VERY LARGE TELESCOPE

DIMM LCU,
Hardware Design Description.

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CHANGE RECORD.

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Draft 1	17 Dec. 1996	All:	First draft.

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1. INTRODUCTION

The VLT DIMM LCU controls the DIMM telescope and dome. This document describes the electronic design of all hardware functions that are supported.
The control of the Eta and Theta axes is to a high extend identical from a functional point of view. Therefore, the description applies to both, unless explicitly noted otherwise.

The LCU controls the following hardware:

- servo amplifiers with integrated velocity controller.
- encoder.
- interlock logic.
- a thermal control unit, which controls the temperature of the LCU cabinet.
- dome.

1.1. CONFIGURATION INFORMATION

All LCU i/o signals, that are referenced in this document, are retrieved from a Database. Changes in the Database affect therefore directly the contents of this document.

The LCU i/o signals are indicated, together with their description, as *italic* text. For example

A1VREFO *A1 velocity reference command*

The table below shows the Change Record of the Database as it is at the time of printing of this document.

Issue	Date	Affected	Comment
Draft 1	17 Dec 1996	All	First draft.

2. MOTOR ASSEMBLY

The motor assembly is modified according to document 'Modifications to motor assembly' xx. The result is the principal mechanical configuration as shown in fig. Figure 1.

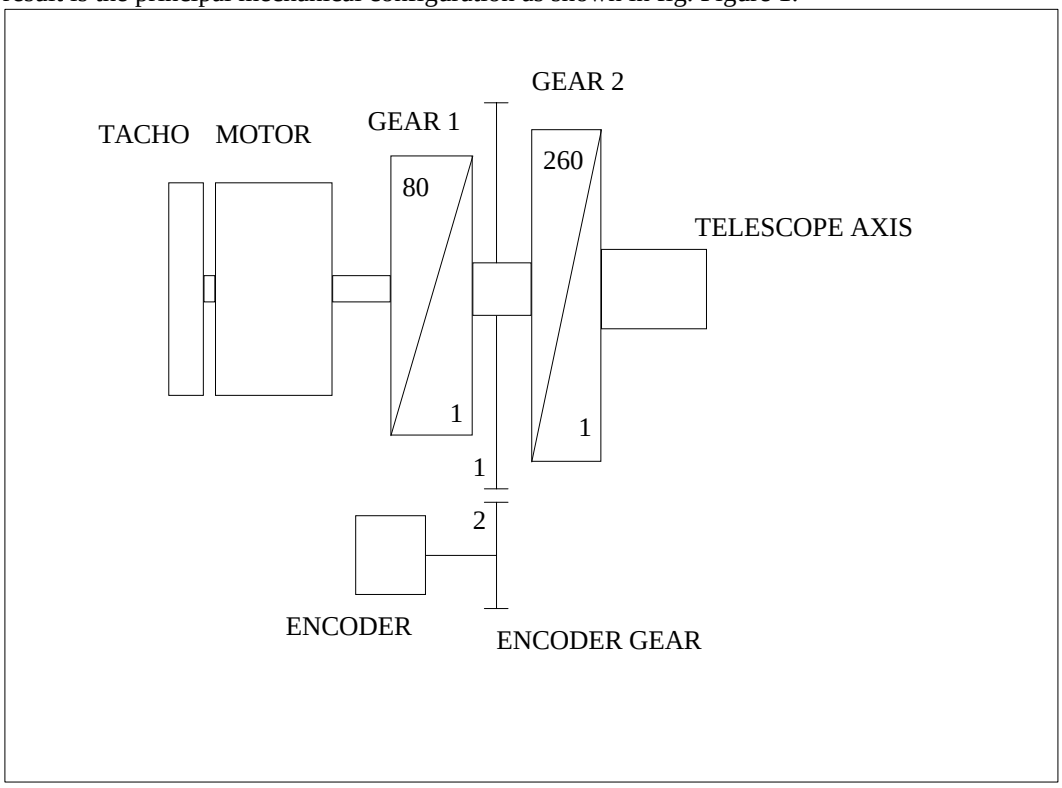

Figure 1 Motor assembly mechanical configuration.

2.1. ENCODER

Manuf.:	Heidenhain
Type:	ROD454M
Ident.:	28116327
Resolution:	1000 lines per turn.

2.2. MOTOR / TACHO

Manuf.:	MATTKE
Type:	F12M2 with tacho FC12T
Ident.:	MF12M2TFC12T
Ident for flat on the axis:	AWAF12M2ESO
Ki of motor:	5.7 Ncm/A
Kn of motor:	6.0 V/1000rpm
Kt of tacho:	6 V/1000rpm

2.3. SCALING FACTORS

2.3.1. VELOCITY

Max input speed of Gear 1 is limited to 2000 rpm. The design is made with a max speed of 1800 rpm. Therefore, the max velocity corresponds to a tacho voltage of

10.8 Volts

and the velocity of the telescope axis is

8.65E-2 rpm = 31.1 deg / minute= 0.519 deg/sec.

The amplifier scaling is then such that a velocity command of

9 Volts corresponds to max speed.

The velocity scaling is therefore 0.519 / 9=

5.77E-2 deg/sec/ V = 1.01E-3 rad/sec/ V

2.3.2. POSITION

1 arcsec on the telescope axis corresponds to 260 x 2=

520 arcsec on the encoder axis.

This corresponds to 520 x 1000 / (360 x 3600)=

0.401 lines

After interpolation on the VME card with a factor 4096, this corresponds to

1643 counts.

Or: 1 count = 6.09E-4 arcsec = 2.95E-9 rad at the telescope axis.

Cross-check for max input frequency of VME card, which is 50 kHz. This corresponds to 50 rotations per second at the encoder axis, or 50 / (2 x 260)=

0.096 rotations per sec = 34 deg/sec at the telescope axis.

This number is much higher than the max rotational speed.

3. OVERVIEW

Figure 2 shows the functional block diagram of the telescope and dome control. This figure shows the main blocks:

- LCU, VME.
- LCU, electronic hardware.

  This part is considered to be a part of the LCU, although this is not according the definition. For clearity, the term ‘LCU h/w’ is used thoughout this document. The VME computer part of the LCU (the VME chassis with the standard boards) is called ‘VME’.
- The ‘Field’.

  This part consists of all equipment that is not located in the LCU cabinet.

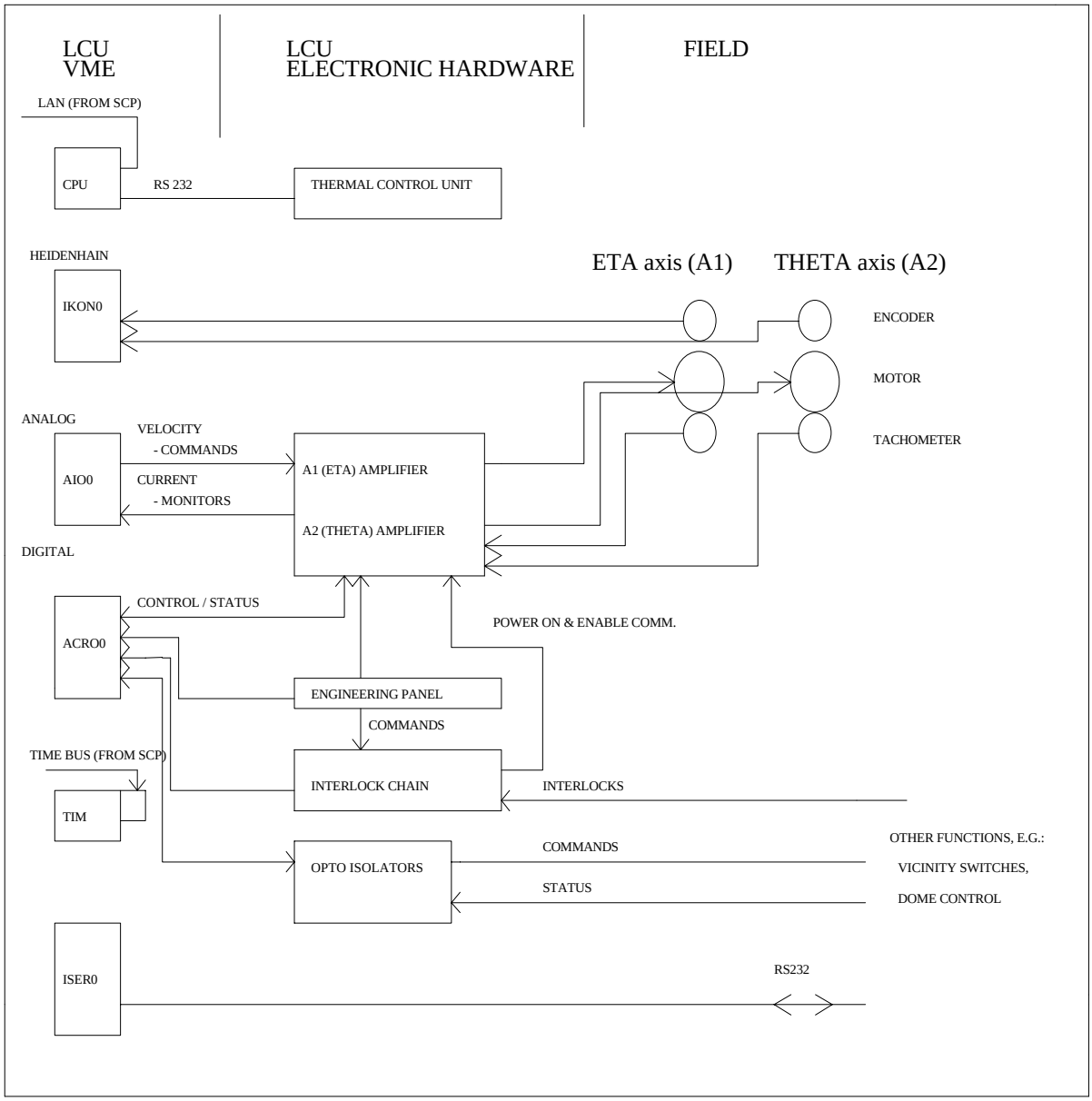

Figure 2 Functional block diagram the telescope and dome control.

3.1. UNIT INTERCONNECTIONS

The LCU Cable routing block diagram, as shown in Figure 3, shows the interconnections between the units:

- VME CPU, analog I/O board 0, digital I/O board 0, encoder interpolator board 0.
- Thermal control unit.
- Amplifier chassis
- Interlock

The identification of the interconnecting cables is shown in *italics*. Cable types, connector types, etc are detailed in the electronic schematic diagrams.

The VME digital I/O boards, coded ACROx, have a small Printed Circuit Board mounted in the VME chassis. This board interfaces from the VME P2 connector (DIN41612, 96 pin) into 4 Flatcable connectors of 50 poles each. The Acromag partnumber of this PCB is: 9921-16.

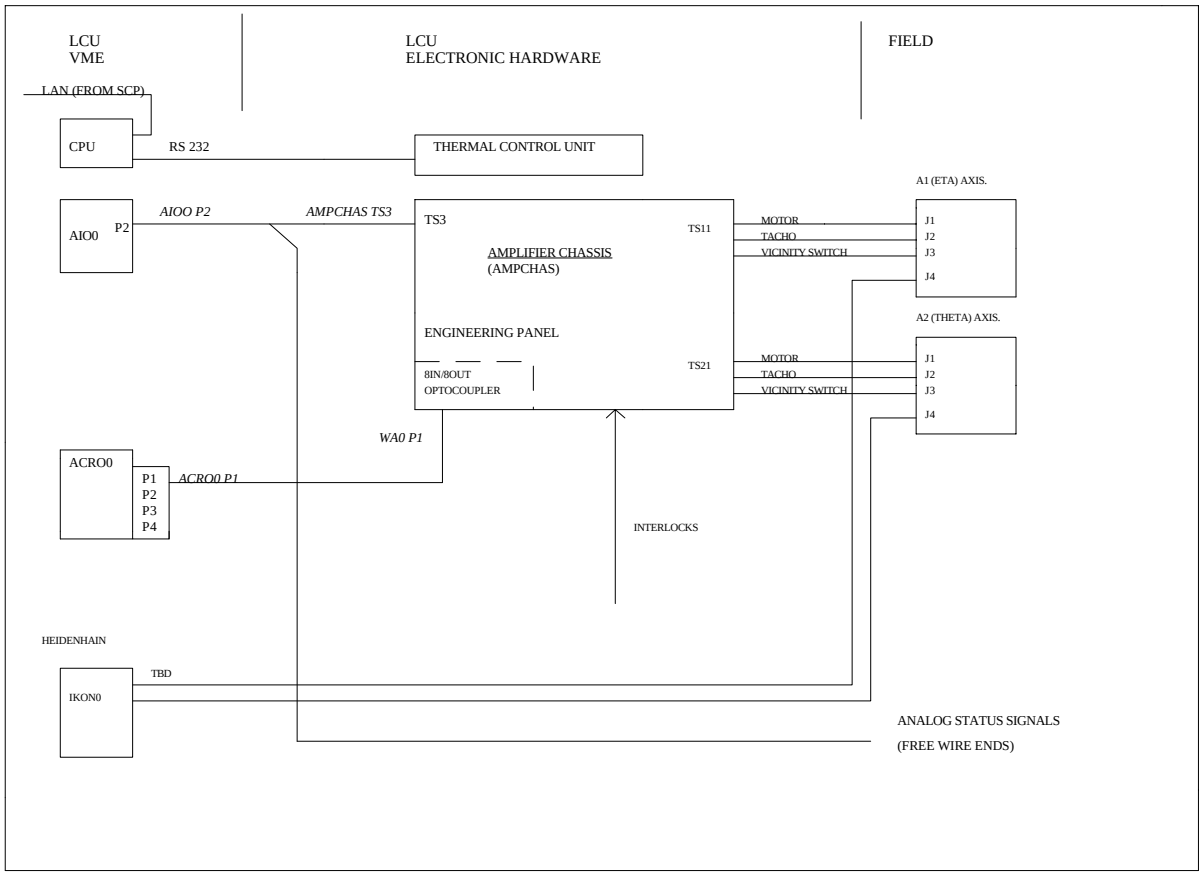

Figure 3 LCU Cable routing block diagram

4. AMPLIFIER CHASSIS

4.1. OVERVIEW

The block diagram of the velocity controller of the Eta and Theta axes is shown in Figure 4.

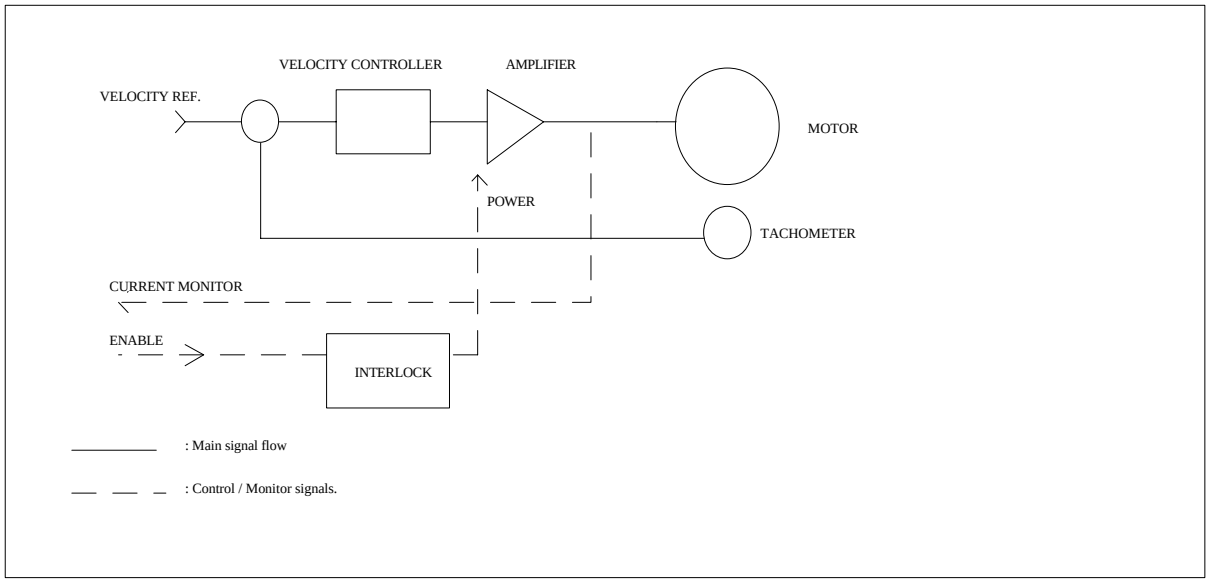

Figure 4 Block diagram of velocity controller.

4.2. LCU I/O SIGNALS

The signal

A1VREFO *A1 velocity reference command*

passes the analog velocity command to the amplifier.
Current into the motor can be monitored with the signal

A1IMONI *A1 motor current monitor*

Manual control in velocity loop mode is possible with the switch on the engineering panel. The velocity command from the VME and from the potentiometer on the panel is then added.
The LCU can monitor the status of this switch with the signal

A1EPSELI *A1 Engineering panel select (manual velocity control)*

4.3. AMPLIFIER ADJUSTMENT

- Check the amplifier motor combination for proper polarities:
  Positive torque must correspond to positive rotation AND to positive tacho voltage.
  Positive rotation is clockwise seen from the telescope axis.
- Adjust the drive amplifiers according to the instruction manual and with the velocity loop scaling as described above.
  Adjust the max current and the I^2t such that the motor can run with max speed in both directions and has still some headroom power available to cope with low temperatures where the friction will be higher.
  Measured friction on a spare motor is 23 Ncm, corresponding to a current of 4.1 Amp.

5. ENCODER

5.1. INITIALISATION

The incremental encoder must be initialised after power up. The axis is therefore rotated in velocity loop mode until the signal

A1VSI *A1 Vicinity switch detected.*

is set.
The axis is then moved in the opposite direction until this signal is cleared, and continues then until the first zero of the encoder is found. This defines the init point.

Note: Depending on axis and telescope pointing location (North or South half sky), the procedure is slightly different. See for details the s/w description.

6. INTERLOCK

6.1. PRINCIPLE OF OPERATION

The interlock system performs the operational safety of the telescope A1 (Eta) and A2 (Theta) axes. Each axis has its own interlock system, the principle diagram is shown in Figure 5.
If all interlocks in OK status, a Power Amplifier power-on command is possible.

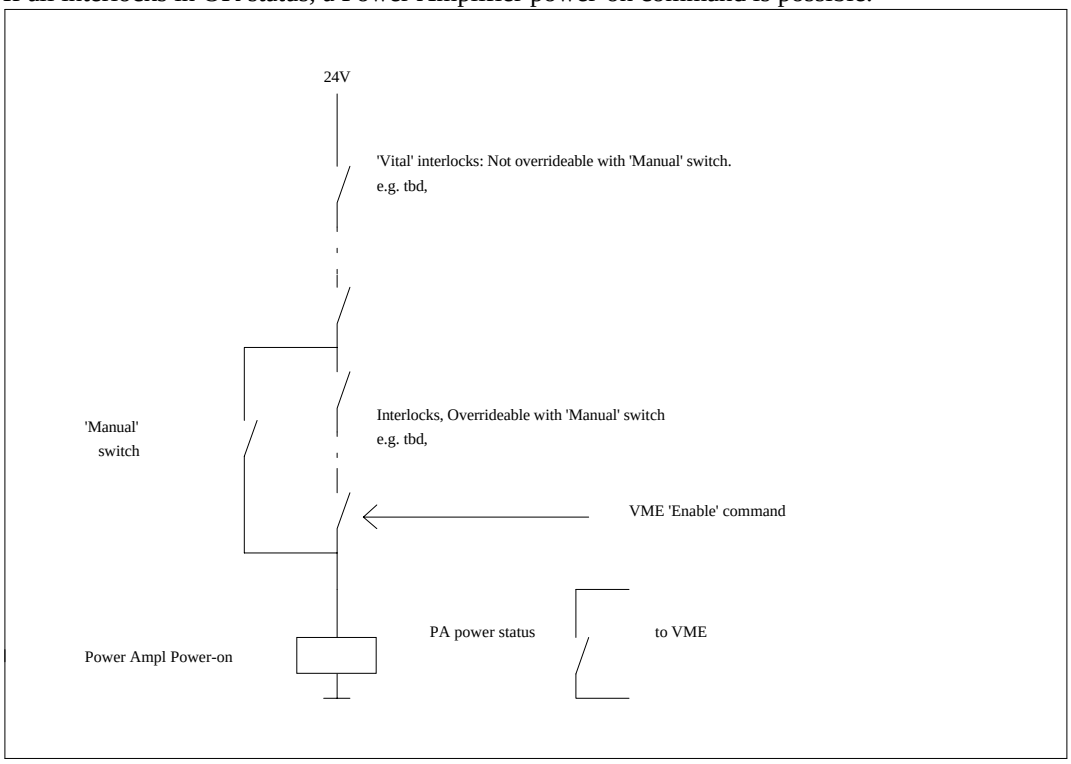

Figure 5. Interlock principle.

6.2. LIST OF INTERLOCK SIGNALS

The list below shows all interlock signals and the axis for which each signal is defined. This list are the signals that are accessible with the VME s/w.

SignalName	Axis	Description
A1ILPAPOWI	A1	A1 Power amplifier powered.
A2ILPAPOWI	A2	A2 Power amplifier enabled.
A1ILENABO	A1	A1 Interlock enable.
A2ILENABO	A2	A2 Interlock enable.

Table 1. Interlock signals.

6.2.1. STARTUP SEQUENCE.

- The LCU s/w must verify that all interlock conditions are in 'OK for start' status. This means:
  All interlock output signals must be 'false'.
  Most interlock input signals must show OK status. Exception is:
  A1ILPAPOWI A1 Power amplifier powered.
  This signals must be false here and switch their status to OK during the start-up sequence.

  Also, the signal
  A1EPSELI A1 Engineering panel select (manual velocity control)
  must be false.
- The LCU s/w must set the velocity controller to start status:
  Set
  A1VREFO A1 velocity reference command
  to 0.
  Set
  ILENABO Enable (LCU s/w start command)*
- After tbd sec, power amplifiers must be powered by the LCU h/w: signal
  A1ILPAPOWI A1 Power amplifier powered.
  must be true. If not, there is a h/w failure in the mains power supply or the power amplifier power supply respectively. The rest of the sequence must then not be executed.
- After tbd sec, the amplifier is ready to accept velocity commands.

7. MOTION STOP

tbd.

8. OPERATIONAL LIMITS

tbd, a 'north / south' detection has to be designed. Necessary also for telescope init.

9. CABINET THERMAL CONTROL

The thermal control of the LCU cabinet is made according the Electr. Design Spec. Design TBD

10. VME COMPUTER

All functions are implemented on a VME computer, consisting of:
- standard CPU, Motorola MVME167.
- standard TIM
- 1 standard digital I/O, Acromag, indicated as /acro0
- 1 standard analog I/O VMIC, indicated as /aio0.
- 1 standard encoder counter card, Heidenhain IL320, indicated as /ikon0 xxx????
- 1 standard serial I/O card, indicated as /iser0 xxx???

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