Australian National University

Electrical Subsystem Design

Prepared For

Advanced Instrumentation and Technology Centre

ANU College of Engineering and Computer Science

Prepared By

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Acronyms

ANU Australian National University.

CAN Controller Area Network.

EC Electronics Cabinet.

EOS Electro-Optic Systems.

GSL Guide Star Laser.

LH Laser Head.

OCS Observatory Control System.

1 Introduction

The Electrical Subsystem Design relates to the power supply and communication interfaces between the Australian National University (ANU) and EOS Guide Star Laser (GSL) Systems and the 1.8m telescope. This includes the Laser Head (LH) and Electronics Cabinet (EC) for each GSL and the chillers detailed in the Environmental Subsystem Design report [1].

2 Communications

Communications relates to the control interfaces between system components that allows them to interact and be controlled remotely.

2.1 Requirements

The requirements for the design of the communication interfaces are taken from the system subsystem document [2], and are reproduced here. These requirements are listed in Table 1.

Table 1: Communication Requirements

Reference	Description
1.4.5	The telescope dictates that 3 free Ethernet connections to the EOS Observatory Control System (OCS) are available within the telescope. 1 on the observation deck and 2 in the electrical cabinet on the entry floor.
2.4.1	The EOS GSL requires that one Ethernet cable be connected for engineering and maintenance [3] .
2.4.2	The EOS GSL requires that Ethernet communication with the EOS GSL be conducted using SSH command line protocol [3] .
2.4.3	The EOS GSL requires that Controller Area Network (CAN) bus protocol be used for control [3].
2.4.4	The EOS GSL requires connection to the EOS OCS for control and monitoring [3].

2.2 Design

An EC, called the Telescope EC in this report, is currently located on the entrance floor of the telescope, which EC relays all communication signals between the EOS OCS and the telescope. All communication signals for the EOS and ANU GSL are therefore routed through the Telescope EC.

The control for the EOS GSL is managed by an auxiliary EC through a CAN bus. This will be connected to the Telescope EC using an Ethernet to CAN gateway. This is necessary since CAN bus is not currently deployed between the OCS and the telescope.

It is recommended that the EOS auxiliary EC is situated on either the entrance level or observation of the telescope. The observation level is preferable since shorter cabling is required between EC and laser head. However, the current height of the EC (1750 mm) prevents it from being placed on the existing

workbench. The proposed solution is to restructure the EC so that it is implemented as two side-by-side stacks. Alternatively, the workbench could be removed from the telescope. Situating the EC on the entrance level does not require such alterations, however longer cabling is required between the EC and laser head. It is also important to note that the EC cannot be placed on middle level since it is too large to fit through the access door, hatches, and stairwells. In this report, it is assumed that the height of the EC will not change and the EC will therefore be situated on the entrance level of the telescope. CAN bus between the EC and laser head will provide control. Specifications for the connections between the EOS EC are provided in Figure 1.

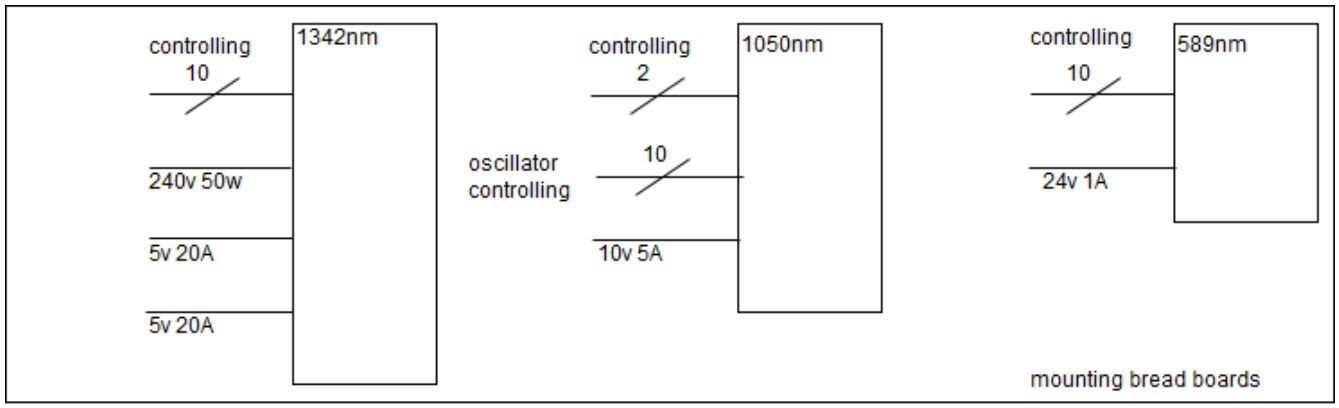

Figure 1: EOS Auxiliary to Breadboards cables

The control for the ANU GSL is also managed by an auxiliary EC. The EC is to be situated beneath the laser head enclosure on the observation level. This is necessary since there is a 2 m upper limit for cabling between the EC and laser head. Control of the EC can be managed by CAN bus routed from the Telescope EC via Ethernet to CAN gateway. Control of the laser head will be provided by cabling between the auxiliary EC and laser head. The type of cabling needs to be confirmed with the ANU laser vendor.

The chillers used in the recommended design are remotely controlled by serial communication [1]. The chiller used in the EOS GSL System is to be controlled through the Telescope EC. This is necessary since control of the chiller is not supported by the EOS auxiliary EC. It is not certain whether control of the ANU chillers is supported by the ANU auxiliary EC. It is assumed that control of the ANU chillers will be provided by the Telescope EC. In this case, all three chillers will be connected to Serial lines converted from single Ethernet lines.

Figures 2 and 3 presents the electrical interfaces for the ANU and EOS GSL Systems. It should be noted that the Figures do not reflect the actual size and placement of each component.

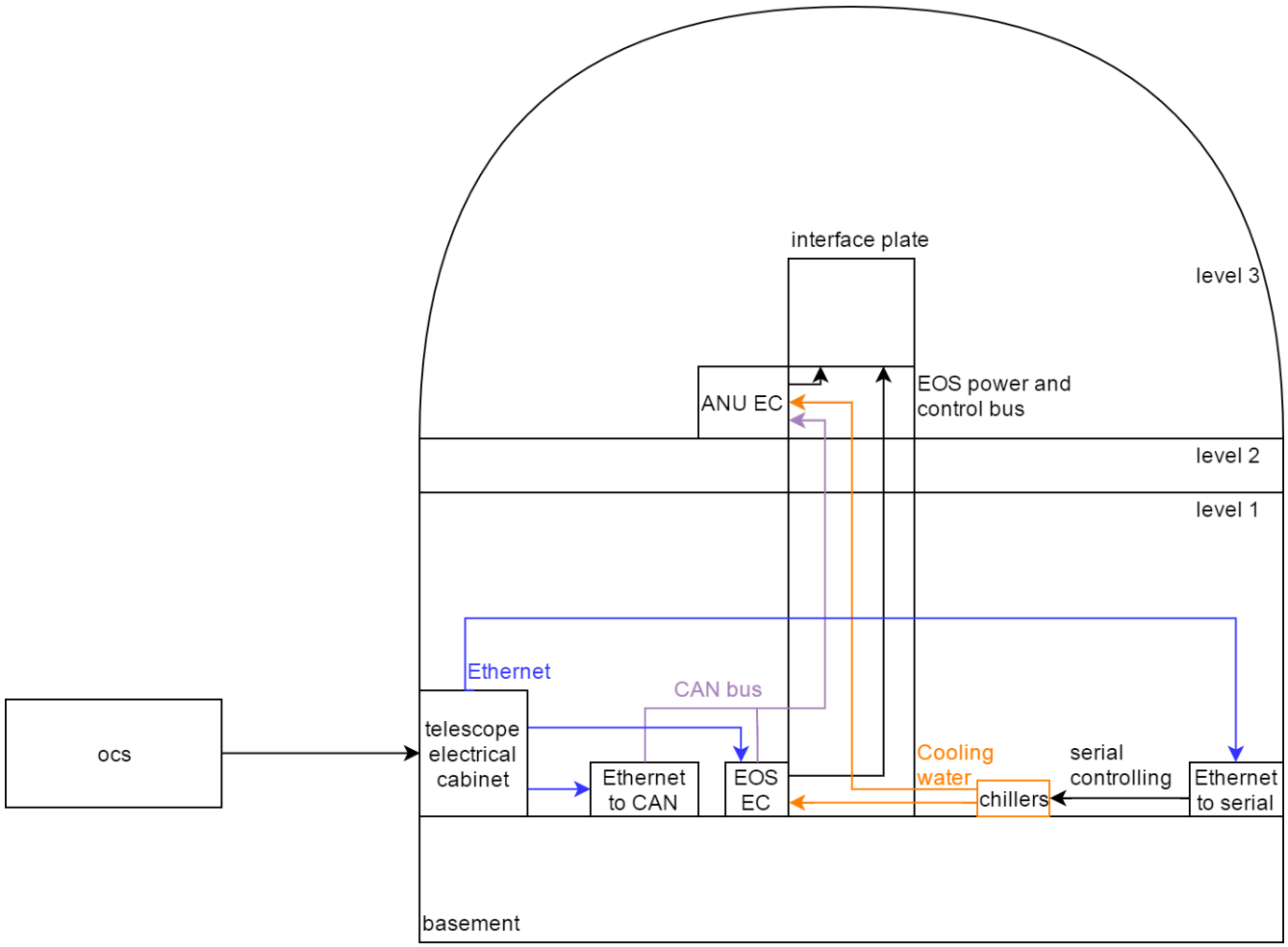

Figure 2: Electrical interfaces and component placement in the telescope (Horizontal view).

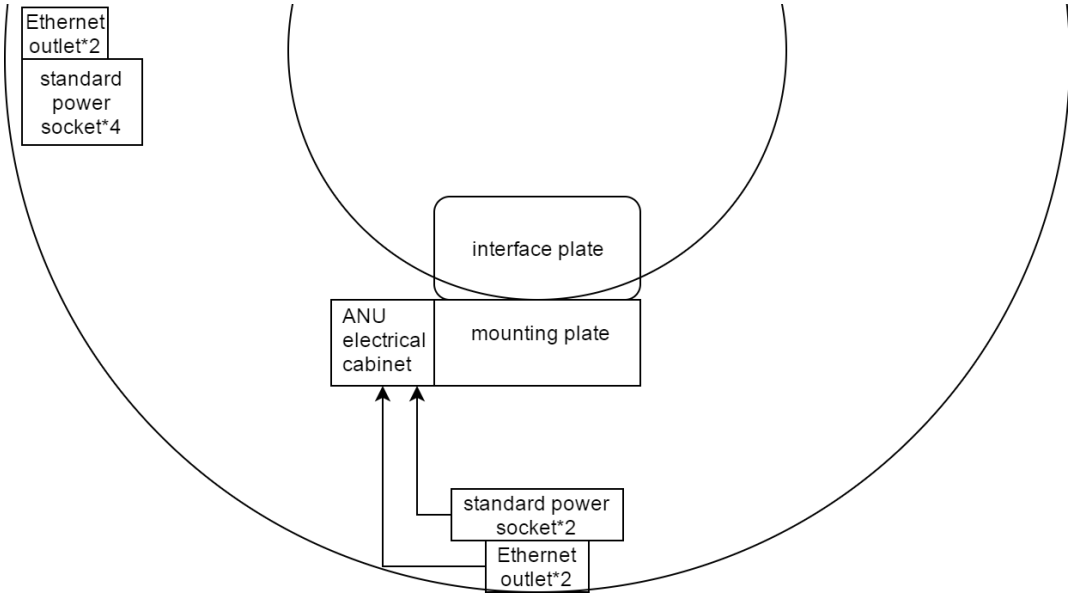

Figure 3: Electrical interfaces and component placement on Level 2 of the telescope (Top view).

3 Power

Power relates to the supply of power to the system components.

3.1 Requirements

The requirements for the design of the power interface are taken from the system subsystem document [2], and are reproduced here. These requirements are listed in Table 2.

Table 2: Power Requirements

Reference	Description
1.2.3	The telescope dictates that the System shall require no more than 6 standard electrical plugs (240 V, 10A) on the top floor of the telescope.
1.2.5	The telescope dictates that the System shall require no more than 8 ~~6~~ standard electrical plugs on the first floor of the telescope.
2.2.1	The EOS GSL requires 2.4kW of power via a standard single phase (230V / 10A) power socket [3].
2.2.3	The EOS GSL requires 1 + 1 power plugs for chillers or oscillator. If the latter is in the clean room, 1 standard power plug for the EC in dome. [3].
3.1.5	The telescope dictates that the ANU GSL be connected to a power supply via 1 standard power socket [4].
3.2.1	The ANU GSL requires less than 800W of cooling [4].
3.3.1	The ANU GSL requires approximately 800W of power for the auxiliary electrical cabinet

3.2 Design

The expected power draw of each system component is provided in Table 3. These details will need to be updated as additional information about both GSLs becomes available.

Table 3: Power Requirements

Source	Draw
EOS Auxiliary EC	< 2400W
EOS Chiller	< 720W
ANU Auxiliary EC	800W
ANU Chiller 1 & 2 (Combined)	< 1680W
Enclosure Environmental Control	< 100W
Total	< 7.8kW

The available power in the telescope is 80A, 3-phase [5], which provides approximately 32kW. The combined system draw is slightly under 25% of the available power, however the two GSLs are not likely to be running at full power concurrently. As a result, the system will require less than the total power indicated in Table 3. This can validated further by establishing the full power draw of the active

components within the dome, and ensuring that there is no possibility of exceeding the available power.

The ANU and EOS ECs and chillers, and Ethernet to CAN gateway each require 1 main power socket. Power to the EOS laser head is provided via the auxiliary EC as shown in Figure 1. Power to the ANU laser head is similarly provided by the ANU auxiliary EC, although the exact specifications need to be confirmed with the Vendor. There are sufficient power sockets currently available in telescope, indicating that the system is viable.

4 Recommendation

The ANU EC is to be situated on the observation level, beneath the laser head enclosure. The EOS EC, chillers, Ethernet to CAN gateway and Ethernet to serial converter are to be situated on entrance level. A summary of the electrical interfaces is presented in Figure 4. Green lines indicate power supply, magenta lines indicates Ethernet cables coming out of the Telescope EC on the entrance level, and blue lines represent CAN bus control for both ANU and EOS auxiliary ECs. It should be noted that the EOS EC also requires an additional Ethernet for engineering and maintenance. The Figure also also shows cooling water connections by yellow lines and laser path by red lines.

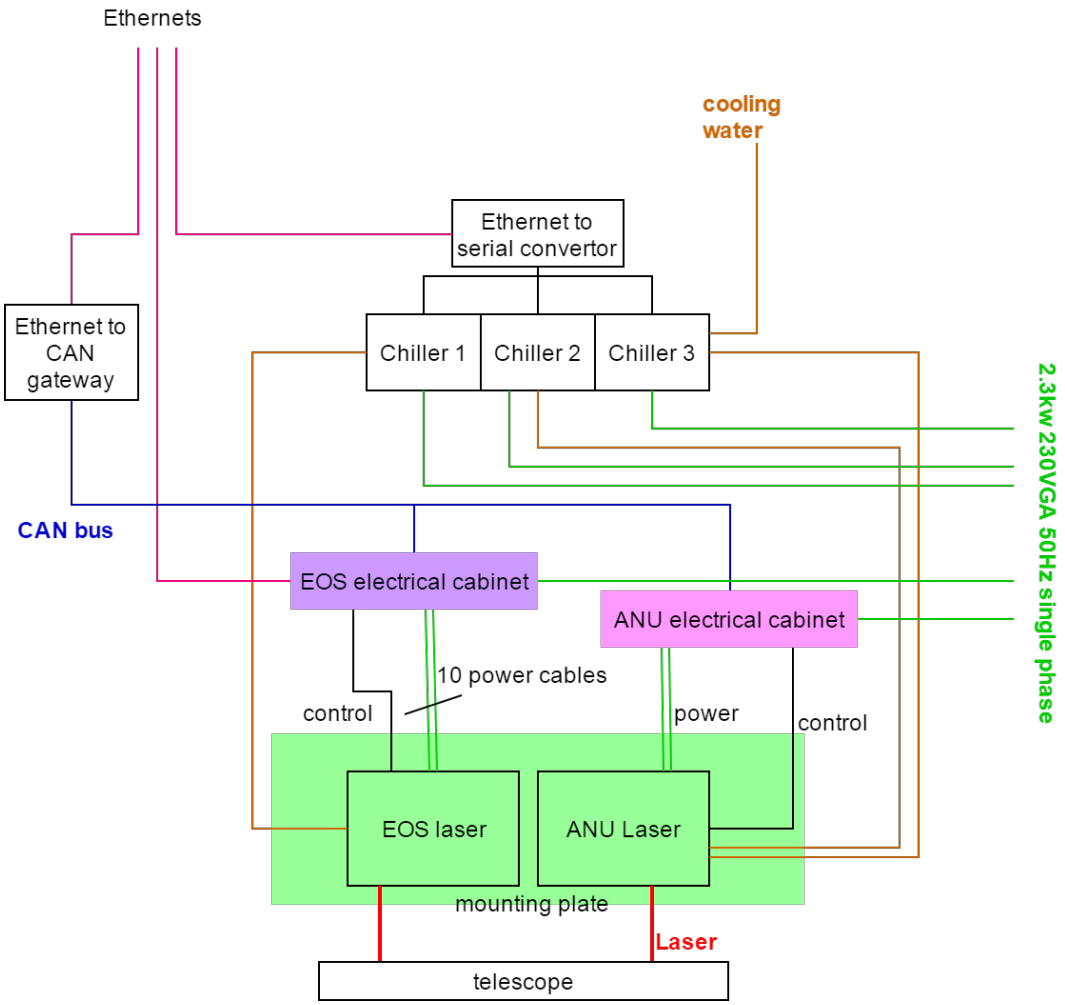

Figure 4: All communication and power connections

References

[1] "Environmental subsystem design," October 2017.

[2] "Updated system subsystem requirements," October 2017.

[3] N. Herald, "Personal Communication 24/03/17."

[4] C. d'Orgeville, "Personal Communication 24/03/17."

[5] A. Gray, "Personal Communication 7/10/17."