FINAL LAB PROJECT

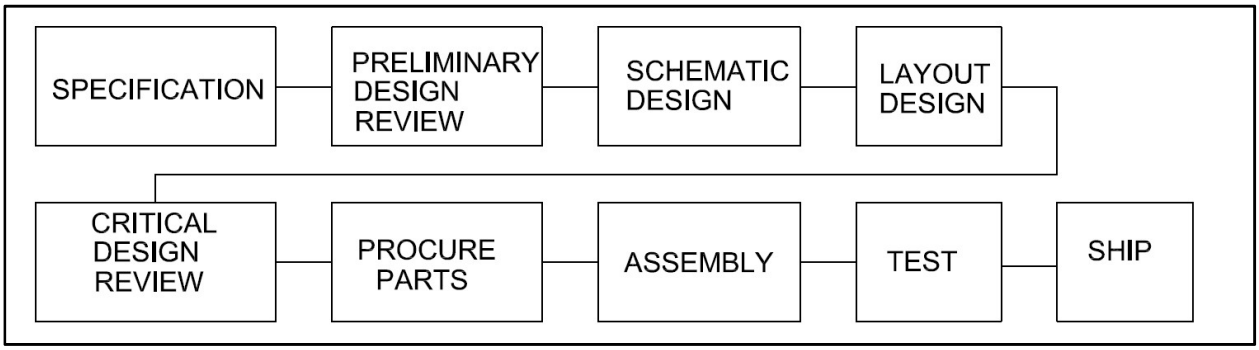
LAB PROJECT PRESENTATION: Detailed below in the "Hardware Development Plan" section of this document is a description of the typical hardware development lifecycle of a project.

Your final project should consist of a PowerPoint presentation that describes the hardware development lifecycle for your project.You will have at-most 20-minutes to present your work. As a general rule-of-thumb, you should budget 60-90 seconds per slide and leave about 3-minutes for Q/A at the end. The presentation should include at-least the following details:

1. Group Members
2. Specification Matrix
3. Block Diagram (System hardware architecture)
4. Design Details
    a. Schematics
    b. Simulations
    c. Measured Results (With functional hardware)
5. Bill of Materials (BOM) – Parts List
6. Cost list to manufacture your prototype
7. Pictures of your hardware and/or layout drawings
8. List of challenges and lessons learned during the development of the hardware

HARDWARE DEVELOPMENT PLAN:

When developing a hardware design, it is useful to follow a design process flow that will guide the development from a conceptual state into physically realizable hardware. You will find that most companies have unique design processes that are typically architected in a way that satisfies their quality management system objectives. The design process described below attempts to itemize the core steps involved in most projects development lifecycle.



HARDWARE DEVELOPMENT LIFECYCLE FLOW-CHART

SPECIFICATION: A design's specification is a list of requirements and performance characteristics of which the final hardware is expected to satisfy. These requirements can be a combination of electrical, mechanical, environmental and/or quality requirements.

EXAMPLE:

Scope of Work: Design of an audio equalizer system that includes three sets of visual displays that will demonstrate the loudness of an audio signal. (For more info, see http://en.wikipedia.org/wiki/Line_level)

System Requirements:

1. Audio Input Signal: "Line Level" input with amplitude ranging between +/- 0.447V and frequency range extending between 8Hz through 20kHz.
2. Display 1: Low frequency range amplitude detection: 8Hz to 200Hz with range of +/-0.447V peak-to-peak with 5-bar LED output.
3. Display 2: Mid-range frequency amplitude detection: 200Hz to 2kHz with range of +/-0.447V peak-to-peak with 5-bar LED output.
4. Display 3: Low frequency range amplitude detection: 2kHz to 20kHz with range of +/-0.447V peak-to-peak with 5-bar LED output.
5. Power Source: 6VDC and 100mA max
6. Mechanical: 3"x5" with 1/8" stereo audio input connector interface

PRELIMINARY DESIGN REVIEW: The "PDR" is the part of the project lifecycle where you present your design approach to your peers and management. Your objective is to demonstrate that you have analyzed the high risk parts of the project and have developed a design plan that will ultimately lead to a first-pass success. The key attributes of a PDR is:

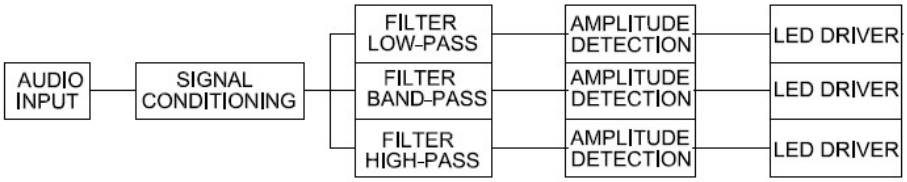
1. Compliance matrix that itemizes the system specifications and details the expected performance from your design. This effectively summarizes the needs and expectations of the program.
2. System design planning and analysis:
    a. A block diagram flowchart of the electrical and/or mechanical system aspects
    b. Electrical and/or mechanical analysis of critical and high-risk parts of your design
3. Identification of parts with high costs and long procurement times. This list is then used to buy parts early in the project lifecycle so that they are available when needed
4. Schedule that itemizes the expected duration of each design phase and ensures they will all be accomplished by the project deadline

EXAMPLE:

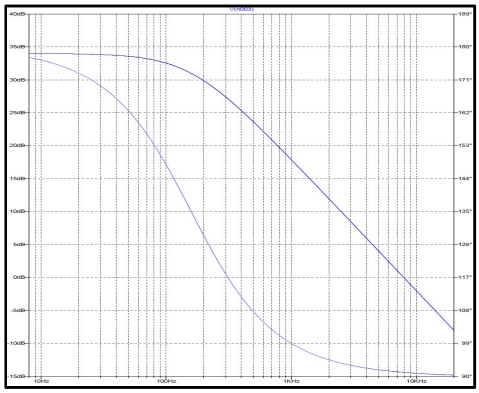
Compliance matrix:

ITEM	SPEC	UNITS	MIN	EXPECTED	MAX	COMPLIANT	NOTES
1	Audio Input Signal	V	-0.447	+/- 0.447	+0.447	YES	None
1	Audio Input Signal	Hz	8	8-20k	20k	YES	None
2	Display 1 (Output)	LED's	5	5	-	YES	None
2	Display 1 (Frequency)	Hz	8	8-200	200	YES	None
2	Display 1 (Amplitude)	V	-0.447	+/- 0.447	+0.447	YES	None
3	Display 2 (Output)	LED's	5	5	-	YES	None
3	Display 2 (Frequency)	Hz	200	200-2k	2k	YES	None
3	Display 2 (Amplitude)	V	-0.447	+/- 0.447	+0.447	YES	None
4	Display 3 (Output)	LED's	5	5	-	YES	None
4	Display 3 (Frequency)	Hz	2k	2k-20k	20k	YES	None
4	Display 3 (Amplitude)	V	-0.447	+/- 0.447	+0.447	YES	None
5	Power Source (Voltage)	V	6	6	-	YES	None
5	Power Source (Current)	A	-	0.1	0.1	YES	None

System Block Diagram:



Analysis:

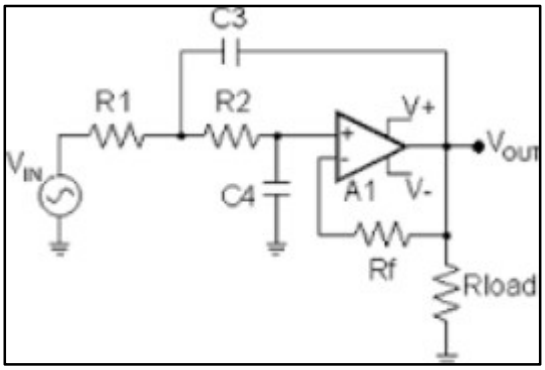


Low-pass Filter

SCHEMATIC DESIGN: After completion of the PDR, you are ready to create a detailed electrical design that includes all parts required in your design. The schematic then map these parts and connects them together in such a way that the final assembly will satisfy the system specification requirements.

Outputs of the schematic design are the wiring map and a Bill-of-Materials (BOM). The BOM is a list that itemizes all electrical components needed in the design.

EXAMPLE:



SCHEMATIC

Component	Component Description	Qty. Required	Type	Unit	Unit Cost	Lead Time
0403	Clamp	1	2	Ea	22	14
1201	Gasket	2	2	Ea	3	7
4209	Painted Tank Top	1	1	Ea	18	14
5319	Valve Assembly	1	2	Ea	137	91
5640	Steel	5	2	Lbs	115	70
5706	5-Gal Painted Tank Bottom	1	1	Ea	38	21
5746	Hose	10	2	In	45	28
7350	5-Gal Tank Subassembly	1	1	Ea	25	14

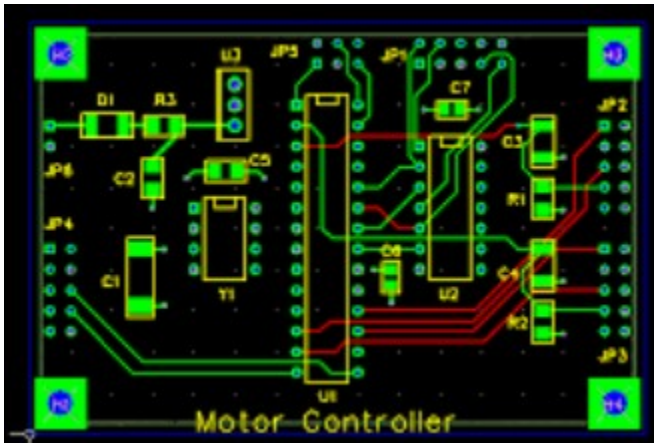
BILL-OF-MATERIALS

LAYOUT DESIGN: After completion of the schematic, a drawing would be created that shows the physical implementation of the wiring map outlined within the schematic. You would draw the physical size of each part and traces/wires interconnecting them since this drawing will be directly used for the assembly of all circuits and components.

The layout also serves as the mechanical design detailing the physical implementation of the mechanical hardware that will be used with the electrical assemblies. Another BOM would also be created that includes any mechanical hardware used in the design.

For the design project, it may be more helpful to create a drawing of your circuit board limits (ie: 3”x5” punch-board) and hand sketch relative size of components and wire placement.

EXAMPLE:



CRITICAL DESIGN REVIEW: The “CDR” is the part of the project lifecycle where you present your design to your peers and management. You would include all aspects from the “PDR” and include the schematics, layout any updatedanalysis that followed the PDR. Your objective is to demonstrate that you have analyzed the high risk parts of the project and have developed a physically realizable system, that when assembled, will meet the system specification requirements.

The CDR is usually used as a critical design path because completion of the CDR leads to purchasing all remaining parts, hardware and circuit boards. Since this can be very costly, it is important to ensure all design rules and details have been implemented before completing the CDR.

PROCUREMENT: After completion of the CDR, the BOM generated from the schematic and layouts would be used to buy parts. Below is a list of typical electrical and mechanical component distributors that can be used for your design.

1. Digikey (http://www.digikey.com)
2. Mouser Electronics (http://www.mouser.com)
3. Avnet Express (http://www.avnetexpress.com)
4. McMaster-Carr (http://www.mcmaster.com)

When you begin procuring parts for the project, you will want to order more parts than you need. This is because part failures are common in new designs. Since, shipping costs can be high and because most of the distributors listed above have “volume” pricing, buying more parts than necessary can help with the development of the hardware if a part fails during assembly or test.

ASSEMBLY: Once all of the material (electronic and mechanical parts) is received, you are ready to put them together. You would typically use the layout or an assembly drawing as a blueprint of how everything comes together.

TEST: Once all of the material is assembles, you are ready to test the system and see if it meets specifications.

SHIP: Once you have verified that all of the specification requirements are satisfied by your design (or have received waivers from your customer), you are ready to ship the hardware.