SDP22
Lecture 9
22 Nov 2021
MDR, HW/SW Exemptions, Lithium Batteries & Digi-Key
UMass Amherst Electrical and Computer Engineering Alumni & Friends

Listed group
7 days to MDR
MDR Scheduling Responsibilities

- Teams schedule MDR (evaluators & advisor)
- Teams reserve conference room
Teams schedule MDRs (evals & advisor)

- Use email (to: evaluators & advisor; cc: team)

- Example email

  Dear Team xy Evaluators,

  I'm reaching out to the Evaluators and Advisor for MDR scheduling. Presently, Team xy is hoping that we can have our MDR presentation on **November 19, Thursday, 18:30**. As of right now, with other classes' final exams taken into consideration, Thursday works the best for Team 29.

  If the time doesn't work, we're also available any time after 17:00 until 20:00. If the date does not work, please let me know and I will speak with the team to figure out a better day.

  Sincerely,

  Team xy

- Team confirms date/time and conference room location with evaluators and advisor

- Day before: Team sends out reminder email to evaluators and advisor.

- Day of: Team emails copy of slide deck to evaluators and advisor. **Team uploads deck and demo video to team slack channel**
Teams reserve conference rooms

- Available conference rooms:
  - KEB 109
  - KEB 211
  - KEB 309
  - Marcus 201
  - Marcus 215

- Reserve conference rooms through staff members (visit or email)
  - Terry Bernard, Marcus 201G, tbernard@ecs.umass.edu
  - Jenn Pease, Marcus 201G, jpease@admin.umass.edu
MDR Presentation

Presentation/evaluation schedule:
- Team presentation and project demo: 30 min (uninterrupted)
- Evaluators Q&A: 20 min (advisor silent)
- Team leaves conference room
- Advisor/Evaluator huddle
- Evaluator feedback sent to advisor
- Advisor shares feedback with team
MDR Rubric (1)

■ **10%** Presentation
  ○ Includes Problem Statement
  ○ Teamliness
  ○ The team scheduled the review in a clear and professional manner
  ○ Evidence that the presentation was rehearsed

■ **20%** Goals, Specifications & Testing Plan
  ○ All items described in detail and refined from PDR
  ○ Goals are design-agnostic
  ○ Quantitative, testable system specifications
    ■ Justifiable benchmarks/thresholds
  ○ What are you measuring and how will you measure it
MDR Rubric (2)

- **20%** System Design Documentation
  - Documentation of the System Design (Software & Hardware)
    - Block diagrams
    - List all hardware and software components & modules used
    - Justification of key hardware and software components & modules choices
    - Any other documentation needed to describe the system design
  - Commitment to the custom PCB plan.

- **40%** Performance of the Integrated System
  - A convincing demonstration of the critical aspects of the integrated system
  - MDR Deliverables achieved
MDR Rubric (3)

- **5%** Project Expenditures (Current and Projected)

- **5%** Project Management
  - Gantt Chart (to CDR)
  - Team Responsibilities
    - Specify the team coordinator
    - Describe the technical responsibilities for each team member
Demo Video

- MDR: Live demo of integrated system required
- Produce demo video (including audio) as backup
- Upload video (and slide deck) to team slack channel on day of MDR
Exemptions due: Friday, 3 Dec’21
SW Requirement

Software requirement which must be satisfied by FPR, showing evidence that the migration process major steps are complete by CDR:

- Use professional IDE (examples: Atmel Studio, MPLabX)
  - (counterexamples: Arduino IDE, Notepad)

- **Must use C/C++ in programming a microcontroller**; e.g., Atmega328P, ESP8266
  - Exemptions; e.g., CircuitPython, submit SW exemption by Friday, 3 Dec’21
  - Arduino libraries not allowed
    - Exception: Can use a library that uses an Arduino library (example: Adafruit’s RTClib library).
SW Exemption Template

Exemptions due: Friday, 3 Dec’21

@channel Hi teams. Today in lecture we will mention the process for getting a software exemption. Much like the hardware exemption, there is a request template we would like you to use. I will send it below and pin it. Thanks!

Pinned by Christopher Caron (TA)

#software_exemption

Team Number:
Team Name:
Software Package:
Reason for Request:
Rechargeable Lithium Batteries

General Info and Safety
The Seriousness of the Situation

• Lithium-ion (Li-ion) batteries are by far the most dangerous object you will be working with in SDP lab.

• Li-ion battery safety is not taken seriously by most users of lithium batteries, the TSA, and plenty of other usually safety centered facilities.

• When used correctly they are innocuous but incorrect usage can be truly catastrophic.

• Li-ion battery fires cannot be extinguished with water, or smothered.
General Battery Info and Terminology

- Alkaline, Lithium, NiMh, Lithium-ion, Lead Acid.
  - What are these chemistries good for?
  - Learn about the differences between the chemistries for safety and to choose a battery that fits your project
  - When I say Li-ion I am referring to most rechargeable batteries with lithium in its chemistry.

- Battery cells, and packs.
  - Cells are individual batteries generally with a single + and -
  - Packs are cells wired in series or parallel usually with more than two electrodes.

- Battery Protection and a BMS
  - Fuses, overcharging, overheating and overdischarging protection
  - BMS- Battery management system for making sure that all cells in a battery pack are being charged/discharged equally

- C-Rate
  - rate at which a battery can discharge or recharge.
  - C-rate * total Ah of the battery = maximum amps the battery can discharge or recharge depending on if the c-rate is for charging or discharging
  - A 4Ah battery with a discharge c-rate of 10C was designed to discharge up to 40 amps.

- Thermal Runaway
  - When heat generated from the battery is more than the amount of heat absorbed by the surroundings.
Time for Smores!
General Safety

- Read the SOP from EH&S: https://ehs.umass.edu/batteries
- Do not cut positive and negative wires together, cut wires one at a time.
- Keep your batteries away from any metals, circuit boards or tools that could inadvertently cause a short. Have the terminals covered when not actively in use.
- Keep the batteries away from materials that could puncture the cells.
- Store batteries in metal container with vent holes (The metal lab bench drawers should be sufficient for the time being).
- Puffed batteries should go to the safe collection area. Tape up terminals.
- Puffed and hot batteries should be treated like an emergency, put in a metal container and put outside until thermal runaway is over.
- Do not throw any batteries away in a normal trash can.
Li-ion Battery
Spicy Pillow
Engineering Safety

• Make sure the battery is not overpowered or underpowered for your project. Read the datasheet and specs to see if it has the correct C rating. If you do not specifically need the qualities of a li-ion battery (high energy density, fast charge rate and fast discharge rate) consider using the cheaper, safer, and more environmentally friendly nickel-metal hydride rechargeable batteries.

• Make sure your projects function without shorts using bench top power supply before you attach a battery to your circuit.

• Make sure your battery has battery protection and a BMS if you are using a battery pack
  • Some batteries have built in battery protection circuitry, some do not, and you will have to add your own.
  • Best to pay extra for a battery that will keep you and your project safe.
  • Add fuses to your circuit

• Do not solder directly to battery terminal, if you absolutely need to, ask staff at the makerspace for assistance.

• Terminate wires that go into screw terminals with wire ferrules.
Wire Ferrules
Questions?
Sources and Reference

- Laptop battery fire: https://youtu.be/NqlMvJi5BOo
- Li-ion battery + Water: https://www.youtube.com/watch?v=bNMfe20l_IE
- Vape explosion due to Li-ion Battery: https://www.youtube.com/watch?v=ImSbVwqbJRM&t=70s
- Li-polymer battery explosion: https://www.youtube.com/watch?v=NQH3mXJ1dmw
- Lithium-ion Battery Pack Explosion: https://www.youtube.com/watch?v=EDhE0pk3FeQ
- Lithium ion safe transport, use and disposal: https://iosh.com/media/9495/lithium-batteries-and-their-safe-storage-transport-use-and-disposal-including-re-use-and-re-cycling.pdf
- Puffy Li-ion Batteries Explained (aka the spicy pillow) https://www.powerbankexpert.com/lithium-battery-spicy-pillow/
- Facial burn from li-ion battery in headphones: https://english.newstracklive.com/news/lithium-ion-battery-21232-1.html
Component Sourcing and Intro to Digi-Key

Christopher Caron
MSECE Candidate
SDP22
Breakout Boards

Prior to MDR, most part sourcing should be done on sites like Adafruit or Sparkfun, where components are sold as part of a:

- Breakout Board (BOB)
- Arduino Shield or FeatherWing
- Development Board
- Single Board Computer (SBC)

The goal is to source proven systems that are breadboard compatible and modular for easy/quick prototyping.
Single-Component Sourcing

As the semester goes on, you may need to source single parts for various reasons:

- M5 does not have the component or values you need
- A datasheet or application notes recommends a specific component
- You need a very special IC
- You wish to demonstrate low level control over a key device for MDR
Digi-Key

- Digi-Key is the recommended supplier for sourcing components for SDP
- ~11.5 million items, and over 2.6 million items ready for immediate shipment
  - (Chances are that if it exists, it is on Digi-Key))
- So large and complicated that we try to teach students how to navigate
How to Navigate the site

Searching the word “resistor” brings up about 1,500,000 items for sale... yikes

The first thing to know is the component category
Categories Example

- Chip Resistors (SMD)
- Through Hole Resistors
- Chassis Mount
- Rotary Potentiometer
- Trimmer (THT)
- Resistor Array (THT)
Filtering Example

Manufacturer
Adequat Industries LLC
Allen Bradley
Bourne Inc.
Caddock Electronics Inc.
Galco Industrial Electronics
Honeywell Sensing and Productivity Solutions
Kemar Inc.
KOA Signal ENDOXICO, INC.
KYOCERA AVX
Micro Measurements (Division of Vichy Precision Group)

Series
- 1
10
100
100/50W/PC Precision
144
20
33
30
40

Packaging
Bag
Box
Bulk
Cut Tape (CT)
Digi-Key
SIP
SMT Tang/Tray
Tape & Reel (TR)
Tray

Part Status
Active
Discontinued at Digi-Key
Last Time Run
Not For New Designs
Obsolete

Resistance
- 9.0
1 m
1.3
2.0
2.3
3.0
3.3
4.0

Tolerance
- ±0.001%
±0.002%
±0.005%
±0.01%
±0.02%
±0.03%
±0.05%
±0.1%
±0.2%
±0.25%

Power (Watts)
- 0.5W, 1/2W
0.35W, 1/4W
0.1W, 1/16W
0.125W, 1/8W
0.0625W, 1/32W
0.0156W, 1/64W
0.0039W, 1/256W
0.00019W, 1/1024W
0.000019W, 1/1024W
0.00002W, 1/5120

Composition
- Carbon Composition
Carbon Film
Ceramic
Ceramic
Metal Element
Metal Film
Metal Foil
Metal Oxide Film
Metal Nitride Film
Thick Film
Thin Film

Features
Anti-Arc
Anti-Arc, Current Sense, Flame Proof, Non-Inductive, Pulse Withstanding, Safety
Anti-Arc, Flame Proof, Moisture Resistant, Non-Inductive, Safety
Anti-Arc, Flame Proof, Moisture Resistant, Safety
Automotive AEC-Q200, Current Sense, Pulse Withstanding
Automotive AEC-Q200, Current Sense, Pulse Withstanding
Automotive AEC-Q200, Current Sense, Pulse Withstanding
Automotive AEC-Q200, Flame Retardant Coating, Fuses, Safety
Automotive AEC-Q200, Flame Retardant Coating, Safety

Temperature Coefficient
- -150°C to 90°C
- 150°C to 300°C
- -100°C to -160°C
- -120°C to -160°C
- -250°C to -300°C
- -200°C to -300°C
- -25°C to -100°C
- -50°C to -200°C
- -100°C to -200°C

Operating Temperature
- -25°C to 150°C
- -50°C to 150°C
- -65°C to 150°C
- -70°C to 150°C
- -70°C to 200°C
- -50°C to 200°C
- -65°C to 250°C
- -65°C to 300°C
- -90°C to 150°C

Package / Case
4 SLP
- Axial - 4 Leads
Axial
Axial, Radial Bend
Axial, Radial Formed
Axial, Radial
Radial - 2 Leads
Radial - 4 Leads

Size / Dimension
- 0.024" x 0.027" (0.62mm x 0.68mm)
- 0.033" x 0.045" (0.80mm x 1.14mm)
- 0.033" x 0.047" (0.80mm x 1.19mm)
- 0.062" x 0.062" (1.57mm x 1.57mm)
- 0.062" x 0.090" (1.57mm x 2.29mm)
- 0.062" x 0.144 (1.57mm x 3.66mm)
- 0.062" x 0.156 (1.57mm x 3.96mm)
- 0.062" x 0.180 (1.57mm x 4.57mm)
- 0.062" x 0.200 (1.57mm x 5.08mm)
- 0.062" x 0.230 (1.57mm x 5.28mm)

Height
- 0.0315" (0.80mm)
- 0.230" (6.00mm)
- 0.230" (6.00mm)
- 0.230" (6.00mm)
- 0.240" (6.00mm)
- 0.250" (6.35mm)
- 0.250" (6.00mm)
- 0.260" (6.60mm)
- 0.260" (6.60mm)
- 0.264" (6.70mm)

Number of Terminations
- 2
- 3
- 4
- M (1%)
- P (0.1%)
- B (0.01%)

Failure Rate
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%
- 0.0001%

Stocking Options
- In Stock
- Normally Stocking
- New Product

Media
- Datasheet
- Photo
- EDA/CAD Models

Environmental Options
- RoHS Compliant
- Non-RoHS Compliant

Marketplace Product
- Exclude
Chris’s Filter Priority Example: Resistors

1. **In Stock**
2. Part Status: Active
3. *MCAD/ECAD model* …*if designing PCB*
4. Composition (Carbon, Metal, Metal-Oxide Film, etc)
5. Resistance
6. Power Rating (¼, ⅛, etc... may be connected to size)
7. Tolerance
8. Package / Case + Size (Axial, Surface Mount, Radial, etc...)
9. Packaging (Cut Tape, Strip, Tray, Tube)
Component Pages

Take note of:

1. Minimum Quantity
2. Stock
3. Unit Prices
4. Shipping Notices
5. Datasheet
6. Part number
7. Datasheet?
8. Other Specs
Intro to IC Footprints

● As time goes on, you will hear us talking about *footprints* more and more often.

● This will be a concern during PCB design, but it is still something to consider.

● “Package” and “footprint” are often used interchangeably, they have slightly different meanings.

● Lots to learn here, so let’s focus on the basics again.
Measurements

- **mm** (Metric) - Millimeter
- **mils** (Imperial) - 1/1000th of an inch, also called thou’s

1 mil = 2.54 mm || 1 mm = ~39.3701 mils

Breadboard = 100 mil (0.100 in) pitch, 1 mm holes

Typical Perf board pad: 1.5 mm annular ring, 1 mm hole
Common Footprints

IC Package - Surface Mount
- SOT23
- SOT223
- TO252
- DDPAK
- SOP
- TQFP
- QFN

IC Package - Through Hole
- PDIP
- DIP
- ZIP
- T7-TO220
- TO2205
- TO220
- TO92
- TO18
Should I Order this Package?

Example: 1450-1017-ND

Example: 568-11903-1-ND
Why use SMT?

- Smaller size
- More modern standards
  - Some newer chips are ONLY offered as SMD
- Can have better electrical performance
- Better thermal dissipation
- Can be more cost effective
- Actually makes PCB design easier
  - And even soldering in many cases!
A Note About Adapters
Digi-Key BOM Management

- Can import CSV files directly into Digi-Key and Save as BOM
- When ready to order parts or boards, input number of assemblies, apply quantity savings, and checkout
- Altium even generates these CSVs automatically!!

Example: https://docs.google.com/spreadsheets/d/13QVVRw7uZ9rnPni03JKcmv87sZluv122-or00Bd0DLI/edit?usp=sharing