Differential line driver B+ MAC4-INC Motion Controller Channel #1
14	ATS	Encoder B-	Differential line driver B- MAC4-INC Motion Controller Channel #1
16	ATS	Encoder I+	Differential line driver I+ MAC4-INC Motion Controller Channel #1
17	ATS	Encoder I-	Differential line driver I- MAC4-INC Motion Controller Channel #1
18		Shield	
SWITCHES: Micromat KS35A11 24V, 4A max. - Repeatability=0.03 degrees			
19	ATS	Reference & Negative Limit (NC)	MAC4-INC Motion Controller Channel #1
20	ATS	Reference & Negative Limit (COM)	MAC4-INC Motion Controller Channel #1
21		Shield	
22	ATS	Positive Limit (NC)	MAC4-INC Motion Controller Channel #1
23	ATS	Positive Limit Switch (COM)	MAC4-INC Motion Controller Channel #1
24		Shield	
25		PE	
26		PE	

3.2.5.2 Nasmyth Beacon light sources interfaces:

ESOOnly	Item	From	To	Signal	Description
	IMAGE BEACON LIGHT SOURCES:				
	100	LCU	ATS	Switch Image beacon light source #1 on/off	contact closed to switch on image beacon light source #1 Digital Output
	101	ATS	LCU	Image beacon light source #1 status	contact closed means light source #1 switched on Digital Input
	102	LCU	ATS	Switch Image beacon light source #2 on/off	contact closed to switch on image beacon light source #2 Digital Output
	103	ATS	LCU	Image beacon light source #2 status	contact closed means light source #2 switched on Digital Input

Last modified: Wed Jan 150 10:20:44 MET 2003

3.2.6 Telescope Temperature Sensors

- Monitoring of the telescope temperature sensors
- Monitoring of the Altitude cabinet temperature sensors
- The control is deployed on the Altitude LCU.
- The Telescope temperature sensors are connected to the Terminal Block **Z4**.
- The Altitude cabinet Temperature sensors are connected to the connector **W12**

Nine (9) temperature sensors PT100 are mounted on various parts of the telescope and are connected to signal conditioners providing a 4-20mA signal output. These signals are connected to a dedicated field interface (ESO supply) for signal formatting before entering the Analog Input ports.
The sensors are monitoring the temperature on the following parts:

- 2 on the telescope **tube**
- 1 on the **top ring**
- 2 on the **fork**
- 1 on the **mirror M7**
- 3 on the **primary mirror M1**

The thermal controller PKC from EROELELECTRONIC keeps the Altitude cabinet internal temperature equal to the ambient air temperature. It acts on a motorized valve regulating the coolant flow inside the heat exchanger of the Altitude cabinet. One PT100 senses the ambient air temperature, the other one senses the Altitude cabinet internal air temperature. The LCU has got no control on the regulation but monitors the two temperature sensors connected to the thermal controller PKC:

- 1 on the **altitude cabinet**
- 1 on the **ambient air**

3.2.6.1 Telescope Temperature Sensors Interfaces:

The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-1769

Item	From	To	Signal	Description
TOP RING SENSOR:				
1	ATS	LCU	Temperature TopRing +	Current Loop 4-20mA (-10,+25C)
2	ATS	LCU	Temperature TopRing -	
3			Shield	
TUBE SENSORS:				
4	ATS	LCU	Temperature Tube A +	Current Loop 4-20mA (-10,+25C)
5	ATS	LCU	Temperature Tube A -	
6			Shield	
7	ATS	LCU	Temperature Tube B +	Current Loop 4-20mA (-10,+25C)
8	ATS	LCU	Temperature Tube B -	

9			Shield	
FORK SENSORS:				
10	ATS	LCU	Temperature Fork A +	Current Loop 4-20mA (-10,+25C)
11	ATS	LCU	Temperature Fork A -	
12			Shield	
13	ATS	LCU	Temperature Fork B +	Current Loop 4-20mA (-10,+25C)
14	ATS	LCU	Temperature Fork B -	
15			Shield	
M7 SENSOR:				
16	ATS	LCU	Temperature M7 +	Current Loop 4-20mA (-10,+25C)
17	ATS	LCU	Temperature M7 -	
18			Shield	
M1 SENSORS:				
19	ATS	LCU	Temperature M1 A +	Current Loop 4-20mA (-10,+25C)
20	ATS	LCU	Temperature M1 A -	
21			Shield	
22	ATS	LCU	Temperature M1 B +	Current Loop 4-20mA (-10,+25C)
23	ATS	LCU	Temperature M1 B -	
24			Shield	
25	ATS	LCU	Temperature M1 C +	Current Loop 4-20mA (-10,+25C)
26	ATS	LCU	Temperature M1 C -	
27			Shield	
Power Supply:				
28	LCU	ATS	Power Supply +	24VDC / 600mA for the 9 Temperature Sensors PT100 and Signal conditioners
29	LCU	ATS	Power Supply -	
30			Shield	

3.2.6.2 Altitude cabinet Thermal controller:

Item	From	To	Signal	Description
COMMUNICATION:				
1	ATS	LCU	Thermal controller Communication	RS485 Port to PKC EROELECTRONIC - Protocol details [RD19]
GENERAL COMMANDS:				
2	ATS	LCU	Read temperatures	**Cabinet Temperature** **Ambient Air Temperature**

Last modified: Wed Jul 4 13:54:55 UTC 2001

3.3 Azimuth LCU

3.3.1 LCU Configuration

	Board	Supplier	Number
ESO Only	CPU	Motorola MVME 2604 (PowerPC, 333 MHz, 16MB)	1
	Time Interface	ESO TIM	1
	Encoder interface	Heidenhain IK 320	2
	Amplifier Interface	ESO TBD	1
	Interlock Interface	ESO TBD	1
	Digital I/O Interface	Acromag AVME 9481	1
	Analog I/O Interface	VMIC VMIVME 3111	1
	Serial Interface	ESD ISER8	1
	Motion Controller	MACCON MAC4-INC	1
	Servo Amplifier	ESO VME4SA-01	1

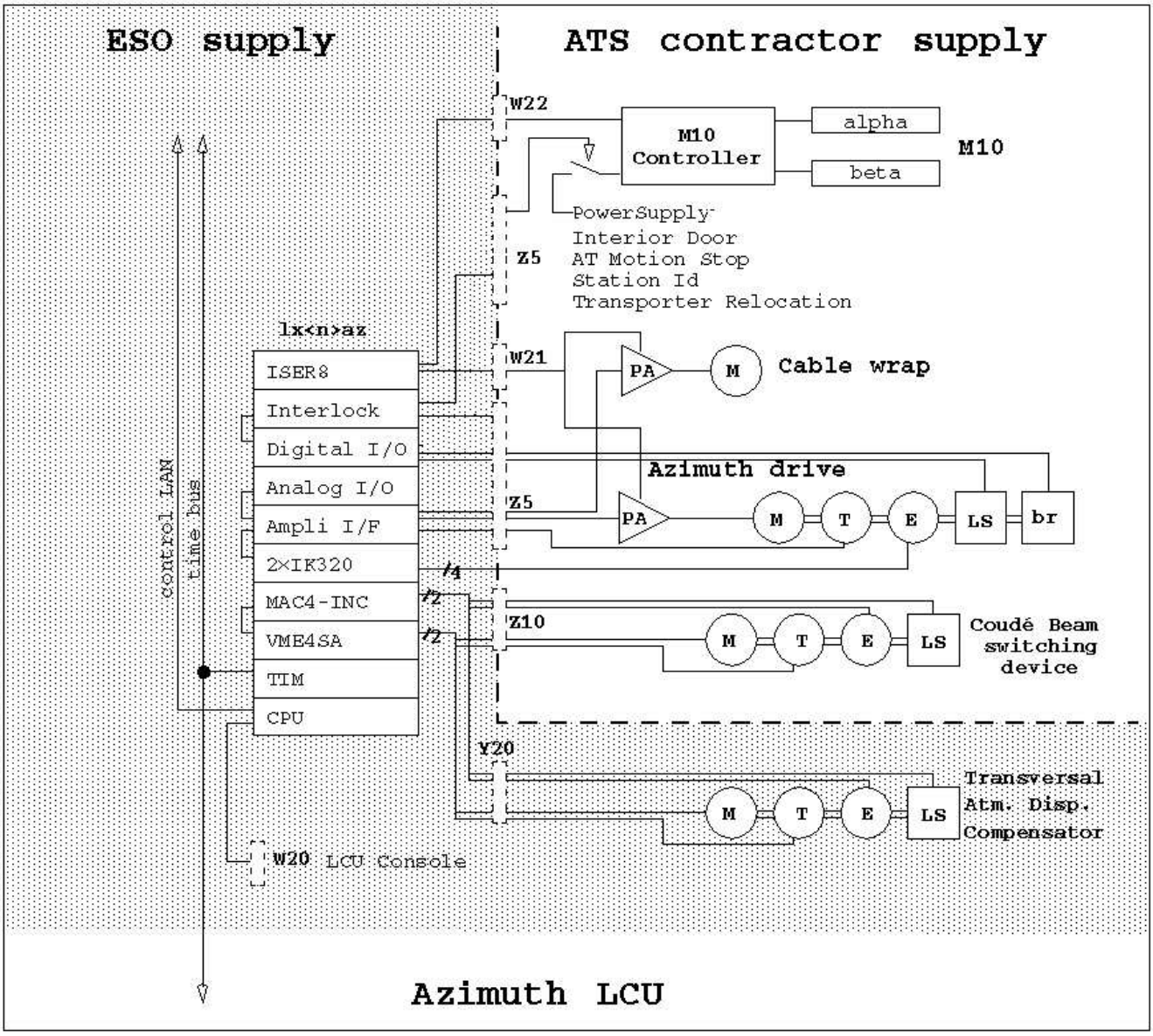
This ICD specifies to use the couple ESO VME4SA servo amplifier (supplied by AMOS) and MACCON MAC4 Motion controller (supplied by ESO) for the implementation of the control of the Coudé Beam Switching device and of the ***Transversal Atmospheric Dispersion Compensator (foreseen at a later stage as an ESO supply)***.

This LCU is responsible for:

Device	Terminal Block
Azimuth drive	**Z5, *W21***
M10 ***(to be replaced by Dual Feed Mirror)***	**Z18 - W22**
Coudé Beam Switching Device	**Z10**
Azimuth cable wrap	**Z5, *W21***

	Future Device	Terminal Block
ESO	M10 Dual Feed Mirror	***Dual Feed LCU***
	Transversal Atmospheric Dispersion Compensator	***Y20***

3.3.1.1 Schematic:



Last modified: Wed Jan 150 10:20:44 MET 2003

3.3.2 Azimuth drive

- Position control of the telescope azimuth axis, including motor, amplifier, tachometer, encoder, brakes and limit switches.
- The control is deployed on the Azimuth LCU.
- The device is connected to the Terminal Blocks **Z5**.
- The amplifier is connected to the Connector **W21**.

The coordinate convention is defined in: Basic Telescope definitions [RD 12] . The telescope azimuth angle is A= 0º; when the tube set horizontal is directed to the south-point. The amount of rotation is measured eastwards of the south-point.
The **PID controller** for the velocity of the Azimuth drive will be included inside the LCU. It will provide an analogue signal as a reference with +-10Vdc maximum to the current loop, which belongs to the supply of the contractor and which may be included in his power amplifiers.
The **tachometer** shall provide an analog signal (+-10Vdc) proportional to the actual speed of the drive system to the LCU as an analog symmetrical signal via a screened twisted pair cable.
The connection between the **encoder** and the IK320 module in the LCU is defined in [AD 07].
The **limit switch** and **brake** status shall be connected to the ESO standard digital I/O board via the interlock system as defined in the Electronic Design Specification [AD 01]. The interlock system is supplied by ESO. The power 24VDC 1.2A for the PHASE drive is supplied by the LCU.

3.3.2.1 Azimuth drive interfaces:

Proposed interface requirements according to the PHASE design using a fully digital amplifier, as in [AD 05]:
The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-1770

Item	From	To	Signal	Description
COMMUNICATION:				
			PHASE Communication	RS485 Port - Protocol S-Link 3 [RD 06]
AMPLIFIER: Drive constant (amplifier + motor) Kt=108 Nm/V				
1	LCU	ATS	Power On + Main power input relay	24VDC, 100mA supply to relay coil Digital
2	LCU	ATS	Power On -	Common
3	LCU	ATS	Amplifier Enable	High = Enable Contact closed to enable the amplifier output stage Toggling that signal resets externally triggered faults .e.i. PTC overtemperatures, Overspeed, encoder fail signal. Digital
4	LCU	ATS	inhibit positive	Low = inhibit is asserted when positive vicinity limit is active. When the amplifier is in speed mode(manual only), the Positive velocity reference is clipped; the amplifier stop further motion in the corresponding direction. When the amplifier is in torque mode (nominal configuration) the ESO velocity speed loop sends apropriate command to stop further motion in the corresponding direction.
5	LCU	ATS	inhibit negative	Low = inhibit is asserted when negative vicinity limit is active. When the amplifier is in speed mode(manual only), the Negative

				velocity reference is clipped; the amplifier stop further motion in the corresponding direction. When the amplifier is in torque mode (nominal configuration) the ESO velocity speed loop sends apropriate command to stop further motion in the corresponding direction
6	ATS	LCU	Overspeed	High = no overspeed. The speed is sensed on the frequency of the Linear Hall Sensors, exceeding the limit will set the Overspeed alarm and keep it latched until the next enable cycle. Source Driver: 24V, 100mA max. Digital
7	ATS	LCU	DriveOK (no-fault)	High = DriveOK (no-fault). When negated (fault), the drive is disabled and latched until a reset is applied. Detailed fault information via the serial link. (Possible faults could be: tacho, hall sensor, over-under voltage, over current,, 50 &70 over temperature etc…) Source Driver: 24V, 100mA max. Digital
8	ATS	LCU	400VAC Power OK	High = the 400VAC Power is OK. Source Driver: 24V, 100mA max. Digital
9	LCU	ATS	Amplifier drive power +	+24VDC, 1.2A
10	LCU	ATS	Amplifier drive power -	GND
14	LCU	ATS	Torque command +	Analog differential +/-10V, Zin = 10kΩ Analog output
15	LCU	ATS	Torque command -	Analog differential +/-10V, Zin = 10kΩ Analog output
16			Shield	PE
18	LCU	ATS	Speed / Torque mode	High = Speed mode. The speed mode is used during manual operation for commissioning or maintenance, with a dedicated hand set. The torque mode is the nominal operation mode, the drive amplifier generates the tacho signal and uses the axis incremental encoder for improved ripple performances.Source Driver: 24V, 100mA max. Digital
19	ATS	LCU	Motor Powered	High = 400V OK and Drive enabled Source Driver: 24V, 100mA max. Digital,
TACHO: scale = 9.4 V*s/deg, speed = 2.12 deg/s at Tacho out = 20V; Tacho output is positive when azimuth moves C.C.W. as seen from the top				
30	ATS	LCU	Tacho signal +	Analog symmetric +/-10V, 5mA Analog input
31	ATS	LCU	Tacho signal -	Analog input
32			Shield	PE
33	LCU	ATS	Tacho Range 8x	High = Sensitivity is increased by factor 8. Contact status: 24VDC, 6.6kΩ to GND Digital
34	ATS	LCU	Tacho Range	High = Sensitivity is increased by factor 8

				Source Driver: 24V, 100mA max. Digital,
35	ATS	LCU	Tacho OK	High = Tacho OK; the tacho signal is ouput to ESO LCU. When Encoder OK is asserted, the drive amplifier uses the sine & cosine signals from the axis encoder are for commutation and improved ripple performances. If coherency between the two signals is lost the tacho OK is negated. Source Driver: 24V, 100mA max. Digital,
ENCODER: 4 heads ERA 780 T Heidenhain IK320 buffered output : 1 V peak-to-peak, sine-cosine A,B signals				
40	LCU	ATS	A+	Output A+
41	LCU	ATS	A-	Output A-
42			Shield	
43	LCU	ATS	B+	Output B+
44	LCU	ATS	B-	Output B-
45			Shield	
46			Global Shield	Chassis GND
47	LCU	ATS	Encoder OK	High = Encoder OK and available, The encoder is powered and provides the sincos incremental signals. The amplifier performs a coherency check between the sine and cosine signals. 24VDC,Source Driver: 24V, 100mA max. Digital,
SWITCHES:				
50	ATS	LCU	Vicinity PLS +	Contact opens if positive vicinity limit is crossed
51	ATS	LCU	Vicinity PLS -	Common
52			Shield	PE
53	ATS	LCU	Vicinity NLS +	Contact opens if negative vicinity limit is crossed
54	ATS	LCU	Vicinity NLS -	Common
55			Shield	PE
56	ATS	LCU	Interlock PLS + (Positive Limit +)	Contact opens if positive interlock limit is crossed
57	ATS	LCU	Interlock PLS - (Positive Limit -)	Common
58			Shield	PE
59	ATS	LCU	Interlock NLS + (Negative Limit +)	Contact opens if negative interlock limit is crossed
60	ATS	LCU	Interlock NLS - (Negative Limit -)	Common
61			Shield	PE

62	ATS	LCU	Direction switch 1+	24VDC, 10W max. Contact • Closed if in range -180 - +45 deg • Open if in range +90 - +360 deg Digital
63	ATS	LCU	Direction switch 1-	Common
64	ATS	LCU	Direction switch 2+	24VDC, 10W max. Contact • Open if in range -180 - +45 deg • Closed if in range +90 - +360 deg Digital
65	ATS	LCU	Direction switch 2-	Common
80	ATS	LCU	Interior door switch +	220VDC
81	ATS	LCU	Interior door switch -	220 VDC
82			Shield	
83	ATS	LCU	Motion Stop +	Contact open Motion Stop is active. 24VDC, 8W max.
84	ATS	LCU	Motion Stop -	Common
85	ATS	LCU	Station Id code	8 Digital lines, pulled down to GND
86	ATS	LCU	Transporter relocation	High = Transporter in station position. Low = Azimuth immobilized because AT not in station position. See Transporter_RelocationStatus 1 Digital line, pulled down to GND
87			Shield	
88	LCU	ATS	Enclosure Working Area +	24V field
89	ATS	LCU	Enclosure Working Area -	Low = maintenance is being performed inside the enclosure; Azimuth AND Enclosure interlocked 1 Digital line, pulled down to GND
BRAKES:				
90	ATS	LCU	Status -U side +	12 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital
91	ATS	LCU	Status -U side -	12 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital
92	ATS	LCU	Status +U side +	12 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital

93	ATS	LCU	Status +U side -	12 NO switches in serie, 30 VDC, 10A max. Contact closed when brakes are disengaged Digital
94	LCU	ATS	Brake command+	High = Enable Contact closes to disengage the brakes
95	LCU	ATS	return	Common
MONITOR:				
100 101	ATS	LCU	Signal monitoring	Buffer amplifier output +/- 10V ,5mA differential for monitoring of internal amplifier variable selected via the serial communication link. Relevant signals for monitoring: • analog input • measured torque (default selection) • measured currents: phase 1, phase2, etc... • hall sensor signal • actual speed from the hall sensors • actual speed from the tacho • any signal specific to the amplifier/motor unit Analog input
110	LCU	ATS	Signal selection	Saturation parameters: • maximum torque: the output torque cannot go beyond the set value • maximum speed: the output speed cannot go beyond the set value Controller parameters: • P,I,D servo loop gain adjustable on the fly • integrator anti windup • integrator limitation

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3.3.3 M10 Drives

- Control of the two low frequency M10 tilt motions, required for output pupil position adjustment. Control of the Dual Feed mirrors (when implemented) for output pupil position adjustment as well as reference object selection and tracking.
- The control is deployed on the Azimuth LCU.
- The device is connected to a **RS232** port via connector **W22**.
  The two axes are driven by one OEM070 controller each. The two controllers are daisy-chained on the communication link.
  The two controllers are located in the ROS and switched OFF when not in use for reduced heat dissipation

The protocol is described in OEM070 User Guide (see Annex 1, p. 23ff. of [RD 03]). The contractor is responsible for the bootstrap procedure, to be burned in EPROM. The α angle is managed by the controller #1, while the β angle from the controller #2.
The conversion between encoder counts (after quadrature interpolation) and radians (or degrees) is given by a formula, given by the contractor.

3.3.3.1 M10 interfaces:

The connection layout and pin assignment of W22 and Z18 is given in Annex 1 VLT-DWG-ESO-15154-1770

Item	From	To	Signal	Description	Pin
COMMUNICATION:					
1			M10 Communication	RS232 Port - Protocol ASCII 9600 baud, 8 data bits, 1 stop bit, no parity	W22
TILTING: M10 Unit conversion formulae in annex					
10	LCU	ATS	Set M10 absolute (α,β) tilt angles	Sets absolute M10 tilt angles (α,β) in encoder counts (two separate commands, one per axis)	Software Command to W22
11	LCU	ATS	Set M10 relative (α,β) tilt angles	Sets relative M10 tilt angles (α,β) in encoder counts (two separate commands, one per axis)	
12	ATS	LCU	Get M10 absolute (α,β) tilt angles	Gets absolute M10 tilt angles (α,β) in encoder counts (two separate commands, one per axis)	
CONTROLLER:					
20	LCU	ATS	Power On +	24VDC, 500mA supply to relay coil	
21	LCU	ATS	Power On -	return	

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3.3.4 Coudé Beam Switching Device

- Control of the selection of the different elements that can be inserted in the beam in front of the Coudé sensor. It consists of 5 elements, namely a Mirror reflecting the beam to FAS only, a Beam Splitter sending the beam to both FAS and FSS, a Free Hole to FSS only, a Light Stop that prevents the beam to reach neither FAS nor FSS and a FSS pupil viewer which enables to view the image of the pupil on the FSS APD using the FAS.

  The motor and tacho are connected to the ESO standard VME4SA Servo Amplifier and the encoder to the MAC4 Motion Controller. The tacho generator is mounted on the motor. The velocity loop is closed in the amplifier. There are two switches; one of them is used as a reference switch.

- The control is deployed on the Azimuth LCU.
- The device is connected to the Terminal Block **Z10**.

ESOOnly	The motor control is a pure SW interface: the target position and velocity are passed to the Motion Controller via the VME bus. The motor control software is provided by ESO. The functionalities to be provided are: Set absolute position of Coudé Beam Switching Device axis: • Set Light Stop • Set FAS only • Set FAS+FSS Beam Splitter • Set FSS only (Free Hole) • Set FSS pupil viewer

3.3.4.1 Coudé Beam Switching Device interfaces:

The connection layout and pin assignment of Z10 is given in Annex 1 VLT-DWG-ESO-15154-1770

Item	From	To	Signal	Description
MOTOR: Minimotor DC Brush 2233-024S 24VDC, 2.53W Gear 29.6:1				
1	LCU	ATS	Motor M+	VME4SA Servo Amplifier Channel #1
2	LCU	ATS	Motor M-	VME4SA Servo Amplifier Channel #1
3			Shield MSH	
TACHOGENERATOR: Minimotor 1.5 G 1.5mV / rpm				
4	ATS	LCU	Tacho T+	VME4SA Servo Amplifier Channel #1
5	ATS	LCU	Tacho T-	VME4SA Servo Amplifier Channel #1
6			Shield TSH	
ENCODER: Minimotor Optical HP HEDL 5540-500 5 VDC - 500 lines/turn - Resolution in Quadrature = 59200 counts/mm = 59.2 counts/µm				

7	LCU	ATS	Encoder 5V VCC	MAC4-INC Motion Controller Channel #1
8	LCU	ATS	Encoder GND	MAC4-INC Motion Controller Channel #1
7	ATS	LCU	Encoder A+	Differential line driver A+ MAC4-INC Motion Controller Channel #1
8	ATS	LCU	Encoder A-	Differential line driver A- MAC4-INC Motion Controller Channel #1
13	ATS	LCU	Encoder B+	Differential line driver B+ MAC4-INC Motion Controller Channel #1
14	ATS	LCU	Encoder B-	Differential line driver B- MAC4-INC Motion Controller Channel #1
16	ATS	LCU	Encoder I+	Differential line driver I+ MAC4-INC Motion Controller Channel #1
17	ATS	LCU	Encoder I-	Differential line driver I- MAC4-INC Motion Controller Channel #1
18			Shield	
SWITCHES: Micromat KS35A11 24V, 4A max. - Repeatability=0.03mm				
19	ATS	LCU	Reference & Negative Limit(NC)	MAC4-INC Motion Controller Channel #1
20	ATS	LCU	Reference & Negative Limti (COM)	MAC4-INC Motion Controller Channel #1
21			Shield	
22	ATS	LCU	Positive Limit (NC)	MAC4-INC Motion Controller Channel #1
23	ATS	LCU	Positive Limit (COM)	MAC4-INC Motion Controller Channel #1
24			Shield	
25			Global Shield	

3.3.5 Azimuth Cable Wrap

- The cable wrap control is an active motorized system and acts as a slave of the azimuth drive. No control by ESO is required but status information shall be provided as listed in the table below. The cable wrap guide has 2 electro-mechanical switches located at each side of the guide pin. The azimuth axis shall be stopped whenever one of the switches is activated. In case it stops the azimuth axis while M7 is blocking the GIS access door; the cablewrap wrap can be manually dragged away. For that purpose the motorization drive is made reversible
- The control is deployed on the Azimuth LCU.
- The device is connected to the Terminal Block **Z5** and **J6**
- The amplifier is connected to the Connector **W21**.

3.3.5.1 Azimuth Cable Wrap interfaces:

The connection layout and pin assignment of Z5 and J6 is given in Annex [AN1] VLT-DWG-ESO-15154-1770

Item	From	To	Signal	Description
COMMUNICATION:				
			PHASE Communication	RS485 Port - Protocol S-Link 3 [RD 06]
CABLE WRAP:				
1	ATS	LCU	No Fault	Contact closed if cable wrap OK (see interlock section) Source driver 24V, 100mA max. Digital Input
2	ATS	LCU	Torque signal + [Nm/V]	Analog signal -10V/+10V, 5mA (differential) Analog input
3	ATS	LCU	Torque signal -	Analog input
4			Shield	
5	LCU	ATS	Amplifier Enable	Contact status 6.6kΩ to GND Digital Output
SWITCHES:				
8	ATS	LCU	Cable Wrap Positive Limit+	Contact opens if Cablewrap do not follow azimuth axis in positive direction
9	ATS	LCU	Cable Wrap Positive Limit-	contact return
10	ATS	LCU	Cable Wrap Negative Limit+	Contact opens if Cablewrap do not follow azimuth axis in negative direction
11	ATS	LCU	Cable Wrap Negative Limit-	return

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3.3.6 M10 Dual Feed Mirror

ESO Only

This function will not be implemented in the initial phase of the project, but at a later stage. However interface requirements related to reserved space, cable routing, plug design, etc... apply.

- Control of the M10 Dual Feed Mirror.

- The control is deployed on the Dual Feed LCU.
- This sub-system belongs to the ESO delivery.

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3.3.7 Transversal Atmospheric Dispersion Compensator

ESO Only

This function will not be implemented in the initial phase of the project, but at a later stage. However interface requirements related to reserved space, cable routing, plug design, etc... apply.

- Control of the Transversal Atmospheric Dispersion Compensator.
  The motor and tacho are connected to the ESO standard VME4SA Servo Amplifier and the encoder to MAC4 Motion Controller. The tacho generator is mounted on the motor. The velocity loop is closed in the amplifier. There are two switches; one of them is used as a reference switch.

- The control is deployed on the Azimuth LCU.
- This sub-system belongs to the ESO delivery.
- The device is connected to the Terminal Block **Y20**.

3.3.7.1 Transversal Atmospheric Dispersion Compensator drive interfaces:

The pin assignment on Terminal Block **Y20** will be identical to the ones used on the Coude Beam Splitting device.

The connection layout and pin assignment of Y20 is given in Annex 1 VLT-DWG-ESO-15154-1770

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3.4 Sensor LCU

3.4.1 LCU Configuration

	Board	Supplier	Number
ESO Only	CPU	Motorola MVME 2604 (PowerPC, 333 MHz, 32/64MB)	1
	Time Interface	ESO TIM	1
	Digital I/O Interface	Acromag AVME 9481	1
	STRAP VME control board	Microgate	1
	TCCD boards	LIB (INMOS BO16) + LAB	1
	28V power supply for TCCD	Kniel CP28.2	1
	Motion Controller	MACCON MAC4-INC	1
	Servo Amplifier	ESO VME4SA-01	1
	+5V +/-15V Supply	KNIEL CPM 101	1

This ICD specifies to use the couple ESO VME4SA servo amplifier and MACCON MAC4-INC motion controller (both supplied by ESO) for the implementation of the control of the FSS Filter Wheel, ***FSS Field Diaphragm*** and the FSS Translation Stage X- & Y-axes.

This LCU is responsible for:

Device	Terminal Block
FSS Filter Wheel	**Z12**
FSS Translation Stage	**Z16** & **Z17**

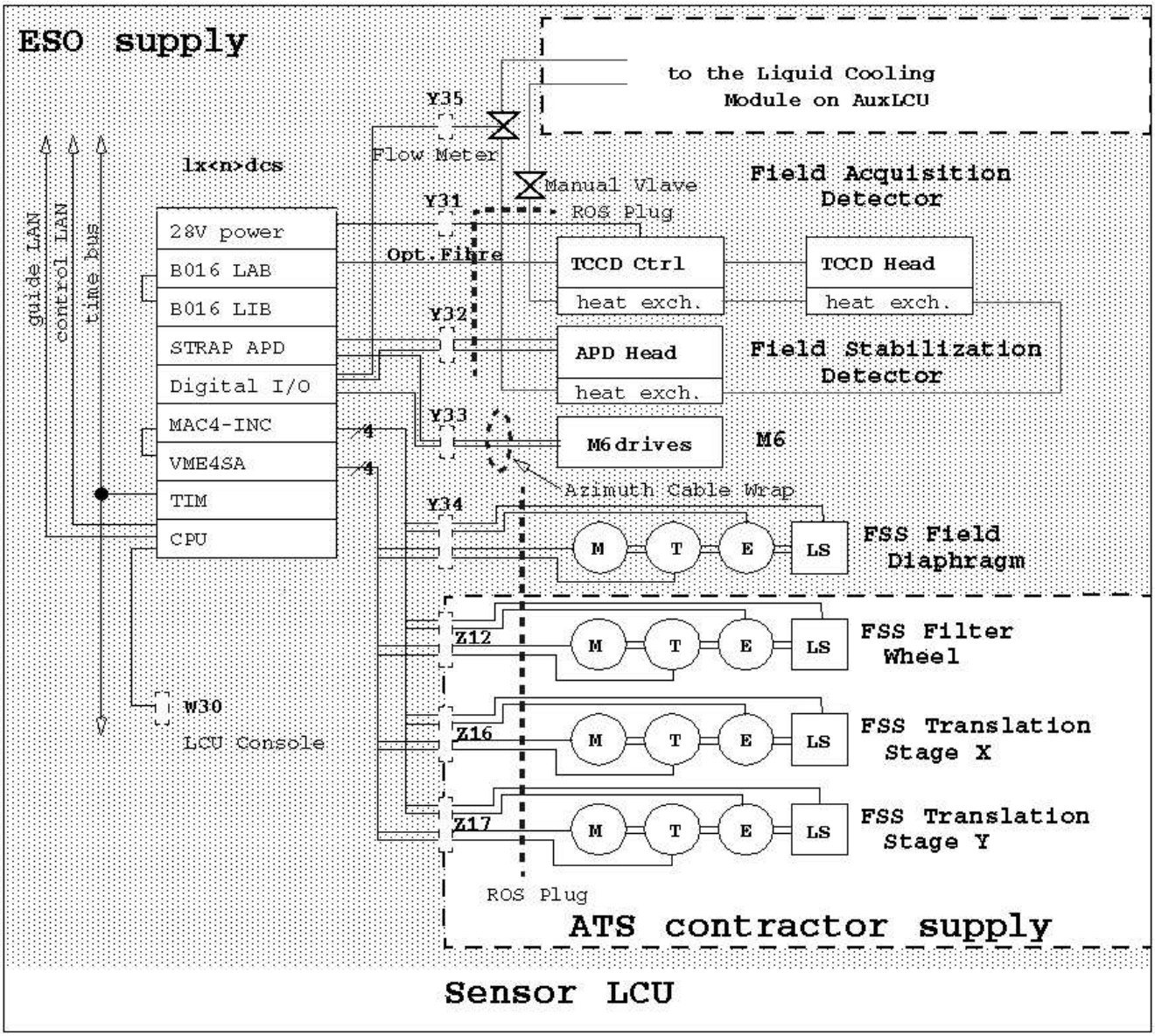
ESO	The field acquisition system, the field stabilization system and the M6 drives and the Field Diaphragm as shown on the Figure below belong to the ESO delivery. There is for those parts only a mechanical interface existing (see 6.3).

	Device	Connection
ESO Only	Field Acquisition System (FAS)	**Y31**
	Field Stabilization System (FSS)	**See** [AD 03]
	M6 (to be replaced by Deformable Mirror)	**Y33**
	FSS Field Diaphragm	**Y34**
	Flow Meter	**Y35**
	Power Supplies +5VDC +/-15VDC & 28VDC	**Y31**
	Future Device	
	M6 Deformable Mirror	***Adaptive Optics LCU***

3.4.1.1 Cooling Monitor:

For safety and maintenance purpose, a flow-meter is installed in the liquid cooling circuit. This device can detect rapidly any leak or obstruction in the cooling pipes.

3.4.1.2 Schematic:



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3.4.2 Field Acquisition System (FAS)

ESO Only

- Control of the Field Acquisition System components (CCD head, pre-amplifier, temperature sensor, liquid cooling). This system is used for Auto Guiding.

- The control is deployed on the Sensor LCU.
- This sub-system belongs to the ESO delivery.
- The device is connected to the Terminal Block **Y31**.

3.4.2.1 Field Acquisition System interfaces:

The reference document for the FAS interface is [RD 05].
The connection layout and pin assignment of Y31 is given in Annex 1 VLT-DWG-ESO-15154-1787

Item	From	To	Signal	Description
TCCD POWER SUPPLY:				
1	LCU	ATS	Power Line +	28VDC, 2A
2	LCU	ATS	Power Line -	
3			Shield	
TCCD OPTICAL FIBRE:				
13	LCU	ATS	Optical Fibre #*n* (*n*=1 to 8)	See [RD 05] and Note 1

Note 1: From LAB Board Front panel to ROS Plug

3.4.3 Field Stabilization System (FSS)

- Control of the Field Stabilization System components (STRAP system, communication link to M6, liquid cooling). This system is used for Field Stabilization.
- The control is deployed on the Sensor LCU.
- This sub-system belongs to the ESO delivery.
- The device is connected to the connectors defined in [AD 03].

3.4.3.1 Field Stabilization System interfaces:

The applicable documents for the FSS interface are [AD 03] and [AD 04].

	Item	From	To	Signal	Description	Pin
ESO Only	**COMMUNICATION:**					
	1	LCU	ATS	STRAP board console For maintenance only	RS232 Port	W31
	APD HEAD CONTROL:					
	10	LCU	ATS	STRAP APD Head control lines	I/O lines to STRAP VME board	
	11	LCU	ATS	STRAP APD Head signal lines	See [AD 03] and [AD 04]	
	APD HIGH VOLTAGE:					
	20	LCU	ATS	High Voltage lines	See [AD 03] and [AD 04]	
	APD GATE CONTROL:					
	30	LCU	ATS	APD gate control +	contact closed to close the APD gate Digital Output	
	31	LCU	ATS	APD gate control -	Common	
	32					
	33	LCU	ATS	APD gate control 50Ω coax	50Ω coax	
	34					

3.4.3.2 Field Stabilization System Software Interface:

The applicable document for the FSS software interface is [RD 07].

	Item	From	To	Signal	Description	Pin
ESO Only	**CONFIGURATION:**					
	2	LCU	ATS	STRAP Static Configuration (Can not be modified while APD is active)	Static parameters: • Open/Close loop • APD Gain • Diagnostic sampling period • Number of cycles • Hook-function name • etc ... (TBD) SW Command	
ESO	3	LCU	ATS	STRAP Dynamic Configuration (May be modified while APD is active)	Dynamic parameters: • Guide Reference Point • Interaction Matrix	

					• Gate for APD gain control • etc ... (TBD) SW Command	
	CONTROL:					
	4	LCU	ATS	Start STRAP	start APD acquisition with current configuration SW Command	
	5	LCU	ATS	Stop STRAP	stop APD acquisition SW Command	
	6	LCU	ATS	Gate APD gain	turn gate on/off for APD gain control (used in chopping mode when alternating between object and sky) SW Command or Digital Output	
	7	LCU	ATS	Update Interaction Matrix	update interaction matrix (for derotating M6 corrections) SW Command	
	8	LCU	ATS	Request Interaction Matrix	retrieve actual interaction matrix SW Command	
	9	LCU	ATS	Update Reference Point (see Note 1 below)	update the APD reference point SW Command	
	STATUS & DIAGNOSTICS:					
Only	10	ATS	LCU	STRAP Status	get STRAP status SW Command / DB attribute	
	11	ATS	LCU	STRAP diagnostics parameters	<u>Diagnostics parameters:</u> • r0, t0, FWHM, SNR, centroid, extrema • etc ... (TBD) SW Command / DB attribute	
	12	LCU	ATS	Error Vector (see Note 2 below)	request the instantaneous Error Vector SW Command	
	SYNCHRONIZATION:					
	13	LCU	LCU	Function Hook (see Note 3 below)	hook a user-defined function synchronous to the APD control loop API Function	

<u>Note 1:</u> The guide reference point is theoretically the optical center of the APD sensor. Since the FSS Translation Stage is a tracking axis, its position will be updated while tracking. However, it might be necessary to interpolate its position between 2 updates. This is achieved by offsetting the APD reference point synchronously with the Translation Stage control loop. The offset shall be less than 1/2 Airy disk (i.e. approx. 0.2" on the sky) so as not to *loose* the object.
<u>Note 2:</u> In order to compensate for tracking drift, the absolute offset of M6 is queried by the M6 Control Loop and sent to the telescope Alt/Az axes. The relative slow correction speed of the main axes allows not to recenter M6 but let the FS loop closed and active, that will bring M6 back to the center.
<u>Note 3:</u> The ATCS Requirements specify the need of synchronizing the acquisition system with the guiding loop. On the UTs, this is implemented between the TCCD system and the AG/FS loops by means of a user-defined function hook that is invoked at each exposure. The details of the function are application specific, the interface is TBD (shall try to match the existing one). The function shall have access to the actual parameters describing the data acquired during this cycle (error vector, SNR, FWHM etc...).

3.4.4 M6 drives

- Interface requirements for M6 electronics located on the fork at a distance <1.5m from M6
- Electrical power: 230V UPS, wire cross section 0.75mm2
- Cooling: one inlet outlet are reserved at the manifold distributor for M6 cabinet Thread type: BSP cylindrical 3/8".
- Electrical signals: Terminal Block **Y33**
- Optical signals: 2 ST Connectors
- Housing of the M6 control electronics: Rittal cabinet 9U height mounted on the fork see Detector and M6 drives

ESO Only

- Control of the High Frequency M6 tilt motions, required for field stabilization and chopping. For Adaptive Optics, a Deformable Mirror controlled by an appropriate electronics will replace M6.
- The control is deployed on the Sensor LCU.
- This sub-system belongs to the ESO delivery.
- The device is connected to the Terminal Block **Y33**.

3.4.4.1 M6 drives interfaces:

The connection layout and pin assignment of Y33 and ST1&ST2 is given in
Annex 1 VLT-DWG-ESO-15154-1787

Item	From	To	Signal	Description
M6 TIP-TILT CONTROL:				
1	LCU	M6	Tip tilt angles α &β	16-bits command via optic fibre
2	LCU	M6	Data Strobe +	COMACK Digital Output
3	LCU	M6	Data Strobe Common	Common
4	M6	LCU	X On-Target +	XTARONI Input. Active high. Monitor Target-On on X channel Digital Input
5	M6	LCU	X On-Target Common	Common
6	M6	LCU	Y On-Target +	YTARONI Input. Active high. Monitor Target-On on Y channelDigital Input
7	M6	LCU	Y On-Target Common	Common
8				
M6 TIP-TILT MONITOR:				
20	ATS	LCU	X-overflow +	XOVERFI* Input. Active low. Overflow error indication on X channel Digital Input
21	ATS	LCU	X- overflow Common	Common
22	ATS	LCU	Y- overflow +	YOVERFI* Input. Active low. Overflow error indication on Y channel Digital Input
23	ATS	LCU	Y- overflow Common	Common
24			Power Monitor	POWMONI Input Active high, Power monitor (M6 and Interface board)
25			Shield	

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Note: This device is controlled via the STRAP system. We need the following commands for centering and tilting M6. They are defined in the STRAP interfaces [RD 07].

O O n l y

3.4.4.2 M6 Software Interface:

Item	From	To	Signal	Description	Pin
CENTERING:					
1	LCU	ATS	Center M6	Set M6 to Center Position M6	Software Command to STRAP
TILTING:					
2	LCU	ATS	Set M6 absolute (α,β) tilt angles	Sets absolute M6 tilt angles (α,β) in radians	Software Command to STRAP
3	LCU	ATS	Set M6 relative (α,β) tilt angles	Sets relative M6 tilt angles (α,β) in radians	
4	ATS	LCU	Get M6 absolute (α,β) tilt angles	Gets absolute M6 tilt angles (α,β) in radians	

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3.4.5 FSS Filter Wheel

- Control of the position of the filter wheel that allows the insertions of 6 neutral density filters before the FSS.

  The motor and tacho are connected to the ESO standard VME4SA Servo Amplifier and the encoder to the MAC4 Motion Controller. The tacho generator is mounted on the motor. The velocity loop is closed in the amplifier. There is one switch used as a reference switch.

- The control is deployed on the Sensor LCU.
- The device is connected to the Terminal Block **Z12**.

ESO	The motor control is a pure SW interface: the target position and Velocity are passed to the Motion Controller via the VME bus. The motor control software is provided by ESO.

3.4.5.1 FSS Filter Wheel interfaces:

The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-1787

Item	From	To	Signal	Description
MOTOR: Minimotor DC Brush 2233-024S 24VDC, 2.53W gear 29.6 + worm gear 180:1				
1	LCU	ATS	Motor M+	VME4SA Servo Amplifier Channel #1
2	LCU	ATS	Motor M-	VME4SA Servo Amplifier Channel #1
3			Shield MSH	
TACHOGENERATOR: Minimotor 1.5 G 1.5mV / rpm				
4	ATS	LCU	Tacho T+	VME4SA Servo Amplifier Channel #1
5	ATS	LCU	Tacho T-	VME4SA Servo Amplifier Channel #1
6			Shield TSH	
ENCODER: Minimotor Optical HP HEDL 5540-500 5 VDC - 500 lines/turn - Resolution in Quadrature = 29600 counts/degree = 0.12"/count				
7	LCU	ATS	Encoder 5V VCC	MAC4-INC Motion Controller Channel #1
8	LCU	ATS	Encoder GND	MAC4-INC Motion Controller Channel #1
10	ATS	LCU	Encoder A+	Differential line driver A+ MAC4-INC Motion Controller Channel #1
11	ATS	LCU	Encoder A-	Differential line driver A- MAC4-INC Motion Controller Channel #1
13	ATS	LCU	Encoder B+	Differential line driver B+ MAC4-INC Motion Controller Channel #1

14	ATS	LCU	Encoder B-	Differential line driver B- MAC4-INC Motion Controller Channel #1
16	ATS	LCU	Encoder I+	Differential line driver I+ MAC4-INC Motion Controller Channel #1
17	ATS	LCU	Encoder I-	Differential line driver I- MAC4-INC Motion Controller Channel #1
18			Shield	
SWITCHES: Micromat KS35A11 24V, 4A max. - Repeatability=0.03degree				
19	ATS	LCU	Reference switch (NC)	MAC4-INC Motion Controller Channel #1
20	ATS	LCU	Reference switch(COM)	MAC4-INC Motion Controller Channel #1
21			Shield	
25			Global shield	PE

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3.4.6 FSS Aperture Field Diaphragm

ESO only

- Control of the Aperture Field Diaphragm before the FSS detector.

  The motor and tacho are connected to the ESO standard VME4SA Servo Amplifier and the encoder to the MAC4 Motion Controller. The tacho generator is mounted on the motor. The velocity loop is closed in the amplifier. There are two switches; one of them is used as a reference switch.

- The control is deployed on the Sensor LCU.
- The device is connected to the Terminal Block **Y34**.

The motor control is a pure SW interface: the target reference position and Velocity are passed to the Motion Controller via the VME bus. The motor control software is provided by ESO.

3.4.6.1 FSS Aperture Field Diaphragm interfaces:

The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-1787

Item	From	To	Signal	Description
MOTOR: Model *TBD* *TBDVDC, TBDW*				
1	LCU	ATS	Motor M+	VME4SA Servo Amplifier Channel #2
2	LCU	ATS	Motor M-	VME4SA Servo Amplifier Channel #2
3			Shield MSH	
TACHOGENERATOR: Model *TBD* *TBDmV / rpm*				
4	ATS	LCU	Tacho T+	VME4SA Servo Amplifier Channel #2
5	ATS	LCU	Tacho T-	VME4SA Servo Amplifier Channel #2
6			Shield TSH	
ENCODER: Model *TBD* 5 VDC - *TDB* counts/turn - Resolution = *TBD* counts/degree = *TBD*"/count				
7	LCU	ATS	Encoder 5V VCC	MAC4-INC Motion Controller Channel #2
8	LCU	ATS	Encoder GND	MAC4-INC Motion Controller Channel #2
10	ATS	LCU	Encoder A+	Differential line driver A+ MAC4-INC Motion Controller Channel #2
11	ATS	LCU	Encoder A-	Differential line driver A- MAC4-INC Motion Controller Channel #2
13	ATS	LCU	Encoder B+	Differential line driver B+ MAC4-INC Motion Controller Channel #2

	14	ATS	LCU	Encoder B-	Differential line driver B- MAC4-INC Motion Controller Channel #2
	16	ATS	LCU	Encoder I+	Differential line driver I+ MAC4-INC Motion Controller Channel #2
ESO only	17	ATS	LCU	Encoder I-	Differential line driver I- MAC4-INC Motion Controller Channel #2
	18			Shield	
	SWITCHES: Model *TBD* *TBDV, TBDA max. - Repeatability=TBDdegree*				
	18	ATS	LCU	Reference switch (NC)	MAC4-INC Motion Controller Channel #2
	18	ATS	LCU	Reference switch (COM)	MAC4-INC Motion Controller Channel #2
	18			Shield	
	18			Global shield	PE

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3.4.7 FSS Translation Stage

- Control of the XY translation stage used as support for the FSS Detector, including motor, tachometer, encoder and reference switches.

  The motor and tacho are connected to the ESO standard VME4SA Servo Amplifier and the encoder to the MAC4 Motion Controller. The tacho generator is mounted on the motor. The velocity loop is closed in the amplifier. There are two switches per axis: a positive limit switch (PLS) and a negative limit switch (NLS). One of them is used as reference switch.

- The control is deployed on the Sensor LCU.
- The device is connected to the Terminal Blocks **`Z16`** for the X-axis and **`Z17`** for the Y-axis.

ESO	The motor control is a pure SW interface: the target position and velocity are passed to the Motion Controller via the VME bus. The motor control software is provided by ESO.

3.4.7.1 FSS Translation Stage interfaces:

The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-1787

X-Axis				
Item	**From**	**To**	**Signal**	**Description**
MOTOR: Minimotor DC Brush 2233-024S 24VDC, 2.53W - GearBox = 29.6:1 - Screw Pitch = 1mm				
1	LCU	ATS	Motor M+	VME4SA Servo Amplifier Channel #3
2	LCU	ATS	Motor M-	VME4SA Servo Amplifier Channel #3
3			Shield MSH	
TACHOGENERATOR: Minimotor 1.5 G 1.5mV / rpm				
4	ATS	LCU	Tacho T+	VME4SA Servo Amplifier Channel #3
5	ATS	LCU	Tacho T-	VME4SA Servo Amplifier Channel #3
6			Shield TSH	
ENCODER: Minimotor Optical HP HEDL 5540-500 5 VDC - 500 lines/turn - Resolution in Quadrature = 59200 counts/mm = 16.9nm/count				
7	LCU	ATS	Encoder 5V VCC	MAC4-INC Motion Controller Channel #3
8	LCU	ATS	Encoder GND	MAC4-INC Motion Controller Channel #3
10	ATS	LCU	Encoder A+	Differential line driver A+ MAC4-INC Motion Controller Channel #3

11	ATS	LCU	Encoder A-	Differential line driver A- MAC4-INC Motion Controller Channel #3
13	ATS	LCU	Encoder B+	Differential line driver B+ MAC4-INC Motion Controller Channel #3
14	ATS	LCU	Encoder B-	Differential line driver B- MAC4-INC Motion Controller Channel #3
16	ATS	LCU	Encoder I+	Differential line driver Z+ MAC4-INC Motion Controller Channel #3
17	ATS	LCU	Encoder I-	Differential line driver Z- MAC4-INC Motion Controller Channel #3
18			Shield	
SWITCHES: Micromat KS35A11 24VDC, 4A max- Repeatability=0.02mm				
19	ATS	LCU	Negative Limit (NC)	MAC4-INC Motion Controller Channel #3
20	ATS	LCU	Negative Limit (COM)	MAC4-INC Motion Controller Channel #3
21			Shield	
22	ATS	LCU	Positive Limit (NC)	MAC4-INC Motion Controller Channel #3
23	ATS	LCU	Positive Limit (COM)	MAC4-INC Motion Controller Channel #3
24			Shield	

Y-Axis				
Item	***From***	***To***	***Signal***	***Description***
MOTOR: Minimotor DC Brush 2233-024S 24VDC, 2.53W - GearBox = 29.6:1 - Screw Pitch = 1mm				
1	LCU	ATS	Motor M+	VME4SA Servo Amplifier Channel #4
2	LCU	ATS	Motor M-	VME4SA Servo Amplifier Channel #4
3			Shield MSH	
TACHOGENERATOR: Minimotor 1.5 G 1.5mV / rpm				
4	ATS	LCU	Tacho T+	VME4SA Servo Amplifier Channel #4
5	ATS	LCU	Tacho T-	VME4SA Servo Amplifier Channel #4
6			Shield TSH	
ENCODER: Minimotor Optical HP HEDL 5540-500 5 VDC - 500 lines/turn - Resolution in Quadrature = 59200 counts/mm = 16.9nm/count				
7	LCU	ATS	Encoder 5V VCC	MAC4-INC Motion Controller Channel #4
8	LCU	ATS	Encoder GND	MAC4-INC Motion Controller Channel #4

10	ATS	LCU	Encoder A+	Differential line driver A+ MAC4-INC Motion Controller Channel #4
11	ATS	LCU	Encoder A-	Differential line driver A- MAC4-INC Motion Controller Channel #4
13	ATS	LCU	Encoder B+	Differential line driver B+ MAC4-INC Motion Controller Channel #4
14	ATS	LCU	Encoder B-	Differential line driver B- MAC4-INC Motion Controller Channel #4
16	ATS	LCU	Encoder I +	Differential line driver I+ MAC4-INC Motion Controller Channel #4
17	ATS	LCU	Encoder I-	Differential line driver I- MAC4-INC Motion Controller Channel #4
18			Shield	
SWITCHES: Micromat KS35A11 24VDC, 4A max- Repeatability=0.02mm				
19	ATS	LCU	Negative Limit (NC)	MAC4-INC Motion Controller Channel #4
20	ATS	LCU	Negative Limit(COM)	MAC4-INC Motion Controller Channel #4
21			Shield	
22	ATS	LCU	Positive Limit (NC)	MAC4-INC Motion Controller Channel #4
23	ATS	LCU	Positive Limit (COM)	MAC4-INC Motion Controller Channel #4
25			Global shield	PE

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3.4.8 M6 Deformable Mirror

ESO Only

This function will not be implemented in the initial phase of the project, but at a later stage. However interface requirements related to reserved space, cable routing, plug design, etc... apply.

- Control of the M6 Deformable Mirror for Adaptive Optics.

- The control is deployed on the Adaptive Optics LCU.
- This sub-system belongs to the ESO delivery.

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3.5 Auxiliary LCU

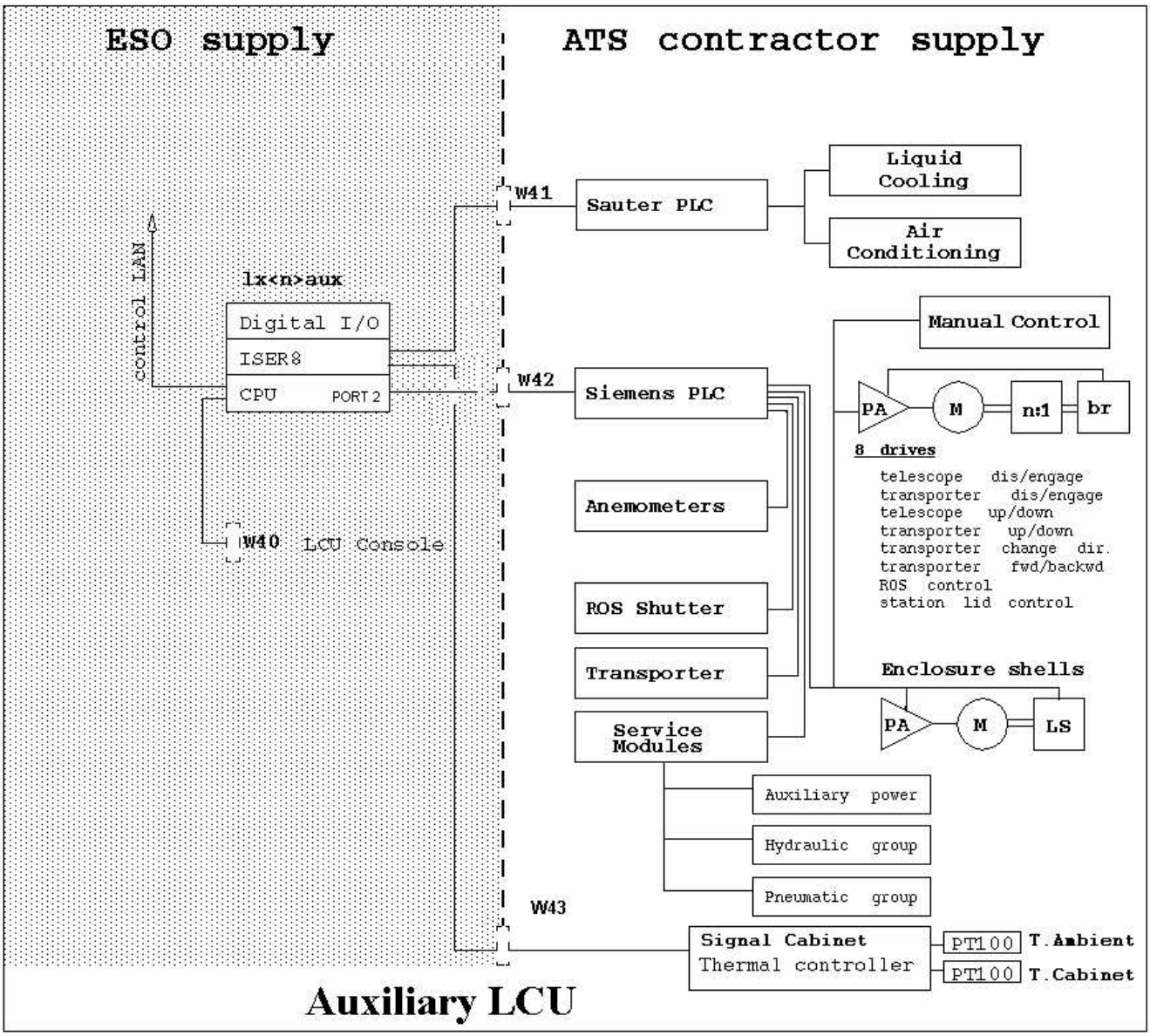
3.5.1 LCU Configuration

ESO	Board	Supplier	Number
	CPU	Motorola MVME 167 (8MB)	1
	Digital I/O Interface	Acromag AVME 9481	1
	Serial Interface	ESD ISER8	1

This LCU is responsible for:

Device	Connector
Enclosure Anemometers	**W42**
Air Conditioning M1 Temperatures Signal Cabinet Temperatures	**W41** **W41** **W43**
Relay Optics Structure (ROS) Shutter	**W42**
Lighting	**Z18**
Transporter	**W42**
Service modules: • Auxiliary power • Hydraulic and Pneumatic systems • Liquid Cooling Module	 **W42** **W42** **W41**

3.5.1.1 Schematic:



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3.5.2 Enclosure and Anemometers

- The telescope enclosure sub-system consists of the 2 half-shells of the enclosure slit, the associated seals, the six (6) clamping actuators and 2 telescope anemometers 3D, located on top of the enclosure and mounted 45 degrees apart the local vertical. This configuration allows proper computation of the wind speed and direction independently of the opening angle of the enclosure shells.
  The slit open/close motion is performed to close the enclosure of the telescope during day-time and so to be able to protect the equipment and control the temperature inside the telescope in the building.
  When the wind speed, measured on the local anemometers, exceeds 18 m/s, the opening of the slit is not allowed; if the slit is open, it is automatically closed if possible.
  The Remote control of the enclosure sub-system is only possible when the corresponding button of the enclosure control panel is in *REMOTE* position.
  All signals described in the table below are mapped into the PLC and are accessible via status commands.
- The control is deployed on the Auxiliary LCU.
- The Enclosure is controlled by a Siemens PLC, connected to a **RS232** Serial Port via Connector **W42**.
- The 2 anemometers 3D are connected to the Siemens PLC. Their monitoring is performed via the Serial link.

3.5.2.1 Enclosure interfaces:

Item	From	To	Signal	Description
COMMUNICATION:				
1			Enclosure and Anemometer Communication	RS232 Port to Siemens PLC Protocol RK512/3964R

Item	From	To	Signal	Description
SEALS STATUS:				
10	ATS	LCU	Enclosure seals inflated + shells clamped status	Bit set if shells clamped and seals fully inflated PLC Digital Input
11	ATS	LCU	Enclosure seals deflated + shells unclamped status	Bit set if seals fully deflated and shells unclamped PLC Digital Input
GLOBAL STATUS:				
20	ATS	LCU	Enclosure closing automatically	contact closed if Enclosure is closing automatically PLC Digital Input
21	ATS	LCU	Enclosure local status	contact closed if Enclosure is in local control PLC Digital Input
ANEMOMETER MONITOR:				
30	ATS	LCU	Anemometer #1 wind speed in X ,Y,Z	Software command to W42 X,Y,Z coded over 8 Bits in m/s Note: directions are related to the Anemometer, hence relative to the opening of the Enclosure shells.
32	ATS	LCU	Anemometer #2 wind speed in X,Y,Z	

Item	From	To	Signal	Description
ENCLOSURE CONTROL:				
100	LCU	ATS	Enclosure front shell open command	asserted to open the enclosure front shell at the next start command. negate to close at the next start command.
101	LCU	ATS	Enclosure rear shell open command	asserted to open the enclosure rear shell at the next start command. negate to close at the next start command.
102	LCU	ATS	Enclosure front shell start command	assert to initiate the opening/closing of the front shell. Negate to stop the motion whenever the desired postion is reached.
103	LCU	ATS	Enclosure rear shell start command	assert to initiate the opening/closing of the rear shell. Negate to stop the motion whenever the desired postion is reached.
104	ATS	LCU	Enclosure front shell actuator#1	Software command to W42 Actuator position coded over 8 Bits Scaling t.b.d.
105	ATS	LCU	Enclosure front shell actuator#2	
106	ATS	LCU	Enclosure rear shell actuator#3	
107	ATS	LCU	Enclosure rear shell actuator#4	

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3.5.3 Air Conditioning

- The air conditioning control is under the contractor's responsibility. It is controlled via a RS232 serial interface and provides the commands to switch on/off the Air Conditioning, read the enclosure temperature and set the reference temperature.

- The control is deployed on the Auxiliary LCU.
- The Air Conditioning is controlled by a Sauter PLC, connected to a **RS232** Serial Port via Connector **W41**.
- The temperature values of the M1 sensors are input to the Sauter PLC, via the Connector **W41**.
- The Air Conditioning Control System gives a Warning flag when the Dew point temperature is reached. The Dew point sensor readout is available to ESO via the RS232. The parameter Dew point Margin Tdm can be adjusted via the RS232.

- The thermal controller PKC from EROELELECTRONIC keeps the Signal cabinet internal temperature equal to the ambient air temperature. It acts on a motorized valve regulating the coolant flow inside the heat exchanger of the Signal cabinet. One PT100 senses the ambient air temperature, the other one senses the Signal cabinet internal air temperature. The LCU has got no control on the regulation but monitors the two temperature sensors connected to the thermal controller PKC via the Connector **W43**.

- 1 on the **Signal cabinet**
- 1 on the **ambient air**

3.5.3.1 Air Conditioning interfaces:

The connection layout and pin assignment is given in Annex 1 VLT-DWG-ESO-15154-1769

Item	From	To	Signal	Description
COMMUNICATION:				
1			Air Conditioning Communication	RS232 Port to Sauter PLC Protocol details in [RD 10]
AIR CONDITIONING:				
10	ATS	LCU	Air Conditioning status	Get status information on the air Conditioning system
11	ATS	LCU	Cooling water temperature	Get cooling water temperature
12	ATS	LCU	Enclosure temperature	Get enclosure temperature
13	LCU	ATS	Start/Stop Air Conditioning	• Start using the reference temperature • Stop

14	LCU	ATS	Air Conditioning Reference Temperature	Set the Reference Temperature
15	LCU	ATS	Dew point sensor	Get Dew point sensor value
16	LCU	ATS	Dew point sensor Temperature Margin	Set the Dewpoint Temperature Margin
17	LCU	ATS	Dew Point Warning	warning Flag ON when Dew Point is reached inside the enclosure during Daytime Stand By mode.
M1 TEMPERATURES:				
20	LCU	ATS	Temperature M1 A,B,C	Mirror M1 temperatures as read from Altitude LCU

3.5.3.2 Signal cabinet Thermal controller:

Item	From	To	Signal	Description
COMMUNICATION:				
1	ATS	LCU	Thermal controller Communication	RS485 Port to PKC EROELECTRONIC - Protocol details [RD19]
GENERAL COMMANDS:				
2	ATS	LCU	Read temperatures	**Cabinet Temperature** **Ambient Air Temperature**

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3.5.4 Relay Optics Structure (ROS) Shutter

- Control of the Relay Optics Structure Shutter

- The control is deployed on the Auxiliary LCU.
- The device is connected to a RS232 Serial Port via Connector **W42**.

3.5.4.1 ROS Shutter interfaces:

Item	From	To	Signal	Description	Pin
COMMUNICATION:					
1			Communication	RS232 Port to Siemens PLC - Protocol RK512/3964R	W42
CONTROL:					Software Command to W42
10	LCU	ATS	ROS Shutter Close command	Bit set to close the ROS Shutter	
11	LCU	ATS	ROS Shutter Open command	Bit set to open the ROS Shutter	
STATUS:					
20	ATS	LCU	ROS Shutter Close Status	Bit set if ROS Shutter is fully closed	
21	ATS	LCU	ROS Shutter Open Status	Bit set if ROS Shutter is fully open	

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3.5.5 Transporter

- The transporter is the mechanical part of the AT that is involved in the relocation procedure and hosts the anchoring system.
- The control is deployed on the Auxiliary LCU.
- The devices are controlled by the Siemens PLC, connected to a **RS232** Serial Port via Connector **W42**.

There will be 10 relative simple on-off drives connected to a manual control panel, for the following functions:

1. telescope engage/disengage
2. transporter engage/disengage
3. telescope up and down
4. transporter wheels up and down
5. transporter direction
6. transporter forwards and backwards
7. ROS up and down
8. enclosure open and close
9. ROS lock and unlock

The complete control of the transporter drives for the whole relocation sequence is under the contractor's responsibility, but status information is provided to the ESO control system via signals connected to the LCUs Digital I/O board.

3.5.5.1 Transporter interfaces:

Item	From	To	Signal	Description
COMMUNICATION:				
1			Transporter Communication	RS232 Port to Siemens PLC - Protocol RK512/3964R
TRANSPORTER:				
10	ATS	LCU	Transporter status	contact closed if transporter is operational, i.e. all following modules are in Normal situation: • Oil level, oil filter and oil Temperature of the hydraulic module are OK • Compressed air in the tank • Generating set & Fuel in tank OK • UPS on line
11	ATS	LCU	Relocation status	Double contact: one contact to altitude & one contact to azimuth: Contacts closed if relocation is completed, i.e. all following conditions are verified: • Transporter centred • Telescope engaged • ROS engaged against Telescope

				• 400V-OK • Generating set command OFF • Remote mode • Portable panel OFF (not connected) • Interior door closed
12	ATS	LCU	Motion Stop status	Double contact: one contact to altitude & one contact to azimuth: Contact open if a Motion Stop is activated, i.e. the following Motion stops are activated: the motion stop identification is done via the serial port • List of Motion stops VLTI Motion Stop Altitude cabinet Motion Stop Signal cabinet Motion Stop ASI II Motion Stop panel -V panel Motion Stop ROS III Motion Stop panel ROS IV Motion Stop panel ASI IV Motion Stop panel

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3.5.6 Service modules

They control and/or monitor the status of:

- Auxiliary power
  The status of the Auxiliary Power System shall be interfaced to the digital I/O interface.
  (See drawing Power distribution schematics in section 3.1.1 on page 8).

- The Hydraulic and Pneumatic systems (HPS) provide hydraulic and pneumatic power to the transporter and the enclosure.
- The Liquid Cooling module (LCM) is providing cooling power to the Air Conditioning, the Thermal Control of the electro-mechanical parts and to the FAS and FSS detectors.
- The control is deployed on the Auxiliary LCU.
- The Power, Hydraulic and Pneumatic modules are controlled by the Siemens PLC, connected to a **RS232** Serial Port via Connector **W42**.
- The Liquid Cooling module is controlled by the Sauter PLC, connected to a **RS232** Serial Port via Connector **W41**.

3.5.6.1 Service modules interfaces:

Item	From	To	Signal	Description	Pin
COMMUNICATION:					
1	ATS	LCU	Power, Hydraulic & Pneumatic Systems	RS232 Port to Siemens PLC - Protocol RK512/3964R	W42
2	ATS	LCU	Liquid Cooling Module	RS232 Port to Sauter PLC - Protocol details in [RD 10] TBD	W41

Item	From	To	Signal	Description	Pin
MONITORING:					
3			Flow Meter monitoring	Digital I/O	Y35

Item	From	To	Signal	Description	Pin
AUXILIARY POWER:					
10	ATS	LCU	main power status	contact open if undervoltages on power line from station plug	Software Command to W42
11	ATS	LCU	Battery status	contact open if battery is NOT OK Digital Input	
HYDRAULIC & PNEUMATIC SYSTEMS:					
20	LCU	ATS	Hydraulic System control	Switch On/Off if control panel button is in	Software

				Remote position	Command to W42
21	ATS	LCU	Hydraulic System status		
22	LCU	ATS	Pneumatic System control	Switch On/Off if control panel button is in *Remote* position	
23	ATS	LCU	Pneumatic System status		
LIQUID COOLING MODULE:					
30	ATS	LCU	LCM Status	Complete LCM status and Liquid cooling Temperature	Software Command to W41
ESO 31	LCU	ATS	Flow-meter +	+24VDC,	Y35_1
ESO 32	ATS	LCU	Flow-meter signal	Frequency as a function of flow	Y35_2
ESO 33			Shield (Y35_1 - Y35_2)		Y35_3

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4 Interlocks

The Interlocks are dependent on the design. They are to be defined during design by the contractor, according to the safety requirements, manual operation and maintenance needs.
ESO has defined three types of interlocks:

- **Motion Stop Interlocks**: general interlocks generated by actuation of the Motion Stop switches mounted in the AT. One of the push-buttons must be of type locking key. All Motion Stop have the same action; their location and quantity are defined in AMOS Control System document [RD03], Chapter 12.
- **Local Interlocks**: these interlocks are used to prevent specific actions between equipment.
- **Equipment Interlocks**: these interlocks are used to prevent specific actions within an equipment.

The hazard analysis is provided in [AD06].

4.1.1.1 Interlocks Table:

Subsystem		>Action	Cause	Recovery Action
Generating	**Receiving**			
VLTI Motion Stop in Control Room	All subsystems except those supplied by battery and small axes	Main Drives immobilized Except small axes (NFD, CFD, FSS, M2, M10).	Button pressed or key removed	Release button or Replace key
AT Motion Stop on AT				
Transporter PLC		Power Shutdown	Watchdog	Reset Transporter PLC
Hardware Limit	Azimuth	Drive immobilized	Limit Switch	Move back into stroke
Hardware Limit	Altitude	Drive immobilized	Limit Switch	Move back into stroke
Interior Door	Azimuth & Transporter up-down	Drives immobilized	Limit Switch	Close the door
Alt-Locking pins	Altitude	Drive immobilized	Limit Switch	Put Alt-Locking pins into unlocking position
Altitude Parking	Telescope Up Shell closing(if Telescope is not in lowest position)	Drive immobilized	Parking Switch	Put Altitude axis in Parking position
Stroke limit	Azimuth & Azimuth Cable Wrap	Drive immobilized	Azimuth CWP Limit Switches	Move back Az axis into stroke
Enclosure Area	Azimuth & Enclosure closing (+ PLC inhibit on enclosure opening & Tel. up-down)	Drives immobilized	Key in EWA position	Turn key in "NOT EWA" position

Transporter PLC	Enclosure	Close Winshield	Anemometer give too high windspeed	none
Relocation status	Altitude & Azimuth	Alt Az Drives immobilized	Relocation not finished	finish Relocation

Important Note: Before undertaking any recovery action, one has to have well understood why the corresponding interlock has been activated and take the corrective action to prevent from activating the interlock in the future. Moreover, there are many internal locks. The Transporter PLC checks the feasibility of each operator command, the Sauter PLC is equipped with a watchdog that stops the air conditioning system and switches the alarm status on, each electrical motor is equipped with PTC sensors, each inverter is equipped with overcurrent protection. See [RD 03] and [AD 06].

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5 Electrical & Optical Interfaces

5.1 Station Plugs

The station plugs accommodate the cables and optical fibres provided by ESO at every station; the details of the implementation is given in Station Plug Interface **[RD 14]**

The main characteristics of the station plug are:

- 400V Non-UPS electrical power + shield -
- 12 Optical fibres - multi-mode graded index with core diameter of 62.5 μm and cladding Φ125μm.

  The optical fibres will carry:

  - Control LAN
  - Guide/Acquisition LAN
  - Time Bus
  - High data rate links 1 & 2.
- 24 Electrical lines Section 0.14mm2 + Shield to PE
  - 2 for Motion Stop
  - 8 for station ID
  - 1 for carriage interlock
  - +24VDC line
  - 12 spare lines

5.2 Cables

ESO provides the guiding and mechanical fixation of the cables connected between LCU and terminal blocks (in order to avoid mechanical stresses on electrical connections). All other cables as described in Installation of ESO cables **[RD 17]** shall be routed and mechanically fixed by the contractor, except Nasmyth and Pupil beacon fiber.

The cables labelling is described in **[RD 17]** It follows the template Ca ESO/b /c where:
a is a sequential number
b is the input connection location
c is the output connection location
The locations and their abbreviation is described in annex 3 of **[RD 17]** and in drawing Telescope control cabling path of AN01

5.3 PLC I/O

I/O characteristics description	Input	Output	Remark
Siemens PLC on Transporter		PNP Open collector	Load between output and ground
PHASE Drive controller		NPN Totem pole	Load between output and ground

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6 Mechanical Interfaces

6.1 Local Control Units

The table sumarizes the volume and location requirements for ESO LCUs and network equipment.

<table>
<tr><th>Equipment</th><th>Size</th><th>Cabinet</th><th>Location</th></tr>
<tr><td>Altitude LCU</td><td rowspan="6">19" VME Chassis
Depth: 500mm
Height: 7U
(6 for VME chassis + 1 for fan)</td><td>Altitude
See [RD 03], Section 5.1</td><td>Fork B side</td></tr>
<tr><td>Azimuth LCU</td><td rowspan="6">The entire left part of the Signal Cabinet is let for integration of ESO equipment.
See [RD 03], Section 5.4</td><td rowspan="6">Transporter</td></tr>
<tr><td>Sensor LCU</td></tr>
<tr><td>Auxiliary LCU</td></tr>
<tr><td>Adaptive Optics LCU</td></tr>
<tr><td>Dual Feed LCU</td></tr>
<tr><td>Network Equipment</td><td>3U x 500mm</td></tr>
</table>

Access to the back of each LCU cabinet is provided.
The signal cabinet will be movable for access to the rear side and to the GIS signal connection point
The Altitude cabinet will be mounted on sliding rails for easier maintenance access.
The Altitude VME occupies the top of the Altitude cabinet, above the M2 control chassis. Its ventilation is vertical. The air intake is done at the bottom of the VME, within the allocated 7U volume. The air exhaust is done at the top of the Altitude VME and requires a clearance of about 2 cm. The space between the top of the Altitude VME and the top cover of the Altitude cabinet is kept free for ventilation.

6.2 Detector and M6 drives

The mechanical interfaces of the Field Acquisition Sensor (TCCD + ACE controller) and the Field Stabilization Sensor (STRAP APD) are defined in AD 09, AD 10 and Drawing 03 of the Technical Specifications [RD 02].
Space and connection means shall be provided from Sensor LCU to FAS via the ROS plug for fibre installation (see [RD 02], section 5.1.14).
Space and cooling capacity for electronics shall be provided in the vicinity (< 1.5 m) of M6. The minimum space required is: Width:19" VME Chassis, Height: 8HU, Depth: 600 mm including 100mm for connectors.

6.3 Pupil Beacon

Space and connection means shall be provided from Altitude LCU to M2 via the tube cable wrap for Pupil beacon fibre installation.see [RD15]

6.4 Nasmyth focus

In view of future installation of specific ESO equipment, the following requirements apply:
Nasmyth Beacon:
Space and connection means shall be provided from Altitude LCU to Nasmyth Wheel for Nasmyth beacon fibre installation (see [RD 02], section 5.1.11).

6.5 Future Extensions

This section defines the internal interface requirements applicable to the ATS design in order to allow future installation of upgrades by ESO.

6.5.1 Adaptive Optics

6.5.1.1 Coudé focus environment

In view of the future installation of the Wave Front Sensor for adaptive optics, the following interface requirements apply:
Space and connection means for cable installation between the Wave Front Sensor and the Terminal Block located inside the Signal Cabinet shall also be provided.
Requirements:
Flanges shall be reserved for later installation of an additional Transporter/RO plug to accomodate the cables needed for future Adaptive Optics and Dual Feed. This additional plug will be installed by ESO. Its supply is outside the contract's scope. This plug shall be able to accommodate the most constraining of the two following connection schemes:

- A) 100 analogue signals pins + 2 fibre connections
- B) 15 analogue signal pins + 28 fibre connections

Space for Cables:
The space to be reserved for cable routing shall accommodate a cable fitting a 20mm thick rectangle (equivalent section of 30mm diameter) with a minimum bending radius of R=100mm running from the Transporter/RO plug to the two corresponding reserved spaces DWG7 and DWG8 of [RD 02].

6.5.1.2 Adaptive Optics LCU

6.5.2 Dual Feed

6.5.2.1 Coudé focus environment

In view of the future installation of the Dual Feed system at the Coudé focus, the following interface requirements apply:
Space and connection means for cable installation between M10df & M11b and the Terminal Block located inside the Signal Cabinet shall be provided,
Requirements are already included in those defined in previous section (cables for AO and WFS)

6.5.2.2 Dual Feed LCU

The space required is defined in Local Control Units.

6.5.3 Atmospheric Dispersion Corrector

The Relay Optics Structure shall provide an interface for future installation of an Atmospheric Dispersion Compensator (ADC). The following requirements apply:

Space and connection means for cable installation between the ADC and the Terminal Block located inside the Signal Cabinet shall be provided with the following characteristics:

- cable diameter: 20mm,
- bending radius: 100mm,
- Connector: 25poles, 1A, low-voltage.

6.6 Connection type & location

6.6.1 Terminal blocks

They are used for common electrical connections; these are referenced Z*n* and Y*n*.
Terminal block type: (eg. Phoenix MTTB1.5, or Wago TBC)
Industrial Type
WAGO INTERFACE MODULE No.289-533 (Z1, Z5)
WAGO INTERFACE MODULE No.289-556 (Y33)
WAGO INTERFACE MODULE No.289-546 (Y333)
WAGO X-COM Serie 870 No.870-101(Z11, Z21, Z22, Z23)
ESO custom made Type:
ATS-MODULE VME4SA-1 INTERFACE (Z3, Z10, Z12, Z16, Z17, Y20, Z34)
ESO-I/O Interface Adapter 9916-21 (Z18)

6.6.2 Serial interfaces

They will be connected through standardized DB9 connectors grouped together on a panel with front access. These are referenced W*n*.

6.6.3 Heidenhain encoders

They will connect directly to the LCU, front panel of the IK320 interface. Connector type DB9

6.6.4 Optical fibre connection

See also [RD17] installation of ESO cables

- Station Plug connector type: Harting HAN Modular
- OpticalLAN connector type: ST
- TIM connector type: ST
- HDRL connector type: ST
- Sensor LCU to Field Acquisition Sensor (TCCD) connector type: SMA
- Pupil Beacon connector type: TBD
- Nasmyth Beacon connector type: TBD

6.6.5 ESO Terminal Blocks Y*n*

Terminal blocks referenced Y*n* are part of ESO supply.

6.7 Cooling

The cooling of the racks is under the contractor's responsibility. See [RD 03], Chapter 5.

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