ECE445: The Design Review

ECE ILLINOIS

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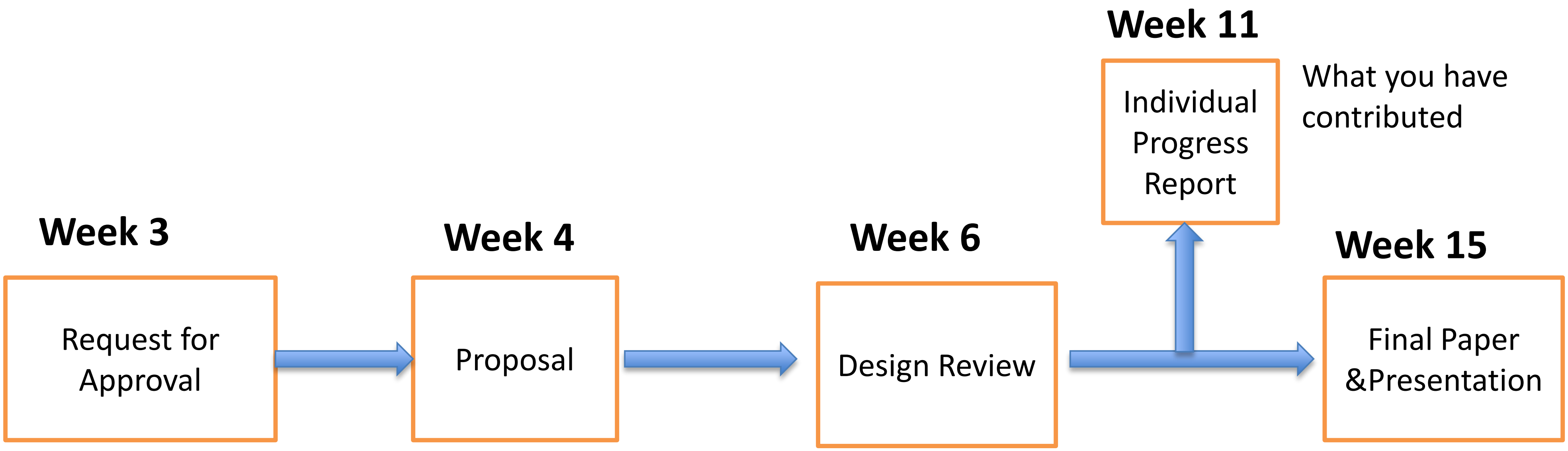
Documentation Roadmap



Week 3 – Request for Approval: A reasonable and novel idea

Week 4 – Proposal: To "sell" your project to "investors":

- Product Feature
- Design overview
- Schedule

Week 6 – Design Review: To discuss your project with fellow engineers:

- Product feature
- Detailed design
- Schedule with more specific engineering goals

Week 15 – Final Paper & Presentation: To discuss the outcome

Check Calendar for Due Dates

What the Design Review is

- Board meeting with engineers-(faculty, TA, classmates)
- Structured discussion of your entire project
- Defense of the **complete electrical** design

What the Design Review is NOT

- Do not prepare a PowerPoint
- Do not dress up
- Do not bring in or demonstrate any hardware
- Do not bring datasheets for all the parts you use

Structure/Sections of the Document

- Introduction
- Design
  - Modular Block Diagrams
  - Written descriptions of each block
  - **Schematics**
  - **Flow chart for software**
  - **Calculation and Simulation**
- Requirements and Verifications
- Tolerance Analysis
- Cost analysis (parts and labor)
- Schedule
- Ethics and Safety
- Citations and References

Block Diagrams

- High level overview of components
- Clearly show hierarchy of blocks
- Clearly show signal and power flow
- Not a flowchart

Block Diagrams

Examples and Considerations

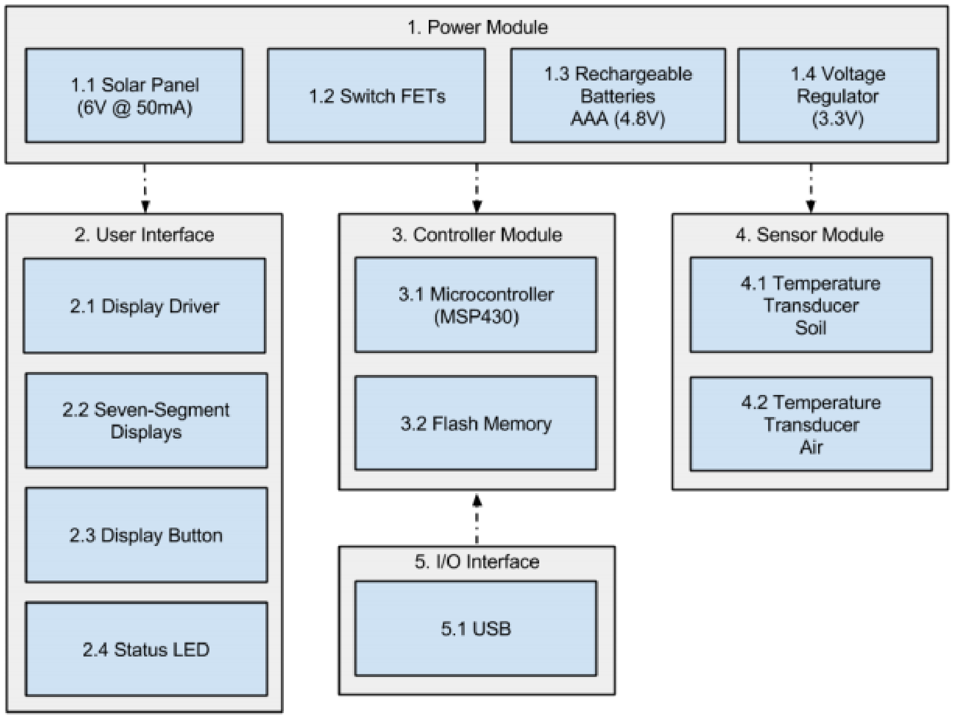


Figure 1: Top Level Power Layout

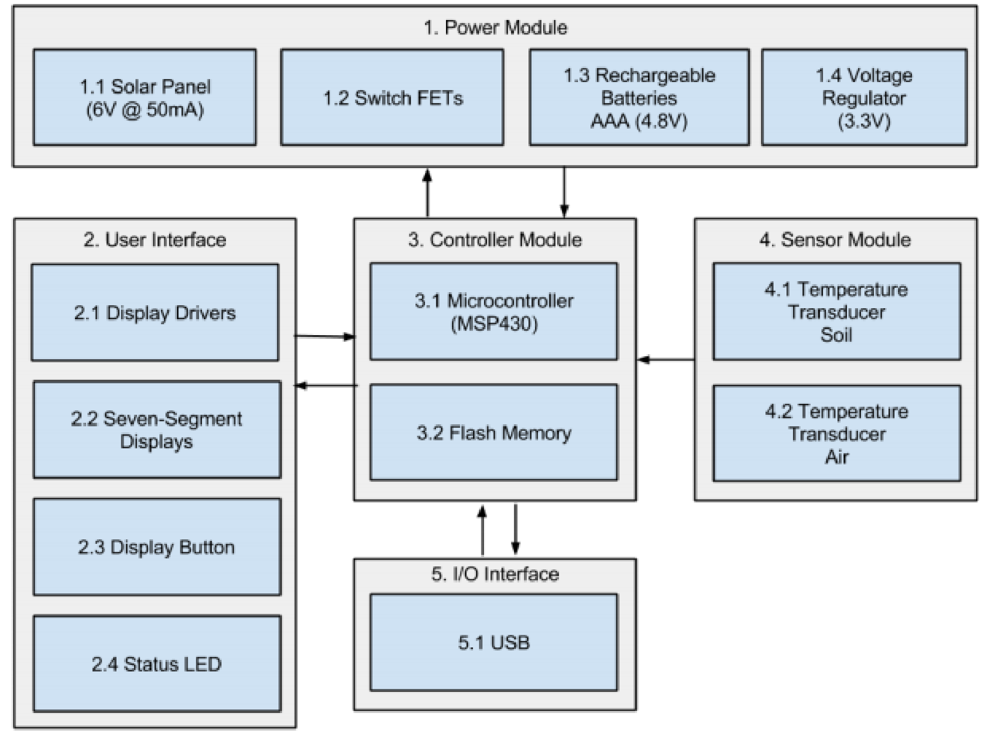
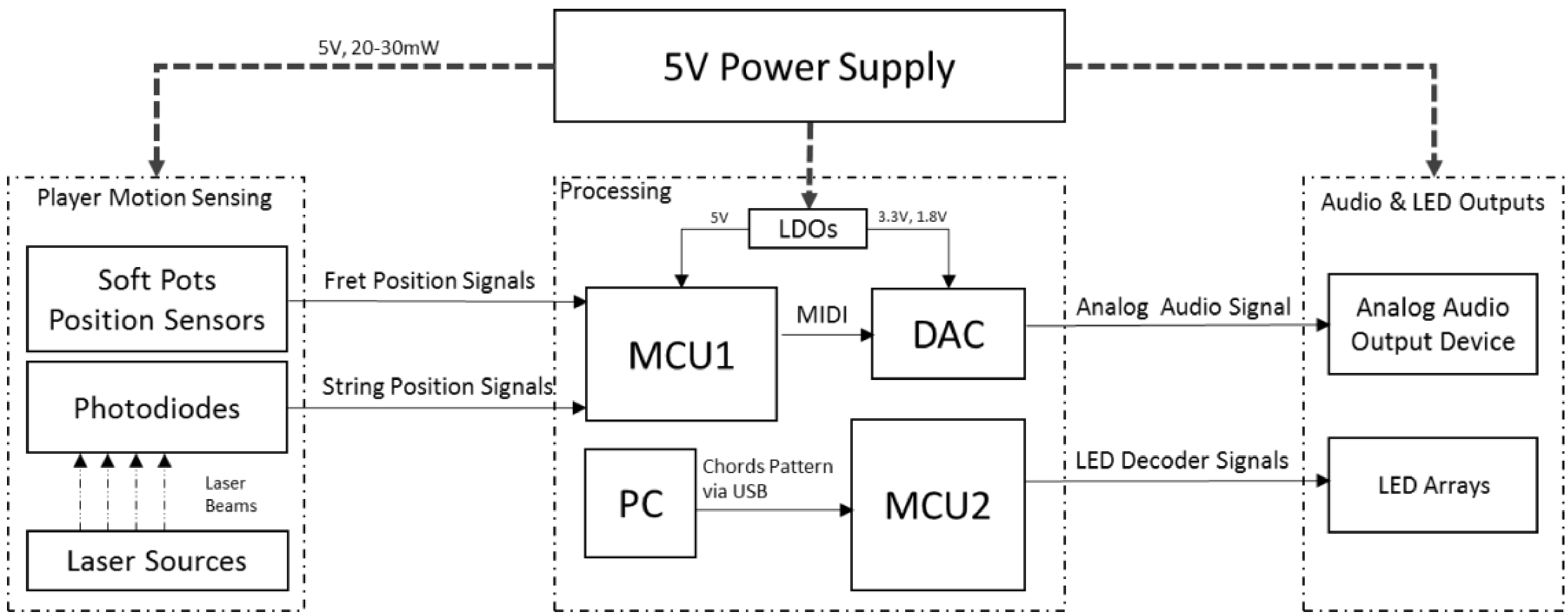


Figure 2: Top level Signal Layout.

Growing Degree Day Monitor, Spring 2014

Block Diagrams

Examples and Considerations



Laser Guitar with Instructional Display, Spring 2015

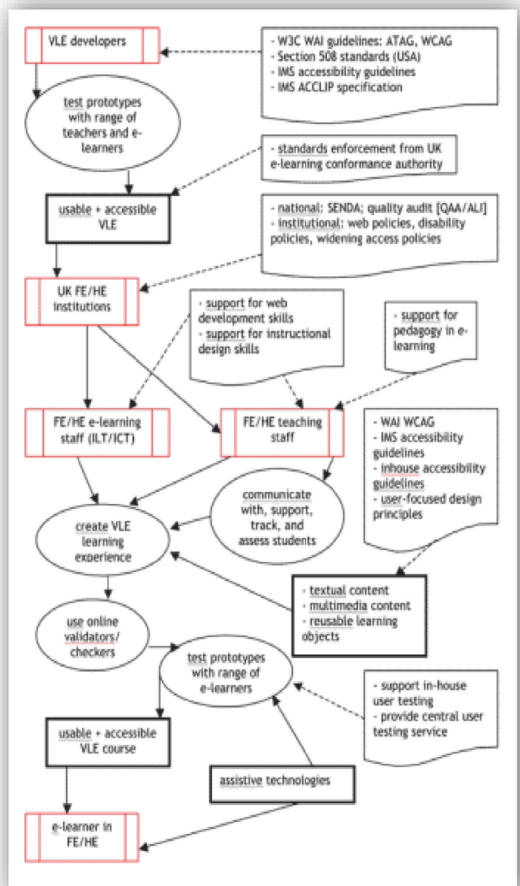
Block Descriptions

- Similar to proposal, but includes detailed design
- Justify your design
- Reference your schematics (see schematics lecture)

Flowcharts

- **Clearly labeled**
- **All decision paths shown**
- **No unnecessary information**

Bad



Good

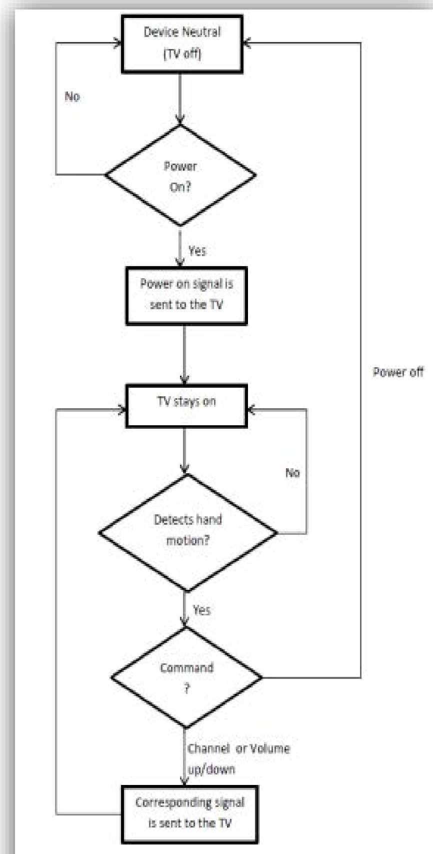


Figure 4: Flow Chart for the Software

Calculations and Simulations

- Calculations for component values
- Simulations of circuit designs
- Experimental results for circuits that are hard to simulate

Calculations and Simulations

Common simulation &calculation:

- Analog filter
- Power supply
- MCU processing ability calculation
- ADC resolution calculation

Common experimental result :

- Laser- Diode Circuit
- Ultrasonic sensor reading

Calculations and Simulations cont.

$$D_{pk\,Vin} = \frac{V_o - V_{in\,(pk)min}}{V_o} = \frac{216V - 155V}{216V} * 100 = 28.24\%$$

$$V = L\frac{di}{dt} => L = \frac{V_{in\,(pk)min} * D_{pk\,Vin}}{f_{switch} * \Delta I_L} = \frac{155V * 0.2824}{100000Hz * 0.0857A} = 5.1mH$$

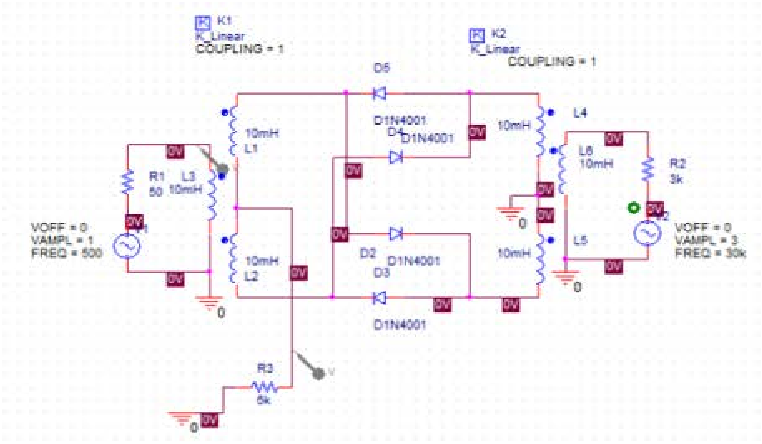
The high frequency input capacitor is used to reduce unwanted harmonics on the line side. It can be calculated assuming a desired 6% ripple is allowable. A film type capacitor will be used because of its low ESL and ESR.

$$C_{in} = \Delta I_L\% \frac{I_{in\,(RMS)max}}{(2\pi)(f_{switch})(r)(V_{in\,(RMS)min})} = 0.2\frac{0.3367A}{(2\pi)(100000Hz)(0.06)(110V)} = 16nF$$

The output capacitor is used to maintain the output voltage while the boost diode is not conducting. An electrolytic will be used because of its excellent storage capabilities. This capacitor will be chosen assuming a 20ms hold up time and allowable minimum voltage sag of 190V. A manufacturing tolerance of 20% is accounted for.

$$C_{out\,min} = \frac{2 * P_{omax} * \Delta t}{V_o^2 - V_{o\,min}^2} = \frac{2 * 30W * .020}{216^2 - 190^2} = 114\mu F$$

$$C_{out} = \frac{C_{out\,min}}{1 - \Delta C_{tolerance}} = \frac{114\mu F}{1 - 0.20} = 143\mu F$$



Schematic 2 -- Layout of Double Balanced Mixer

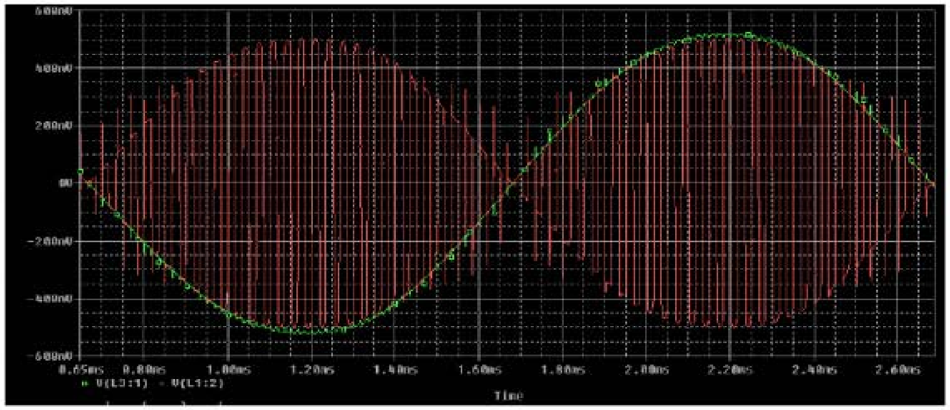


Figure 4 -- Simulation of Mixer Circuitry

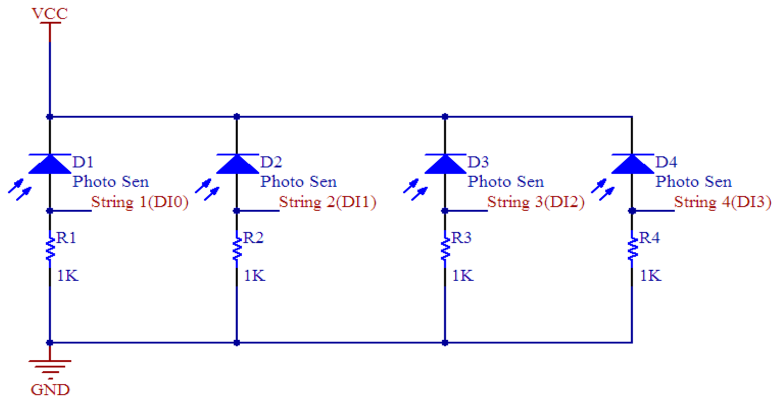
Requirements and Verification

Logic:

1. I need implement this functional block. (mostly from block diagram)
2. In order to make the whole project work, what are the required functions and specs for this block. (Requirements)
3. Select components and design circuit based on your requirements.
4. Verify this functional block will complete the task. (Verification)

Requirements and Verification

- **Example: Laser- Diode Circuit for Laser Guitar**
  1. Laser-diode pair should generate digital High/Low voltage to microcontroller
  2. Read microcontroller I/O requirements for voltage levels
  3. Select parts and design circuits
  4. Verify the laser-diode pairs can produce desired voltage levels



Requirements and Verification

- **Requirements**
  - Quantitative operational requirements
  - Break down into sub-requirements if necessary

Laser-photodiode circuit	1.The circuit will trigger a low voltage when the laser is turned off. the output low should be between 0V-0.1V.	1. Connect the circuit as shown in figure 5. Record voltage with laser off
	2 The circuit will trigger a high voltage when the laser is turned on. Make sure the output high is between the 4.5V-5.5V.(Distinguishable with the output low voltage)	2. Turn on the laser. Record forward output voltage and current. If the output voltage is out of the desired range, adjust the value of pull down resistor.

Requirements and Verification cont.

- **Verification**
  - Method to confirm each requirement
  - Checklist of acceptable results, quantitative
  - Debugging plan
  - “Make sure it works” is not a verification (it works because it works…)
  - **Not a verification of data sheets**

Laser-photodiode circuit	1.The circuit will trigger a low voltage when the laser is turned off. the output low should be between 0V-0.1V. 2 The circuit will trigger a high voltage when the laser is turned on. Make sure the output high is between the 4.5V-5.5V.(Distinguishable with the output low voltage)	1. Connect the circuit as shown in figure 5. Record voltage with laser off 2. Turn on the laser. Record forward output voltage and current. If the output voltage is out of the desired range, adjust the value of pull down resistor.

Tolerance Analysis

- **General logic:**

  Given that we have a goal of X, The accuracy of component Y must be Z to achieve X properly

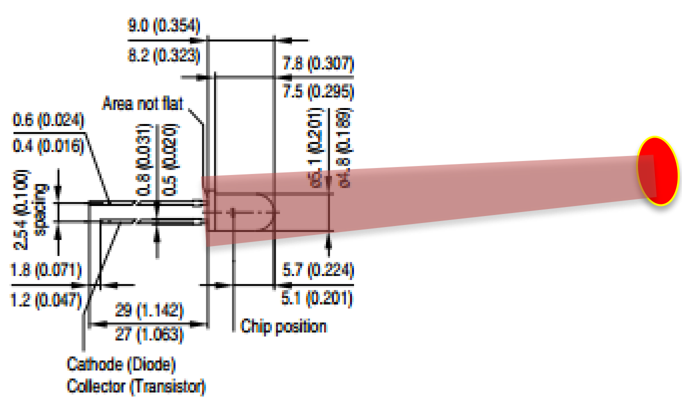
- **A part of the design process**
- **R/V Table is a guide to goals of tolerance analysis**
- **Actual test procedure in a separate section outside the R&V table**

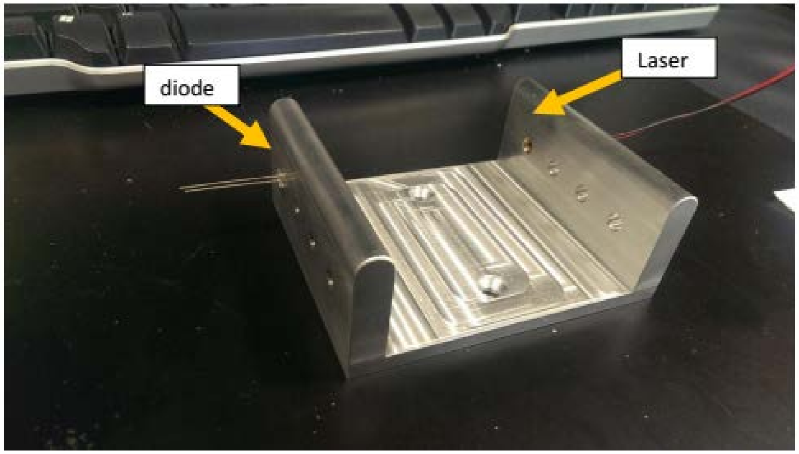
Tolerance Analysis

- **Laser-Diode Circuit Example:**
  1. Laser should shine on active area of the diode to deliver enough energy for it to produce enough current
  2. Tolerance analysis:
     1. Mechanical misalignment of mounting holes
     2. Laser beam divergence angle. Gaussian distribution of photonic energy
     3. Formula for design:

Laser Beam Divergence Radius + tan(error for alignment angle) + Energy Gaussian Distribution Radius Standard Deviation $\leq$ Radius of the diode package

     4. Find the allowed error for alignment angle. Verify produced voltages at such angles. Decide machining method





Cost Analysis

- Bill of Materials (BOM)
  - Specific part numbers & component values
  - Module that uses it
  - Price and quantity
- Labor costs

Part #	Mft	Desc	For	Price	Qty	Total
9C12063A3900FKHFT	Yageo	390 Ohm – ¼ W	TXM	$0.42	1	$0.42
PIC16F877	MOT	8-bit PIC	ALL	$5.46	2	$10.92
ECS-3951C-200-TR	ECS	20 MHz Oscillator	PIC	$2.78	1	$2.78
1206CG200J9B200	Yageo	20 pf CAP	PIC	$0.32	2	$0.64
C0603C104J4RACTU	Kemet	0.1 uf CAP	PIC	$0.32	5	$1.60
9C08052A1002JLHFT	Yageo	10 K RES	PIC	$0.32	4	$1.28
C0805C105K4RACTU	Kemet	1.0 uf CAP	PIC	$0.32	3	$0.96
ECJ-4YB1C106K	PAN	10 uf CAP	PIC	$0.32	2	$0.64
AD725	AD	VGA to NTSC coder	DC	$2.34	2	$4.68
AD7083	AD	Video OP-Amp (3)	DC	$1.72	1	$1.72
Total						$25.64

Schedule

- Week-by-Week
- Break down tasks
- Assign responsibility
- Stick to it

Week	Tasks	Member
2/6	• Research parts for user interface	Bob
	• Research power supply and transceiver • Complete proposal	Annie
2/13	• Sign-up for Design Review • Finalize and order parts • Preliminary simulation	Bob
	• Setup microcontroller and Putty • Complete design review	Annie
2/20	• Interface with magnetic reader	Bob
	• Interface with transceiver and RTC	Annie
2/27	• Interface with LCD monitor	Bob
	• Interface with thermal printer	Annie
3/5	• Built and test user interface	Bob
	• Program and test data logger	Annie
	ETC.	

Ethics

- IEEE/ACM code of ethics
  - Do not just copy/paste this into your paper
  - Know and understand it
  - http://www.ieee.org/about/corporate/governance/p7-8.html
- Discuss ethical concerns as they apply to your project
- Human (IRB) and animal (IACUC) test approval
- If no ethical concerns, justify yourself

Safety

- Discuss safety concerns
  - Electrical safety
  - Mechanical safety
  - Lab safety
  - Consider safety of both yourselves and end users
  - Make a safety plan if necessary
  - If few safety concerns, justify yourself
- If you have hazardous, or volatile elements of your project, you must create a "Lab Safety Manual"

Citations and References

- **List of references formatted using the IEEE standard**
  - http://www.ieee.org/documents/ieeecitationref.pdf
- **Should include things like…**
  - Textbooks or datasheets where you got design equations
  - Informative articles or tutorials used (example codes…)
  - IEEE code of ethics
- **Please let us know if you are carrying over projects from other places (classes, startups, student teams…)**

Administrative

- Mock DR
- DR week
  - Don't forget to sign up to peer-review another project
- Grading rubric on the website
  - 60/515 (item with second most points)
- Description on the website