SPACE GENERATION ADVISORY COUNCIL

ACHIEVED ACADEMY PROGRAM

Class: MBSE

MBSE Assignment

Lunar Habitat Module Architecture Model

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Instructions

Assignment to apply the principles of Model-Based Systems Engineering (MBSE) using the ARCADIA methodology and the Capella tool to design a conceptual model for a Lunar Habitat Module, which would serve as a living and research space for astronauts during extended missions on the Moon.

Objectives

- To understand and apply the ARCADIA methodology in the context of space exploration systems.
- To use the Capella tool to create and analyse the systems architecture of a Lunar Habitat Module.
- To identify and model the key operational activities, functions, interfaces and components of the habitat.

Deliverables

- Operational Analysis – Define the mission activities and operational context. Identify the main actors and their interactions.
- System Analysis – Capture the habitat's high-level functions based on its operational context.
- Logical Architecture – Develop a component breakdown of the habitat, detailing the major systems and sub-systems.
- Physical Architecture (Optional) – Propose a preliminary physical design, including layout diagrams and component specifications.

Evaluation criteria

- Completeness – All deliverables are addressed and thoroughly developed.
- Understanding of MBSE – Demonstrates a clear understanding of the ARCADIA methodology and effective use of the Capella tool.
- Quality of Model – The model is well-organized and clear and includes appropriate diagrams that effectively communicate the design and intent.

Methodology

Taking into account the requirements of the mission: "…design a conceptual model for a Lunar Habitat Module, which could serve as a living and research space for astronauts during extended missions on the Moon." There are three important parts to take into account in the system to develop for a Lunar Habitat Module: Lunar environment (extreme environments), life support system for long term (security), research station (laboratory).

Following the V Model for the Systems Engineering Process (Figure 1), and also following the Lifecycle of a space project (Figure 2), the initial phases of the Mission Requirement Definition that will be proposed.

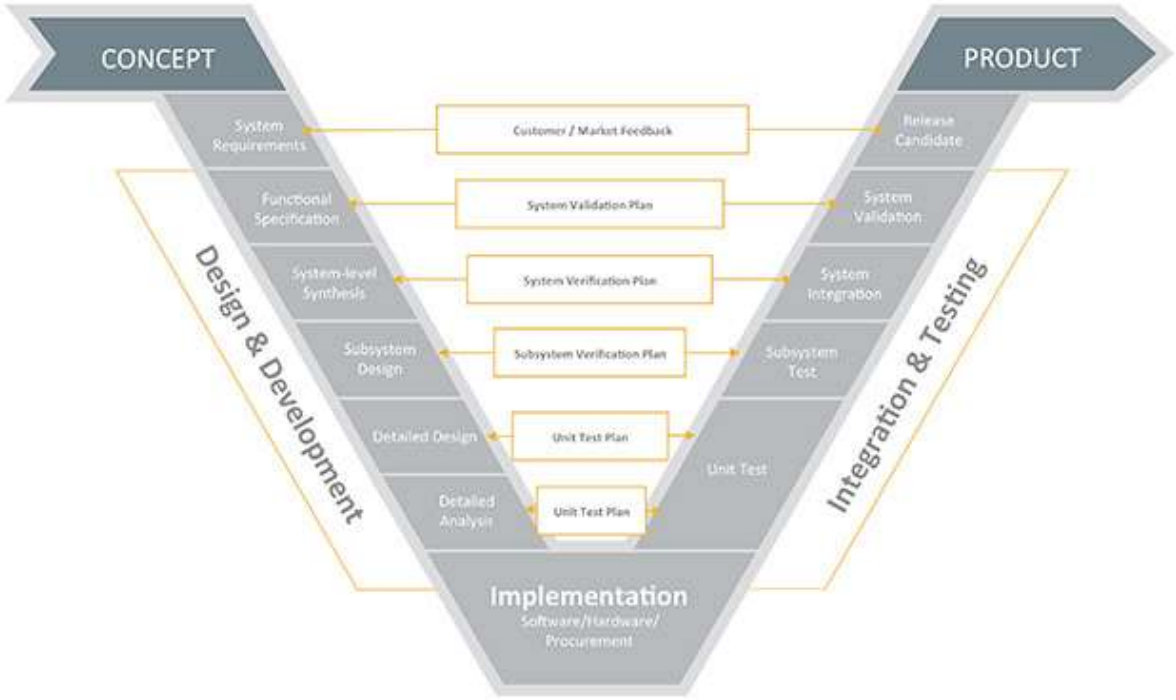


Figure 1. V Model for Systems Engineering Process.

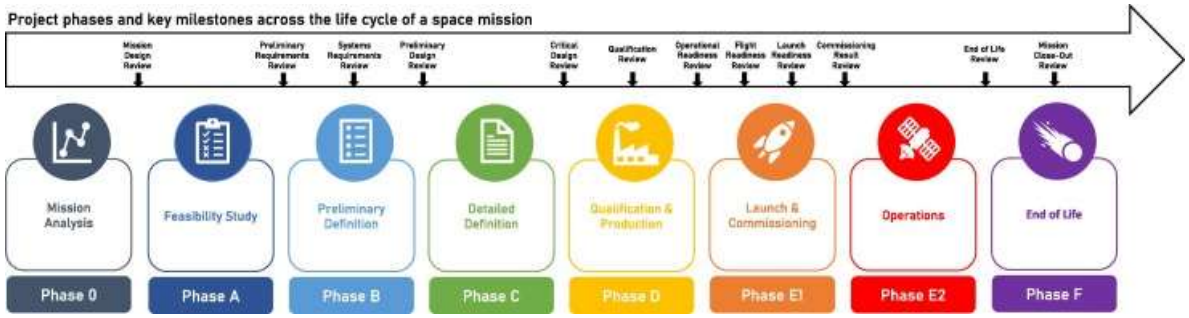


Figure 2. Project phases and key milestones across the life cycle of a space mission.

Mission Objectives

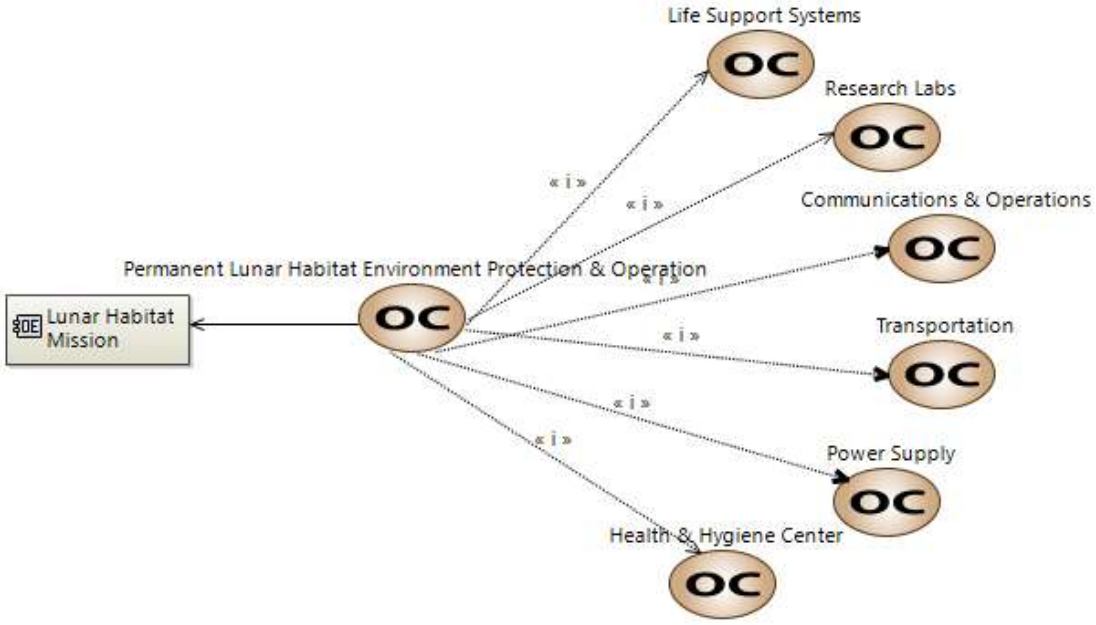
- Develop a conceptual model for a lunar habitat to carry out manned lunar exploration missions.
- Conduct research in lunar conditions.
- The lunar habitat would be for extended missions.

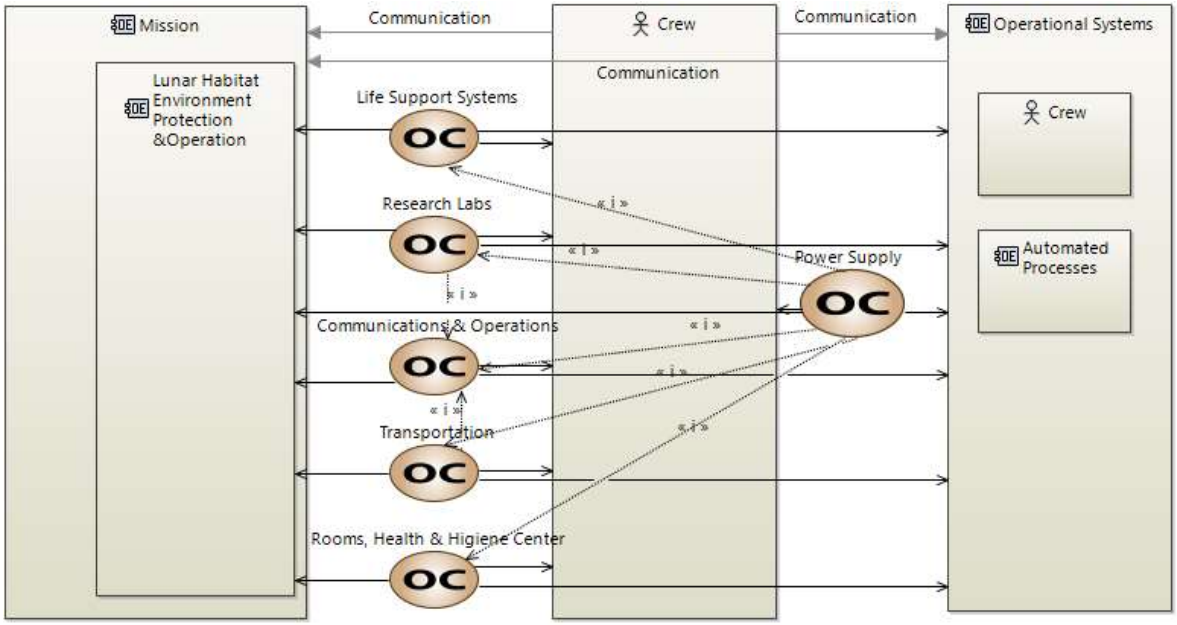
The High Level Requirements (HLR) are:

- [HLR-01]: The Lunar Habitat must provide protection from extreme environments to all systems.
- [HLR-02]: The Lunar Habitat must provide life support.
- [HLR-03]: The Lunar habitat must provide facilities for research.
- [HLR-04]: The mission must last at least 3 months to be considered a long-term mission.

Operational Analysis

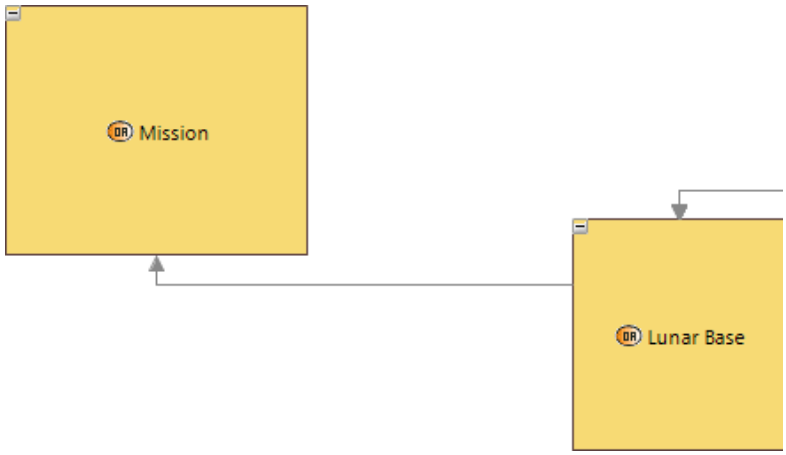
Define the mission activities and operational context. Identify the main actors and their interactions.



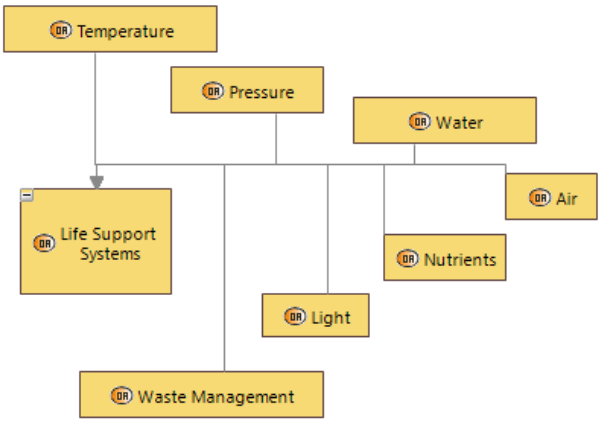


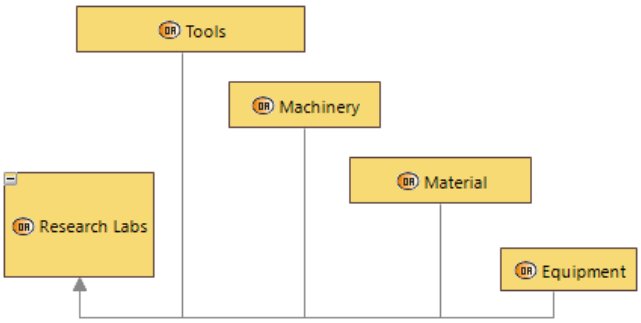
System Analysis

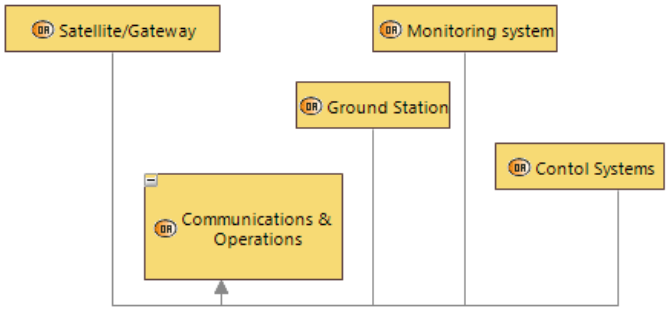
Capture the habitat's high-level functions based on its operational context.

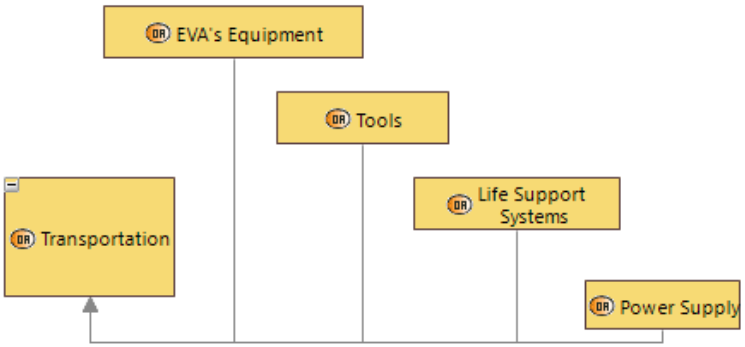


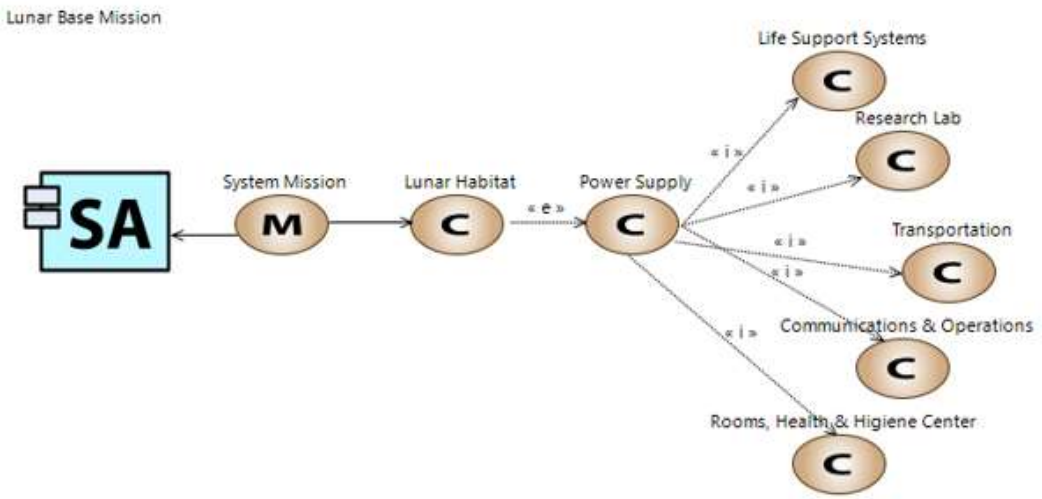
In this case, "Mission" is the first block, "Lunar Base" the second, and then, the principal blocks of the next models are connected with the "Lunar Base" block.


Temperature
Pressure
Water
Air
Life Support Systems
Nutrients
Light
Waste Management


Tools
Machinery
Material
Research Labs
Equipment

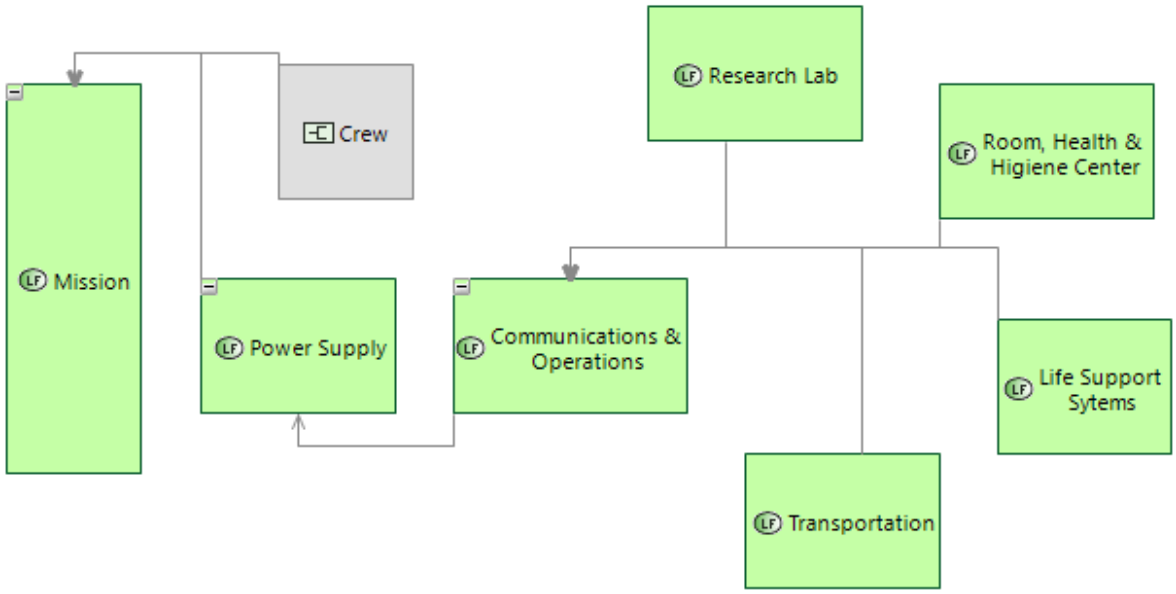

Satellite/Gateway
Monitoring system
Ground Station
Contol Systems
Communications & Operations


EVA's Equipment
Tools
Life Support Systems
Transportation
Power Supply



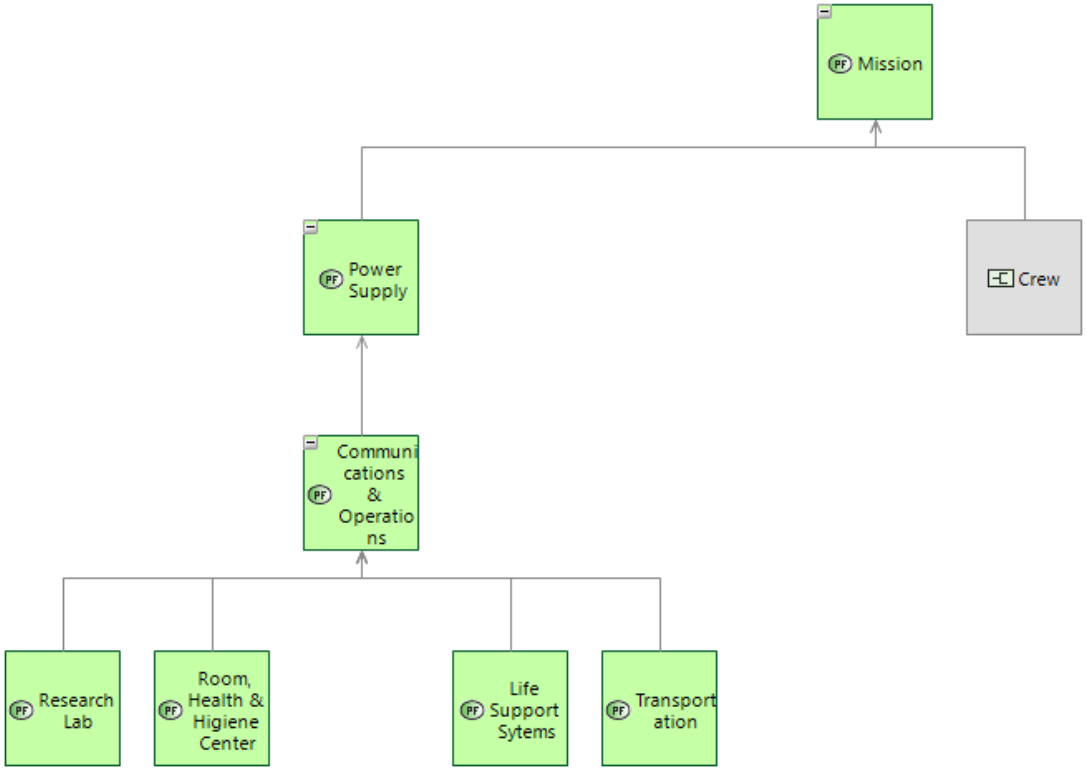
Logical Architecture

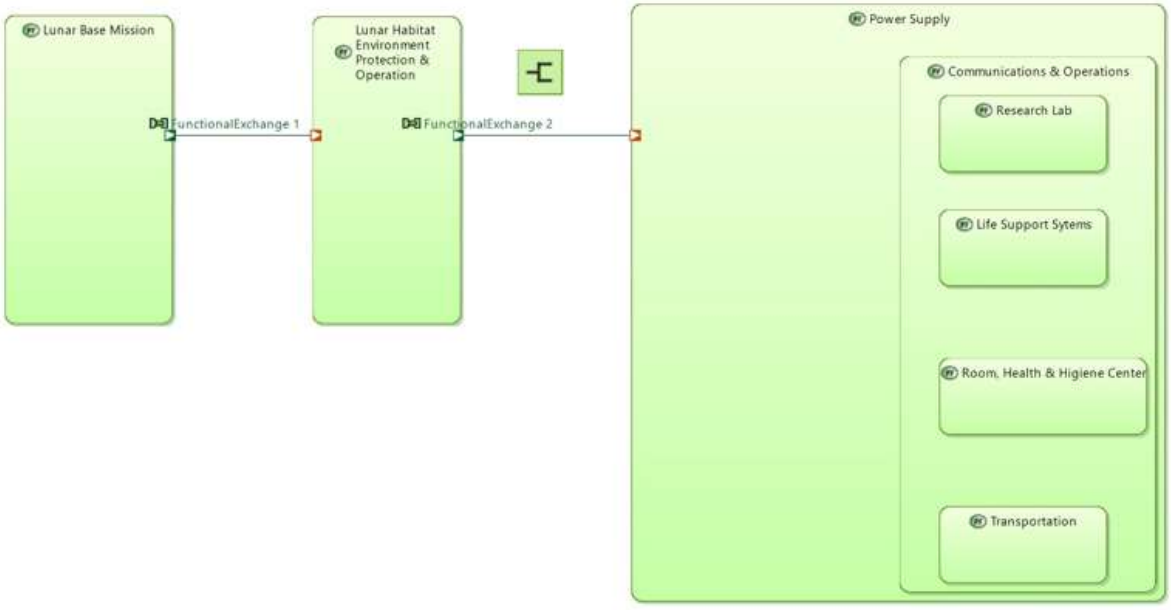
Develop a component breakdown of the habitat, detailing the major systems and sub-systems.



Physical Architecture

Propose a preliminary physical design, including layout diagrams and component specifications.





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