BME Design-Fall 2023 - REBECCA POOR
Complete Notebook

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Team contact Information

HUNTER BELTING - Sep 14, 2023, 9:52 AM CDT

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Project description

REBECCA POOR - Oct 10, 2023, 3:26 PM CDT

Course Number: BME 300

Project Name: Specialized Pads for Dual Sequential Defibrillation

Short Name: DSD Team

Project description/problem statement:

Cardiac arrest is a sudden loss of heart function that can be attributed to an abnormal electrical signal in the heart. Defibrillation is a technique used to deliver an electrical shock to the heart and revert it back to a sinus rhythm. During a cardiac arrest in which the patient is in ventricular fibrillation or ventricular tachycardia and has not responded to three standard defibrillation attempts or medication, Dual-Sequential Defibrillation (DSD) is a last resort method that can be used by healthcare providers to reset the patient's cardiac rhythm. In DSD, two electrical shocks are delivered to the heart in sequence and require the addition of a second set of defibrillation pads to the patient. Unfortunately, the Lund University Cardiopulmonary Assist System (LUCAS), a device used to provide high-quality cardiopulmonary resuscitation, makes it difficult to access multiple vector positions for additional defibrillation pad placement. Currently, healthcare professionals must remove the LUCAS device in order to place an additional set of pads. This project is focused on creating cardiac pads that allow for two shocks to be delivered to the patient through one defibrillation system. This product will eliminate the need for additional cardiac pads to be placed on the patient in the event that DSD is needed. By creating this new system for DSD implementation, medical providers will be able to easily initiate DSD during resuscitation efforts in which the LUCAS is in use.

About the client:

The client for this project is Dr. Mike Lohmeier. Dr. Lohmeier is an Emergency Medicine doctor at UW Hospital and previously managed a EMS service in Dane County.

2023/9/13: Client Meeting 1

Daisy Lang - Sep 14, 2023, 9:49 AM CDT

Title: Client Meeting 1

Date: 9/13/2023

Content by: Daisy Lang

Present: All

Goals: Today we met with our Client to learn about his vision for the the project. We will meet at the UW hospital and get to see the Lucas device and simulation labs. We will present our list of questions to the client to get a better grasp on the project design predications.

Content:

Questions for Client:

- Would the defibrillator ever be used without LUCAS also being attached to the patient?
  - If EMS witnessed it
  - Need to have a shockable rhythm
- Should this pad be approximately the same size as a standard defibrillation pad?
  - Large enough to fit both pad location with one set of pads, but not too large to limit size of pads' electrodes
- What are current workarounds for when protocols indicate DSD and LUCAS are in place?
  - Only workaround is to remove device and place new pads
- How often, if ever, is the decision made to remove LUCAS temporarily to place additional pads in the ventral/dorsal orientation for DSD to take place?
  - See above question
- Based on research there are three main theories, which one do you want us to use? Or do you have a different idea in mind?
  - Power Theory= administration of more joules during transthoracic defibrillation will allow for the conversion of all the monocytes out of RVF, Requires two currents from both defibrillators devices to be administered at the same time
  - Setting Up Theory = requires the two currents to be delivered close together but not as the same time,st current lowers the defibrillation threshold, increasing the second current's success at converting remaining fibrillation myocytes
  - Multiple Vector Theory = application of multiple defibrillator pads will increase the number of vectors used to reach the myocardium

PDS Related Questions:

- Price Range for project?
  - ~$500
- Who is using this product?
  - Emergency Medical Services (often times don't have 2 monitors in the field)
  - ED
  - Ambulance is the first on scene: by the time they get to ER they are very hard to bring back
  - Need to find a way to get around needing two monitors to get the two shocks
- Where will the product be stored?
- Size Specifications for the product
  - Doesn't think size matters as long as it can deliver the joules
  - Need to be placed on before the Lucas is added
- Will it be single use or multiple uses? How often will it be used?
  - Single used – used for one patient, but many shocks for one patient
  - This is a very rare case of cardiac arrest
- What current safety precautions are included in the current defibrillators used that we should be aware of and consider including in our design?

  - All Clear: can’t be wet, can’t be in water/puddle
  - Three people: chest compressions, ventilation, running monitor
  - Every 3 to 5 minutes the loops goes around
  - Some ome charges the monitor
  - Pulse check and rhythm check
  - If there is no pulse and no rhythm, the shock is delivered
  - All hands off → takes 10 seconds then loop starts again
- How precise does the time between shocks need to be?
  - He doesn’t know, doesn’t think that anyone knows this
  - Maybe we can just prove that it works
- Plugged into the wall or battery powered?
  - Battery powered device but has enough power – don’t need to worry
- How do you set up using a defibrillator? (Ergonomic restrictions while in use)
  - How does it need to fit around Lucas?
- What materials cannot be included in the product?
  - Shy away from latex
  - Can’t generate heat or spark
  - Pads have a gel that stick on to people really well
- Specific Colors or labeling system that needs to be followed?
- Other client opinions?
  - Like the ability to potentially just change vector
  - Likes the idea that you don’t need to think about when to use DSD, the fail safe will just initiate it after the designated number of defibrillators

Other Notes:

VFIB or VTACH

With 2 monitors it is called dual sequential defib

Hard because you either need two monitors

Switching to have manual switches would involve a whole new device

The monitors can deliver 200J

Worry about potentially hurting one of the devices

Want to prevent the breaks in chest compressions, this is why we don’t want to take off the Lucas

How many cases of dual sequential defibs?

Ideally have the choice between dual sequential defib and changing vectors.

May be able to have both in single device

Mostly wiring work – client said maybe mechanically slow down charge by adding lots of wire? May not work…

There are defibrillators (Tempest) that has a separate battery for the defibrillator

Have pads that can be used for testing!

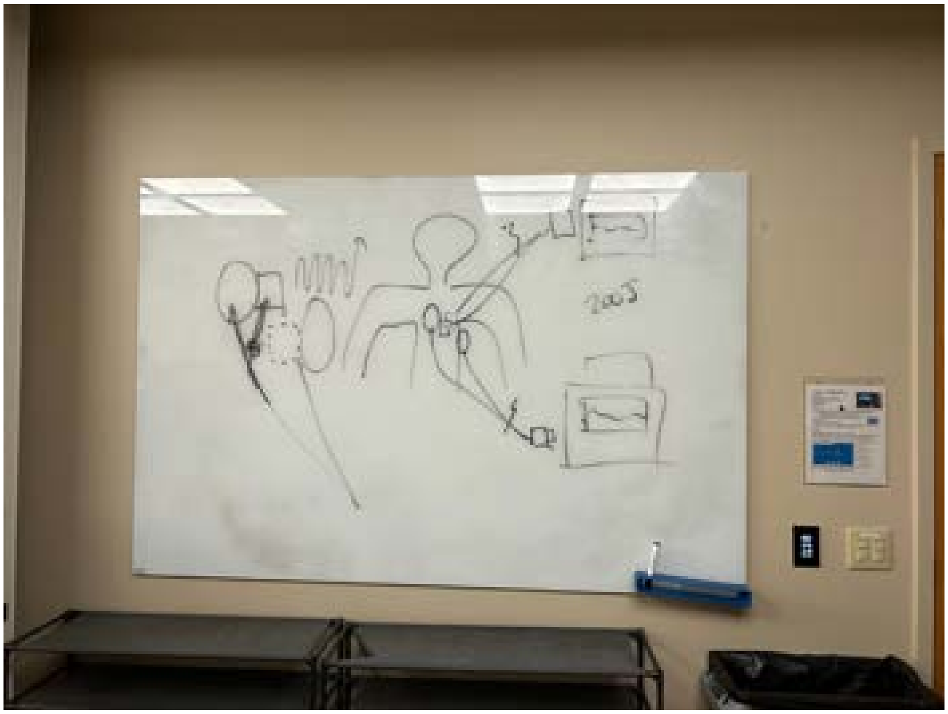
2 things that make a difference:

1. High quality chest compressions (interrupted)
2. Early access to defibrillation

Client think that there is no other product on the market like this

Client does not know of any literature to prove that DSD will work, thinks that this device could jump start some research

Picture From Client:



Conclusions/action items:

This was a very productive meeting with our client. Based on our conversation today, the team has developed two main goals for the semester.

1. We will develop a design for a two defibrillators pads connected as one
2. We we develop a circuit that can divide the voltage between the two pads. It will need to have a fail safe to the DSD is not initiated until after 3 defibrillators have been attempted. It will also need to have some sort of delay so that the defibrillators do not give the shock at the same time.

Our next steps will be to continue research on the current circuits used in defibrillators and techniques regarding DSD. We will meet with Dr. P on Friday to discuss our progress and get advice on our semester goals.

2023/9/28: Client Meeting 2

Daisy Lang - Sep 29, 2023, 9:02 AM CDT

Title: Client Meeting 1

Date: 9/28/23

Content by: Daisy Lang

Present: All

Goals: Today we will discuss our design ideas with our client and get his input. We also have a few questions about the direction of our project and need to make a decision regarding the path of our design.

Content:

Questions for Client:

1. What is the company that created the modular cardiac monitor you mentioned in our first meeting?
    a. Corpuls?
    b. Tempus
    c. Yes that is it
2. For dual sequential defibrillation, would you like us to tackle the problem thinking we only have one monitor and have to create a way to make the second shock, or can we assume that an additional monitor will be available
    a. Better to focus on second monitor available and then streamline that process rather than focusing on making a second monitor that is able to deliver shock
    b. Good idea about toggling between with box → Hunter's idea combined with Zoll general idea with the one combined pad
        i. Have 2 sets of pads to come out along with box too
        ii.
    c. Are LifePacks viable to use for 360/2 for 180 DSD
        i. Good idea → client likes splitting 360 and in sequence and more down line of what he is thinking
3. If we are unable to make a device to create a second shock and only one monitor is available, is it sufficient for us to create a method to change vectors and when an additional monitor is present switch to DSD?
    a. *Idea of just having 2 sets of pads and only using 1 and alternating vectors as needed until another monitor is available and then plugging them both to have full power to 2 sets of pads*
    b. *Generally along these lines combined with Hunter's idea*
    c. *Box is multiuse and pads per patient*
4. Do you know which is better, biphasic or monophasic, and if we were to create a way to shock, which should we use?
    a. If we can only create monophasic shock, is it even worth it?
5. Do we need to be able to switch which vector is shocked first during DSD with 2 monitors?

Big question:

Are you expecting us to create a device that is able **to create and deliver a second shock when an additional monitor/AED isn't present**, or are you asking for methods to **allow DSD to happen easier when 2 monitors are already present**?

- Communication between devices isn't a problem
    - Getting second device is tough
    - Making a standalone product that communicates is ideal but tough to make and budget
    - Makes more sense to integrate with second monitor — use with second monitor
        - But better than just two cables connected
    -

Choice: make defib or make pads and electrical circuitry to allow 2 to be easiest to work together

Design Presentation:

LIfe Pack Idea:

This would supply enough power to the two different sets of pads. He thinks it is clever and could work because they never give the full 360J and is onboard with splitting it into 180J.

3 out of 7 services use Life Pack.

Client favors this idea- seems more practical. Likes the idea of choosing between two vectors or DSD.

He thinks the adapter box should stay there the whole time.

If we build it, he has a lifepak we can test.

Modular Idea:

Company is called Tempas

Idea is to integrate the battery pack so we can deliver the shock

Gets around the need to calculator impedance and resistance

Main problem: too expensive

Wants to pads to be connected → more user friendly

We need to look into the best size of pads in order to fit all four and still prevent overlap and let the LUCAS stay in place.

I Want to have buttons for switching between the options on the device.

Likes the modular idea between vector switch and DSD so it can help with

Clients will look to see if 100J is enough to be effective

Conclusion:

From input on our client, we decided the Life Pack Design was the best. He likes this idea the best and approves our idea to design our adapter for just the the Life Pack Monitor. Also, he really likes the idea of the modular aspect of the design that allows for vector change or DSD. Moving forward, we will create our design matrix and evaluate our designs. Also, we will consult Dr. N for circuit advice.

2023/9/22: Design Discussion 1

Daisy Lang - Sep 22, 2023, 9:51 AM CDT

Title: Design Discussion 1

Date: 9/22/2023

Content by: Daisy Lang

Present: Becca, Nick, Hunter, Jack, Maribel

Goals: We will discuss our individual design our ideas and funnel our ideas in a cohesive direction. We will make a semester outline for how we need to proceed.

Content:

BIG IDEA: the second set of pads doesn't need to have a complex monitor system that the reads the heart as long as we already have a monitor that is reading the heart connected to the first set of pads, it just needs to be able to deliver the shocks

Maribel: Idea for a button to initiate the second shock, light will go on when the time of DSD is acceptable and off when the time range has passed (safety)

Jake and Daisy: make a set of pads so that all 4 vectors are accounted for in the one set of pads, ability to switch the current flow in between the two sets --> allow for vector change with out

Plan of Action: want to build a circuit that could work for proof of concept with our worrying about the

- ONE: Meet with Client and ask final questions
- TWO: Decide on three designs based on that
- THREE: Consult Faculty in Bioinstrumentation for advice on projects

Main Ideas:

- Just Pads
- Can we use the "just shock machine" - Modular
- Switch
- LED
- Light indicator method

Conclusions/action items:

We decided on a few core ideas to present to our client. We have decided that we want to make our project

2023/9/29: Circuit Discussion

REBECCA POOR - Sep 29, 2023, 2:27 PM CDT

Title: Circuit Discussion

Date: 9/29/2023

Content by: Becca

Present: Becca, Hunter, Daisy

Goals: We are discussing our original circuit idea and design idea to Dr. Nimunkar to discuss if it is a feasible idea.

Content:

Is this feasible?

YES

How is our black box going to measure impedance and relay this information to the monitor? Is it an option to have a set impedance that our black box has and will use for all patients? Is it an option to sector out the impedance cord and not run it through our black box, just run it directly from the monitor to the pads?

allowing two pads for the current to flow, assuming that it is half and half, that is enough.

How do we incorporate buttons to switch between vectors and DSD? How does this affect our circuitry?

The button could be connected into the circuit. It would be easy to integrate that into the design idea. It would close one of the circuits or open it depending on what vector we wanted to do. If we did DSD then both of the circuits was open. The placement of the circuit switch will change based on what we want.

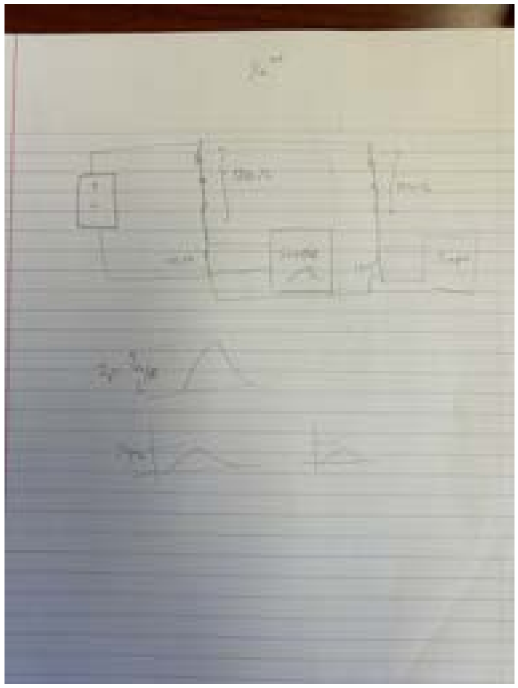
Will the defibrillator read it is a closed circuit even with our circuitry between the pads and the monitor?

The monitor will send a small amount of really high current and this will make a high volateg. We have to make sure that the connections is turned on so that the cycle still runs correctly.

Conclusions/action items:

Our magic black box idea is feasible! YEY! We will have to move forward with the

Daisy Lang - Oct 04, 2023, 1:34 PM CDT



Download

IMG_1838.jpg (2.3 MB) Example Circuit Drawn By Dr. N to show us how we can test the circuit and see how voltage can be split across the circuit.

2023/10/06: Preliminary Presentations

REBECCA POOR - Oct 06, 2023, 12:10 PM CDT

Title: Preliminary Presentations

Date: 10/06/2023

Content by: Becca

Present: entire team

Goals: To share our preliminary designs and findings with other teams in the BME department.

Content:

talked through our design and presentation slides to the client, advisors, and other students in the BME department

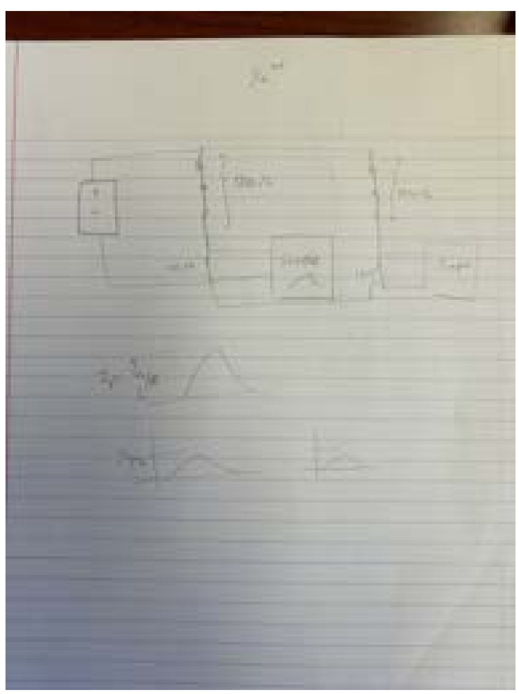
received questions regarding our presentation and designs

listened to other groups present their projects and preliminary slides

Conclusions/action items:

The presentation went well and we successfully presented our designs and ideas. The next steps are to start developing the circuit design.

REBECCA POOR - Oct 06, 2023, 12:04 PM CDT



Download

IMG_1838.jpg (2.3 MB) Example Circuit Drawn By Dr. N to show us how we can test the circuit and see how voltage can be split across the circuit.

2023/10/15 - Circuit Design Brainstorm

REBECCA POOR - Oct 17, 2023, 9:59 PM CDT

Title: Circuit Design Brainstorm team meeting

Date: 10/15/2023

Content by: Becca

Present: Entire Team

Goals: To understand more about the circuit design and create a list of questions for Dr. N

Content:

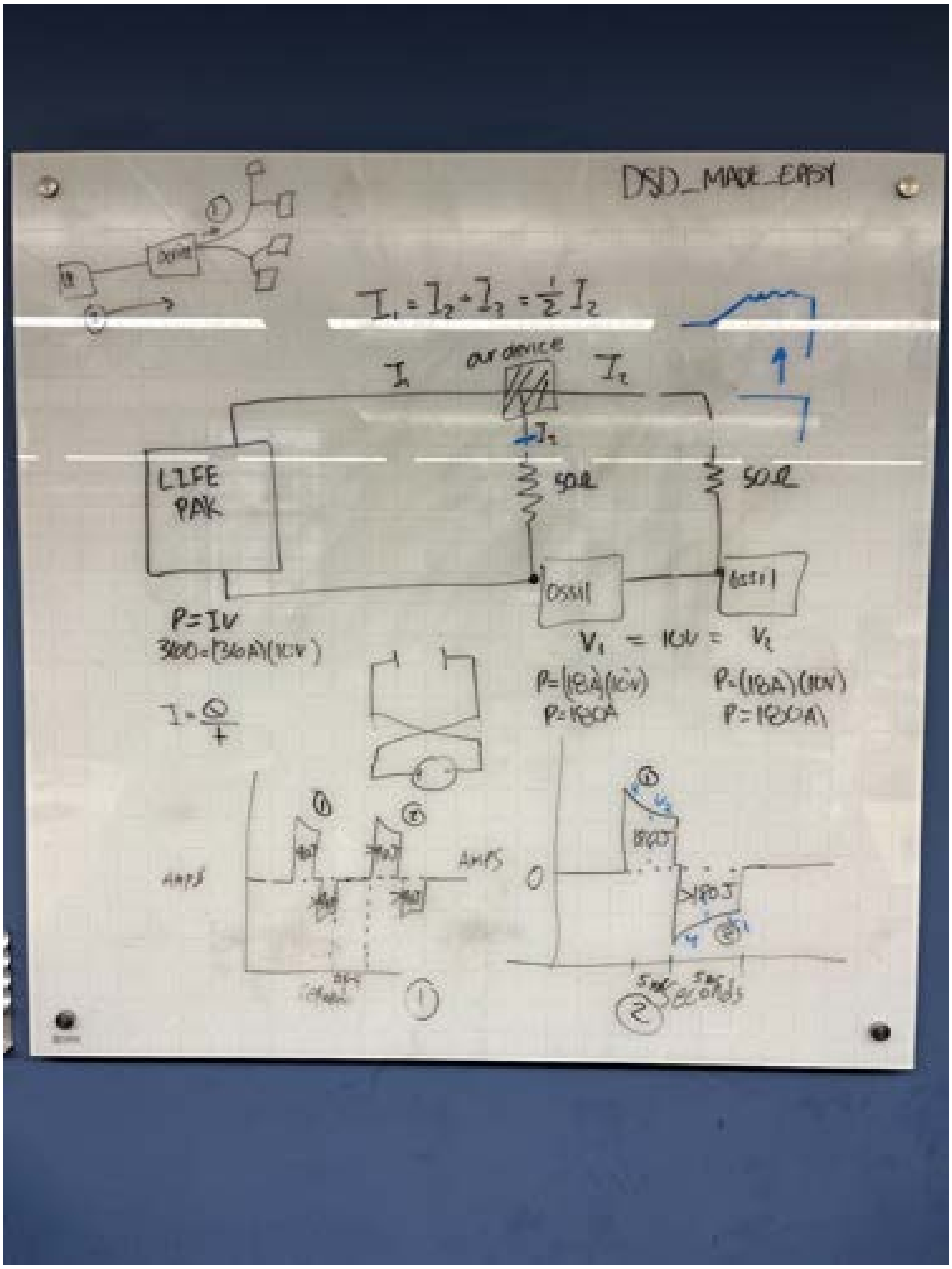
Questions for Dr. N:

Two Ideas:

- One side of the circuit open for 8 ms and then the other open for 8 ms (monophasic) (top picture)
    - Main question: what do we use for a time delay
- Use two H Bridges to split the depolarization and repolarization between the two vectors so that it keeps a biphasic shock (Bottom picture)
    - Is the monitor going to freak out with the H bridge for when there is supposed to be current running through it and there isn't

General questions:

- What idea does he have for a time delay?
- Is there a risk of the shock jumping between pads if we have simultaneous shocks?
    - Do we even need to worry about a time delay?



Conclusions/action items:

The team came up with multiple good ideas that we find feasible for this project and would fill the clients goals. The next step is to take these well defined ideas and "pitch" them to Dr. N to receive feedback about them. From there we want to start building a circuit so we are prepared to share for the show and tell presentation.

2023/10/22 - Beginning Step of Building Circuit

REBECCA POOR - Oct 22, 2023, 3:30 PM CDT

Title: Beginning Steps of Building the Circuit

Date: 10/22/2023

Content by: Becca

Present: Entire Team

Goals: To create a basic design/prototype for the show and tell

Content:

Pads Portion:

- want to see if it is still feasible for the physician to place the pads on the patient if they are in two big pads for both vectors instead of 4 individual pads

- for each "big pad" have a connector for the wire (potentially) like electrical tape to only have one wire from each pad instead of 4

- at each connect the wires would split so it made it easy to connect to the device

- a piece of foam the adequete size would be placed between the two pads on the front and a piece between the two pads on the back to allow for single placement

Conclusions/action items:

REBECCA POOR - Oct 22, 2023, 3:31 PM CDT

[Download]

Show_and_Tell_goals.pdf (14 MB)

2023/11/03- Show and Tell Prep

REBECCA POOR - Nov 03, 2023, 9:20 AM CDT

Title: Show and Tell Prep

Date: 11/03/2023

Content by: Cultivate our elevator pitch

Present: Team

Goals: To understand what the project encompasses.

Content:

Project is specialized pads for dual sequential defibrillation. The goal is to create two sequential shocks that are .5-2 msec apart. This is used to help increase the chance that someone can return to normal rhythm when they are in cardiac arrest.

Pads: two sets of pads, on the front of the patient there will be

Adaptors: can harvest a male lifepak pads adaptor to put into the defib, we will use a zoll to philips adaptor and harvest the one side of it to use as the female end for the device and for the pads to plug into

Circuit: using diodes, the diode can read the positive and negative voltage, when there is positive it will pass through one path and when it is negative it will pass through another path using the diodes.

Conclusions/action items:

Present this afternoon

2023/11/03- Show and Tell Feedback

REBECCA POOR - Nov 03, 2023, 1:46 PM CDT

Title: Show and Tell

Date: 11/03/2023

Content by: Becca

Present: Entire Team

Goals: Receive feedback from other teams regarding our prototype

Content:

Look into UL for testing with the circuit components to handle the high amount of voltage

look at current devices to see what technology they use

Direct sodering.

Conclusions/action items:

Overall we can look into direct sodering and how this would affect being able to switch between DSD and the vectors. We are going to also look into UL the company and how it works.

2023/11/05- Circuit Components Meeting

REBECCA POOR - Nov 05, 2023, 12:04 PM CST

Title: Circuit Components

Date: 11/05/2023

Content by: Becca

Present: Becca, Hunter, Jack, Nick, Daisy

Goals: To find circuit components that can withstand the high volatge that we are sending through the circuit.

Content:

- found diodes on digikey that can withstand 2200V and 30 Amps

- using pads to harvest the adaptors needed between the project box and the defibrillator

- currently stuck on a switch or button that can withstand the amount of voltage and current that we need to send through it

- we are planning on ordering some components of the project today (emailing them to the client) so that we can begin constructing the circuit

Conclusions/action items:

We need to meet with the makerspace again to look into and get advice regarding the switch problem. Once we know the size of the buttons then we can move forward and find a project box that fits the buttons.

2023/9/29: Advisor Meeting 2

Daisy Lang - Sep 29, 2023, 9:25 AM CDT

Title: Advisor Meeting 2

Date: 9/29/2023

Content by: Daisy

Present: All

Goals: Today we will meet with Dr. P and present our current design ideas. We will get his advice and incorporate it into our design matrix and preliminary presentation.

Content:

LED Design Presentation:

- Suggests that we meet with Dr. N
- Explained that we can't solve the problem of two monitors, new idea is to use one monitor as easily as possible
- Incorporate the number 120J minimum in our PDS
- Provide standard defibrillation numbers and ranges in our PDS (don't focus on the magic 200 number as much)
- We have an idea for pads, but not the main focus of the project for the semester
    - Adjust the PDS to match our new focus
- SCOPE FOR THE SEMESTER: making the black box :)

3 Ideas:

1. LED
2. Interface
3. BYO Monitor

Design Matrix:

- Include Feasibility
- Need to talk to Dr. N before the presentation next Friday (3355 Engineering Hall)
- Include the South Korean patent picture in our competing designs section of the presentation

Conclusions/action items:

One of the main points Dr. P made was that we need to update our PDS to match our new project focus for the semester. There were many quantifying details we mentioned with our new direction that need to be added to the PDS so readers can better understand our project. Moving forward we need to meet with Dr. N prior to our presentation next friday to determine disability.

2023/10/13- Advisor Meeting

REBECCA POOR - Oct 13, 2023, 3:33 PM CDT

Title: Advisor Meeting

Date: 10/13/2023

Content by: Becca

Present: Team and Dr. Puccinelli and Tyler Ross

Goals: To check in with advisors after preliminary deliverables

Content:

- No big concerns currently
- Big question: what are the next steps?
  - Meet with Dr. N so that we can make a circuit diagram on LTspice
  - Touch base with the client to get access to the LIFEPAK monitor
  - Start ordering parts for the circuit in a week so we can have a design for the show and tell
- Make sure to have the progress reports uploaded to the website before meeting with advisor
- CC Dr. P and Tyler on the emails to the client with the progress report
- Any problems we see add to the progress report when it comes to the circuit design
- Daisy - mentioned splitting the team into two groups so that some can work on the pads and some can work on the circuit design
- In terms of the pads want an insulating piece to connect the pieces together
- In terms of the pads connector just cut off the pads and then attach to an attachment we can buy so that the pads are easily connected to the project box
- For seen problems: IMPEDANCE, this will be determined once the circuit design begins
- Idea is for the team to create the circuit and then bring to Dr. N with idea and questions to receive feedback
- Idea is to go to the Emergency Education Center, bring a voltmeter, then just run the defibrillator connected to a manikin and then see how much voltage is going
- Get some measurements off the LIFEPAK retired monitor as soon as possible to help create the circuit design

Conclusions/action items:

The meeting was successful in sharing the teams current standings and future plans for work on the design itself. The next steps are to meet with Dr. N and create the circuit so that we can test at the EEC.

2023/10/20- Advisor Meeting

REBECCA POOR - Oct 20, 2023, 9:23 AM CDT

Title: Advisor Meeting

Date: 10/20/2023

Content by: Becca

Present: Team and Tyler Ross

Goals: To check in with advisor about the process of our design

Content:

- we met with Dr. N yesterday and there are two main concerns with our initial design
  - risk causing an electrical shock instead of a defibrillator shock
  - no way to cause a time delay with AC
- Dr. N had some suggestion ideas but many of them have some problems when it comes to the execution
- We have some other ideas but we will have to test if they are feasible but we will need some future testing to move forward
- we are hitting a point in the semester where we are realizing that the project is much more complex than what we realized
- In terms of the project we are still interested in splitting the current from one monitor, we need to look into the delay period
  - two delay periods: .5 -2 sec, as low as 10 ms to 70 ms
  - the two times refer to two situations
  - the .5-2 sec is when you are using two monitors but the 10ms to 70ms is if we are using one monitor
  - if we put the shock through all four pads at once then there is a chance it could jump between the pads and burn the patient
- potentially using a microcontroller to switch between vectors
- a microcontroller could detect the shock and would be able to switch vectors within the time constraint
  - sense that it started and then wait this time length, and then switch the vector
  - since we will always be doing DSD at 360 joules then we should be able to hard code the microcontroller
  - another question: with the single shock there are two phases, with DSD do we want the phases?
    - we were trying to take the positive and split into positive negative but that won't work
    - instead of flipping the positive and negative we will split between the vectors, reduce complexity by one level
- We will ultimately have to decide how we want to move forward
- We have a good set of ideas and how we want to move forward with some devices
- Liked the third design, have a power bank and then will deliver a second shock

Conclusions/action items:

2023/10/19: Meeting with Dr. N

Daisy Lang - Oct 22, 2023, 9:15 PM CDT

Title: Meeting with Dr. N

Date: 10/19/2021

Content by: Daisy

Present: Nick and Jack

Goals: Today we will present our H-Bridge Idea to Dr. N and get his input. We will guide the next steps on out project based on his feedback.

Content:

We presented the design attached to this note to Dr.N and he told us that he did not think it is possible to split the current from one defibrillator and deliver it in two shocks safely. He explained that there is a very narrow ratio for which we can deliver the 360J safely to the patient. There is a specific ratio of voltage to current that can depolarize the cells. Any other combination could not cause depolarization and would just be an electrical current through the heart and would harm the patient.

Dr. N suggested that we look into proving the concept that the current can be split from the defibrillator. He thinks that we can start with making a mock model of the circuit and supply a small power source to the device to find a way to split the circuit. Additionally, he said he would help us make a model so we can discharge the defib machine into our circuit.

Conclusions/action items:

Our next step will be to make start making a mock circuit for show and tell so we can have a better idea of what components we will need. We also think we should spend more energy working on the pads and the adaptors needed for our project. In our next team meeting, Jack Nick and I will talk to the rest of the team about our meeting with Dr. N and make a plan to split in to teams to accomplish more in our project.

2023/11/10 - Advisor Check In

REBECCA POOR - Nov 10, 2023, 9:28 AM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Advisor Check In

Date: 11/10/2023

Content by: Becca

Present: Team and Dr. P and Tyler Ross

Goals: To check in with Dr. P and Tyler on our progress

Content:

- gave update on the current progress made which includes ordering pieces for the circuit and adaptors
- direct solder the components of the circuit once they all ship
- hopefully the parts are shipped this next week
- there are boxes in the storage closet in the BME room
- We will meet next Friday, we won't meet the week of Thanksgiving, then two weeks after we have the poster session
- Want to make sure we have testing scheduled
- Get going on testing protocols, writing them
- Try and test the Monday or Tuesday after Thanksgiving
- For testing measure the voltage at each location over several tests, use a T test to make sure they are not significantly different
- Should be able to run over and over (a dozen to 2 dozen times)
- Potentially look at the time difference between shocks, try and find the standard deviation between those
- When using single shock is it working correctly, are we keeping the current system the same/safe?
- As for the notebook we can continue to log in the individual notebook

Conclusions/action items:

We are making good process on the project but we need to make sure we stay on top of the ordering and fabrication. Try and schedule the testing right away so that after thanksgiving we aren't rushed towards the end of the semester.

2023/11/17- Advisor Meeting

REBECCA POOR - Nov 17, 2023, 9:34 AM CST

Title: Advisor Meeting

Date: 11/17/2023

Content by: Becca

Present: Becca, Maribel, Hunter, Nick

Goals: To review the progress from the past week and receive feedback on some temporary problems.

Content:

- at the makerspace they have a 3d scanner so it will scan a product and then will transfer it to a scan so that we can 3D print

- the adaptor can then be added to the project box and integrated into it

- take the current defibrillator as it is and run the testing protocal so that we know what data to collect and how to collect

- look into getting a multimeter that can measure the data when we do our testing

- on the website the poster presentation schedule is posted

- we are welcome to send the poster presentation schedule to our client

- CHECK FOR POWER!! by where we are for the poster session

- for the poster session have a video of the testing we did

- use the LED design we used for the show and tell

- they are happy to look at the poster!! Send by TUESDAY of the week

- get to college library by thursday at 5PM for printing the poster

Conclusions/action items:

Continue working!

2023/12/01- Advisor Meeting

REBECCA POOR - Dec 03, 2023, 11:18 AM CST

Title: Advisor Meeting

Date: 11/17/2023

Content by: Becca

Present: Becca, Maribel, Hunter, Nick, Jack

Goals: To review the progress from the past week and receive feedback on some temporary problems.

Content:

- need to find a time to meet with Dr. P and Tyler the week of finals week, after the poster presentation

- what's the best way to choose the statistically significant value to compare the arch of the switches to? try and find research that is the set minimum value allowed for it

can also create a standard deviation between the values and prove that it is not statistaiclly different

also show that humidity or noise is causing this arch (showing that it is so negligable)

Work out on paper how we can fix the switches being in weird directions, so if something is in the wrong position then it won't break or cause damage, this just needs to be on paper for the final report

- Contacter (needs to be powered)

Fix the drilled out nicer (fix the lid of the box) is the only portion for the final design prior to the presentation (make the switches all go one direction so flip one around)

As for the final report (have a safer fix for the switches so that it doesn't get mixed up)

For the report

Path 1 for pad 1 with the flow

Path 2 for pad 2 with the flow

Path 3 for DSD with the flow

Conclusions/action items:

Test each aspect of the project to ensure that it works! Continue working on the poster.

2023/11/30: Final Circuit Design

Daisy Lang - Nov 30, 2023, 10:35 PM CST

Title: Final Circuit Design

Date: 11/30/2023

Content by: Daisy

Present: N/A

Goals: Today I will document the final design we will use for our circuit. The design will consist of two diodes and three switched. The hand made and electronic schematics are included in this entry.

Content:

<u>Circuit Diagram:</u>

The plan is to incorporate three separate switches into the circuit and have three pathways:

1. Normal Defibrillation path: this path leads only to Pads 1 and bypasses the diode circuit. This path is connected to the central power line and the central ground on the front end of the switch. On the back end of the switch, the wired combine with the wires from the positive diode path and lead to pads 1.

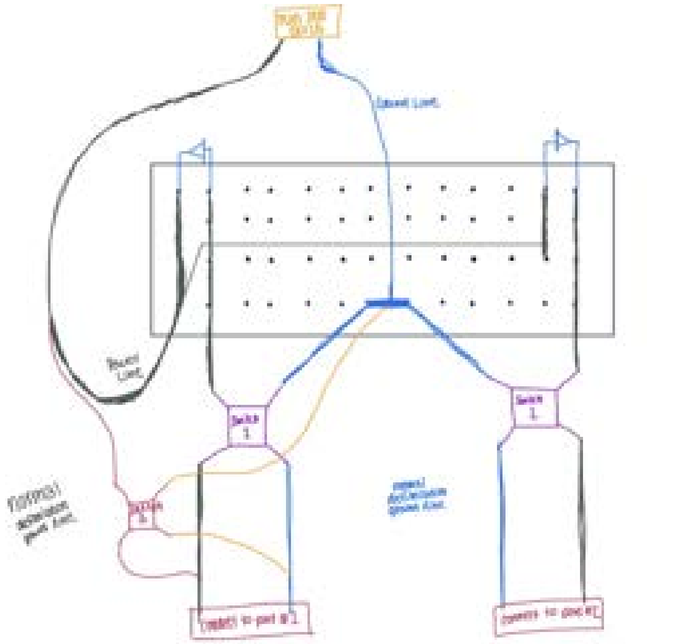
2. The Positive Diode path: leads to path 1

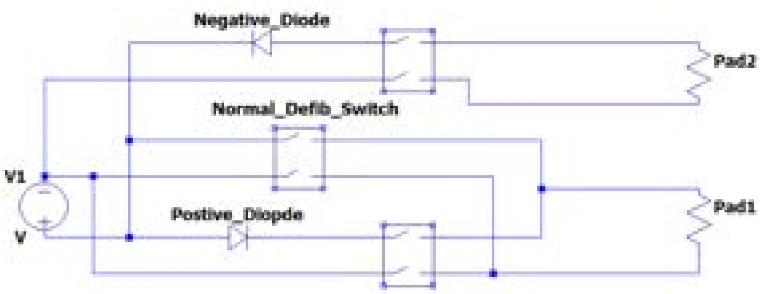
3. The Negative Diode path: leads to path 2

There are two possible configurations with in the switch:

1. The switch to the normal defibrillation path is open, and both DSD switches are closed

2. The switch to the normal defibrillation path is close, and both DSD switches are open





In the design, the postive diode path and the normal defibrillation switch lead to the same pad (Pad1). The Negative Diode Switch leads to pad 2. Three paths all share the same postive power line and the same ground line. The Voltage source is meant to represent the defibrillator monitor. The switches used are single throw double pull switches. We decided to not add the second set of diodes to simplify the fabrication process. The second set of diodes was only a safety measure, and given that there is very little current leak, we do not see the need for them.

When the diode switches are closed, DSD is initiated.

When the normal defib switch is close, the current will bypass the diodes and deliver the full shock through path one.

Conclusions/action items:

We as a team are happy with this final design and believe that we can fabricate it in the Team Lab. We will show this design to the makerspace expert and learn how to solder the wires together. We have a few more pieces we need to purchase, but we can but these at the maker space.

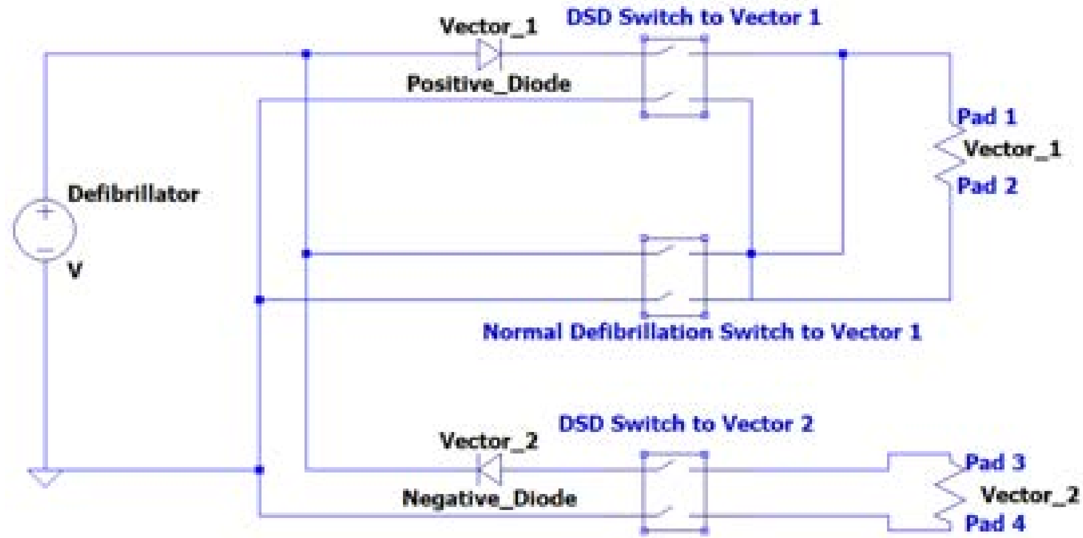
Daisy Lang - Dec 07, 2023, 10:57 AM CST

Updated Circuit Diagram:

Nothing has changed in the design, this is just a more organized diagram

Pads 1 and 2: Vector 1

Pads 3 and 4: Vector 2



2023/11/5: Voltage Calculations

Daisy Lang - Nov 05, 2023, 12:15 PM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Voltage Calculations

Date: 11/5/2023

Content by: Daisy

Present: All

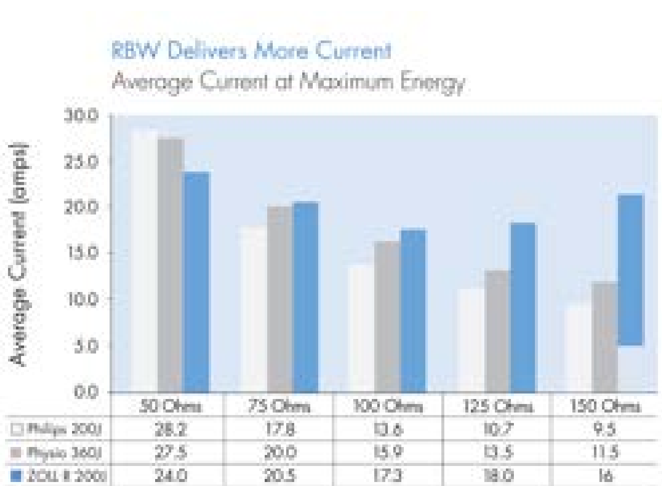
Goals: Using the Zoll Study found by Jack, we will calculate the maximum and minimum voltage that will be sent through our circuit.

Search Term: "LIFEPACK 15 Current"

Link:
https://www.zoll.com/-/media/uploadedfiles/public_site/forms/highcurrentvshighenergy_whitepaper_0712_v1.ashx

Content:

We used this graph get the average currents for the LIFEPAK at 360J. We are using the fact that the LIFEPAK 15 shock duration is on average 12ms.

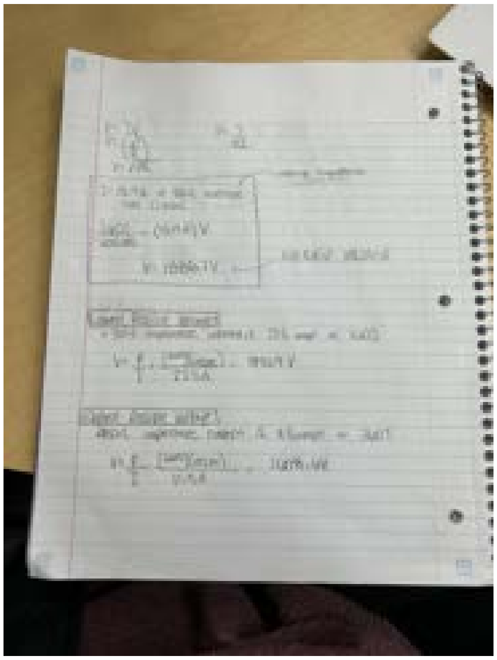


<u>Based on these values, we have:</u>

Min Voltage = 1090.9 V

Average Voltage = 1886.7 V

Max Voltage = 2608.6V



Conclusions/action items:

With these calculations in mind, we need to find parts for the project that can handle these high voltages. We will design the device around the average voltage at the 100 ohm impedance to start. The next step is to meet with a Makerspace expert to check these calculations are valid and too get assistance in finding parts.

Daisy Lang - Nov 05, 2023, 12:04 PM CST

High-Current vs. High-Energy Biphasic

Which One Matters Most?

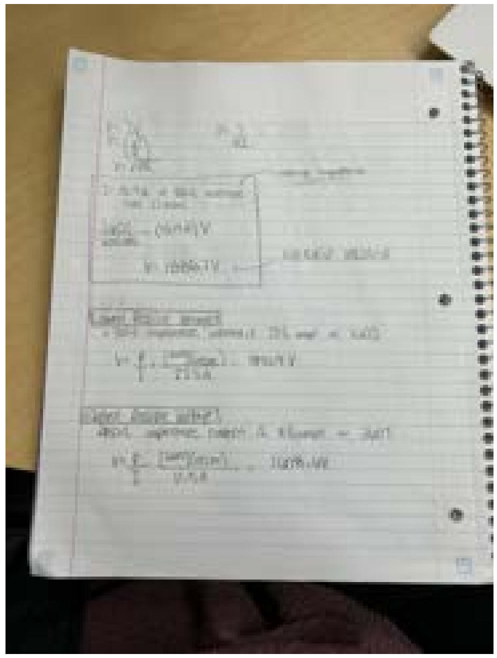
Introduction

The Scientific Evidence is Clear

[Download](#)

highcurrentvshighenergy_whitepaper_0712_v1.pdf (832 kB)

Daisy Lang - Nov 30, 2023, 12:02 PM CST



Download

1699207118674.png (3.48 MB)

2023/11/30: Circuit Materials

Daisy Lang - Nov 30, 2023, 10:45 PM CST

Title: Circuit Materials

Date: 11/30/2023

Content by: Daisy

Present: NA

Goals: Today I will document the materials that we will use to fabricate the circuit.

Content:

All materials were purchased from sparkfun, LIFEPAK, or the UW makerspace.

1. One 14 gauge perf board that is 3in x .5in

2. Two sets of LIFEPAK defibrillation pads. All wires used in this circuit will be harvested from these pads.

3. Two diodes: rated for 2000 V of energy

4. Three single throw double pull switches: rated for 2000V

5. Heat Shrink: 6 pieces around .5cm in diameter.

Conclusions/action items:

A more exhaustive and detailed list of our materials can be found in the final expense report, but this is a documentation of what is used in our circuit design.

2023/11/29: Project Box Materials

REBECCA POOR - Dec 03, 2023, 12:36 PM CST

Title: Project Box Materials

Date: 11/39/2023

Content by: Becca

Present: NA

Goals: Today I will document the materials that we will use to fabricate the project box.

Content:

All materials were purchased from UW makerspace.

1. super glue (.11oz)

2. Project Box

3. 12, 8-32 1/2 inch screws

4. 12, 8-32 nuts

Conclusions/action items:

A more exhaustive and detailed list of our materials can be found in the final expense report, but this is a documentation of what is used in our project box design.

12/13/2023: Final Expenses

Nick Johnson - Dec 13, 2023, 6:40 PM CST

Title: Final Expenses

Date: 12/13/2023

Content by: Nick Johnson (BPAG)

Present: Whole group

Goals: Document the total expenses of the project and make sure we were within budget.

Content:

Order Number	Item To Order	Purpose	Amount	Price Individual	Total Price
1	Adult "Leads-Out" Defib Pads for Physio Quik Combo for LifePak	TO harvest male lifepak leads	2	38.44	76.88
2	DIODE GEN PURP 2.2KV 30A TO220AC	To create two seperate shocks for DSD	4	4.55	18.2
3	ZOLL® Electrode to Physio QUIK-COMBO Adaptor	Adapter to get female end of zoll pads	3	49	147
4	Hinges	Connect Switches to Box	6	1.75	10.5
5	Screws and Nuts	Connect Switches to Box	24	0.1	2.4
6	Hot Glue	Connect Switches to Box	1	1.15	1.15
7	Heat Shrink	Protect wires inside circuit box	1	2.25	2.25
8	Printed Circuit Board	Solder diodes to	1	1	1
9	Black Project Box	Project Circuit from Users	1	9	9
10	Toggle Switch DPST Panel Mount	3 Switches for the design	3	29.56	88.68
			Total Price:		357.06

Conclusions/action items: The group spent a total of 357.06 which was $142.94 below the total budge of $500 given to us by the client.

Nick Johnson - Dec 13, 2023, 6:40 PM CST

Download

Screenshot_2023-12-13_182924.png (99.6 kB)

2023/11/29-30: Circuit Fabrication

Daisy Lang - Dec 01, 2023, 7:51 PM CST

Title: Circuit Fabrication

Date: 11/29/2023- 11/30/2023

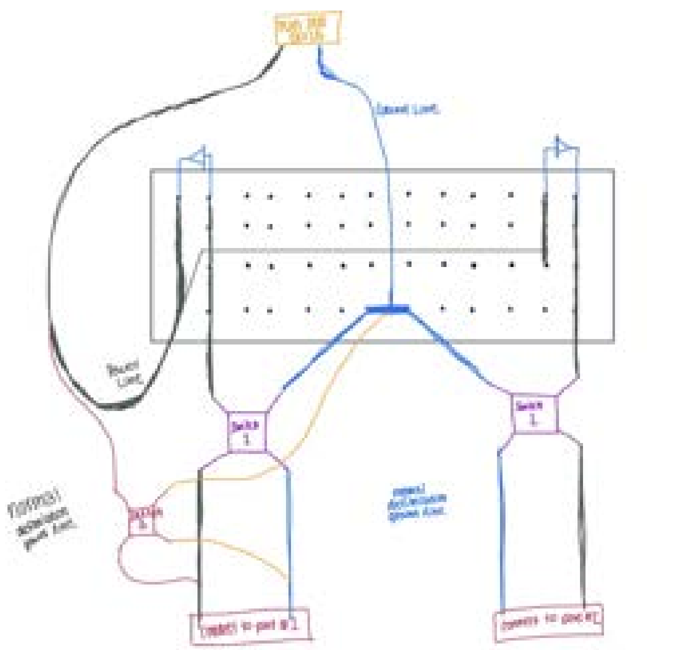
Content by: Daisy, Becca

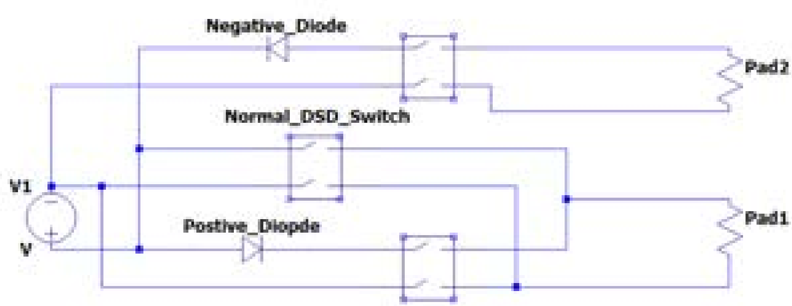
Present: All

Goals: Today we will meet with an expert in the TeamLab to work on fabrication of our circuit and learn how to solder. Our goal is to assemble the circuit today to be ready for testing on Friday in the education center.

Content:

Circuit Diagram:





Materials:

1. One 14 gauge perf board that is 3in x .5in

2. Two sets of LIFEPAK defibrillator pads. All wires used in this circuit will be harvested from these pads.

3. Two diodes: rated for 2000 V of energy

4. Three single throw double pull switches: rated for 2000V

5. Heat Shrink: 6 pieces around .5cm in diameter.

6. Solder Wire

<u>Equipment:</u>

1. Safety Glasses

2. Soldering Wand

3. Heat Gun

4. Wire Cutter

5. 14 Gauge Wire Stripper

<u>Steps to Fabrication:</u>

1. Take the LIFEPAK pads and using the wire cutter, remove the pads from the wires.
2. Separate the wires from each other into a wire wire and blue wire, leaving the defibrator plug-in intact.
3. Using the wire cutter, cut 8, 3 inch long pieces of both white and blue wire.
4. Using the 14 guage wire stipping tool, strip off .25 in of the plastic coating on each end of the wire.
5. Using the 14 gauge wire stripping tool, strip off .25 in of the plastic coating off the blue and white wires that are still attached to the defibrillator connector.
6. CONNECTING THE CENTRAL GROUND WIRES:
    1. Collect three of the 3 inch blue wires and the blue wire that is connected to the defibrillator connector
    2. Fan out the exposed wires ends on one end of each of the small blue wires wires and the defibrillator connector wire
    3. Mesh the fanned ends together and twist them
    4. Using the solder wand and solder, solder together the new wire connection
    5. Slide a 1 cm diameter heat shrink tube up the wire and use the heat gun seal the heat shrink around the wire connect you just soldered
7. CONNETING THE CENTRAL POWER WIRES AND POSITIVE DIODE:
    1. Take the white wire that is connected to the defibrillator connector and seperate the exposed end into three sections
    2. Twist each section and slide the three sections through the three holes on the second to last row on the left end of the perf board (this step is only needed if you do not have 14 gauge wire perf board)
    3. On the bottom side of the perf board, twist the ends of the wire together and lie them flat on the surface of the perf board
    4. Saluter the ends of the wire flat to the bottom of the perf board
    5. In the same line that you just added the white wire, place the first diode in the postive orientation
    6. Bend the end of the diode so that is lays flat on the perf board
    7. Take a 2 pieces of the 3 in white wire and follow steps 2-3 to add one end of each of these wires to the lines directly adjacent to the wire from the defibrillator connector.

    8. Use the solder wire to saulter together the wire from the defibrillator connector, the diode, and the two short wires that have been added to the solder board.
8. ADDING THE NEGATIVE DIOPDE:
    1. Take the second diode and add it to the right side of the board and in the opposite orientation to the first diode
    2. Fold the pongs of the diode flat on to the back side of the perf board.
    3. Take one of the short white wired that is connected to the power line and twist the end into three sections
    4. Feed the three section of the wire through the perf board in the line adjacent to the negative diode and solder the ends of the wire to the diode.
9. ADDING THE OUTGOING POWER WIRES TO THE DIODES:
    1. If you have not already, fold the second prong on both of the diodes down so it lays flat against the perf board
    2. Take two 3 inch white wires and twist them into three pieces and slide them into the board (one in each line adjacent to the diode prong that you just folded down).
    3. Solder the wired to the end of th diode prong.
    4. Now you should have both diodes soldered to your board and three short wires coming out from the board.
10. CONNECTING THE SWITCHES:
    1. Take the three switches and line them up so they are in the same orientation (on/off are facing in the same direction)
    2. The switches connect paths across their long side
    3. For each switch, connect one of the white wires coming out from the board to the prong on the left side of the switch on the side closest to the perf board using solder.
    4. For each switch, take one of the blue wires from the ground connection and connect it to the prong on the right side of the switch on the side closest to the perf board using solder.
11. CONNECTING THE NEGATIVE DIODE TO PAD 2:
    1. Taking the switch that is connected to the negative diode, solder a 3 in white wire to the left side of the switch on the side further away from the perf board and do the same for a 3 in blue wire on the right side.
    2. On the switch, the white wires will be on the same side and the blue wires will be on the other side.
    3. Solder the ends of the wires leaving the switch to the metal prongs in the adaptors.
    4. The path to pad 2 is now complete.
12. CONNECTING THE NORMAL DEFIB AND POSITIVE DIODE PATH TO PAD 1:
    1. For both the switches, follow steps 1 and 2 in step 11 to attach the outgoing wires.
    2. Take the outgoing white wires and fan out the wires in their exposed end.
    3. Take the last 3 in white wire and fan out the wire in one of the exposed ends.
    4. Twist the three white wires together and solder.
    5. Add heat shrink over the connection and melt it using the heat gun.
    6. Follow steps 2-5 but for the blue wires.
    7. Now the outputs of both of the switches should be connected.
    8. Solder the blue and white wires to the adaptor to pad 1.
13. Now all the connections within the switch are complete.
14. The switch can be added to the project box and the switches secured following the project box protocol.

Conclusions/action items:

This protocol is used to create the circuit element. The circuit and switches can be added to the project box following the project box protocol. I will show this protocol to my teammates for any needed revisions. Next steps included adding the cricut to the project box and a testing it in the education center.

2023/11/29- Pad Fabrication

REBECCA POOR - Dec 03, 2023, 12:15 PM CST

Title: Pads Fabrication

Date: 11/29/2023

Content by: Becca

Present: All

Goals: To attatch the pads together to simplify the combination of parts.

Content:

1. place the front pads together, when looking at the pads, the pad on the left should be horizontal in direction and the second pad to the right should be vertical
2. place the pad on the right (the vertical pad) one inch overlap on the horizontal pad so that only the foam is overlapping
3. take superglue and combine the pads together by placing glue on the back of the vertical pad and sticking to the top of the pad on the left
4. take each wire that is coming out of each pad and hold them together till reaching the base of the connections
5. super glue the wires together from where the wire starts at the pads and until where they combine with other wires, 2 ft from the pads
6. grab each pad plug adaptor and stack them on top of each other so that the horizontal faces are on top of each other
7. go down the wires 6 inches from where they connect to the plug in and place some glue at this point so that the wider portions of the wires are on top of each other and connected
8. from that point and towards the pads glue together the two wires till they meet the junction where they split apart

Conclusions/action items:

To fabricate the system to ensure it is easy to apply. Receive feedback from medical professionals to ensure that the system is being simplified

2023/11/29- Project Box Fabrication

REBECCA POOR - Dec 03, 2023, 12:32 PM CST

Title: Project Box Fabrication

Date: 11/29/2023

Content by: Becca

Present: Becca, Hunter

Goals: To fabricate the circuit box so that it can house the circuit and effectively hold all materials.

Content:

1. Place the project box on the side that is longest with the lid removed
2. Find the middle of the box from left to right and then go to the top portion of that side in the center
3. drill two holes .1 inches in diameter from the top of the box down .25 inches, the holes should be .2 inches apart
4. go to the opposite side of the box
5. find the center of the left quadranth of that side
6. drill two holes .1 inches in diameter from the top of the box down .25 inches, the holes should be .2 inches apart
7. find the center of the right quadranth of that side
8. drill two holes .1 inches in diameter from the top of the box down .25 inches, the holes should be .2 inches apart
9. Find the center of the lid
10. Cut the WIDTH OF THE SWITCH, LENGTH OF SWITCH out from the exact center of the box
11. to the left and right of the center switch hole in the longest direction cut out WIDTH OF THE SWITCH, LENGTH OF SWITCH, BLANK distance between them
12. drill 1/3 inch diameter holes with BLANK distance away from the switch, with BLANK distance between the two holes on one side of the switch
13. Follow step 12 for the other side of the switch
14. Follow steps 12-13 for the other two switches
15. glue the hinge to either long side of the switch with the hinge facing upwards
16. follow step 15 for the side of the switch
17. follow step 15-16 for all three switches
18. place the switches in the cutouts in the top of the project box with the hinges resting on the top of the box with their holes lining up with the holes in the project box
19. place 8-32 screw in the hole through the project box and hinge
20. follow step 19 for all 12 holes
21. place a 8-32 nut on the backside of the lid and screw on tight to the screw to ensure nothing moves
22. follow step 21 for all 12 nuts
23. place the circuit within the box and string the wires through the cutouts on the side of the box

** In the future there will be 3D printed adaptors attatched to the box to simplify the connecting of the pads to the device

Conclusions/action items:

Execute fabrication.

2023/11/30-Adapter Fabrication

HUNTER BELTING - Dec 10, 2023, 1:52 PM CST

Title: Adapter Plug Fabrication

Date: 11/30/23

Content by: Hunter Belting

Present: Hunter and Maribel

Goals: Layout the steps involved in the fabrication of the adapter plugs that the pads will be plugged into.

Content:

1. Obtain a caliper and take measurements on the Zoll pad plug.
2. Using the measurements taken on the Zoll pads, design the simplified plug within software such as solidworks using the dimensions measured.
3. To ensure the pad adapter will fit in the plug being created, a tolerance should be added. This tolerance was in the range of 2-5 mm in each of the dimensions measured.\
4. Once the adapter is created, the negative will have to be created.
5. This can be done by creating a box that is dimensionally larger than the adapter by 5-10 mm in each dimension.
6. With both the box and the adapter created, start an assembly and add the two parts into the assembly.
7. Click on the box and edit the part. Go to the features tab and select cavity.
8. Drag the adapter into the box where you want the cavity to be and click the green check mark to create the cavity within the box.
9. Now you have the negative that will act as the plug that the pads will be plugged into in solidworks.
10. Convert the file to a stl file that can be 3-D printed.
11. The material used was petg with carbon fiber embedded. This allows for a strong plug that is much less likely to be damaged.
12. Multiple iterations may be needed to get the desired connection between plug and pads.
13. The last portion of the fabrication is adding the electrode prongs that allow electricity to flow from the circuit to the pads.
14. Holes are to be drilled and prongs places in the drill holes. These prongs will be super glued to the plug and soldered to wiring from the circuitry.

Conclusions/action items:

Execute the fabrication.

2023/11/30: Switch Testing in WEMPEC Lab Protocol

Daisy Lang - Nov 30, 2023, 11:31 PM CST

Title: Switch Testing in WEMPEC Lab Protocol

Date: 11/30/2023

Content by: Daisy

Present: Daisy and Jack

Goals: Today Jack and I will document the protocol we used to test the switch in the WEMPEC lab. The goal of this testing is to determine if the switch has a significant arc when tested under 1000V, 2000V, and 2600V.

Content:

In order to test the switch for arching, we will test use the GwINSTEK GPT-9804 AC/DC Withstanding Voltage/ Insulation Resistance / Ground Bond Tester. This device is located in the WEMPEC lab in Engineering Hall. Pia Straamp helped us in with using this device in the WEMPEC lab.

In this test, we are looking to see if there is significant arch across over our switch while is in in the off position. When the switch is off, we want the arc value over the switch to be negligible. Given that the current through our circuit will vary between 10 - 30 A, we decided that .0005% current arching is acceptable. This is roughly .100 mA.

<u>Steps:</u>

1. Connect the power end and the ground coming from the testing machine to the one the longitudinal pathways on the switch.
2. Place the switch on the rubber mat and place the plastic covering box on top to protect the user from accidentally touching the switch.
3. Make sure the switch is in the off position (make sure the path is open).
4. On the testing machine, set the ramp time to .1 seconds and the testing time to 2 seconds. These are the lowest values on the machine and the closest we can get to simulating the 16 ms pulse that will be sent through the circuit from the defibrillator.
5. Set the reference value to 0.100 mA. This means that if the machine senses an arch value of greater than .100 mA, the switch will fail the test.
6. Set the voltage to 2000V.
7. Once the machine has been configured and the switch is safely in the box, press start on the testing machine. The test will run for 2 seconds then turn off and display the results.
8. Record the arc value displayed on the machine. If it is less than .100mA, the circuit passes the test.
9. Repeat this 4 more time for the 2000V.
10. Repeat this test ato voltages of 1000V and 2600V.

Conclusions/action items:

We will use this testing protocol to test the switch in the WEMPEC lab. Using the results from this test, we will determine if the arch on the switch is safe to use. We need to consult Dr. P to ensure that our value of 0.100 mA is valid.

2023/12/01- Single Vector and Connections Testing at EEC

REBECCA POOR - Dec 03, 2023, 11:57 AM CST

Title: Single Vector and Connections Testing at EEC

Date: 12/01/2023

Content by: Becca

Present: Becca

Goals: To test that the device can handle the correct Joules being delivered and confidently send a shock. Also, testing to ensure all adaptors and connections are secure.

Content:

Single Vector Connections Test

1. connect the device to the LIFPAK 15 monitor
2. connect the device to the heart simulator through the single vector wire
3. Flip the switches so the DSD function is off and the single vector switch is ON
4. turn on RVF on the heart simulator
5. Read the value shown on the defibrillator to ensure the device is properly passing the rhythm
6. Set the monitor to run 50 J through the circuit
7. Send the shock
8. Ensure the shock was delivered to the hear simulator
9. Run step 6-8 with Joule values of 100 J, 125 J, 200 J, 275 J, 360 J

Conclusions/action items:

Run the tests!

2023/12/01- Single Vector Impedance and Effectiveness Testing at EEC

REBECCA POOR - Dec 03, 2023, 11:57 AM CST

Title: Single Vector Impedance and Effectiveness Testing at EEC

Date: 12/01/2023

Content by: Becca

Present: Becca

Goals: To test that the device can handle the correct Joules being delivered and confidently send a shock. Also, testing to ensure all adaptors and connections are secure.

Content:

Single Vector Effectiveness and Impedance Test

1. connect the device to the LIFPAK 15 monitor
2. connect the device to the manikin through the single vector wire
3. Flip the switches so the DSD function is off and the single vector switch is ON
4. Read the value shown on the defibrillator to ensure the device is properly passing the rhythm from the manikin to the defibrillator
5. Set the monitor to 150 J (Max amount)
6. Send the shock through the manikin
7. Record the measured Joules the manikin received

* due to the testing site the test was only ran once

Conclusions/action items:

Run the tests!

2023/12/3: DSD Functionality Testing Protocol

Daisy Lang - Dec 04, 2023, 9:39 PM CST

Title: DSD Functionality Testing Protocol

Date: 12/3/2023

Content by: Daisy

Present: All

Goals: Today we will create a plan for how we want to test the DSD functionality of our circuit. We will be testing in the green room of ECB and using the oscilloscope and signal generator.

Content:

- We will test the DSD functionality of the device using a voltage supply and measuring the voltage drop across the pads for each vector path over a range of voltages
- Small voltages are used as a safety concern and fear of breaking any expensive equipment
- Voltage measured using a voltage meter

Procedure:

1. Using alligator clips, take the defibrillator plug in and connect the pin corresponding to the blue wire to ground on the voltage supply and the pin corresponding to the white wire to the postive power supply.
2. Take the pads attached to vector one and wrap a 100 ohm resistors around the plug in pins to connect them.
3. Attach one of the alligator clips from the voltage meter to each pad plug in pin.
4. Starting at 0V, increase the voltage from the power supply to 1V, 2V, 3V, 4V, and 5V, and record the value on the voltage for each voltage.
5. Preform step 4 three times.
6. Switch the alligator clip connecting the defibrator plug in to the negative power supply and preforms steps 4 and 5 but this time using 0, -1V, -2V, -3V, -4V and -5V.
7. Repeat this procedure for the pad ending for vector 2.

Conclusions/action items:

Using this test we will test the functionality of DSD in our device. We expect to see that vector 1 can only respond to postive voltage and vector 2 can only respond to postive voltage. The next step is to implement this procedure during testing in ECB.

2023/11/30: Switch Testing in WEMPEC Lab Testing Experimentation

Daisy Lang - Nov 30, 2023, 11:49 PM CST

Title: Switch Testing in WEMPEC Lab Testing Experimentation

Date: 11/30/203

Content by: Daisy

Present: Daisy and Jack

Goals: Today we will test the switch using the testing protocol in the above folder. We will record the arch values from each of the trials and use them to a preform a statistical analysis.

Content:

1) Testing at 2KV ramp up 0.1S applied over 2 seconds with tolerance 0.1 mA ---- passed === leaked .019 mA

2) Testing at 2.608KV ramp up 0.1S applied over 2 seconds with tolerance of 0.1 mA ------ passed ==== leaked .023mA

3) Testing at 1KV ramp up 0.1S applied over 2 seconds with a tolerance of 0.1mA ----- passed ==== leaked 0.012mA

We ran the test at 1000V, 2000V, and 2600V because these are the values that we calculated at our maximum, minimum, and average voltages that can be used to create the 360 J based on the different impedance values of the body (see the math in circuit research section of Daisy's notebook).

Allowable leak current was calculated by taking the 0.0005% of the current value. We decided that a leak of 0.0005% was acceptable for our device.

Voltage Level	Voltage Value	Current	1	2	3	4	5	Allowable Leaks
Low	1000V	27.5 A	0.012 mA	0.012 mA	0.012 mA	0.012 mA	0.012 mA	0.1375 mA
Average	2000V	15.9 A	0.019 mA	0.019 mA	0.019 mA	0.019 mA	0.019 mA	0.0795 mA
High	2600V	11.5 A	0.023 mA	0.023 mA	0.023 mA	0.023 mA	0.023 mA	0.0575 mA

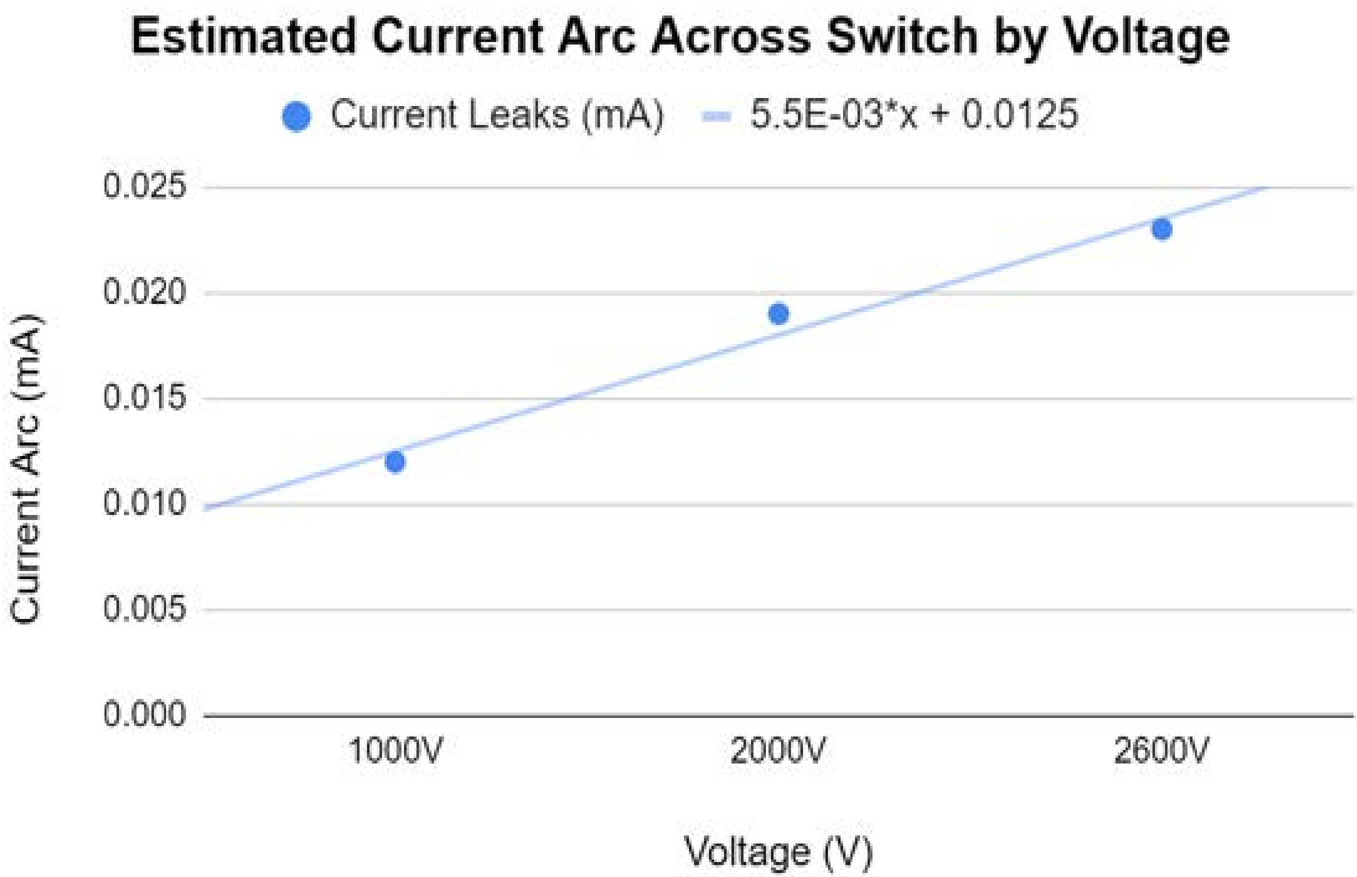
Conclusions/action items:

We will use this data to preform a statistical analysis to ensure that this level of current leak is valid. In all cases, the leaked current was less than the allowable current and it passed the test. In our meeting tomorrow with Dr. P, I will ask him how he suggests we analyse this data and get our validity measurement approved.

Daisy Lang - Dec 03, 2023, 4:43 PM CST

Graph to calculate expected current arc across the switch based on voltage

In future, we should run more tests over a wider range of voltage values to get a better predictive curve



Daisy Lang - Dec 09, 2023, 9:11 AM CST

			1	2	3	4	5		Allowable Leaks
LOW	1000V	27.5A	0.012mA	0.012mA	0.012mA	0.012mA	0.012mA	Leaks!	0.1375 mA
AV	2000V	15.9A	0.019mA	0.019mA	0.019 mA	0.019mA	0.019mA		0.0795 mA
HIGH	2400V	11.5A	0.023mA	0.023 mA	0.023 mA	0.023mA	0.023 mA		0.0575 mA

Fail @ .1mA AVC
set on machine

Ramp Time = .1Sec
Administer: 2.0 sec

$.1mA = \underline{1\times10^{-4}\ A}$

Allowable Leak = 5×10^{-4} % of current through circuit

We feel comfortable moving into the testing phase
if no more than 0.100 mA is lost through current leak in switch

2023/12/01- Single Vector and Connections Testing Results

REBECCA POOR - Dec 03, 2023, 11:55 AM CST

Title: Single Vector Testing Results

Date: 12/01/2023

Content by: Becca

Present: Becca, Hunter, Jack, Nick

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Joule Value	50 J	100 J	125 J	200 J	275 J	360 J
Shock Effective?	yes	yes	yes	yes	yes	yes

The shock was succesfully sent to the heart simulator at 6 different joule values including the max value that would ever be sent of 360 J. This proves the connections are complete and compatible with devices that are currently on the market. It is also ensures that the circuit and device are effective for use for single vector sending!

Conclusions/action items:

Make some additions to the circuit to ensure that the DSD function also works.

2023/12/01- Single Vector Accuracy and Impedance Testing Results

REBECCA POOR - Dec 03, 2023, 12:07 PM CST

Title: Single Vector Accuracy and Impedance Testing Results

Date: 12/01/2023

Content by: Becca

Present: Becca, Hunter, Jack, Nick

Goals: To test the device following the protocol that was written and to see how our device affects the impedance if at all.

Content:

We ran the defibrillator at 150 J as this was the max allowed by the manikin. The manikin received 175 J meaning that our device does not affect the impedance reading of the patient done by the defibrillator. The 150 J was the goal amount of joules received by the manikin at their heart and based on the impedance 175 J was sent from the machine. This ensures that our device sends the entire shock and does so without altering the impedance reading!

Conclusions/action items:

Make some additions to the circuit to ensure that the DSD function also works.

REBECCA POOR - Dec 03, 2023, 12:01 PM CST

Download

Complete_circuit_.jpg (107 kB)

REBECCA POOR - Dec 03, 2023, 12:04 PM CST

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REBECCA POOR - Dec 03, 2023, 12:04 PM CST

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REBECCA POOR - Dec 03, 2023, 12:04 PM CST

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2023/12/03: DSD Functionality Testing Results

Daisy Lang - Dec 04, 2023, 9:26 PM CST

Title: DSD Functionality Testing Results

Date: 12/3/2023

Content by: Daisy

Present: All

Goals: Today we will test the DSD functionality of the device following the DSD functionality testing protocol. We will be testing in ECB using a Voltage generator and testing over low levels of voltage due to safety concerns.

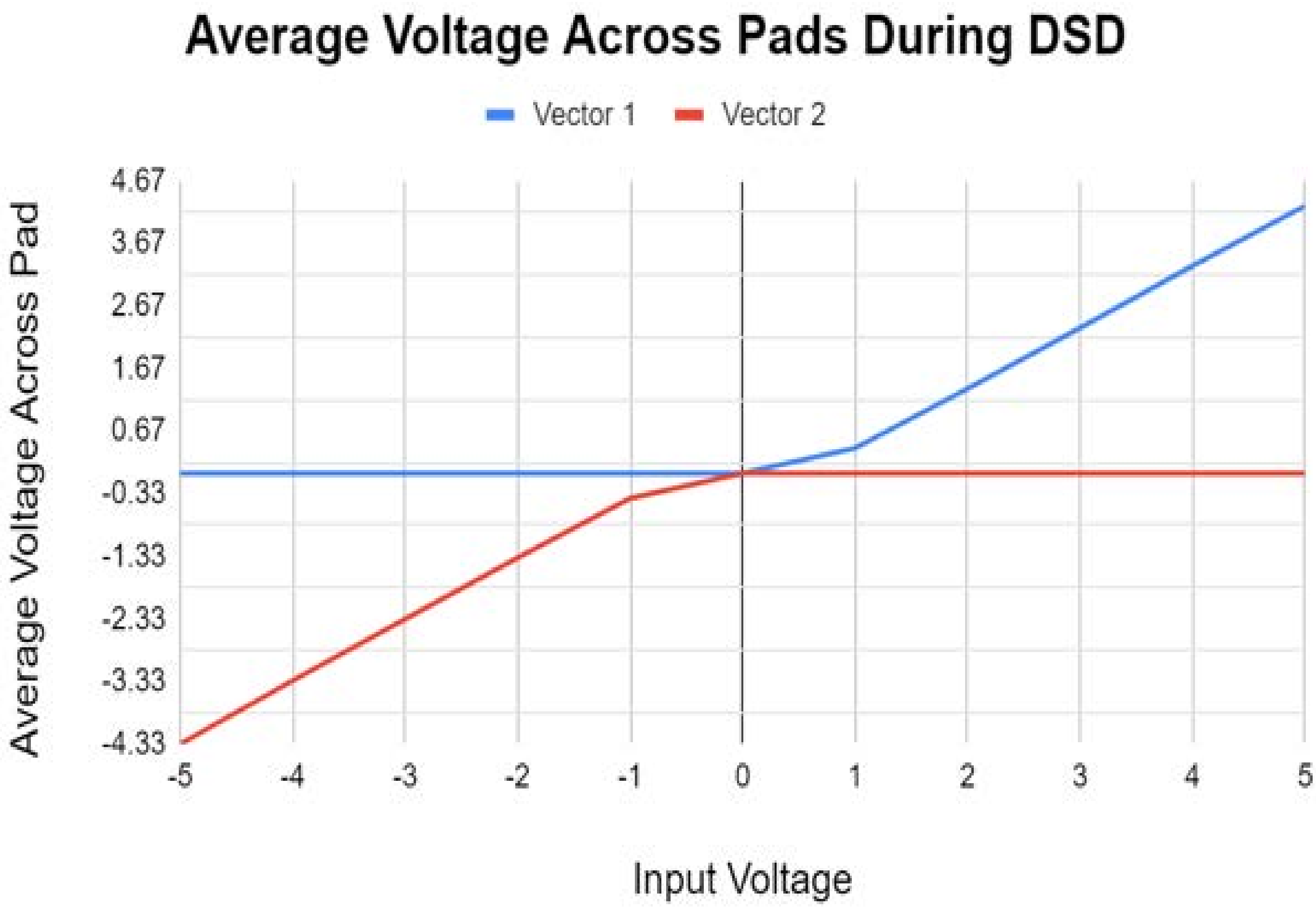
Content:

Results all in Voltage:

	Vector 1				Vector 2			
Voltage Input	Trial 1	Trial 2	Trial 3	Avg	Trial 1	Trial 2	Trial 3	Avg
-5	0	0	0	0	-4.30	-4.29	-4.30	-4.30
-4	0	0	0	0	-3.31	-3.32	-3.31	-3.31
-3	0	0	0	0	-2.33	-2.33	-2.33	-2.37
-2	0	0	0	0	-1.35	-1.35	-1.35	-1.36
-1	0	0	0	0	-.40	-.40	-.40	-.40
0	0	0	0	0	0	0	0	0
1	0.40	0.40	0.40	0.40	0	0	0	0
2	1.35	1.35	1.35	1.35	0	0	0	0
3	2.32	2.32	2.32	2.32	0	0	0	0
4	3.33	3.30	3.31	3.31	0	0	0	0
5	4.28	4.29	4.26	4.28	0	0	0	0

We ran one additional trial at 25.0V just to see what happened and the output was 24.40V.

Graph:



- Vector 1 only allowed postive voltage
- Vector 2 only allowed negative voltage
- There is a drop in voltage that occurs before the pads (we know this because the voltage is is not the full value that we put into the circuit)
- We think this voltage drop is due to the diode resistance, appears to stay constant and is independent of voltage (will run stats test on this)

Conclusions/action items:

This test proved to be extremely helpful as it proved that the circuit works and the DSD set up with the diodes will direct the postive and negative voltage accordingly. There is a voltage drop witnessed, but we believe this is due to the diode resistance and will be negligible at higher voltages. The next step is to test the device on an actually defibrillator.

2023/12/4: DSD Functionality Test Results Analysis

Daisy Lang - Dec 04, 2023, 9:32 PM CST

Title: DSD Functionality Test Results Analysis

Date: 12/4/2023

Content by: Daisy

Present: N/A

Goals: Today I am going to run an ANOVA test on the the data we collected from the DSD Functionality Test with the goal of determining if we can claim that the average voltage drop we witnessed in each of the trials is the same.

Content:

- For this test, the postive and negative voltages will be grouped into one population (the 1V and -1V trials well be treated as the same group)
- When the voltage across the pad = 0V, we will not include these values in the population
- I will run this test with 5 groups that each contain 6 values
    - Groups: +-1, +-2, +-3, +-4, +-5 V
    - The 6 values in each group represent the voltage drop observed at each trial
        - For example: When 1V was inputted and 0.4V was measured the drop across the pads, the difference was calculated as 1.0-0.4 = 0.6V
- Null Hypothesis: There is no significant difference in the mean across the 5 different voltage groups

<u>Raw Data:</u>

v1 = +-1V ect

v1	v2	v3	v4	v5
0.6	0.65	0.68	0.67	0.7
0.6	0.65	0.68	0.7	0.71
0.6	0.65	0.68	0.69	0.7
0.6	0.65	0.69	0.67	0.72
0.6	0.65	0.69	0.67	0.71
0.6	0.65	0.69	0.68	0.7

<u>Anova Test Results:</u>

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	6	3.6	0.6	0
Column 2	6	3.9	0.65	0
Column 3	6	4.11	0.685	3E-05
Column 4	6	4.08	0.68	0.00016
Column 5	6	4.24	0.706667	6.67E-05

ANOVA

rce of Varia	SS	df	MS	F	P-value	F crit
Between G	0.040853	4	0.010213	198.961	1.46E-18	2.75871
Within Gro	0.001283	25	5.13E-05			
Total	0.042137	29				

<u>Discussion:</u>

- The p value was 1.46E-18 so we reject the null hypothesis and cannot say that the difference across the means for all of the voltages is significant
- I am concerned about this result because the we observe that as the voltage values increase, the voltage drop be observe before the pad measurement stays relatively constant
- Believe that the drop is due to the resistance of the diode
- I think that if we ran more tests over a larger range of voltages we would see that the difference in the voltage drop was insignificant
- Based on our observations, the drop was relatively constant, so based on our knowledge of physics, we can hypothesize that it will be the same for all voltages --> physics says it shouldn't change
- Another potential source of error of cause of voltage drop could be the voltage meter drawing current (in future can use the larger voltage meter with higher impedance to match the circuit)

Conclusions/action items:

This ANOVA test showed up that the difference in the average drop of voltage prior to the pads was significant. Based on our knowledge of circuits, this result does not make sense as a diode is a static element and its resistance should not change with voltage. Knowing this, I believe that if we ran more trials over a larger range of voltages, we would not see a significant difference. Knowing this, at 2000V I think the drop across the diode will be basically insignificant.

2023/12/7: DSD Functionality T-Test Results

Daisy Lang - Dec 09, 2023, 8:47 AM CST

Title: DSD Functionality T-Test Results

Date: 12/7/2023

Content by: Daisy

Present: NA

Goals: Today I will run a T-test on the results of the DSD testing to determine if the difference between the expected value and mean of the measured values of reach magnitude of input voltage is significant.

Content:

- All the trials from the -1 and 1 trials were groups together and I looked at the absolute value
- This was done to increase the number of test points and because the sign should not impact the magnitude
- Compared the expected output to the measured output to see if they are significantly different
- Saw that they were significantly different, but the value decreased with increase voltage input
- Hypothesize that at extremely high voltages, there will be no significant difference

v1	d1	v2	d2	v3	d3	v4	d4	v5	d5
1	0.4	2	1.35	3	2.32	4	3.33	5	4.28
1	0.4	2	1.35	3	2.32	4	3.3	5	4.29
1	0.4	2	1.35	3	2.32	4	3.31	5	4.26
1	0.4	2	1.35	3	2.33	4	3.31	5	4.3
1	0.4	2	1.35	3	2.33	4	3.32	5	4.29
1	0.4	2	1.35	3	2.33	4	3.31	5	4.3
P for group 1:		P for group 2:		P for group 3:		P for group 4:		P for group 5:	
3.6186E-160		1.7042E-154		3.40705E-17		1.87188E-18		5.53197E-17	

Conclusions/action items:

We found that there is a significant difference between the measured and expected value, but we believe that at high voltages this difference will be negligible. The value of the voltage loss does not scale with input voltage, so we think that it is due to the diode resistance. Further testing at high voltages will need to be done to ensure that out hypothesis is correct.

2023/12/11: DSD Functionality Test at EEC

Jack Sperling - Dec 11, 2023, 5:02 PM CST

Title: Final testing of DSD function at the EEC

Date: 12/11/2023

Content by: Jack and Hunter

Present: Jack and Hunter

Goals: Determine if the DSD mode of the final prototype can deliver the 2 separate charges to the manakin.

Content:

Situation 1: V1 to manakin, V2 to rhythm generator

Test 1 @ 100J ---- no rhythm recorded by the lifepak when manakin or rhythm generator connected to either lead

Conclusions/action items:

The DSD function of the device was not able to function with the lifepak even though our circuit was successful in our previous tests. The bypass function still worked, however the DSD function was not able to detect the rhythm on the manakin or the rhythm generator box.

2023/9/9 - "The controversial role of dual sequential defibrillation in shockable cardiac arrest"

REBECCA POOR - Sep 09, 2023, 3:00 PM CDT

1. REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: :"The Controversial Role of dual sequential defibrillation in shockable cardiac arrest"

Date: 09/09/2023

Content by: Becca

Present: N/A

Goals: To understand the use and what dual sequential defibrillation is.

Search Term: "dual sequential defibrillation"

Link: https://pubmed.ncbi.nlm.nih.gov/29880409/

Citation:

[1] P. A. J. D;, “The controversial role of dual sequential defibrillation in Shockable cardiac arrest,” The American journal of emergency medicine, https://pubmed.ncbi.nlm.nih.gov/29880409/ (accessed Sep. 9, 2023).

Content:

- over 350,000 cardiac arrests occur outside the hospital and 209,000 occur in the hospital annually
- ventricular fibrillation has survival rate of 35-30% outside of the hospital
- the total energy used and the voltage required to return back to normal was lower when using DSD
- numerous large EMS companies across the country have begun to integrate DSD into their protocol and has been an effective technique in ridding VF

Conclusions/action items:

DSD has been shown to help solve VF in numerous cases in and outside the hospital. VF is very common in and outside the hospital and if not solved/noticed quickly it can lead to intense brain injuries and bodily harm. DSD is an integral part of numerous treatments of VF and should continue to be researched. My next step is to look into how the dual sequential defibrillation works and what there is to be done to improve the current model.

2023/9/9 - "Dual sequential defibrillation"

REBECCA POOR - Sep 09, 2023, 3:30 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Dual Sequential Defibrillation

Date: 09/09/2023

Content by: Becca

Present: N/A

Goals: To understand the benefits of dual sequential defibrillation.

Search Term: Dual Sequential defibrillation

Link: https://www.resuscitationjournal.com/action/showPdf?pii=S0300-9572%2820%2930104-0

Citation:

[1] “Resuscitation,” Resuscitation | European Resuscitation Council Guidelines for Resuscitation 2021 | ScienceDirect.com by Elsevier, https://www.sciencedirect.com/journal/resuscitation/vol/161/suppl/C (accessed Sep. 9, 2023).

Content:

about 20% of VF will remain in VF after 5 shocks

initial defib pads are placed in a standard antero - lateral position and the second pair is placed alongside the first or in an antero - posterior position

after they noticed that shocking both at the same time led to damage in the defibrillators, there is now a slight pause between the shock in each defibrillator

there are three reasons as to why DSD is better for VF

1. "The defibrillation threshold for each cardiac myocyte is lowest when defibrillation takes place along the longitudinal axis of the cell", so by using two vectors by using two pads will help to expose for myocytes to the shock along their longitudinal axis, this could also lead to more myocytes being terminated

2. the second shock could help increase the current density which means that the shock itself would be more impactful

3. to have a successful defib you must defib a critical mass of myocardium, by having the second pad there is an increased chance of myocardium tissue being shocked

Conclusions/action items:

Overall, there are numerous reasons to why DSD is beneficial to use instead of a regular singular shock. The biggest reason for a shock is to stop the myocytes from contracting and causing the VF. By having numerous shocks and from two pads this helps to increase the chance of shock. The next steps to research is what level of shock needed for a dual DSD shock.

2023/9/9 - "What’s in a cardiomyocyte – And how do we make one through reprogramming?"

Title: "What’s in a cardiomyocyte – And how do we make one through reprogramming?"

Date: 9/9/2023

Content by: Becca

Present: N/A

Goals: To understand what a cardiomyocyte is and how it creates a VF.

Search Term: Cardiomyocyte

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6911029/#:~:text=From%20the%20perspective%20of%20cardiology,executing%20the%20c

Citation:

[1] B. Keepers, J. Liu, and L. Qian, “What’s in a cardiomyocyte - and how do we make one through reprogramming?,” Biochimica et biophysica acta. Mole https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6911029/#:~:text=From%20the%20perspective%20of%20cardiology,executing%20the%20contractior Sep. 9, 2023).

Content:

a muscle cell of the heart

myocardium's smallest constituents

cardiomyocyte is the cell responsible for the contraction of the heart

contracts using contractile proteins and ion transporters

the main process is to continue the contraction relaxation cycle

it is a myocyte that resides in the heart and is responsible for the hearts contraction

the myocyte develops from myoblasts and has a central nucleus

Conclusions/action items:

The myocyte is what is in charge of causing the heart to contract and relax. There are different types of myopcytes and one kind being cardiac understand the use of the myocyte because it causes the VF. The reason behind the shock is to try and terminate VF and stop the myocytes fro relaxing. In the next portion of research I want to know how the myocytes cause VF.

2023/9/9 - "Refractory Ventricular Fibrillation in Traumatic Cardiac Arrest: A Case Report and Review of the Literature"

REBECCA POOR - Sep 09, 2023, 5:05 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Refractory Ventricular Fibrillation in Traumatic Cardiac Arrest: A Case Report and Review of the Literature"

Date: 09/09/2023

Content by: Becca

Present: N/A

Goals: To understand what Refractory ventricular fibrillation is and what causes it.

Search Term: refractory ventricular fibrillation

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8703203/

Citation:

[1] M. Alageel et al., "Refractory ventricular fibrillation in traumatic cardiac arrest: A case report and review of the literature," Cureus, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8703203/ (accessed Sep. 9, 2023).

Content:

refractory ventricular fibrillation is a cardiac arrhythmia that leads to cardiac arrest

it is triggered by acute myocardial ischemia

"Ventricular Fibrillation is a life threatening cardiac arrhythmia that causes loss of heart function and sudden death

VF is a disorganized and irregular electrical activity with no pattern

the ventricles are "quivering" instead of beating

Refractory ventricular fibrillation is the inability to obtain a return of spontaneous circulation (ROSC) within 10 minutes despite three defibrillation attempts, 300 mg of amiodarone, and 3mg of epinephrine

The incidence of refractory VF is estimated to be between 0.5 and 0.6 per 100,000 persons [2]. When refractory VF presents, mortality rates are estimated to be between 85% and 97%

Conclusions/action items:

The refractory ventricular fibrillation is related to ventricular fibrillation but is caused when it is longer than 10 minutes. In the future I want to look into the process of how the shock relates to the VF and what would be better for the patient when in VF versus RVF.

2023/9/21- "All About Cardiovascular System and Diseases"

REBECCA POOR - Sep 21, 2023, 4:30 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "All About Cardiovascular System and Diseases"

Date: 2023/9/21

Content by: Becca

Present: N/A

Goals: To better understand the difference between a monophasic and biphasic shock.

Search Term: Difference between monophasic and biphasic shock

Link: https://johnsonfrancis.org/professional/difference-between-a-monophasic-and-biphasic-defibrillator/

Citation:

[1] J. Francis, WPW Syndrome – the great mimicker| Mar 21,Johnson Francis, Former Professor of Cardiology, and J. F. F. P. of Cardiology, “All about cardiovascular system and disorders,” All About Cardiovascular System and Disorders, https://johnsonfrancis.org/professional/difference-between-a-monophasic-and-biphasic-defibrillator/ (accessed Sep. 21, 2023).

Content:

monophasic shock is when the shock is only sent one direction from one electrode to the other

biphasic shock the shock reverses direction from the initial shock by changing the polarity of the electrodes

biphasic shocks are more effective and require less energy

200 J are given for a biphasic shock

360 J are given for a biphasic shock

a monophasic shock is not as effective as a biphasic shock as the beginning cells receive a higher shock but it may not depolarize all myocardial cells

in biphasic shocks the reversal of the polarity helps to sweep off all of the cells

Conclusions/action items:

Overall, biphasic defibrillation is more effective than monophasic defibrillation. This is due to monophasic defibrillation not always depolarizing all cells. Also, since biphasic shock is done at a lower threshold then there is a lower risk of harming the heart with the shock. We should try to ensure that our design uses biphasic shocks to reduce the chance of harming the heart tissue and increasing the chance of helping the patient exit RVF.

2023/09/21 - "A simulation study of the reaction of human heart to biphasic electrical shocks"

REBECCA POOR - Sep 21, 2023, 5:01 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "A simulation study of the reaction of human heart to biphasic electrical shocks"

Date: 2023/09/21

Content by: Becca

Present: N/A

Goals: To understand how a biphasic shock is sent and what the purpose of the shock is.

Search Term: Biphasic shock and response

Link: https://pubmed.ncbi.nlm.nih.gov/15212691/

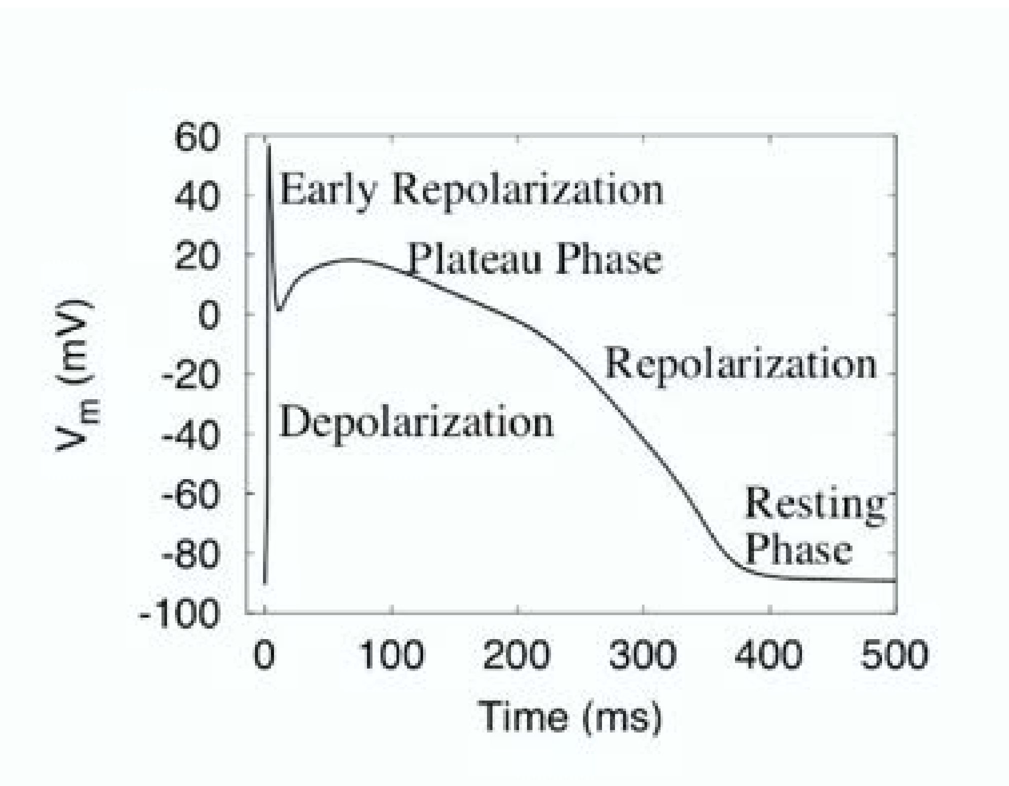
Citation:

[1] P. L. G. O;, "A simulation study of the reaction of human heart to biphasic electrical shocks," BMC cardiovascular disorders, https://pubmed.ncbi.nlm.nih.gov/15212691/ (accessed Sep. 21, 2023).

Content:

after the shock is sent depolarization occurs on average 5 ms after the shock is sent

the time needed for the heart tissue to be fully depolarized is much shorter when biphasic shock is applied



Conclusions/action items:

Based on the study done there is more research needed to determine the effect of the heart cleft when the heart is being depolarized. The effect of the shape of heart has changes based on the type of shock. A biphasic shock will depolarize the tissue until it returns back to its regular resting phase. The next thing to continue to research is the effectiveness of the two vectors.

2023/09/21 - "Double sequential external defibrillation for refractory ventricular fibrillation"

REBECCA POC

REBECCA POOI

Title: "Double sequential external defibrillation for refractory ventricular fibrillation"

Date: 09/21/2023

Content by: Becca

Present: N/A

Goals: To understand where the pads are placed during DSD and how a change in vector affects the shock.

Search Term: Change in vector for DSD

Link:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9907872/#:~:text=Vector%20change%20(VC)%20defibrillation%2C,the%20standard%20anterior%

Citation:

[1] S. Cheskes, S. McLeod, and D. C. Scales, "Double sequential external defibrillation for refractory ventricular fibrillation," Intensive care medicine, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9907872/#:~:text=Vector%20change%20(VC)%20defibrillation%2C,the%20standard%20anterior%2D (accessed Sep. 21, 2023).

Content:

vector change is the process of switching defibrillator pads from anterior - lateral to anterior - posterior position

DSD is the process of using both sets of pads in the anterior lateral and anterior posterior position

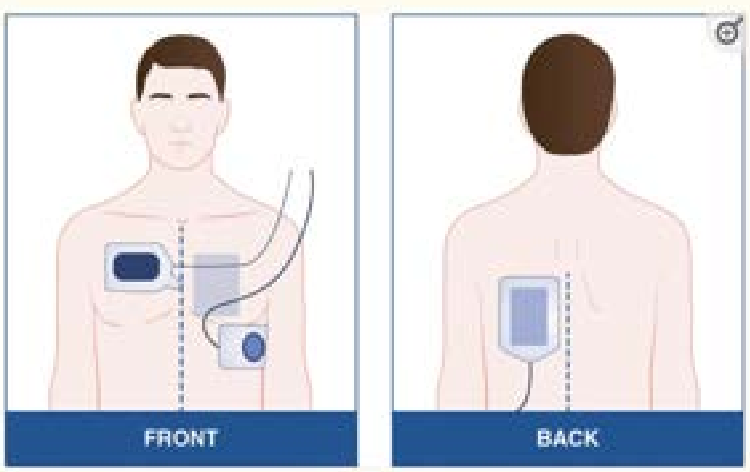


Fig. 1

Pad placement for the different defibrillation strategies. Dark blue defibrillation pads indicate pad placement in the anterior-lateral position. Light-blue defibrillation pads indicate pad placement in the anterior–posterior (VC) position. DSED utilizes both configurations

DSED has proven to be more efficient and reliable for helping a patient come out of VF

it is recommended to use DSED before trying the placement of VC

for refractory ventricular fibrillation DSED is recommended but if blocked than VC is another viable option

Conclusions/action items:

The vector switch is determined based on if after shocks the heart cannot be removed from VF. There are two different pad locations: anterior - posterior position. These have both been proven to be reliable for pad placement but one is better than the other. DSED is what should be tried Especially for RVF, which is what we will be dealing with during this project.

2023/10/03 - "Does change in thoracic impedance measured via defibrillator electrode pads accurately detect ventilation breaths in children?"

REBECCA POOR - Oct 03, 2023, 6:05 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Does change in thoracic impedance measured via defibrillator electrode pads accurately detect ventilation breaths in children"

Date: 10/03/2023

Content by: Becca

Present: N/A

Goals: To understand how the change in impedance can affect the defibrillator.

Search Term: Impedance in defibrillator

Link: https://www.sciencedirect.com/science/article/pii/S0300957210004132?via%3Dihub

Citation:

[1] Author links open overlay panelKathryn Roberts a et al., “Does change in thoracic impedance measured via defibrillator electrode pads accurately detect ventilation breaths in children?,” Resuscitation, https://www.sciencedirect.com/science/article/pii/S0300957210004132?via%3Dihub (accessed Oct. 3, 2023).

Content:

the study was used to test thoracic impedance to see if the monitor could sense the ventilations in children

changes in thoracic impedance obtained via defibrillator pads can accurately detect ventilations

less sensitive with smaller volumes

shallow ventilations during CPR might be missed

NO difference in impedance measurement between standard AA pad position and AP pad position

Conclusions/action items:

From this study I learned that impedance can be measured through the defibrillator pads and will be sent back to the monitor. The impedance will not vary between the placement of the pads. This is good because if we use DSD we do not want the amount of Joules going through the body to vary via the impedance between those two pads at that specific location.

REBECCA POOR - Oct 03, 2023, 6:06 PM CDT

Resuscitation

Does change in thoracic impedance measured via defibrillator electrode pads accurately detect ventilation breaths in children?

Download

does_chabge_in_thoracic_impedance_measured_vid_.pdf (744 kB)

2023/10/03 - "Anteroposterior Pacer Pad Position Is More Likely to Capture Than Anterolateral for Transcutaneous Cardiac Pacing"

REBECCA POOR - Oct 03, 2023, 6:17 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Anteroposterior Pacer Pad Position Is More Likely to Capture Than Anterolateral for Transcutaneous Cardiac Pacing"

Date: 10/03/2023

Content by: Becca

Present: N/A

Goals: To understand the difference between the different placement for the pads and how this affects the shock being sent.

Search Term: AA versus AP pad placement

Link: https://www.ahajournals.org/doi/epub/10.1161/CIRCULATIONAHA.122.060735

Citation:

[1] P. Patel, S. Moayedi, and N. Brady, “Anteroposterior pacer pad position is more likely to capture than Anterolateral for Transcutaneous Cardiac Pacing,” Circulation, https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.122.060735 (accessed Oct. 3, 2023).

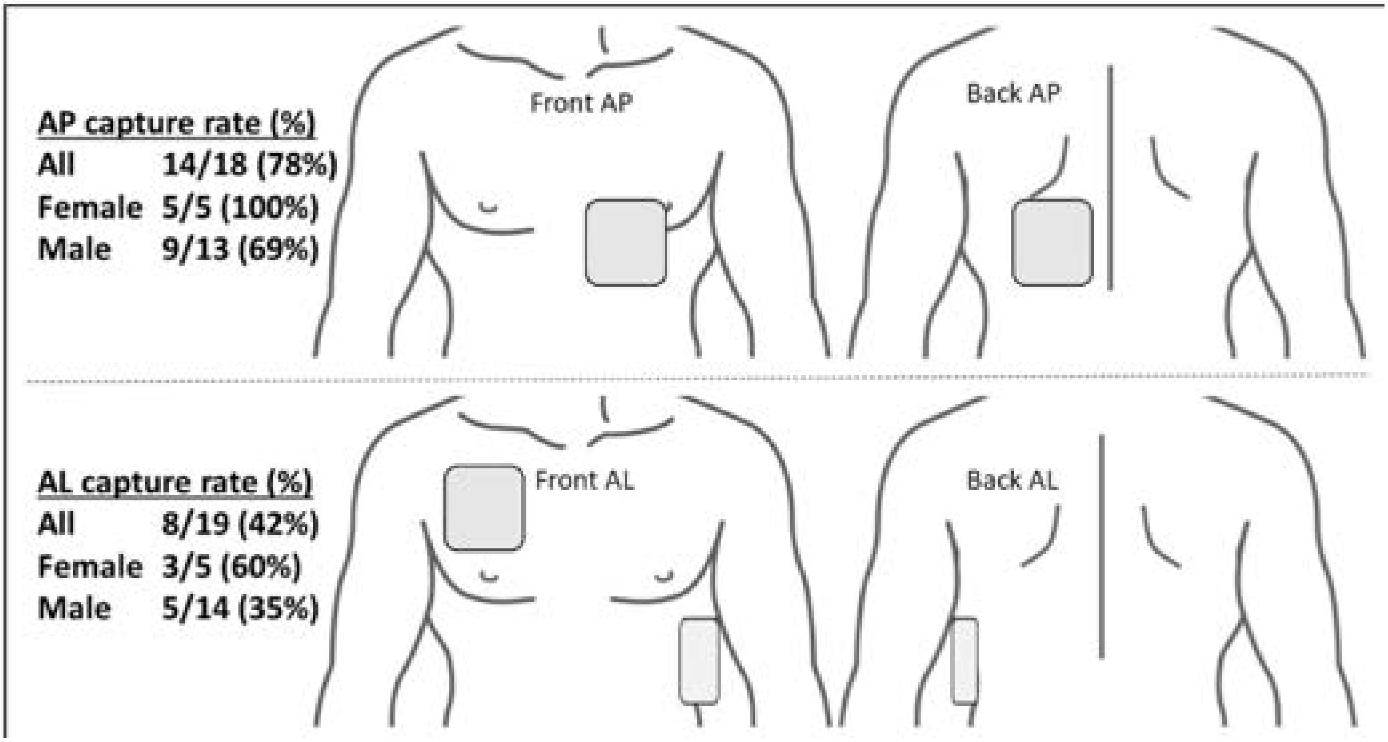
Content:

two most common pad placement sites are the anteroposterior (AP)

- the positive electrode placed under the left scapula and the negative electrode placed on left parasternal chest wall

Anterolateral (AL) placement

- positive electrode placed on the right upper anterior chest wall and the negative electrode placed on the left lower midaxillary line



they used a 200 J biphasic shock with R series monitor/defibrillator from Zoll

AP pacing position is more likely to capture than the AL position

only 42% to 78% of patients may respond to transcutaneous cardiac pacing

capture was 80% more likely in the AP rather than in the AL position

Conclusions/action items:

Based on the information provided in this article, a medical professional is more likely to place the pads in the AP position than the AL position. The plus side of having an option to switch vectors is that in case a patient can't use a specific type of position.

REBECCA POOR - Oct 03, 2023, 6:09 PM CDT


Circulation

RESEARCH LETTER

Anteroposterior Pacer Pad Position Is More Likely to Capture Than Anterolateral for Transcutaneous Cardiac Pacing

Download

moayedi-et-al-2022-anteroposterior-pacer-pad-position-is-more-likely-to-capture-than-anterolateral-for-transcutaneous.pdf (185 kB)

2023/10/03 - "Defibrillation"

REBECCA POOR - Oct 03, 2023, 6:34 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Defibrillation"

Date: 10/03/2023

Content by: Becca

Present: N/A

Goals: To understand the workings and the need of defibrillator pads when in VF.

Search Term: How do Defibrillator pads work

Link: https://www.ncbi.nlm.nih.gov/books/NBK499899/

Citation:

[1] J. S. Cooper, “Defibrillation - statpearls - NCBI bookshelf,” Stat Pearls, https://www.ncbi.nlm.nih.gov/books/NBK499899/ (accessed Oct. 3, 2023).

Content:

in adults, VF is the most common cause of sudden cardiac arrest

the definitive treatmetn for VF is to perform electrical defibrillation

when defib is delayed, effectiveness is reduced by almost 10% per minute

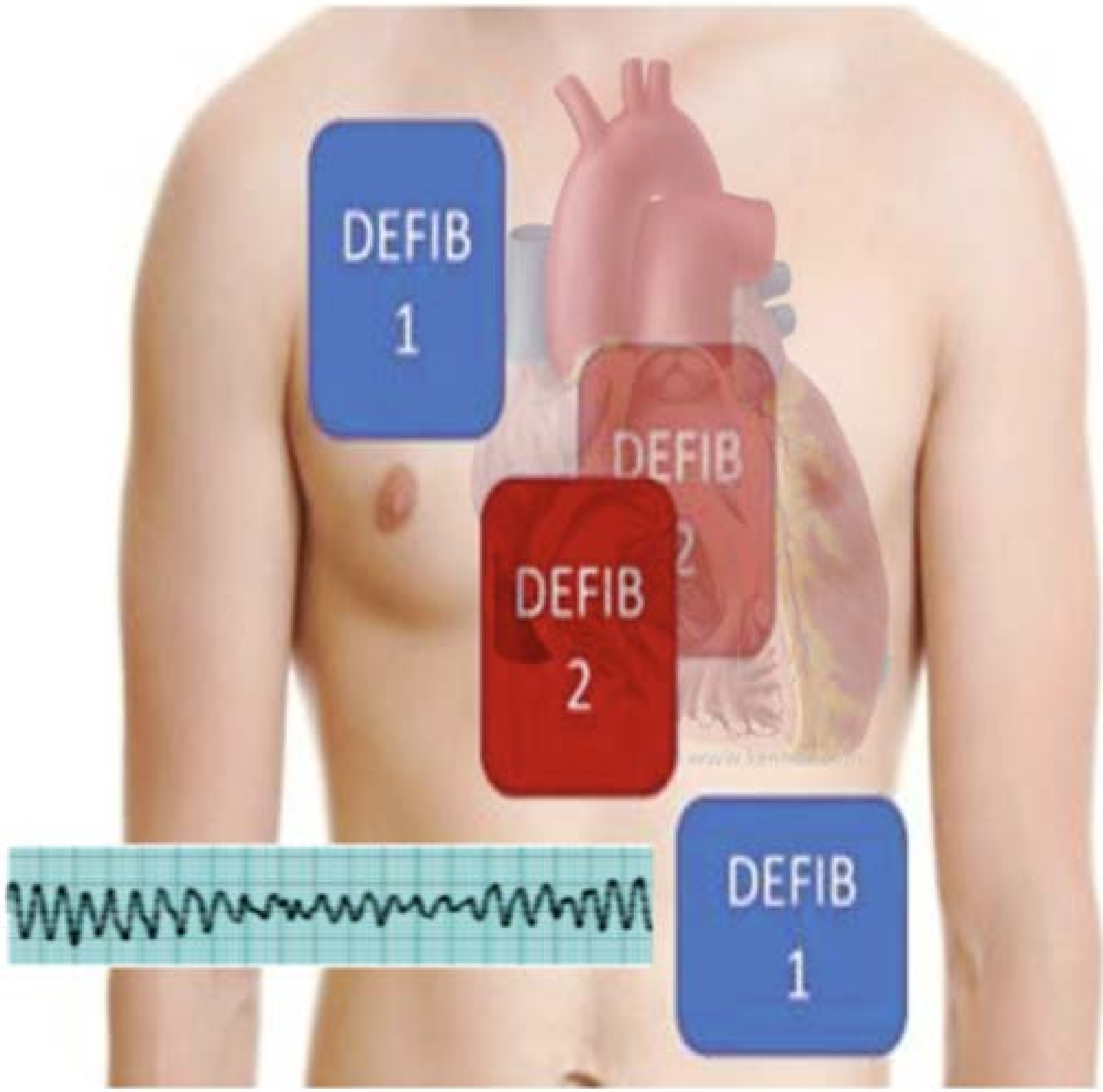
according to the CDC, 610000 deaths occur annually in the US from heart disease

heart disease is the number one cause of death in both sexes

Defibrillation is the creation of of nearly simultaneous depolarizations of critical mass of myocardium

biphasic defibrillator usually shocks between 120 joules to 200 joules

monophasic defibrillator usually shocks with 360 joules



Double defibrillation. Image courtesy Dr Chaigasame

Conclusions/action items:

Defibrillation is very important as it treats and is the most effective way to treat ventricular defibrillation. This is very common across the world but also in the US. Defibrillation is sending a shock between 120 and 360 joules depending on the type of wave shock. Using this we can determine the specific type of shock we want to use. More research needs to be done to determine the size of the pads to best depolarize the cells.

REBECCA POOR - Oct 03, 2023, 6:35 PM CDT

Download

Defibrillation_-_StatPearls_-_NCBI_Bookshelf.pdf (783 kB)

2023/10/03 - "Theory and practice of defibrillation: (2) defibrillation for ventricular fibrillation”

REBECCA POOR - Oct 03, 2023, 7:07 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: “Theory and practice of defibrillation: (2) defibrillation for ventricular fibrillation,”

Date: 10/03/2023

Content by: Becca

Present: N/A

Goals: To understand how impedance affects a shock and how a shock is created from a defibrillator.

Search Term:

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1768652/

Citation:

[1] A. A. J. Adgey, M. S. Spence, and S. J. Walsh, “Theory and practice of defibrillation: (2) defibrillation for ventricular fibrillation,” Heart (British Cardiac Society), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1768652/ (accessed Oct. 3, 2023).

Content:

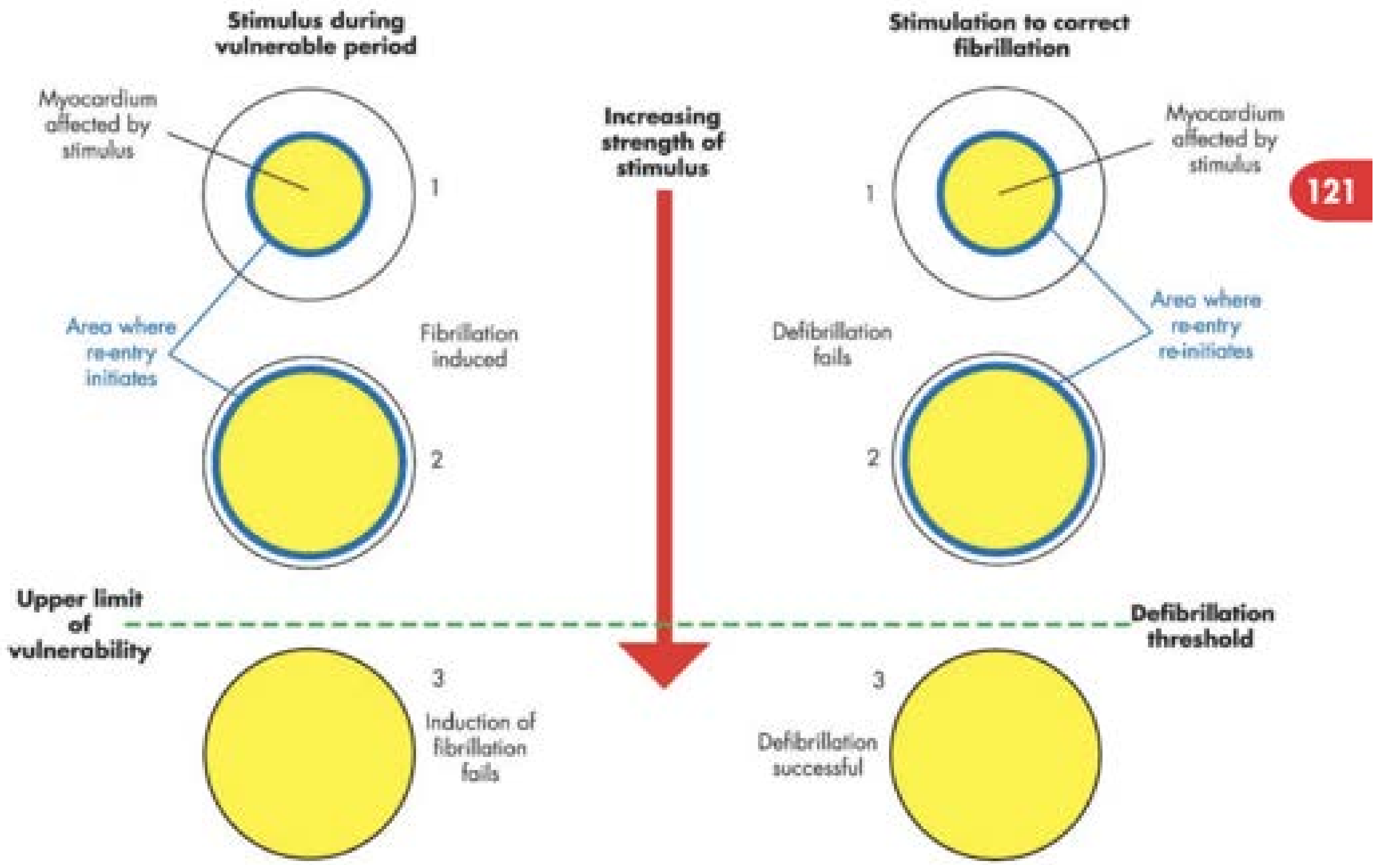


Figure 2 Relation between the upper limit of vulnerability and defibrillation threshold. The myocardium affected by the electrical stimulus is represented in yellow. In the left half of the diagram shocks are delivered to induce VF during the vulnerable period while in the right half of the diagram shocks are delivered during VF to attempt defibrillation. As the strength of electrical stimulus increases from 1 to 2, the area of myocardium affected increases. The zone where re-entry occurs after the shock (blue region) moves away from the area where the shock is delivered. A further increase in the intensity of stimulus (3) affects all of the myocardium and prevents induction of VF above the upper limit of vulnerability and successfully defibrillates above the defibrillation threshold.

Transthoracic impedance (TTI) is an important determinant of successful defibrillation.

Defib is accomplished by passage of sufficient electric current through the heart and between the two pads

the energy chosen and the TTI, or resistance to current flow, determine the current flow

factors that determine TTI: energy selected, electrode size, paddle - skin coupling material, number and time interval of previous shocks, phase of ventilation, distance between electrodes (size of the chest), and paddle electrode pressure

modern defibrillators use biphasic shock and are calibrated to alter the waveform delivered to the patient based on the TTI

the defibrillator aims to deliver a shock "dose" that is proportional to each patient

patients with low TTL are typically smaller and lighter

to make sure that patients with different TTI receive same energy the peak voltage or current can be adjusted or waveform tilt or waveform duration adjusted

Conclusions/action items:

This is extremely important for the project. Based on the TTI the monitor will adjust different things. This means that for each patient depending on their size they will have a different TTI affecting the amount of energy that actually gets passed. Different aspects of the shock can be changed to try and ensure that all patients no matter their TTI receive the adequate shock. The next step of research would be to see what the normal impedance is and how that affects our device.

REBECCA POOR - Oct 03, 2023, 6:52 PM CDT

THEORY AND PRACTICE OF DEFIBRILLATION: (2) DEFIBRILLATION FOR VENTRICULAR FIBRILLATION

Download

hrt09100118.pdf (253 kB)

2023/10/15- "Transthoracic Impedance"

Title: Transthoracic Impedance

Date: 10/15/2023

Content by: Becca

Present: N/A

Goals: To understand what the impedance of the average person is to have a greater understanding of how to build the preliminary circuit

Search Term: defibrillator impedance

Link: https://www.ahajournals.org/doi/10.1161/circ.102.suppl_1.I-90#:~:text=Transthoracic%20Impedance,-Defibrillation%20is%20accomplished&text=The%20average%20adult%20human%20impedance%20is%20approximately%2070%20to%2080%20

Citation:

[1] “Part 6: Advanced cardiovascular life support | circulation,” Aha Journals , https://www.ahajournals.org/doi/10.1161/circ.102.suppl_1.I-90 (accessed Oct

Content:

average adult human impedance is 70 to 80 ohms

if the transthoracic impedance is too high then the shock will not send

the defibrillator will read the original impedance and use that to determine whether or not it is safe for the shock

if the impedance is too high then a low energy shock will not be sufficient to bring the patient back to normal rhythm

Conclusions/action items:

The circuit should be based originally on the patient having approximately 70 to 80 ohms. This will help us to normalize the values to test to se build a circuit with this 70 to 80 ohms value.

2023/11/07 - "A Reed Bi-Stabe relay"

REBECCA POOR - Nov 07, 2023, 6:48 PM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "A Reed Bi-Stable Relay"

Date: 11/07/2023

Content by: Becca

Present: N/A

Goals: To understand the use of a reed relay and how it is used.

Search Term: Reed Relay

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1338106/pdf/jeabehav00173-0062.pdf

Citation: SLOANE H. N., Jr (1965). A REED BI-STABLE (LATCHING) RELAY. *Journal of the experimental analysis of behavior*, *8*(5), 328. https://doi.org/10.1901/jeab.1965.8-328

Content:

- electro mechanical relays are slow and noisy

- a reed relay throws on pulse onset

- rated for 24 V DC

- contains two 2400 ohm coils

- one SPST sitch

- easy to put in circuit with an IN538 diode

- it costs ~ 6.10 for one coil

Conclusions/action items:

This is a viable option for us to use if we can find a reed relay that can handle high voltages. The goal of the relay would be to help switch each side of the circuit from off to on and be able to handle the high voltage value. The coil would be powered from a separate source. The next step is to find a relay that can handle the high voltage.

REBECCA POOR - Nov 07, 2023, 6:44 PM CST

Download

jeabehav00173-0062.pdf (68.4 kB)

2023/11/10- Tong Lecture

REBECCA POOR - Nov 10, 2023, 12:41 PM CST

Title: Tong Lecture from Travelle F.F. Ellis

Date: 11/10/2023

Content by: Becca

Present: Entire BME Department

Goals: To listen and hear about "Where preparation meets opportunity"

Content:

- She is from Washington D.C
- Wanted to be a doctor at first and then realized she didn't find it interesting
- Started at Pitt and then graduated and continued education at UW
- FIRST: find your people
- SECOND: Do things that scare you
    - its a process
    - if you start doing things that you don't like then get through it
    - but it is an experience to have
- THIRD: Laugh until you cry, cry until you laugh
- Someone is counting on you
- Practice is important
- If you fail at school it is okay but when you are grown then you don't have as much flexibility
- What is your story?

Conclusions/action items:

Take the experiences you have in college and apply them in adult life. Love the people around you right now as they are making a large impact on you and you are making a large impact on them. Be intentional to them!!

"The circuit elements of a simple defibrillator"

Title: "The circuit elements of a simple defibrillator"

Date: 09/14/2023

Content by: Becca

Present: N/A

Goals: To understand how a simple circuit works for a defibrillator.

Search Term: circuit defibrillator

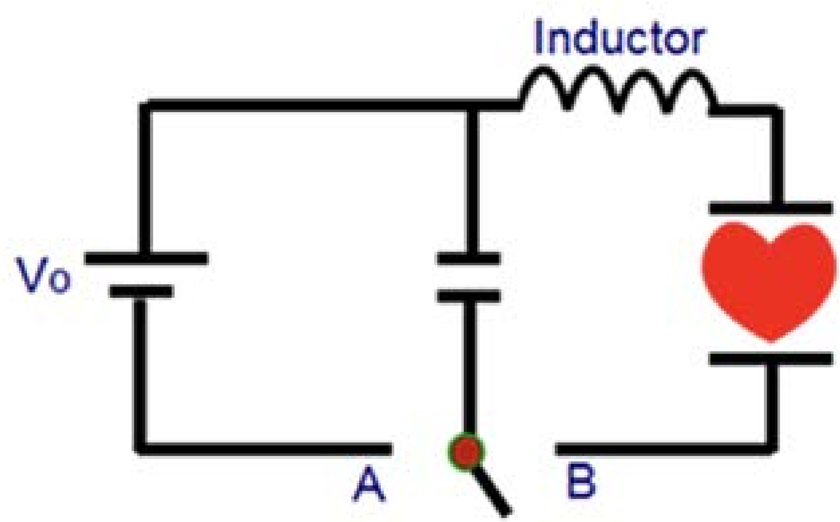
Link: https://www.khanacademy.org/test-prep/mcat/physical-sciences-practice/physical-sciences-practice-tut/e/the-circuit-elements-of-a-simple-defibrillator#:~:text=A%20simple%20defibrillator%20consists%20of,diagram%20of%20a%20simple%20defibrillator.&text=When%20the%2

Citation:

[1] "The circuit elements of a simple defibrillator (practice)," Khan Academy, https://www.khanacademy.org/test-prep/mcat/physical-sciences-practice/phys defibrillator#:~:text=A%20simple%20defibrillator%20consists%20of,diagram%20of%20a%20simple%20defibrillator.&text=When%20the%20switch% Sep. 14, 2023).

Content:

1. circuit includes power supply, a capacitor, an inductor, and a set of paddles



2.
3. switch connected to point A then capacitor is connected to the power supply
4. $I = (V_o/R)e^{(-t/RC)}$
5. switch connected to point B then the capacitor will begin to discharge and electrical energy to released from the paddles

Conclusions/action items:

Based on this research and understanding of the basic circuit I can start to think of design ideas for mixing two sets of pads. I also now know w next thing I will do based on this will research more of the specifics for each aspect. For example, what size capacitor and inductor is needed.

2023/10/03 - United States Patent 4,090519

REBECCA POOR - Oct 03, 2023, 7:16 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: United States Patent 4,090519

Date: 2023/10/03

Content by: Becca

Present: N/A

Goals: To find a patent of a defibrillator circuit and understand how the circuit flows.

Search Term: Defibrillator patent

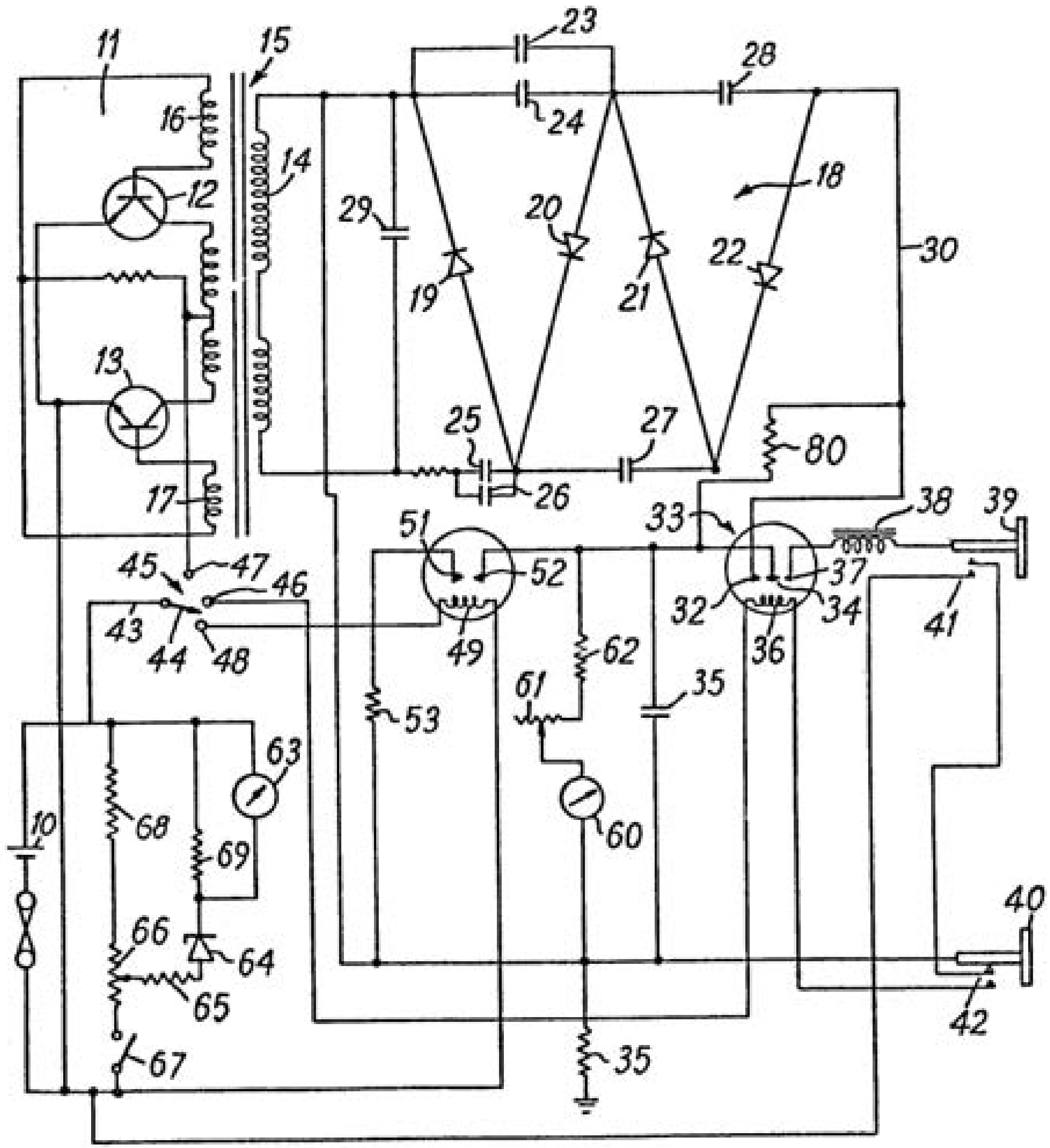
Link: https://patentimages.storage.googleapis.com/07/89/3a/660f9c2923d2cb/US4090519.pdf

Citation:

[1] J. F. Pantridge, “Defibrillator”

Content:

FIG. 1



This is a circuit of a defibrillator.

"A defibrillator which may be portable and which may be used without relying on electrical supply mains. The apparatus comprises a capacitor, an inductance and a pair of electrodes whereby the capacitor is discharged through a patient and the selection of the energy level, the capacitor and the inductance being such that the voltage wave-form of the discharge pulse has a duration of between ten and fifteen milliseconds, a peak value of not more than 4 kilovolts and a minimum rise time to that peak of 1,000 microseconds."

Conclusions/action items:

Using this defibrillation circuit we can begin to understand how the shock is set from the defibrillator. It also helps us to create our circuit as we need to harness the shock sent from the defibrillator. We need to look into more how this relates to current defibrillators on the market.

2023/10/03 - United States Patent US 8,335,562 B2

REBECCA POOR - Oct 03, 2023, 7:24 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: United States Patent US 8,335,562 B2

Date: 10/03/2023

Content by: Becca

Present: N/A

Goals: To understand the makeup and other competing designs currently on the market.

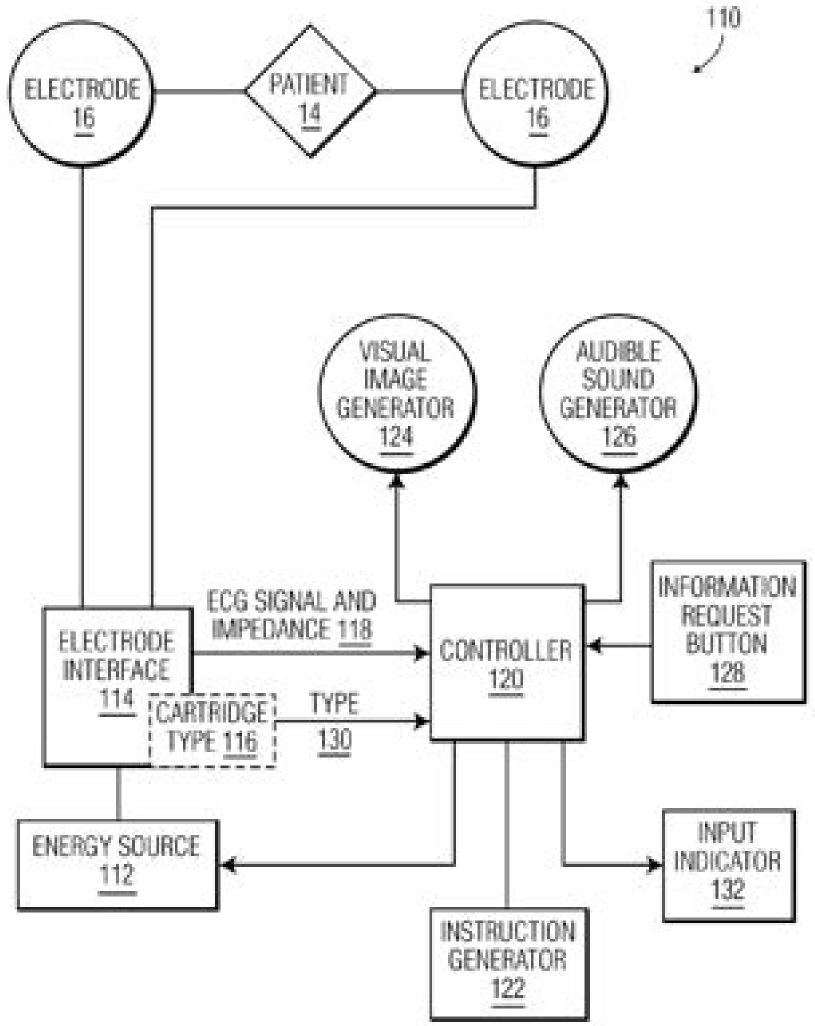
Search Term: Defibrillator portable patent

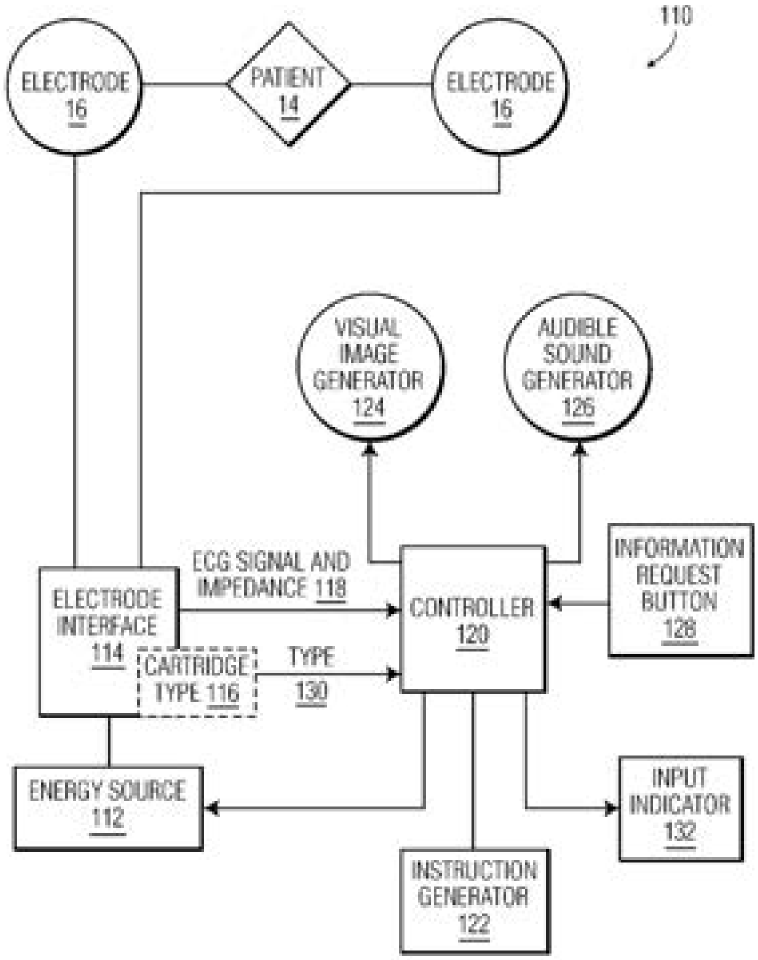
Link: https://patentimages.storage.googleapis.com/a4/78/6c/f67cfa1a796a00/US8335562.pdf

Citation:

[1] K. Hansen, C. Fischer, and J. Froman, “AUTOMATED EXTERNAL DEFIBRILLATOR (AED) WITH CONTEXT-SENSITIVE HELP,” Dec. 18, 2012

Content:


110
ELECTRODE 16
PATIENT 14
ELECTRODE 16
VISUAL IMAGE GENERATOR 124
AUDIBLE SOUND GENERATOR 126
INFORMATION REQUEST BUTTON 128
ECG SIGNAL AND IMPEDANCE 118
ELECTRODE INTERFACE 114
CONTROLLER 120
CARTRIDGE TYPE 116
TYPE 130
ENERGY SOURCE 112
INPUT INDICATOR 132
INSTRUCTION GENERATOR 122

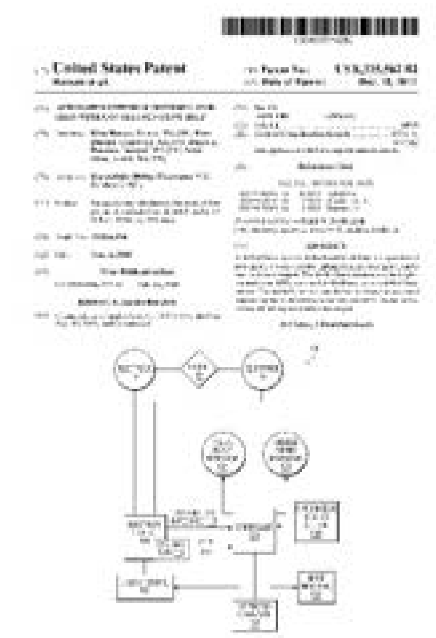


"A defibrillator system is disclosed including an operational state input, a user-operated information request input, and a user guidance output. The defibrillator system can be implemented as an AED, a manual defibrillator, or as a defibrillator trainer. The defibrillator system further utilizes the state and request inputs to determine a context-sensitive rescue information which is provided to the output."

Conclusions/action items:

This design is patented for specifically a portable defibrillator. This is a little different than our exact needs for a defibrillator but still relates to the need of the project. Potentially we could use an AED as our second power source instead of having to use two monitors which are much more expensive. Also, based on the information provided in the patent we can see the flow of information and how the shock is sent from the defibrillator itself.

REBECCA POOR - Oct 03, 2023, 7:21 PM CDT


United States Patent

Download

US8335562.pdf (940 kB)

2023/10/03 - United States Patent US 8,965,501 B2

REBECCA POOR - Oct 03, 2023, 7:35 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: United States Patent US 8,965,501 B2

Date: 10/03/2023

Content by: Becca

Present: N/A

Goals: To understand how a defibrillator sequence works when sending a shock.

Search Term: Dual Sequential Defibrillation patent

Link: https://patentimages.storage.googleapis.com/cc/bc/9d/4515983cfbc10e/US8965501.pdf

Citation:

[1] J. L. Sullivan, “Sequential stacked capacitor defibrillator and waveform generated therefrom,” Feb. 24, 2015

Content:

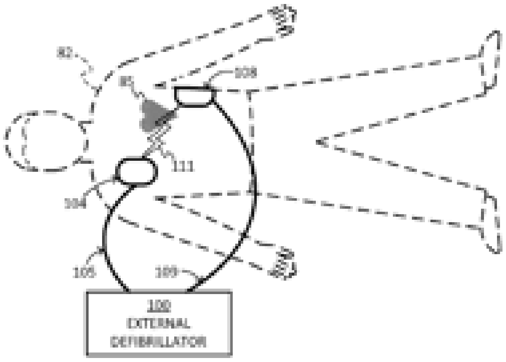


FIG. 1 *DEFIBRILLATION SCENE*

TYPE OF EXTERNAL DEFIBRILLATOR	INTENDED TO BE USED BY PERSONS:	
	IN THE MEDICAL PROFESSIONS	NOT IN THE MEDICAL PROFESSIONS
DEFIBRILLATOR – MONITOR	√	
AED	√	√

FIG. 2 *EXAMPLES OF EXTERNAL DEFIBRILLATORS*

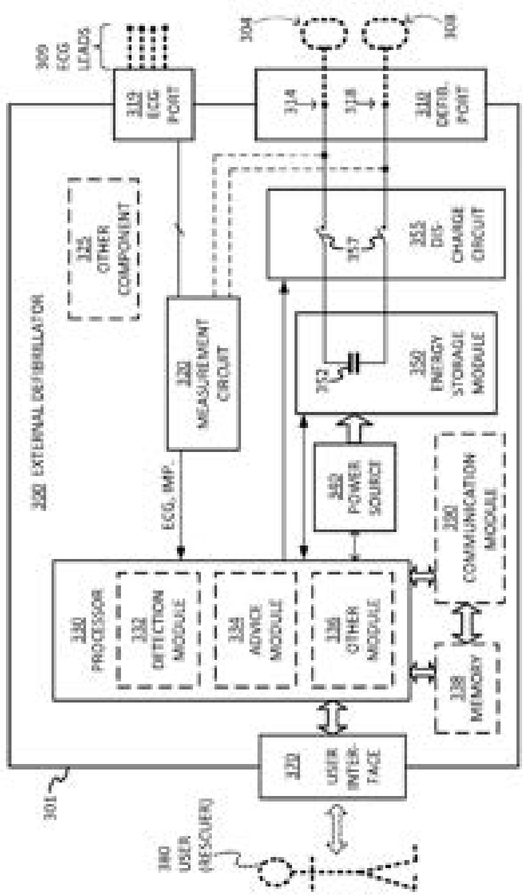


FIG. 3 *COMPONENTS OF EXTERNAL DEFIBRILLATOR*

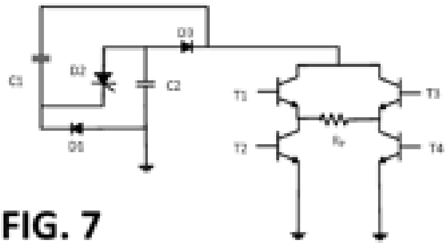


FIG. 7

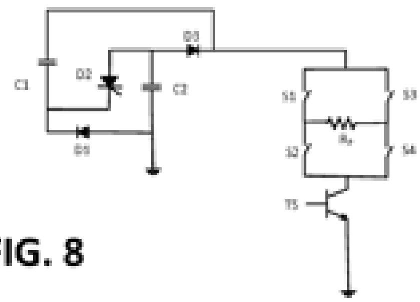


FIG. 8

SEQUENTIAL STACKED TWO-CAPACITOR CIRCUITS

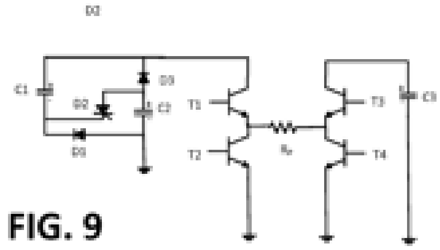


FIG. 9

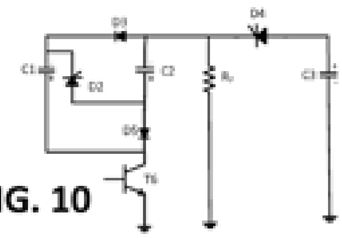


FIG. 10

SEQUENTIAL STACKED THREE-CAPACITOR CIRCUITS

1100

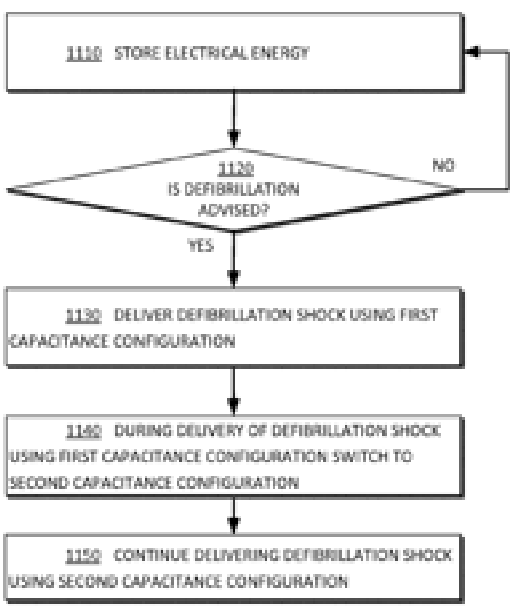
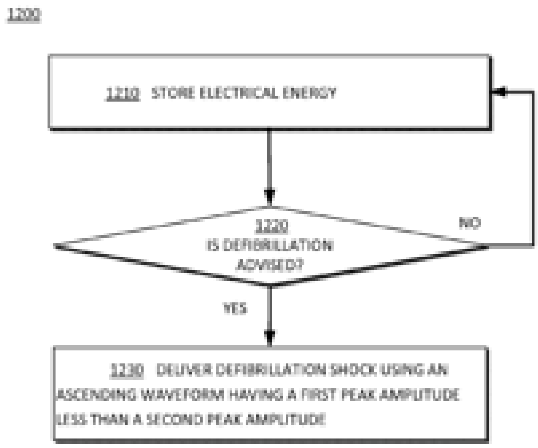


FIG. 11 *METHODS*



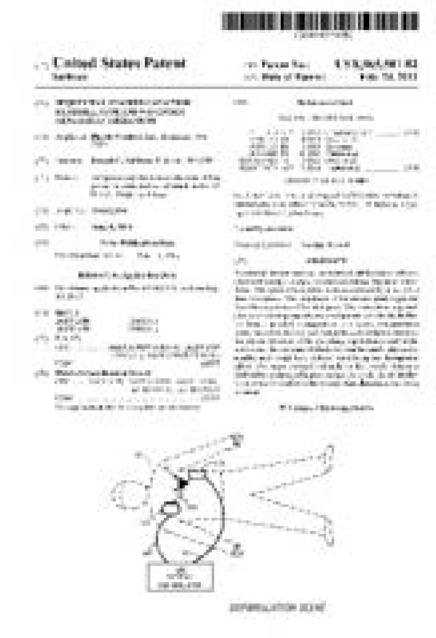
METHODS

"A medical device such as an external defibrillator deliverselectrical therapy using a special ascending, biphasic waveform. The special waveform is characterized by a set of atleast two peaks. The amplitude of the second peak is greaterthan the amplitude of the first peak. The waveform is generated by Switching capacitance configuration in the defibrillator from a parallel configuration to a series configurationwhile the defibrillator is delivering the defibrillation shock to the patient. Because of the Switching capacitances and/or thewaveform, the external defibrillator can be made physically Smaller and weigh less, without sacrificing the therapeutic effect of a larger external defibrillator that would deliver adefibrillation shock of higher energy. As such, the defibrillator is easier to configure for transporting, handling, and even wearing."

Conclusions/action items:

This patent is significant as it is for a defibrillator producing a biphasic shock. This biphasic will be sent different than a monophasic shock and is stored up differently. Our device could use a biphasic shock. By understanding how the shock is created and released it will allow us to harness it and then split it before sending it to the defibrillator pads on the body. The next step is to work through the circuit with a divider to see if it will affect the amount of current flowing to the pads.

REBECCA POOR - Oct 03, 2023, 7:36 PM CDT



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US8965501.pdf (2.04 MB)

2023/09/21 - Design 1: Single Circuit Adaptor

REBECCA POOR - Sep 21, 2023, 5:26 PM CDT

Title: Design 1: Single Circuit Adaptor

Date: 09/21/2023

Content by: Becca

Present: Becca

Goals: To create a design that can produce dual sequential defibrillation.

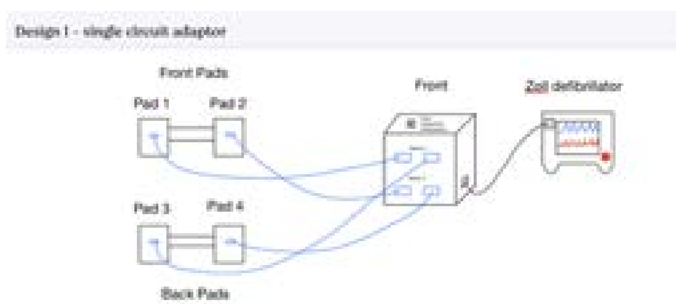
Content:

This design works by have two sets of pads, one adaptor circuit, and one Zoll defibrillator. One set of pads will be placed on the front of the patient and one set on the back. Each set of pads includes two pads to ensure that the vectors can be switched. The wires will have the ability to easily attach and detatch from the adaptor thus whatever wire is attatched to the adaptor will receive the shock from the defibrillator. For dual sequential defibrillation all four wires will need to be plugged into the adaptor. There is a button on the top of the adaptor that says "dual sequential defibrillation". This button will get pushed thus charging the adaptor and preparing it to send a monophasic shock to the second vector of pads with a shock of 360 J. When the defibrillator sends its shock through the adaptor to the first set of pads there will be a minimal delay to ensure that the patient is not over shocked. Then the monophasic shock will be sent to the second vector.

Conclusions/action items:

This design allows the physician to switch vectors along with utilize DSD without having to remove or add extra pads later on. It also only uses one defibrillator so it is more accessible in the field. The next steps would be to see if it is possible to create a 360 J shock.

REBECCA POOR - Sep 21, 2023, 5:21 PM CDT



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IMG_5D1B850429A6-1.jpeg (362 kB)

2023/09/21 - Design 2: Dual Defibrillator Circuit

REBECCA POOR - Sep 21, 2023, 5:30 PM CDT

Title: Design 2: Dual Defibrillator Circuit

Date: 09/21/2023

Content by: Becca

Present: Becca

Goals: To create a design that can produce dual sequential defibrillation.

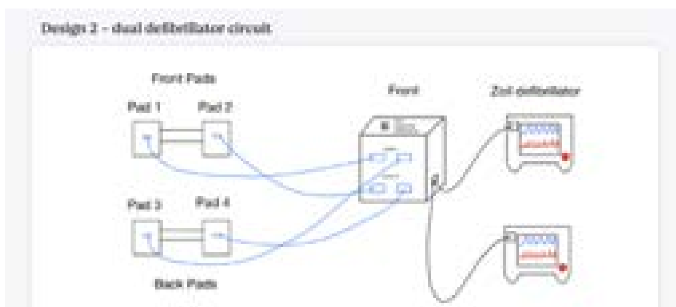
Content:

This design works by have two sets of pads, one adaptor circuit, and two Zoll defibrillators. Within the circuit it could just pass the shock through to the pads from the defibrillator. If DSD was required there is a button on the top of the adaptor to choose that option. If that is selected, then when the shocks are sent from the defibrillator one of the shocks would go through a circuit causing it to have a delay. This delay would ensure that the person didn't get shocked twice at the same time and would stop the equipment from getting damaged.

Conclusions/action items:

This design allows the physician to switch vectors along with utilize DSD without having to remove or add extra pads later on. It also only uses one defibrillator so it is more accessible in the field. The next step would be to create a circuit that could switch between the different pads.

REBECCA POOR - Sep 21, 2023, 5:28 PM CDT



Download

IMG_A78692AAC253-1.jpeg (388 kB)

2023/10/21 - Single Unit Pads Design

REBECCA POOR - Oct 25, 2023, 5:39 PM CDT

Title: Single Unit Pads Design

Date: 10/21/2023

Content by: Becca

Present: Becca

Goals: To create a pad design that incorporates pads that are currently on the market.

Content:

using two sets of LIFEPAK pads and connecting the front set, one for each vector

taped the wires together where they do not need to be separated allowing for easier application and use of the pads

a singular set of front pads along with connected back pads allows for easier application of two vectors under high stress situations

by using pads currently on the market, it allows the adaptors to be similar to others and simplifies the circuit design later on

the pad design is also compatible with use of the LUCAS device which was a main design criteria set by the client at the beginning of the project

Conclusions/action items:

The next steps are to create a prototype of the pads to see if it is feasible to have both vectors be one unit. The next step would be to prototype with ZOLL pads as that is all we access to currently but then switch to LIFEPAK pads. Once a design is created then we would like to test them on a manikin at the emergency education center to ensure that they are compatible with the LUCAS device.

2023/10/25 - Wire Connector for Pads

REBECCA POOR - Oct 25, 2023, 5:56 PM CD

Title: Wire Connector for Pads

Date: 10/25/2023

Content by: Becca

Present: Becca

Goals: To find a way to safely, simply, and cheaply connect the wires between the pads.

Content:

https://www.amazon.com/560PCS-Heat-Shrink-Tubing-Eventronic/dp/B072PCQ2LW/ref=asc_df_B072PCQ2LW/?tag=hyprod-20&linkCode=df0&hvadid=198097502341&hvpos=&hvnetw=g&hvrand=5579592825372175119&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018948&hvtargid=pl 385502389148&gclid=CjwKCAjw-eKpBhAbEiwAqFL0mpwYQBjrdC69TaZtz7EUQ8wIeciweTyQiWw0gRMB2UsZ4k8VquYOyhoC4l4QAvD_BwE&th=1

using these existing product on the market this would allow us to connect the wires where it is needed and make design changes when necessary as the material can be removed\

it is simply applied by wrapping around the wires and then heated, not a significant amount, but enough to melt the material around the wires

this would simplify the device and allow for easy presentation and use by the physicians

Conclusions/action items:

The next step would be to order this or find a similar material in the makerspace where we can prototype. We would want to make sure this doesn't affect the signal from the pads to the device Overall, I think it would be a good addition to the pads design.

2023/10/23 - Circuit Design 1

REBECCA POOR - Oct 25, 2023, 6:30 PM CDT

Title: Circuit Design 1

Date: 10/23/2023

Content by: Becca

Present: Becca and John Lombardo

Goals: To build a circuit that can detect the shock and then send two sequential shocks.

Content:

Met with John Lombardo in the makerspace to consult him regarding the circuit for the device

determined that a latching relay like a beefcake will take ~3 sec for the 1200 V to move through the circuit

Transistor is a better option: it is an insulated gate bipolar, compatible with an arduino, can be in two different formats

- NPN and PNP

- takes nsec to switch between the two which is much more optimal for the project

Opto - isolator:

- one for each polarity

- takes nsec to read

- this can read the polarity and then determining on the polarity it will send it through or close the other portion of the opto isolator to send it to the next one

Digikey is a great resource for looking up resources

Attached are images that were sketched for the circuit.

Conclusions/action items:

The next step is to find a transistor that is sufficient for the voltage level that is supplied by the defibrillator. Also, need to do more research on how the opto isolator will be affected by the high voltage.

2023/11/06- Switch Template

Title: Switch Template

Date: 11/06/2023

Content by: Becca

Present: Hunter, Jack

Goals: To find a solution for a switch that could withstand the high voltage passing through the circuit

Content:

Want a double pull switch on each side of the DSD

Double pull single throw (need two of them)

Get high voltage power supply to test the switch, add an appropriate load, put voltmeter at the end, see if when the switch is open if any voltage flows through the switch

Potential Switch:

S822/CUL

https://www.digikey.com/en/products/detail/nkk-switches/S822-CUL/4512508

Other option is to use a high voltage relay to mechanically switch, this would need to have power to power the coil and then have a switch attached to it

https://www.pickeringrelay.com/reed-relays/high-voltage/?13202_attr_pa_series%5B0%5D=1677&13202_attr_pa_series%5B1%5D=969&13202_attr_pa_series%5B2%5D=955&13202_attr_pa_series%5B3%5D=1741&13202_a

Part number: 119-1-A-5/3D

https://www.pickeringrelay.com/pdfs/119-high-voltage-micro-sil-reed-relays.pdf

Conclusions/action items:

We emailed NKK Switches to ask about the usage of the switch. Based on the schematics online they are not rated for the usage that we need for the project but we think it may be able to be

REBECCA POOR - Nov 06, 2023, 3:32 PM CST

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IMG_7928.HEIC (1.31 MB)

2023/11/07- Wire Syncher Design Idea

REBECCA POOR - Nov 07, 2023, 6:27 PM CST

Title: Wire Syncher Design Idea

Date: 11/07/23

Content by: Becca

Present: Becca

Goals: To create a portion of the pads that can hold the wires together on the back portion of the patient.

Content:

using a clip to hold the wires together on the back set of pads

the pads on the back/side of the patient will need to alter their lengths between them depending on the size of the patient

To make it easier for application and for use the physician may want to slick the wires together simplifying the system every further

The wires would come synched together at their closest parts and then ideally the physician could slide or move it down so that they could make it the length they needed between the pads

One wire could be attached in the top part and then stuck in, then based on the placement the clip would connect to the other pads wire

Conclusions/action items:

Overall this seems like a good idea but we would have to test to see if the wires fit within the clip and how functional it is. Also, more research needs to be done to determine the size variations between different types of pads.

2023/11/07- Cold Shrink Wire Simplification

REBECCA POOR - Nov 07, 2023, 6:38 PM CST

Title: Cold Shrink Wire Simplification

Date: 11/07/2023

Content by: Becca

Present: Becca

Goals: To come up with a more permanent solution for the connection of the wires than tape that can be attatched even with the pads on the end of the them.

Content:

For the wires used in the two sets of pads many of them will be running the same track so we want to better simplify the system by combining those sets of wires. This is specifically on the pads on the front of the body and the two sets of wires going to the plug in

The design idea is cold shrink tape.

Cold Shrink Tape requires no heat or chemicals to form

It is also meant to form a waterproof weathertight seal that is important so the wires aren't exposed and cause harm to the patient

It is generally used to cover cables, splices and terminations.

We could use part of this to adhere together the wires in a simpler and more aesthetic fashion than the current prototype.

Scapa B2515-30B Black Cold Shrink Amalgamating Tape

- this is a brand of tape that would be sufficient for the project

Conclusions/action items:

We would need to order the tape and test it out to see if it was sufficient. One of the biggest concerns with the tape is if it will adhere to the wires and if it will make a the system simpler for the user. The goal of altering the pads is to simplify the system.

2023/24/33- Pad Prototyping with Zoll Pads

REBECCA POOR - Oct 25, 2023, 5:47 PM CDT

Title: Prototyping Pads with Zoll Pads

Date: 10/24/2023

Content by: Becca

Present: Becca, Jack

Goals: To create a singular unit of front pads and simplify the connections between all of the pads using existing pads.

Content:

In the images attached below it shows the prototype pads placed at their ideal placement on a patient. Using tape from the makerspace Jack and I were able to connect the wires where they would be fused together to represent that they are one. This simplifies the system for physicians when they need to place the pads under high stress situations. The front set of pads is also attatched to allow for simpler application of the pads. There will be one piece of adhesive on the back to allow for simple application. There will be a connector between the two back pads and their wires. This will be similar to a connector found between old apple headphones to keep the wires together at a specific point that would be adjustable based on the size of the patient.

Conclusions/action items:

The next steps are presenting the prototype to receive client feedback before further, more extensive, prototyping is completed. The preliminary prototype will also be used at the emergency education center to see how it fits on different sized manikins.

REBECCA POOR - Oct 25, 2023, 5:43 PM CDT

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IMG_7790.HEIC (1.9 MB)

REBECCA POOR - Oct 25, 2023, 5:43 PM CDT

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IMG_7791.HEIC (1.84 MB)

2023/11/07- Switch Testing Protocol

REBECCA POOR - Nov 07, 2023, 6:04 PM CST

Title: Switch Testing Protocol

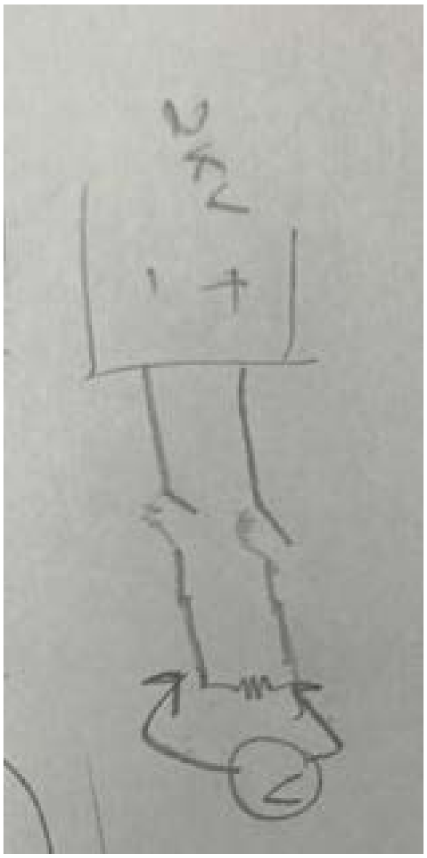
Date: 11/07/2023

Content by: Becca

Present: Becca

Goals: To establish a protocol that can be used to test the switch to determine if it can handle the large amount of voltage flowing through it.

Content:



We would have a power source around 2 KV that is similar to the voltage that flows through our circuit. This would be attatched to the switch and then there would be a voltmeter of some type at the end. We would start by having the switch open and running the voltage through it. Ideally we would not see any voltage on the voltmeter as the circuit is technically open. If there is voltage that slips through then we know that the switch is not sufficient for our use with such high voltages.

Conclusions/action items:

The next steps are accessing the switch and ordering it. We also need to check in with Dr. N to see if there is a power source that large that we can access as we do not want to use the defibrillator for testing of the switch due to safety concerns. The switch is not rated for use with such a high DC voltage which is the main reason for the concern and need to test it.

2023/02/10 Biosafety Training Certification

REBECCA POOR - Feb 17, 2023, 4:08 PM CST

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Screen_Shot_2023-02-10_at_3.12.00_PM_1_.png (384 kB)

2023/02/10 Chemical Safety Training Certification

REBECCA POOR - Feb 17, 2023, 4:09 PM CST

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Screen_Shot_2023-02-10_at_3.12.00_PM_1_.png (384 kB)

2023/02/10 HIPAA Privacy and Security Training Certification

REBECCA POOR - Feb 17, 2023, 4:10 PM CST

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Screen_Shot_2023-02-10_at_3.12.00_PM_1_.png (384 kB)

2023/02/10 Green Pass Certification

REBECCA POOR - Feb 17, 2023, 4:11 PM CST

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1676063694.565256_1_.jpg (2.15 MB)

2023/09/14-DSD for out of Hospital Cardiac Arrests

HUNTER BELTING - Sep 14, 2023, 9:46 PM CDT

Title: Double sequential defibrillation therapy for out-of-hospital cardiac arrests: The London experience

Date: 9/14/23

Content by: Hunter Belting

Goals: Learn about the benefits and what dual sequential defibrillation actually involves, especially when used in the field.

Content:

- Recent evidence suggests that double sequential defibrillation (DSD), where two shocks are delivered to the patient in quick succession, may provide an effective therapy for RVF.
- A comparator group of patients who received more than six consecutive standard shocks (not DSD) for persistent VF was also identified. Outcomes included pre-hospital return of spontaneous circulation (ROSC), ROSC sustained to hospital, and survival to hospital discharge.
- Observed similar ROSC and survival rates amongst those who received standard defibrillation only.
- The observational study did not find any clear benefit of DSD use by EMS in the treatment of RVF. However, we find that 3 patients, who were treated with DSD following unsuccessful single shocks, had their VF terminated.

Conclusions/action items:

Though the literature states there was not a major benefit to those who receive DSD compared to standard defibrillation there needs to be more research done. This is only further realized when the fact that CPR has to be stopped to put more pads on or there needs to be multiple defibrillation devices on hand which generally isn't a possibility for out-of-hospital care.

HUNTER BELTING - Sep 21, 2023, 5:51 PM CDT

citation: Emmerson AC, Whitbread M, Fothergill RT. Double sequential defibrillation therapy for out-of-hospital cardiac arrests: The London experience. Resuscitation. 2017; 117:97-101. [pubmed]

HUNTER BELTING - Sep 21, 2023, 5:54 PM CDT

Download

1-s2.0-S030095721730254X-main.pdf (392 kB)

2023/09/14-LUCAS Device with Long Compression Intervals

HUNTER BELTING - Sep 14, 2023, 10:25 PM CDT

Title: LUCAS Device Use Associated with Prolonged Pauses during Application and Long Chest Compression Intervals

Date: 9/14/23

Content by: Hunter Belting

Goals: Learn about how the LUCAS device compares with traditional chest compressions and how defibrillation devices work in conjunction with defibrillation pads/devices.

Content:

- Fifty-eight (58) resuscitations met the inclusion criteria and were included for analysis, and Figure 1 demonstrates a typical resuscitation. Median age was 62.5 years (IQR 49.3– 70.8), 47% were female, and 66% were nonwhite. Initial rhythm was commonly asystole (34, 59%) or pulseless electrical activity (15, 26%), with 9 (15%) in ventricular fibrillation. EMS witnessed the cardiac arrest in 8 (14%) cases, and 18 (31%) were witnessed by bystanders. CPR was performed prior to EMS arrival in 24/50 cases not witnessed by EMS.
- The LUCAS was applied before or simultaneous with the cardiac monitor; this includes 1/8 cases of EMS witnessed cardiac arrest and 3/9 cases presenting with ventricular fibrillation.
- Despite experience with clinical use of the LUCAS device and an established quality review process, we observed significant interruptions in compressions and delayed opportunities for rhythm analysis associated with use of a LUCAS device. However, Manual compressions were more frequently interrupted; most of these breaks in compressions were early in the resuscitation, less than 10 s, and occurred in patients without advanced airways.
- LUCAS use was associated with long compression intervals without identifiable pauses to assess for pulse or cardiac rhythm, and device application resulted in longer pauses than airway management or defibrillation.

Conclusions/action items:

Based on the article it is integral to incorporate defibrillation with the LUCAS device as this helps with situations in which longer compression interruptions occurred. With that being said the ability to change vectors without stopping compressions should have a greater impact on survivability for patients in VTACH and VFIB.

HUNTER BELTING - Sep 21, 2023, 5:55 PM CDT

citation: Morgan S, Gray JJ, Sams W, Uhl K, Gundrum M, McMullan J. LUCAS Device Use Associated with Prolonged Pauses during Application and Long Chest Compression Intervals. Prehosp Emerg Care. 2023 Mar 9:1-4. doi: 10.1080/10903127.2023.2183294. Epub ahead of print. PMID: 36857205.

HUNTER BELTING - Sep 21, 2023, 5:55 PM CDT

Prehospital Emergency Care

LUCAS Device Use Associated with Prolonged Pauses during Application and Long Chest Compression Intervals

Download

LUCAS_Device_Use_Associated_with_Prolonged_Pauses_during_Application_and_Long_Chest_Compression_Intervals.pdf (830 kB)

2023/09/21-Monophasic vs. Biphasic Shocks

HUNTER BELTING - Sep 21, 2023, 8:01 PM CDT

Title: Monophasic and biphasic shock for transthoracic conversion of atrial fibrillation: Systematic review and network meta-analysis

Date: 9/21/2023

Content by: Hunter Belting

Goals: Learn about what mono/biphasic shocks are and how they differ as well as which is more effective in treating cardiac arrests.

Search Term: Biphasic Shock

Link: https://pubmed.ncbi.nlm.nih.gov/26777209/

Citation:

Inácio JF, da Rosa Mdos S, Shah J, Rosário J, Vissoci JR, Manica AL, Rodrigues CG. Monophasic and biphasic shock for transthoracic conversion of atrial fibrillation: Systematic review and network meta-analysis. Resuscitation. 2016 Mar;100:66-75. doi: 10.1016/j.resuscitation.2015.12.009. Epub 2016 Jan 8. PMID: 26777209.

Content:

> It is known that biphasic shock waveforms need lower energy than monophasic shock waveforms for transthoracic cardioversion of AF. Recommendations for initial energy have been set to 120 J for biphasic waveforms, and 200 J for monophasic waveforms.
>
> Two major types of biphasic waveforms are known as Rectilinear Biphasic Waveform (RBW) and Biphasic Truncated Exponential (BTE.) Different BTE manufactures can have different peak voltages, positive and negative cycle's durations and tilts. In both types of biphasic waveforms the defibrillator reads the patient's transthoracic impedance during energy delivery, and adjusts its outputs in order to deliver the selected energy to the patient. However they differ in how they adjust their output to compensate for the patient's impedance. Rectilinear Biphasic Waveform (RBW), developed by Zoll, has a 200 J limit and adjusts its internal impedance to deliver a constant current.
>
> One major Biphasic Transthoracic Exponential waveform is the ADAPTIV developed by PhysioControl. It has a 360 J limit and controls lead-edge voltages and adjusts pulse duration. Another major BTE waveform is the Philips SMART Biphasic, it has a 200 J limit, constant edge voltages and it controls pulse tilts and adjusts pulse duration.
>
> PhysioControl Biphasic was significantly superior to Monophasic in the 4 outcomes. Both Philips SMART Biphasic and Zoll Rectilinear Biphasic were superior to Monophasic in 3 outcomes (1st shock success, cumulative energy and number of shocks). There were no significant differences in any of the 4 outcomes in comparisons between any of the Biphasic waveforms.

Conclusion:

Overall it is recommended that biphasic shocks are set to 120 J, with that being said the design we go for could be catered to the PhysioControl which allows for a 360 J limit. With this limit we would still be able to hit close to the high end of the spectrum when splitting the energy with 180 J going through each set of pads. This would still be close to the 200 J limit of both the Zoll and Philips defibrillators while also giving the opportunity for modification without the addition of a separate defibrillator or charging pack. It is also important to note that we should focus our attention on biphasic shocks to maximize success rates in treatments.

2023/09/21-South Korean Patent

HUNTER BELTING - Sep 29, 2023, 9:25 AM CDT

Title: Defibrillator for multiple sequential defibrillation

Date: 9/21/2023

Content by: Hunter Belting

Goals: Find patents similar in nature to what we are tasked with in our project regarding circuitry in DSD

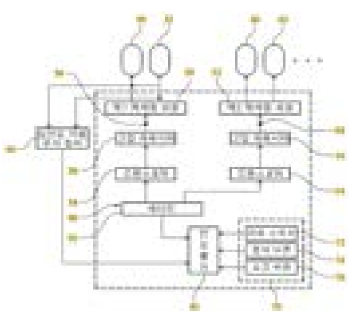
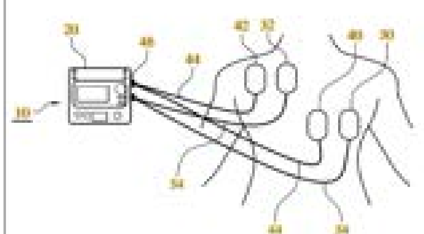
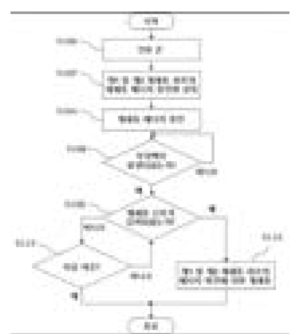
Search Term: Double Sequential Defibrillation

Link: https://patents.google.com/patent/KR20210149258A/en?q=(Dual+Sequential+Defibrillation)&oq=Dual+Sequential+Defibrillation

Citation:

"KR20210149258A - defibrillator for multiple sequential defibrillation," Google Patents, https://patents.google.com/patent/KR20210149258A/en?q=%28Dual%2BSequential%2BDefibrillation%29&oq=Dual%2BSequential%2BDefibrillation (accessed Sep. 21, 2023).

Content:

- The images above depict the interpretation and patent filed by a South Korean source of DSD.
- A controller is connected with the first and second defibrillation circuits for controlling operation of the first and second defibrillation circuits to execute electric defibrillation. The controller may perform electric defibrillation simultaneously or with a time difference according to the same or different voltage through the pair of first and second defibrillation electrodes.
- The present invention performs dual or multiple sequential shock defibrillation by the first and second defibrillation electrodes to efficiently treat refractory ventricular fibrillation (VFIB).

Conclusion:

Though it would be very difficult to do, this would be the ideal path and result the team should go down. The difficulty in creating a novel defibrillator, however, makes this extremely difficult as current defibrillators do not have paths for multiple pads.

2023/09/21-Medi-Trace Cadence Defibrillation Electrodes

HUNTER BELTING - Sep 21, 2023, 7:32 PM CDT

Title: Medi-Trace Cadence Defibrillation Electrodes

Date: 9/21/2023

Content by: Hunter Belting

Goals: Research current designs on the market and their shortcomings when it comes to DSD.

Search Term: defibrillator pads manufacturer

Link: https://www.cardinalhealth.com/en/product-solutions/medical/patient-monitoring/electrocardiography/defibrillation-electrodes/medi-trace-cadence-defibrillation-electrodes.html

Citation:

Medi-TraceTM Cadence Defibrillation Electrodes - Cardinal Health, https://www.cardinalhealth.com.au/en_au/medical-products/patient-care/electrocardiography/defibrillation-electrodes/medi-trace-cadence-defibrillation-electrodes.html (accessed Sep. 21, 2023).

Content:

Medi-Trace™ Cadence Defibrillator electrodes can connect directly to compatible defibrillators without the use of adaptors.

The compatibility with defibrillators is something that we will want to have ideally instead of a single connection for certain defibrillators such as the Zoll or LifePack systems. However in order to actually provide DSD there would need to be another defibrillator with another set of electrodes.

Conclusion:

Though these electrodes are great for normal defibrillation use, it currently lacks the modularity needed to properly and effectively provide a capable DSD shock through a single defibrillator.

2023/09/21-LIFEPAK 15 monitor/defibrillator

HUNTER BELTING - Sep 21, 2023, 9:31 PM CDT

Title:

Date: 9/21/2023

Content by: Hunter Belting

Goals: Gain a greater insight into the LIFEPAK system and how we can possibly use this device to implement DSD

Search Term: lifepak® 15 monitor/defibrillator shock circuitry

Link: https://www.stryker.com/content/dam/stryker/ems/resources/operating-instructions/international/3314911-030_int-eng_lifepak_15_operating_instructions.pdf

Citation:

Lifepak® 15 monitor/defibrillator - operating instructions - stryker, https://supportstryker-emergency-care.zendesk.com/hc/en-us/articles/12424655511323-LIFEPAK-15-monitor-defibrillator-Operating-Instructions (accessed Sep. 21, 2023).

Content:

The LIFEPAK 15 monitor/defibrillator operates either on battery power using two Lithium-ion batteries, or with auxiliary power using the AC Power Adapter or DC Power Adapter. Batteries may be charged in the Station or Mobile Li-ion Battery Charger, the REDI-CHARGE™ Battery Charger, or in the monitor/defibrillator if it is connected to auxiliary power.

Replacing and Removing Therapy Electrodes Replace adult QUIK-COMBO electrodes with new electrodes after one of the following occurs: • 50 defibrillation shocks • 24 hours on the patient's skin • 8 hours of continuous pacing

Replace pediatric QUIK-COMBO electrodes with new electrodes after one of the following occurs: • 25 defibrillation shocks • 24 hours on the patient's skin • 8 hours of continuous pacing Chapter 6 | Paddle Accessory Options ©2019 Physio-Control, Inc. LIFEPAK 15 Monitor/Defibrillator Operating Instructions 155 To remove QUIK-COMBO therapy electrode

When you turn on the LIFEPAK 15 monitor/defibrillator, a new Patient Record is created and stamped with the current date and time. All events and associated waveforms are digitally stored in the Patient Record as reports, which you can print, transmit, or download to the LIFENET® System, or to post-event review products such as CODE-STAT™ or DT EXPRESS™ software.

Conclusion:

I believe that this system gives our group the best ability to implement a shock that changes vectors as well as delivering DSD when needed. The ability to have access to a full 360 J and implement a system in which two sets of electrodes are implemented seems like a feasible option within the design.

2023/10/07-Sequential Timing of DSD

HUNTER BELTING - Oct 09, 2023, 8:39 PM CDT

Title: Sequential Timing for a DSD Shock

Date: 10/07/2023

Content by: Hunter Belting

Goals: Research current findings on DSD timing between the two shocks and whether waiting longer or shocking almost instantaneously is more effective in treating VF or VTach.

Search Term: Dual Sequential Defibrillation timing of shocks

Link: https://www.jems.com/patient-care/double-sequential-external-defibrillation-for-refractory-ventricular-fibrillation/

Citation:

S. Cheskes, “Double sequential external defibrillation for refractory ventricular fibrillation: It’s all about the timing - JEMS: EMS, emergency medical services - training, paramedic, EMT News,” JEMS, https://www.jems.com/patient-care/double-sequential-external-defibrillation-for-refractory-ventricular-fibrillation/ (accessed Oct. 9, 2023).

Content:

- During the study period, 252 patients met inclusion criteria. Of the 252 patients included in the analysis, 201 (79.8%) received standard defibrillation and 51 (20.2%) patients received DSED. Age, sex, location of arrest, EMS witnessed arrest, bystander witnessed status and rate of bystander CPR were similar between standard and DSED groups.
- results suggest that successful resuscitation with DSED may be time-sensitive, with greater success early in the resuscitation.
- Animal studies suggest that DSED may be successful by lowering the defibrillation threshold. Previous research suggests the optimal timing of the two shocks may be as short as 10 milliseconds (ms), or between 75-125 ms with a period of increased defibrillation threshold existing between 50 and 75 ms. Periods longer than 125 ms were not studied. The known refractory period of ventricular muscle is between 50-75 ms, which may be a particularly vulnerable period to reintroduce ventricular fibrillation.
- Contrasting these findings and those of earlier animal studies, Hoch et al., have demonstrated successful use of DSED in refractory VF with shocks separated by 0.5 to 4.5 seconds with no pharmacological therapy provided between unsuccessful and successful (DSED) shocks.

Conclusion:

It is very interesting that there are almost two different time periods that could work, being 10-125 ms or between 0.5-4.5 seconds. This could definitely be something that is tested in the future to see if there is a possibility on the manikin to measure effectiveness in some manner.

2023/10/09-Minimum Shock Effectiveness

HUNTER BELTING - Oct 09, 2023, 9:13 PM CDT

Title: Energy Requirements for Defibrillation

Date: 10/09/2023

Content by: Hunter Belting

Goals: Research current findings on biphasic minimum shock needs in order to gain effective results in treating cardiac arrests. This should also include DSD shocking.

Search Term: Lowest effective joules for dual sequential defibrillation

Link: https://www.ahajournals.org/doi/10.1161/circ.102.suppl_1.I-90

Citation:

"Part 6: Advanced cardiovascular life support," *Circulation*, vol. 102, no. suppl_1, 2000. doi:10.1161/circ.102.suppl_1.i-90

Content:

- There is no definite relationship between body size and energy requirements for defibrillation in adults. Transthoracic impedance does play an important role.
- The first biphasic AED approved for use in the United States used a waveform set at a lower energy (150 to 175 J) than that recommended by the AHA (200 J) for the first shock.
- Researchers have collected data both in-hospital (electrophysiological studies and ICD testing) and out of hospital. This research indicates that repetitive lower-energy biphasic waveform shocks (repeated shocks at ≤200 J) have equivalent or higher success for eventual termination of VF than defibrillators that increase the current (200, 300, 360 J) with successive shocks.
- The energy chosen (joules) and the transthoracic impedance (ohms), or resistance to current flow, determine the current flow. Factors that determine transthoracic impedance include energy selected, electrode size, paddle-skin coupling material, number and time interval of previous shocks, phase of ventilation, distance between electrodes (size of the chest), and paddle electrode pressure. The average adult human impedance is approximately 70 to 80 Ω.
- The most important determinant of survival in adult VF is rapid defibrillation. Give shocks as soon as a defibrillator is available.

Conclusion:

The general consensus is that shocks under 200 J can be just as effective. The general minimum that has been cited in this paper is about 150 J, however other sources have stated even as low as 120 J. With that being said it is still lower than the 180 J that we will be supplying during DSD.

2023/11/10-Tong Distinguished Lecture

HUNTER BELTING - Nov 10, 2023, 12:31 PM CST

Title: Tong Distinguished Speaker Lecture

Date: 11/10/2023

Content by: Hunter Belting

Goals: Learn about and listen to the speakers experiences and message to us.

Content:

Where Preparation Meets Opportunity:

- an engineer is a skillful contriver or originator of something.
- Find your people, do things that scare you, and laugh until you cry, cry until you laugh.
- lean into the practice here at Madison because it will shape who you become.
- Everyone is counting on you!!!! I have the ability to change the world.

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2023/09/21-Preliminary Design 1

HUNTER BELTING - Sep 21, 2023, 10:48 PM CDT

Title: Design 1: Single Circuit Adaptor

Date: 09/21/2023

Content by: Hunter Belting

Goals: To design a system that can produce dual sequential defibrillation, ideally with one monitor/defibrillator.

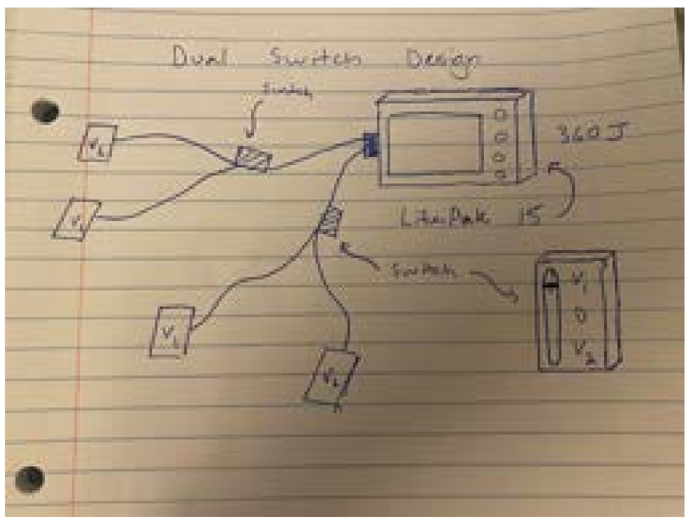
Content:

The design is attached below.

Conclusions/action items:

This design would utilize the 360 J LIFEPAK 15. With this amount of energy it is still possible to get a viable shock while splitting the current between the four electrodes in the design.

HUNTER BELTING - Sep 21, 2023, 10:45 PM CDT



Download

Dual_Switch_Design.jpg (2.45 MB)

2023/09/21-Preliminary Design 2

HUNTER BELTING - Sep 21, 2023, 10:52 PM CDT

Title: Design 1: Single Circuit Adaptor

Date: 09/21/2023

Content by: Hunter Belting

Goals: To design a system that can produce dual sequential defibrillation, ideally with one monitor/defibrillator.

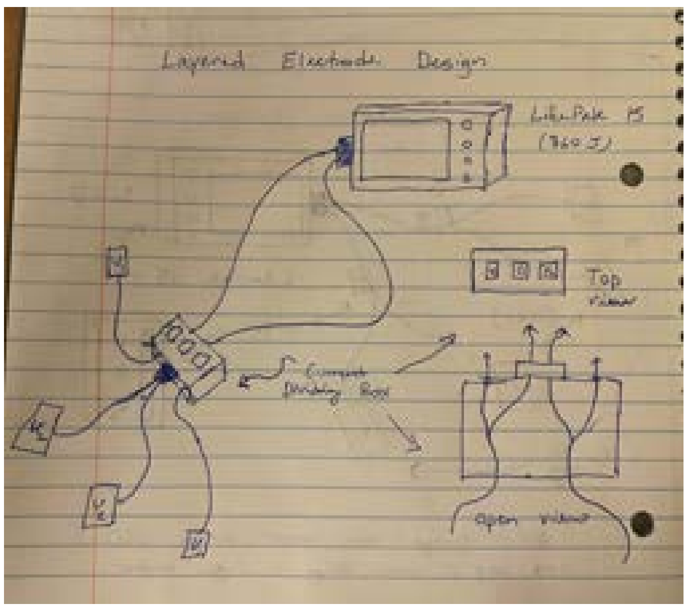
Content:

The design is attached below.

Conclusions/action items:

This design would utilize the 360 J LIFEPAK 15. With this amount of energy it is still possible to get a viable shock while splitting the current between the four electrodes in the design. The design implements a secondary plug for the second set of electrodes, simplifying the circuitry involved to just the initial electrode pair that is being modified while also confining the design to a sleek controller/box.

HUNTER BELTING - Sep 21, 2023, 10:48 PM CDT



Download

Layered_Electrode_Design.jpg (2.15 MB)

2023/10/09-Layered Electrode Second Iteration

HUNTER BELTING - Oct 09, 2023, 9:22 PM CDT

Title: Layered Electrode updated iteration

Date: 10/09/2023

Content by: Hunter Belting

Goals: Updated iteration to the layered electrode design that we will be moving forward with to design a DSD device.

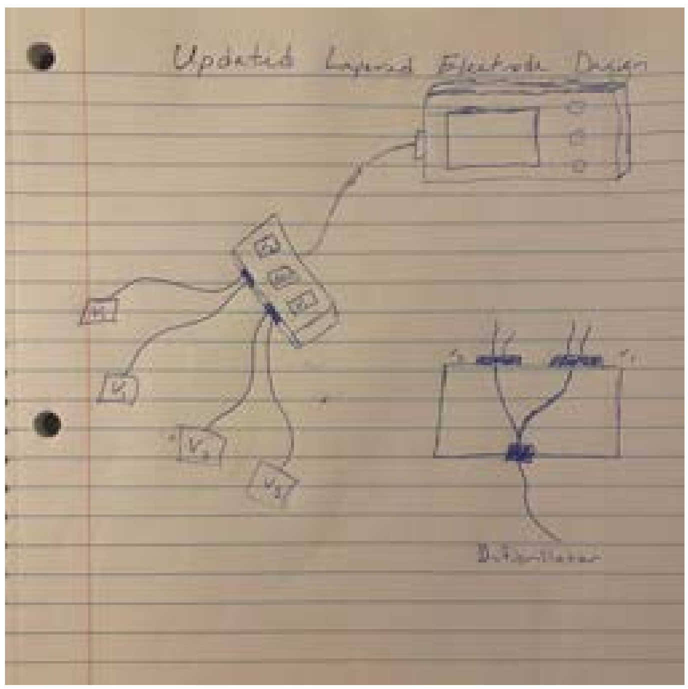
Content:

The design is attached below.

Conclusions/action items:

The update to the box allows for two pads to be plugged into the box instead of the one set splitting the current into another set of pads. The box will instead be directly connected to the defibrillator and then split the current within the circuit, also allowing for vector changes/DSD.

HUNTER BELTING - Oct 09, 2023, 9:33 PM CDT



Download

UpdatedLED_BME300.jpg (1.74 MB)

2022/11/22-Green Pass Documentation

HUNTER BELTING - Feb 22, 2023, 9:21 AM CST

Title: Green Pass

2023/02/21-Biosafety Training

HUNTER BELTING - Feb 22, 2023, 9:16 AM CST

Title: Biosafety Training

Training Information Lookup Tool University of Wisconsin-Madison

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Hunter Belting has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2021	2/21/2023	
Chemical Safety: The OSHA Lab Standard	Final Quiz	2/21/2023	

Data Last Imported: 02/22/2023 08:37 AM

2023/02/21-Chemical Safety

HUNTER BELTING - Feb 22, 2023, 9:15 AM CST

Title: Chemical Safety

Training Information Lookup Tool University of Wisconsin-Madison

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Hunter Belting has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2023	2/21/2023	
Chemical Safety: The OSHA Lab Standard	Final Quiz	2/21/2023	

Data Last Imported: 02/21/2023 08:37 AM

2023/05/03-CNC Mill Upgrade

HUNTER BELTING - May 03, 2023, 8:42 AM CDT

Title: CNC Mill Upgrade

You have the following permits and upgrades:

Name	Date
Green Permit	11/22/2022
Lab Orientation	01/27/2022
Red Permit	02/15/2022
CNC Mill 1	04/11/2023
Laser 1	02/17/2022

2023/11/01- EEC Adapters

HUNTER BELTING - Dec 10, 2023, 12:19 PM CST

Title: EEC Adapters for Reference

Date: 11/01/23

Content by: Hunter Belting

Present: Hunter, Maribel, and Jack

Goals: Look into what the EEC has to offer and identify what kind of adapter is needed for our own circuitry.

Content:

There are many different kinds of adapters that will work and are shown below. This is due to the different companies such as Zoll making their own style of adapters.

Conclusions/action items:

After looking at the different adapters and learning about the most common pads used in the Madison area we will move forward with finding an adapter that is compatible with Zoll pads.

2023/11/29-3-D Scanning Zoll adapter

HUNTER BELTING - Dec 10, 2023, 12:30 PM CST

Title: 3-D Scanned Adapter

Date: 11/29/23

Content by: Hunter Belting

Present: Hunter Belting

Goals: 3-D scan a set of Zoll adapters to be able to 3-D print the inverse to use in our circuit

Content:

The scanned product will be linked below.

Conclusions/action items:

Though this was a good technique to possibly make the adapter, the scan didn't come out perfect and would require extensive work within a software program such as blender.

HUNTER BELTING - Dec 10, 2023, 12:31 PM CST

Download

connector.stl (1.23 MB)

2023/11/30-3-D Printing Adapter

HUNTER BELTING - Dec 10, 2023, 1:17 PM CST

Title: 3-D Designing and Printing Adapter

Date: 11/30/23

Content by: Hunter Belting

Present: Hunter and Maribel

Goals: Design the adapter in Solidworks and 3-D print the design.

Content:

Designing the adapter requires taking measurements on the Zoll pad adapter and building that within solidworks, then taking that and creating basically a mold out of it by taking the negative of the design.

Below is linked the built adapter and the respective negative that will be implemented in the design.

Here is a picture of the actual adapter on the pads for a reference as well as the 3-D printed part that the pads plug into.

Conclusions/action items:

Due to the 3-D printing process and tolerances with the adapter, multiple iterations may be needed in order to design a working adapter. The other portion of the adapter is the electrical wiring which will need to be put in place to connect the circuit box to the pads.

HUNTER BELTING - Dec 10, 2023, 12:53 PM CST

Download

Adapter_negative_part_-_Adapter_negative_part-1.STL (21.1 kB)

HUNTER BELTING - Dec 10, 2023, 12:53 PM CST

Download

Adapter_negative_part_-_Adapter_positive-1.STL (13.9 kB)

Tong Lecture Notes

Daisy Lang - Nov 10, 2023, 1:25 PM CST

Tong Lecture Notes:

Date: 11/10/2023

Speaker: Travelle E.F Ellis

Notes:

- Started with an interest in mechanical heart pump - this sparked her interest in research
- She found that she thrived in problem based learning
- UW Madison MD/PhD program
    - She knew she wanted to help people with cool technology
    - Learned the importance of presenting complicated science
- There is value for finding mentors in all of your relationship -- NEED TO FIND YOUR PEOPLE
- The people ahead of you and before you are important (you are here because someone opened the door for you, it is our responsibility to do the same for others)
- DO THINGS THAT SCARE YOU
- She did not match into residency - this taught her to pivot
    - She had to learn to put her big girl pants on and redefine herself
    - Look at what you are good at and take steps forward
- Important to stay in touch with the people that are important to you
    - Call people in the car:)

2023/9/12: Questions for Client

Daisy Lang - Sep 12, 2023, 10:11 PM CDT

Title: Questions for Client

Date: 9/12/2023

Content by: Daisy Lang

Present: N/A

Goals: Today I will create an organized list of questions regarding our project to have ready for our first client meeting on 9/13 at the UW Hospital.

Content:

1. Price Range for project?
2. Who is using this product?
3. Where will the product will be stored?
4. Size Specifications for the product
5. Based on research there are three main theories, which one do you want us to use?
    - Power Theory= administration of more joules during transthoracic defibrillation will allow for the conversion of all the monocytes out of RVF, Requires two currents from both defibrillators devices to be administered at the same time
    - Setting Up Theory = requires the two currents to be delivered close together but not as the same time,st current lowers the defibrillation threshold, increasing the second current's success at converting remaining fibrillation myocytes
- Multiple Vector Theory = application of multiple defibrillator pads will increase the number of vectors used to reach the myocardium

7. Will it be single use or multiple uses? How often will it be used?
8. What current safety precautions are included in the current defibrillators used that we should be aware of and consider including in our design?
9. How precise does the time between shocks need to be?
10. Plugged into the wall or battery powered?
11. How do you set up using a defibrillator? (Ergonomic restrictions while in use)
- How does it need to fit around Lucas?
13. What materials cannot be included in the product?
14. Specific Colors or labeling system that needs to be followed?
15. Other client opinions

Conclusions/action items:

I will add these questions to our group document in google drive and come prepared to our client meeting to ask these questions. The questions I have listed will be used to guide the information in our PDS for this design project.

2023/9/10: Dual Sequential Defibrillation

Daisy Lang - Sep 12, 2023, 10:15 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Dual Sequential Defibrillation

Date: 9/10/2023

Content by: Daisy

Present: N/A

Goals: I will read the article to gain an understanding of Dual Sequential Defibrillation and how 2 vectors can be beneficial in treating refractory VF.

Search Term: What is Dual Sequential Defibrillation

Citation:

M. Ramzy and P. G. Hughes, "Double Defibrillation ," *National Library of Medicine* , Apr. 2023.

Link: **https://www.ncbi.nlm.nih.gov/books/NBK544231/**

Content:

- Double External Defibrillation= apply transthoracic electrical currents from 2 defibrillator devices to a single patient experiencing refractory ventricular fibrillation
- Used after a single defibrillator has failed to terminate the refractory ventricular fibrillation
- Three Theories:
  - Power Theory= administration of more joules during transthoracic defibrillation will allow for the conversion of all the monocytes out of RVF, Requires two currents from both defibrillators devices to be administered at the same time
  - Setting Up Theory = requires the two currents to be delivered close together but not as the same time,st current lowers the defibrillation threshold, increasing the second current's success at converting remaining fibrillation myocytes
  - Multiple Vector Theory = application of multiple defibrillator pads will increase the number of vectors used to reach the myocardium
- Placement of second defibrillators need to be as close to the first as possible, but they cannot touch each other

Conclusions/action items:

This article was extremely helpful in understanding Dual Sequential Defibrillation and how it can be helpful in treating RVF. The three theories explored by this review are a great start point for building questions for our client. I will refer back to this article more more links to case studies on DSD.

2023/9/17: DSD Controlled Trial

Daisy Lang - Sep 17, 2023, 11:03 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: DSD Controlled Trial

Date: 9/17/2023

Content by: Daisy Lang

Present: N/A

Goals: I will read this field study regarding the DSD and see how the results of the study will compare to those from the change in vector group. Based on this knowledge, our group can direct our design ideas.

Search Term: The DOSE VF Pilot Randomized Controlled Trial

Link: https://pubmed.ncbi.nlm.nih.gov/32084567/

Citation:

[1] R. Matthews and A. Young, “Double sequential external defibrillation for refractory ventricular fibrillation: The dose VF pilot randomized controlled trial,” *The Journal of Emergency Medicine*, vol. 59, no. 1, pp. 164–165, 2020. doi:10.1016/j.jemermed.2020.06.074

Content:

- After three unsuccessful defibrillation shocks, patients in study either recieved standard defib, VC defib, or DSED
- Inability to have a second defib machine was the main reason why EMTS could not use DSED
- Access to DSED is limited in rural communities
- 76.3% receiving DSED saw VF termination (66.^% in the standard group)

Table 2 – Event characteristics.

Variable	Standard (n = 36)	Vector change (n = 61)	DSED (n = 55)
Median (IQR) time from initial call to first shock	11.1 (6.2)	11.0 (4.4)	10.7 (4.2)
Prehospital intubation	14 (38.9%)	35 (57.4%)	30 (54.5%)
Median (IQR) pre-shock pause (seconds)	5.2 (6.7)	4.8 (5.9)	5.8 (6.5)
Median (IQR) post-shock pause (seconds)	4.0 (1.1)	4.4 (4.2)	4.3 (2.3)
Mean (SD) compression rate	111.3 (6.8)	112.6 (7.7)	112.4 (7.2)
Mean (SD) compression depth	6.1 (1.2)	5.9 (1.1)	5.7 (1.0)
Mean (SD) chest compression fraction	83.0 (6.2)	80.4 (10.4)	81.5 (6.0)
Mean (SD) number of standard shocks	6.8 (2.1)	NA	NA
Mean (SD) number of vector change shocks	NA	3.3 (2.7)	NA
Mean (SD) number of DSED shocks	NA	NA	2.8 (2.2)
Amiodarone given	29 (80.6%)	45 (73.8%)	42 (76.4%)
Mean (SD) amiodarone dose (mg)	413.8 (65.3)	403.3 (77.2)	385.7 (75.1)
Epinephrine given	34 (94.4%)	60 (98.4%)	49 (89.1%)
Mean (SD) epinephrine dose (mg)	4.2 (2.0)	4.4 (2.0)	4.1 (3.0)
Median (IQR) time to first ROSC	15.0 (11.0)	13.5 (7.0)	15.0 (11.3)
Mean (SD) number of shocks to first ROSC	5.6 (1.6)	5.1 (2.1)	5.9 (2.2)

DSED = double sequential external defibrillation; IQR = interquartile range; SD = standard deviation; ROSC = return of spontaneous circulation.

Conclusions/action items:

This study showed that DSED can be an improved option when treating a patient in refractory VF as compared to not changing the defibrillation technique. The major limitation is lack of access to a second monitor by EMTs. This information will be included in our PDS

Daisy Lang - Sep 17, 2023, 10:50 PM CDT


Resuscitation

Clinical paper

Double sequential external defibrillation for refractory ventricular fibrillation: The DOSE VF pilot randomized controlled trial

Download

1-s2.0-S0300957220300745-main.pdf (618 kB)

2023/9/17: DSD for out of Hospital Refractory VF

Daisy Lang - Sep 17, 2023, 11:26 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: DSD for out of Hospital Refractory VF

Date: 9/17/202

Content by: Daisy Lang

Present: N/A

Goals: I will read about the results of DSD found in the study. This study included details on how DSD is delivered so I will use it to learn more about the technique.

Search Term: DSD for out of hospital refractory VF

Link: https://pubmed.ncbi.nlm.nih.gov/31937443/

Citation:

[1] D. Miraglia, L. A. Miguel, W. Alonso, and J. E. Ayala, "Double sequential defibrillation for out-of-hospital refractory ventricular fibrillation: A scoping review," *The American Journal of Emergency Medicine*, vol. 38, no. 6, pp. 1211–1217, 2020. doi:10.1016/j.ajem.2019.12.047

Content:

- Currently no efficacious treatments for patients who remain in refractory VF after not responding to standard defib
- All patients received at least 3 SD shocks before DSD
- There were very few cases where DSD has statically significantly different outcomes than SD
- 1 set of pads placed in AL and the other placed adjacent to the first set or in the anero-posterior position
- Shocks are delivered simultaneously or near simultaneously
  - depends on duration of defibrillation potential and inershocl k interval between the two defibrillator shocks
- No evidence to suggest that sequential vs simultaneous is more effective
- Higher energy is delivered to overcome the defibrillator threshold
- Common concern is potential injury from more energy in DSD
  - several studies showed it is safe in patients receiving 200J and 320J of biphasic energy from each defibrillator for conversion of refractory
- First shock can lower defibrillation threshold
- Near simultaneous defibrillation can create a longer duration of defibrillation exposure

Table 2
Characteristics of DSD in refractory VF arrest and subsequent outcomes

Author, year Country	DSD pads placement	DSD shocks	Time to DSD[a]	Joules	VF terminated, n (%)	ROSC, n (%)	Resuscitation time[a]	Survival[b], n (%)	CPC ≤ 2[c], n (%)
Ross et al. 2016 USA [25]	AP or AL	...	...	400	...	16 (32.0)	...	4 (8.0)	3 (6.0)
Emmerson et al. 2017 UK [26]	AP or AL	2.5	...	720	...	17 (37.8)	...	3 (6.7)	...
Cheskes et al. 2019 Canada [28]	AP	2.2	...	400	39 (76.5)	9 (17.5)	...	...	...
Mapp et al. 2019 USA [29]	AP or AL	...	...	400	...	5 (20.0)	...	4 (16.0)	3 (12.0)
Beck et al. 2019 USA [27]	AP or AL	2.2	...	720	...	28 (39.4)	...	10 (14.3)	...

AL = anterior-lateral; AP = anterior-posterior; CPC = cerebral performance category; DSD = double sequential defibrillation; ellipses (...) = data not available; ROSC = return of spontaneous circulation; VF = ventricular fibrillation.
Notes: Total percentages are referred to studies with available data.
[a] Time to DSD shocks and resuscitation are reported in minutes.
[b] Refers to survival to hospital discharge.
[c] Refers to CPC at the time of discharge.

Conclusions/action items:

The biggest take away I had from this study is that the shocks in DSD need to be near simultaneous. This means our circuit doesn't need to have a huge time delay in between shocks. In theory, DSD should work great but there is little evidence to support it.

Daisy Lang - Sep 17, 2023, 11:22 PM CDT

Download

1-s2.0-S0735675719308514-main.pdf (383 kB)

2023/9/19: DSD Case Study

Daisy Lang - Sep 19, 2023, 7:19 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: DSD Case Study

Date: 9/19/2023

Content by: Daisy Lang

Present: N/A

Goals: Today I will read this article that contains more information on specific instances of DSD. This will help us quantify the problem and learn more about the demographic our device will treat.

Search Term: Defibrillator Vector

Link: https://www-clinicalkey-com.ezproxy.library.wisc.edu/#!/content/playContent/1-s2.0-S0733865118308257?returnurl=null&amp

Citation:

[1] E. M. Simon and K. Tanaka, “Double Sequential Defibrillation,” *Cardiology Clinics*, vol. 36, no. 3, pp. 387–393, 2018. doi:10.1016/j.ccl.2018.03.006

Content:

- Refractory VF is very rare (.05-.06 per 100000 individuals)
- Mortality rate for Refractory VF is 85%-97%
- There is in no proven statistically significant benefit of DSED
- High opportunity for use for EMT services
- Multiple schools cause greater intracardiac current flow in myocardium
- Additional vector increases myocyte response
  - Cardiac Fibers display directional sensitivity to electrical fields

Conclusions/action items:

This article provided good insight to the number of cases of Refractory VF and its survival rate. It also included a good explanation for why DSED could work in theory. Moving forward, I want to learn more about the circuits used in a defibrillator and how pad placement can be changed.

Daisy Lang - Sep 19, 2023, 7:15 PM CDT


Double Sequential Defibrillation

Download

1-s2.0-S0733865118308257.pdf (274 kB)

2023/10/4: Ethical Considerations

Daisy Lang - Oct 04, 2023, 6:50 PM CDT

Title: Ethical Considerations

Date: 10/4/2023

Content by: Daisy

Present: N/A

Goals: I will document some of the the ethical considerations our team has discussed over the course of this project.

Content:

1. Above All, we know that the safety of the patient and the operator are our number 1 priority

2. We need our device to be cost effective if it is going to be used. We think that if it is an add on to the current monitor system, this will make is more affordable for many different hospital and EMS services. This prevents the hospitals from needing to purchase new monitors. Also, we want all EMS systems, well funded and not as well funded to have access to this device.

3. Refractory DSD is so rare and very hard to predict, so we need our device to work on patients of all sizes and make up. Larger patients or patients with breasts both need to be able to be treated by our device.

Conclusions/action items:

These are the three main ethical considerations our team has discussed so far in our project. I will continue to add to this list as the semester progresses.

2023/9/10: Understanding Cardiac Arrest

Daisy Lang - Sep 10, 2023, 12:00 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Understanding Cardiac Arrest

Date: 9/10/2023

Content by: Daisy Lang

Present: N/A

Goals: Today I will watch this video to understand cardiac arrest. I need this understanding to further my research in how defibrillators are used to restart the heart.

Search Term: What is Cardiac Arrest?

Link: https://www.youtube.com/watch?v=7lMiXJH_bw4

Citation:

[1] The British Heart Foundation , 2018.

Content:

- Problem in the electrical signaling system in the heart causes it to stop pumping blood
- Electrical circuit in heart stops working as it should
- The heart quivers, stops pumping blood, and can cause the person to collabs
- Ventricular Fibrillation
- Chest compressions take over the role of the heart and continue to pump blood to the body
- Defibrillator: delivers electrical shock to restore regular rhythm to heart
- Rescue Breaths ensure O2 is still in the blood
- The best chance at survival from cardiac arrest is immediate CPR to continue blood flow and O2 in the body

Conclusions/action items:

From this video I learned that cardiac arrests arises when there is an arrythmia causing the electrical circuit in the heart to stop working and stop pumping blood through the body. A defibrillator can fix this by delivering an electric shock to the hear to help it restart on this normal rhythm. My next step will be to research arrythmias that do not respond to medication and therefore need a a second shock sequence.

2023/9/10: Refractory V-Fib

Daisy Lang - Sep 12

REBECCA POOR - Jan 24

Title: Refractory V-fib Treatment

Date: 9/10/2023

Content by: Daisy Lang

Present: N/A

Goals: I will research refractory V-Fib as this is one of the two conditions specified by the client that could benefit from dual sequential defibrillation treatm

Search Term: Refractory V-fib Treatment

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8703203/#:~:text=Refractory%20ventricular%20fibrillation%20(RVF)%20is,mg%20of%20epinephrine

Citation:

A. Mohammed *et al.*, “Refractory Ventricular Fibrillation in Traumatic Cardiac Arrest: A Case Report and Review of the Literature,” *National Library of Medi* 2021.

Content:

- VF causes heart to quiver and stop pumping blood
- VF is defined as irregular electrical activity with no discernable pattern
- Refractory Ventricular Fibrillation: inability to obtain a return of spontaneous circulation within 10 minutes despite three defibrillation attempts, 300 mg amiodarone, and 3 mg of epinephrine

Conclusions/action items:

This article went in depth on a case study and how incasing interventional were able to improve survivable rates of V-Fib cardiac arrest. This information is applicable to our project, but it did provide me with a better understanding of Refractory Ventricular Fibrillation (the condition our device will treat). My next research dual sequential defibrillation.

2023/9/19: How the Heart Responds to Defibrillation

Daisy Lang - Sep 19, 2023, 7:42 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: How the Heart Responds to Defibrillation

Date: 9/19/2023

Content by: Daisy Lang

Present: N/A

Goals: I will learn about the anatomy of the heart and how defibrillation works to restore a normal rhythm to a heart in cardiac arrest.

Search Term: How does the heart respond to defibrillation?

Link: https://www.ncbi.nlm.nih.gov/books/NBK499899/

Citation:

[1] A. Goyal, L. Chhabra, J. C. Sciammarella, and J. S. Cooper, “Defibrillation ,” *StatPearls* , Jan. 2023.

Content:

- Transthoracic Electrical current is delivered to the heart in dysrhythmias (VF or VT)
- VF occurs when the normal electrical conduction of the heart in interrupted
    - Dysrhythmic firing of multiple irritable myocardial foci in the ventricles will cause fibrillation
- Defibrillation produces nearly simulants depolarization of myocardium and causes a cessation of all cardiac activity
- Pads are placed in the anteroposterior configuration or one along the upper right sternal border and other other at the cardiac apex
- CPR is resumed for 2 minutes after the shock is delivered

Conclusions/action items:

This article had great information on how the heart responds to defibrillation shocks and described where pads should be placed during the treatment. This is useful information to the project so we can plan where the pad should be placed in relation to the LUCAS. Next, I will learn more about the vectors of the shocks delivered.

Daisy Lang - Sep 19, 2023, 7:38 PM CDT

Download

Defibrillation_-_StatPearls_-_NCBI_Bookshelf.pdf (699 kB)

2023/9/19: Vectors In DSED

Daisy Lang - S

REBECCA POOR - Ja

Title: Vectors in DSED

Date: 9/19/2023

Content by: Daisy Lang

Present: N/A

Goals: I will learn more about pad placement during defibrillation and how it impacts the vector delivered to the body.

Search Term: Vectors in Defibrillation

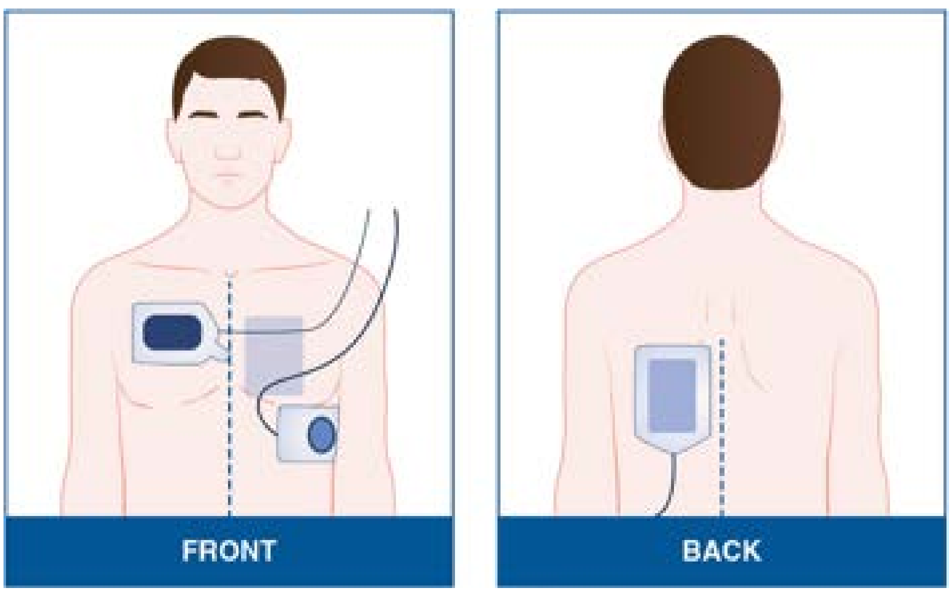
Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9907872/#:~:text=Vector%20change%20(VC)%20defibrillation%2C,the%20standard%20anterior%2D

Citation:

[1] S. Cheskes, S. McLeod, and D. C. Scales, “Double sequential external defibrillation for refractory ventricular fibrillation,” *Intensive Care Medicine*, vol. 4
457, 2023. doi:10.1007/s00134-023-06993-1

Content:

- Defibrillation pads start in anterior-lateral position to the anterior posterior position
- "The anatomical location of the left ventricle, a posterior structure, is the region of the heart that is furthest from the direct line between the standard lateral electrode pads, resulting in the potential for the left ventricle to be inadequately defibrillated."
- Combination of two different pads placed in two different vectors provided more homogeneous distribution of current through the myocardium



Conclusions/action items:

The change in vector is beneficial as it can cover more of the heart tissue during defibrillation. I want to incorporate a way that our pads could allow for DS
change or both.

Daisy Lang - Sep 19, 2023, 8:07 PM CDT

Double sequential external defibrillation for refractory ventricular fibrillation

Springer

Download

134_2023_Article_6993.pdf (590 kB)

2023/9/19: Pad Placement

Daisy Lang - Sep 19, 2023, 8:18 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Pad Placement

Date: 9/19/2023

Content by: Daisy Lang

Present: N/A

Goals: I will learn about where the defibrillator pads can be placed during defibrillation.

Search Term: Defibrillator Pad Placement

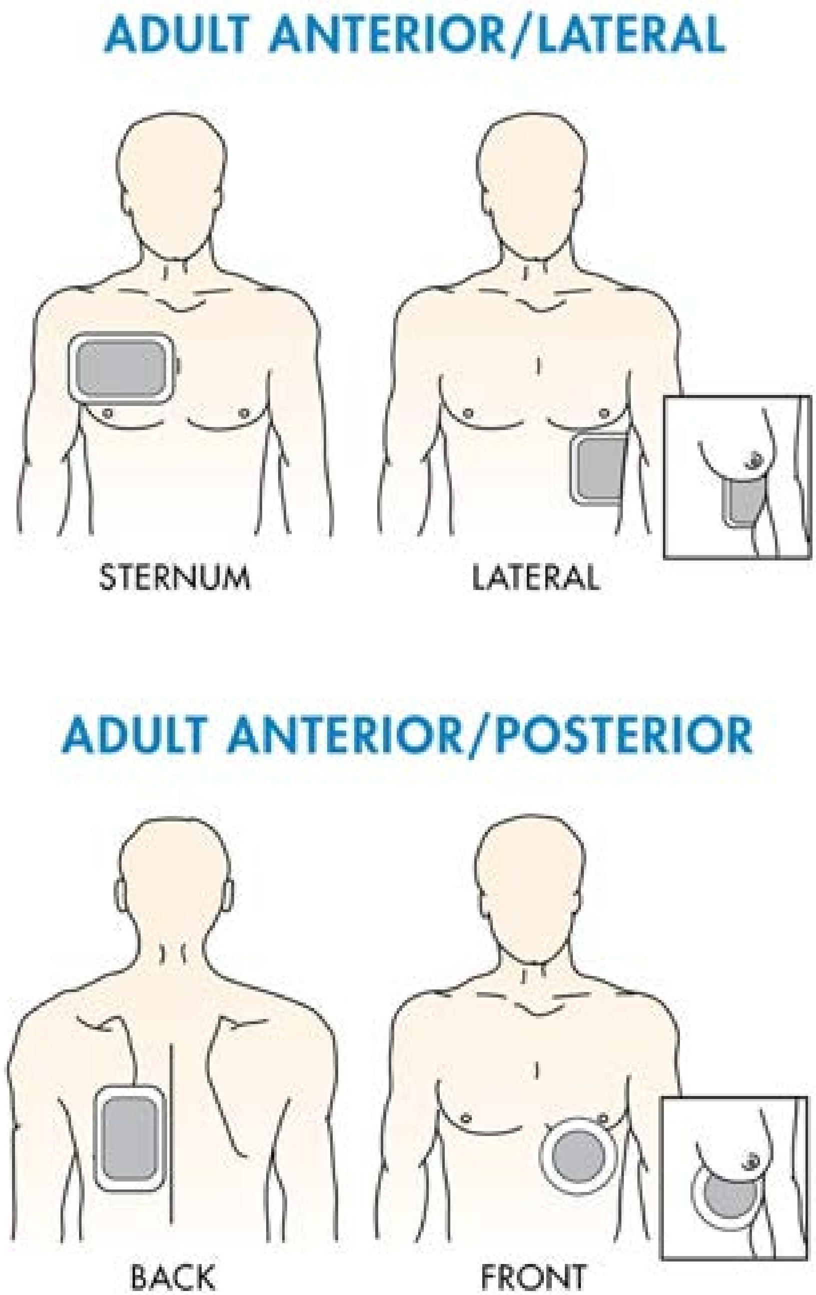
Link: **https://www.zoll.com/resources/correct-pad-placement#:~:text=Place%20the%20posterior%20pad%20to,the%20breast%20on%20a%20female**

Citation:

[1] "ZOLL Medical Corporation," ZOLL Medical, https://www.zoll.com/resources/correct-pad-placement (accessed Sep. 19, 2023).

Content:

- American Heart Association recommends either positioning pads in anterior-lateral or anterior-posterior



Conclusions/action items:

The two approved positions from the American Heart Association are anterior-lateral or anteroposterior. I think we can find a way to design a pad that can fit both of these options. My next steps will be to brain strom this design.

Daisy Lang - Sep 19, 2023, 8:14 PM CDT

Download

Defibrillator_Pad_Placement_-_ZOLL_Medical.pdf (632 kB)

2023/10/3: Transthoracic Impedance

Da

REBECCA

Title: Transthoracic Impedance

Date: 10/4/2023

Content by: Daisy Lang

Present: N/A

Goals: I will learn more about Transthoracic Impedance and how it is measured by a Defibrillation monitor.

Search Term: Transthoracic Impedance

Link: https://pubmed.ncbi.nlm.nih.gov/10720010/#:~:text=The%20transthoracic%20electrical%20impedance%20is,and%20therefore%20the%20

Citation:

F. A. Hatib, E. Trendafilova, and I. Daskalov, “Transthoracic electrical impedance during external defibrillation: Comparison of measured and modelled wav *Measurement*, vol. 21, no. 1, pp. 145–153, 2000. doi:10.1088/0967-3334/21/1/318

Content:

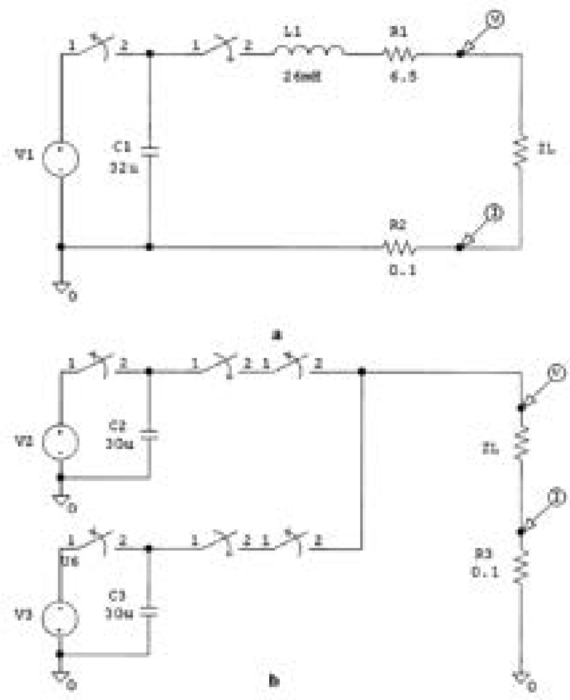
- Electrodes have low resistive conductance
- Defibrillator Load Impedance = electrode-skin and patente transthoracic impedance
  - Used to determine the defibrillation current amplitude and energy (defibrillation threshold)
- Circuit Used to Measure Voltage across the thorax and current flowing during the defibrillation impulse
  - 

    Figure 2. Equivalent defibrillator circuits used for modelling and computing the defibrillator load impedance Z_L: (a) for a classical defibrillator and (b) for our experimental defibrillator.
- Load impedance is a pure resistance: Meaning that there is a lack of observable phase difference between voltage and current waveforms
- Plots in study can be used to look at type and quality of thoracic resistance during the delivered shock

Conclusions/action items:

This article details a study performed on transthoracic impedance based on the shock being monophasic or biphasic. My biggest take away is that transth resistance, which I took to mean that it does not change with differing current. I will make sure to ask Dr. N about this our next meeting.

Daisy Lang - Oct 04, 2023, 1:41 PM CDT

Download

F_Al_Hatib_2000_Physiol._Meas._21_145.pdf (185 kB)

2023/10/4: Calculate Transthoracic Impedance

Daisy Lang - Oct 04, 2023, 6:26 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Calculate Transthoracic Impedance

Date: 10/4/2023

Content by: Daisy

Present: N/A

Goals: I will learn more about how the defibrillator calculated Transthoracic Impedance and why it is important to defibrillation.

Search Term: How does a defibrillator calculate Transthoracic Impedance?

Link: https://www.intechopen.com/chapters/62457

Citation:

[1] D. M. Gonzales-Otero, S. Ruiz de Guana, and J. J. Gutierrez, "Applications of the Transthoracic Impedance Signal during Resuscitation," in *Special topics in resuscitation*, T. K. Aslanidis, Ed. London: IntechOpen, 2018

Content:

- Resitivies For Different Tissues:
  - Blood = 150 ohm/cm
  - Cardiac = 750 ohm/cm
  - Lung = 1275 ohm/com
- TI = the resistance of the thorax to current flow
  - measured by passing an alternate current through the tissue and measuring the induced voltage drop
- Defibrillators measure te TI to check that the pads are placed correctly
- TI in Adults = 70-80 ohm
- TI range is 15- 15- ohm across subjects
- Too high of impedance will indicate that the interface between the electrodes and the skin is inadequate
  - Need good contact for safe delivery of shock and correct ECG acquisition
- Some defibrillators use the TI measurement to adjust the energy of the shock
  - Need sufficient current flow through the heart muscle for defibrillation but too much will damage the myocardial cells
  - Biphasic defibrillators measure TI and adjust energy
- Hard to get a baseline value b/c the tissue composition is redistributed across patients and fluid moves (during CPR)
  - Circulation induces low amplitude fluctuations in TI

Conclusions/action items:

This article was awesome for explaining TI and how it fluctuates between patients. I now have a clear understanding of what TI is and how it is measured and why it matters. I think that for our circuit, we might need to assume the standard of 70-80ohm for TI because I don't think we have enough background knowledge to incorporate a TI sensor system into our circuit. Or we need to figure out how to maintain the TI measurement aspect of the monitor with our black box. Next, I will look into biphasic defibrillators.

Daisy Lang - Oct 04, 2023, 6:06 PM CDT

Download

Applications_of_the_Transthoracic_Impedance_Signal_during_Resuscitation___IntechOpen.pdf (2.31 MB)

2023/9/8: What is a Defibrillator?

Daisy Lang - Sep 10, 2023, 11:13 AM CDT

Title: What is a Defibrillator?

Date: 9/8/2023

Content by: Daisy Lang

Present: None

Goals: I will research Defibrillators in order to establish a baseline understanding of their usage and how they function.

Content:

Link: https://www.nhlbi.nih.gov/health/defibrillators

Citation:

"What are defibrillators?," National Heart Lung and Blood Institute, https://www.nhlbi.nih.gov/health/defibrillators (accessed Sep. 10, 2023).

Page Title: What are Defibrillators?

Content:

- Apply and Electric charge to the heart to help restore a normal heartbeat
- Types of Defibrillators:
  - Automated External Defibrillators: in public spaces, unit gives instructions, meant for untrained people to use in an emergency
  - Implanted Cardioverter Defibrillators: surgically placed in the chest, detect cardiac arrest/ life threating arrhythmia, send electric charge to stop arrhythmia or cardiac arrest, can act as pacemaker, can send pulses to electricity to sync rhythm of heart lower chambers
  - Wearable Cardioverter Defibrillators: vests, automatically detect life threating rythin am send an electrical charge to restore it to normal

Conclusions/action items:

This article was useful in providing in fomration about the different types of defibrillators. I learned that there are defibrillators meant for use by the public and those that can be implements or worn by people at high risk of cardiac arrest. This is useful information, but my next steps will be to look into the science behind how defibrillators work.

2023/9/10: Current Method for RVF Treatment

Daisy Lang - Sep 12, 2023, 10:23 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Current Method for RVF Treatment

Date: 9/10/2023

Content by: Daisy Lang

Present: N/A

Goals: I will research the current methods used to treat RVF and

Search Term: Dual Sequential Defibrillation Treatment

Link: https://www.nejm.org/doi/full/10.1056/NEJMoa2207304

Citation:

S. Cheskes, R. Verbeek , I. R. Drennan, and S. L. McLeod , "Defibrillation Strategies for Refractory Ventricular Fibrillation ," *The New England Journal of Medicine* , Nov. 2022.

Content:

- Double Sequential Defibrillation is providing rapid sequential shocks from two defibrillators in two different plants (anterior lateral and anterior posterior)
- Vector Change Defibrillation: switching defibrillation pads form anterior-lateral to anterior-posterior, offers to possibility to defibrillate portion of ventricle not normally hit in standard formation
- Suggested that earlier use of DSED is associated with higher rates of termination of RVF
- Based on this study, termination of RVF was more common with DSED

Conclusions/action items:

This study included a really great discussion of how treatment of RVF with VC or DSED differs. In conclusion, DSED was proven to have really good outcomes and is used in practice. I will refer back to this study to learn more about the outcomes associated with DSED treatment. Next, I will start looking into how DSEDs work and how they can be placed with being used with a Lucas.

Daisy Lang - Sep 17, 2023, 11:47 PM CDT

Defibrillation Strategies for Refractory Ventricular Fibrillation

Download

nejmoa2207304.pdf (1.04 MB)

2023/9/17: Patent Multipath Transthoracic Defibrillation

Daisy Lang - Sep 17, 2023, 12:07 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Multipath Transthoracic Defibrillation Patent

Date: 9/17/2023

Content by: Daisy Lang

Present: N/A

Goals: I will read through this patent on a Multipath Transthoracic Defibrillation device that allows for multiple vectors to cross through the heart during defibrillation. I will use this information to guide our PDS.

Search Term: Dual Sequential Defilation

Link: https://patents.google.com/patent/JP5427209B2/en?q=(dual+sequential+defibrilation)&q=(A61N1%2f3912)

Citation:

Content:

- In VF, "muscle fibers in heart contract asynchronously and chaotically due to abnormal l electrical activity within the heart"
- "According to a conceptual assumption called the critical quantity hypothesis, the reason for the success of defibrillation shocks is that defibrillation shocks reduce the critical amount of muscle by depolarizing all tissues that are not refractory within the critical quantity range."
- "According to the assumption of upper limit of vulnerability (ULV) theory, shock succeeds by stopping the ventricular fibrillation (VF) wavefront by prolonging the refractory period in the myocardium in front of the wavefront.
- Shock cannot initiate a wavefrount that cuases ne bribillation at the boundary of the shock depolarization region
- US Patent No, 6057077 discloses an early type dual pulse cardiac defibrillator
  - two capacitors are sequentially discharged between a single pair of electrodes
- This patent device has 3 electrodes configures to be worn on patients thorax to establish an electrical pathway
- The defibrillator circuit is able to generate different defibrillation wave froms across at least two electrical paths
- Transthoracic impedance distribution is changed between positions and can be delivered in different waveforms
- The device has a method for establish at least two electrical pathways across the patient's body
  - the three of more electrode can determine impedance distribution across the body, generate electromagnetic waveform transcersign each of the least two electrical paths

Conclusions/action items:

This device is able to create multiple vectors through the body for use during defibrillation, allowing the provider to chose different vector directions. It also can sense the body's thoracic impedance and use this information to establish different waveforms. This device also mentions a patent for a device that might use DSD so I will look into that next.

Daisy Lang - Oct 04, 2023, 1:29 PM CDT

Citation: “Multipath transthoracic defibrillation,” Feb. 26, 2014

2023/9/17: Defibrillator Circuits

Daisy Lang - Sep 17, 2023, 11:46 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Defibrillator Circuits

Date: 9/17/2023

Content by: Daisy Lang

Present: N/A

Goals: I will learn about the circuits used in defibrillators and see how they can be applied to our design.

Search Term: Defibrillator Circuits

Link: https://www.intechopen.com/chapters/41776

Citation:

[1] H. Delgado, C. Mitroi, I. F. Lozano, J. Toquero, and V. Castro, *Principles of External Defibrillators*. INTECH Open Access Publisher, 2013.

Content:

- Most defibs are energy based (charges a capacitor to selected voltage then delivers the prespecified amount of energy in joules)
- The amount of energy that arrives at the myocardium is depended on the selected voltage and transthoracic impedance
- Dfibs are either
  - Monophasic: current in one polarity
  - Biphasic: current flows in positive direction for a time then reverses to flow in the negative direction (lower DFT)
- For VF= at least 150 J for biphasic and 360 for monophasic
- Capacitors used can hold up to 7kV of electricity, deliver up to 400J
- All sequential shocks should increase in potential
- Transthoracic Impedance: dissipation of energy in the lungs, thoracic cage and other structures in chest
  - TTI for humans is 70-80 ohms
  - to reduce TTI, defib should use conductive materials

Conclusions/action items:

The safe level of shock for a biphasic defb is at least 150 J while in VF. This is in the range given to us by the client. Defibs also use capacitors to store energy to be used in the shock. My next steps are to learn more about the cirucut design used in a defib.

2023/9/19: Patent Systems and Methods for Double Sequential Defibrillation

Daisy Lang - Oct 03, 2023, 9:59 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Systems and Methods for Double Sequential Defibrillation Patent

Date: 9/19/2023

Content by: Daisy Lang

Present: N/A

Goals: I will read this patent that details systems and methods that are used in DSED to see what has already been created and what could be incorporated into our design.

Search Term: Double Sequential Defibrillation

Link: https://patents.google.com/patent/US10625088B1/en?q=(double+sequential+defibrillation)&oq=double+sequential+defibrillation

Citation:

[1] F. W. Chapman et al., "Systems and methods for double sequential defibrillation," Apr. 17, 2020

Content:

- Consist of defibrillation therapy module configured to discharge one or more energies
- Monitor will measure physiological indicators of a person in an emergency scenario and project them on screen
- Software included Analog Microprocessors and Microcontrollers
- Electrodes measure the impedance of the body
- Would incorporate a method so the monitor can monitor heart and see if DSD is needed
  - Not much detail on how this would happen
- For DSD it should include software and/or hardware to assist with preventing electrotherapy discharge from one defibrillator device causing damage to the other defibrillation device
  - "In an example, the electrotherapy discharge from each defibrillation device can be coupled so as to discharge the second electrotherapy with a specific timing relative to the discharge of the rst electrotherapy"
  - Coupling prevents this both output relays from being closed at the same time
- Detect Refractory VF

Conclusions/action items:

This patent is interesting as it does not explain the workings of an actual device, but rather the concepts behind how DSD could be implemented in to a defibrillation device. It has a lot of applicable ideas and ways that the we can incorporate protective measures into our device. I will show this to my team when we meet to discuss our circuit design.

Daisy Lang - Sep 19, 2023, 8:24 PM CDT

Systems and methods for double sequential defibrillation

Download

US10625088B1_-_Systems_and_methods_for_double_sequential_defibrillation_-_Google_Patents.pdf (2.29 MB)

2023/10/4: Patent Timing Device for DSD

Daisy Lang - Oct 04, 2023, 1:26 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Timing Device for DSD Patent

Date: 10/4/2023

Content by: Daisy Lang

Present: N/A

Goals: I will read this patent to learn about the timing device implemented in this defibrillator circuit. We need to find a way to add a time delay into our circuit so I think the ideas in this patent will be applicable to our project.

Search Term: Dual Sequential Defibrillation

Link: https://patents.google.com/patent/US10981014B2/en?q=(dual+sequential+defibrillation)&oq=dual+sequential+defibrillation

Citation:

T. G. Taylor , F. W. Chapman, and G. Walcott, “Dual sequential defibrillation systems and methods,” Apr. 20, 2021

Content:

- Dual Sequential System

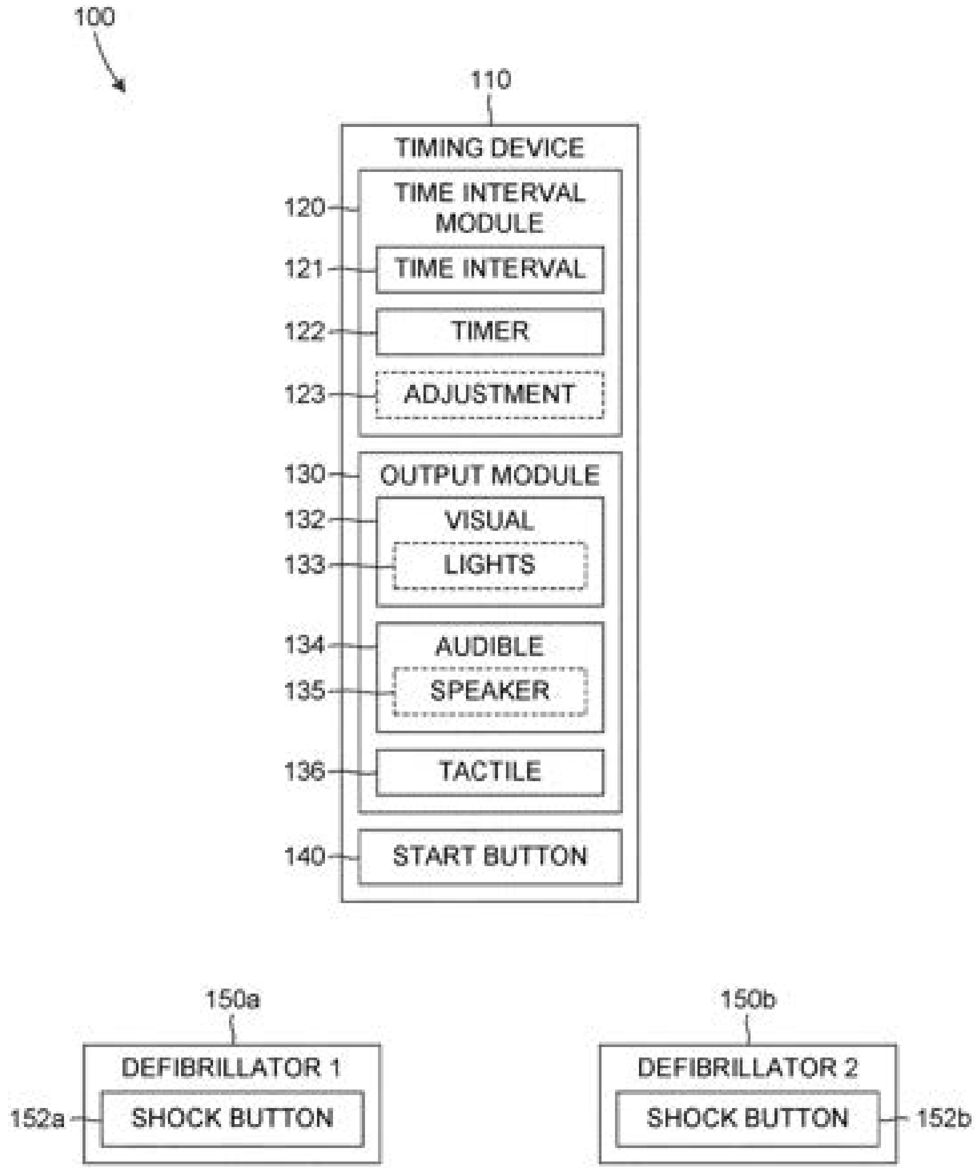


FIG. 1

- Timing of Dual Sequential System

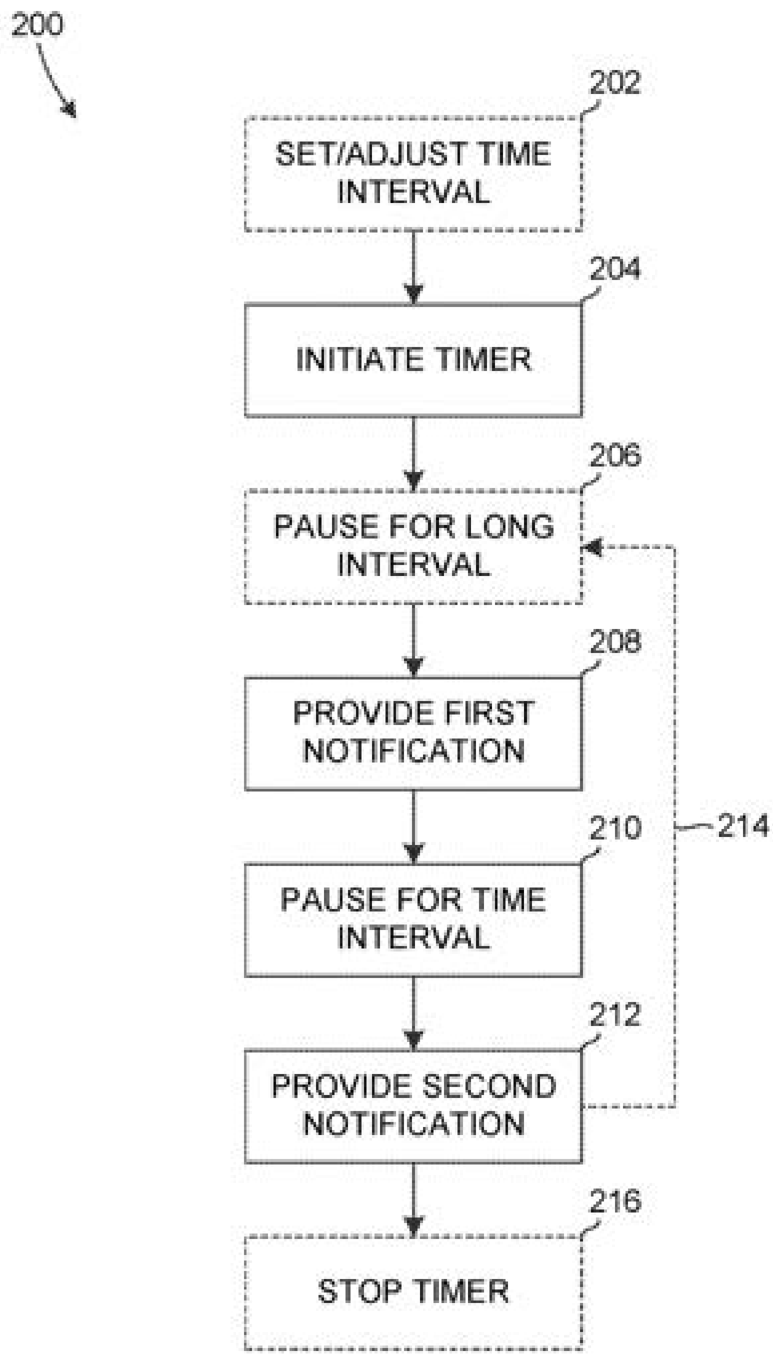


FIG. 2

- The timing device can provide an indication to the user of the right time to indicate the second shock
- Can be designed so they are separate shocks or can be designed so that they have some overlap
- This device is meant to be used with 2 monitors
- Pressing the start button on the timing device will cause the output module to output two or more notification that are spaced by the time interval
- Can program or manually set the time interval

- Timing device can be computer programed or its own separate device

Conclusions/action items:

This patent is very similar to Maribel's idea of a light indicator. The patent describes a stand along timing device that can be used to help an operator know when to deliver the second shock when using TWO monitors. Our goal is to use 1 monitors, so our timing device must be a delay implemented into the circuit rather than a stand alone device.

Daisy Lang - Oct 04, 2023, 1:18 PM CDT


United States Patent

Download

US10981014_1_.pdf (1.45 MB)

2023/10/4: Zoll Rectilinear Biphasic Waveform

Daisy Lang - Oct 04, 2023, 6:38 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Zoll Rectilinear Biphasic Waveform

Date: 10/4/2023

Content by: Daisy

Present: N/A

Goals: I will look at this Zoll Defibrillator to learn more about how the biphasic technology can calculate impedance.

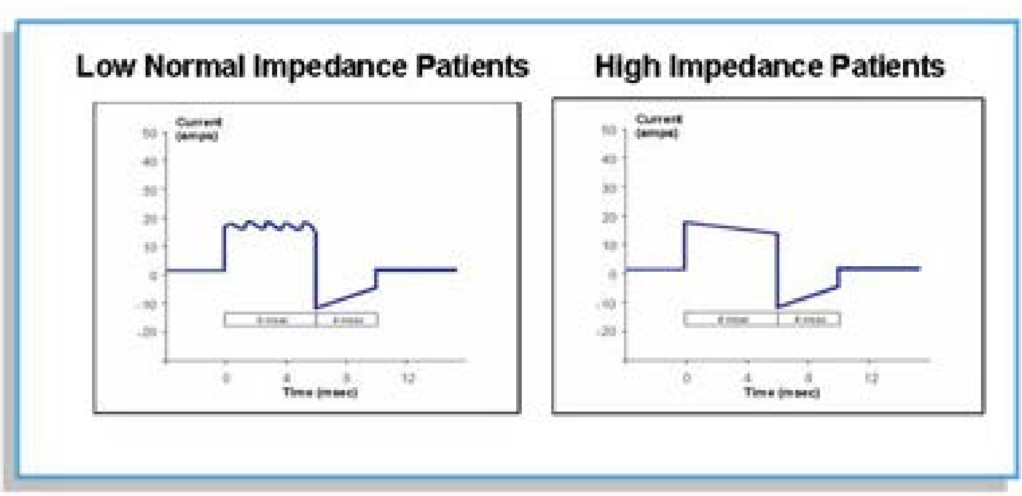
Search Term: Biphasic Defibrillator Impedance Measurement

Link: https://www.zoll.com/au/medical-technology/defibrillation/rectilinear-biphasic-waveform/impedance#:~:text=While%20average%20patient%20impedance%20is,35%20ohms%20to%20150%20ohms.

Citation:

“Biphasic technology - impedance,” Biphasic Technology - Impedance - ZOLL Medical Australia, https://www.zoll.com/au/medical-technology/defibrillation/rectilinear-biphasic-waveform/impedance#:~:text=While%20average%20patient%20impedance%20is,35%20ohms%20to%20150%20ohms. (accessed Oct. 4, 2023).

Content:

- Controls Impedance with series of digital resistors inside the monitor
- Add between 0 to 70 ohms
- Functions:
  - Compensate for variations in patient impedance to control total impedance
  - Keep average current delivery relatively constant over the first phase of the shock
- Measurement:
  - A test pulse is applied prior to the delivery (250 microseconds)
  - All 70 ohms are engaged and the amount of current flowing through the patient is measured
  - Once the patient impedance is measured, the monitor can change the resistance for that patient
  - MAIN GOAL = consistent location
- 

Conclusions/action items:

This Zoll Monitor measures impedance by using a test shock and then can adjust the resistance to match the TI of the patient. It does this by using resistors in series. I will show this too my team when we start talking about circuit design.

2023/10/22: Beefcake Component

Daisy Lang - Oct 22, 2023, 9:27 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Beefcake Component

Date: 10/22/2023

Content by: Daisy

Present: Nick

Goals: Today Nick and I started working on the circuit design and decided that we need a relay component. I know we have used a BeefCake before and want to look into this as a way to control our circuit relay.

Search Term: "BeefCake"

Link: https://www.electronics123.com/shop/kit-13815-sparkfun-beefcake-relay-control-kit-8323#attr=2288,467

Citation: N/A

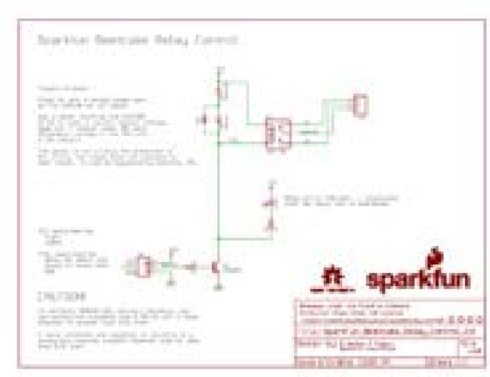
Content:

- The beefcake is a relay control element that is compatible with the arduino uno
- Controlled with 5V logic through a transistor
- LED tells you when the relay is closed
- Rated for 15A max
- 28V DC and 220V AC Rating
- Need 4-6 V Vcc (power)

Conclusions/action items:

We can use the beefcake in our overall demo circuit and can use it to control when each pathway of our circuit is on or off. Based on the rating I found online, I don't think we can use this in our real circuit because it is limited to 28V DC. I will reach out to Dr. P so see if you can borrow one to use in our circuit. Also, we need to do more research to find out if we can use the beefcake to connect two pathways, or if we would need two in our design.

Daisy Lang - Oct 22, 2023, 9:27 PM CDT



Download

SparkFun_Beefcake_Relay_Control_Kit_v20a.pdf (69.2 kB)

2023/10/22: Relay Componenets

Daisy Lang - Oct 22, 2023, 9:50 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Relay Components

Date: 10/22/23

Content by: Daisy

Present: N/A

Goals: Today I will look into how the relay component that we plan to add to our circuit functions. My main goal is to learn if we can use it to switch between pathways in a circuit schematic or if we would need two relay components.

Search Term: "How doe a Control Relay work?"

Link: https://electgo.com/resources/control-relay#:~:text=A%20Control%20Relay%20is%20also,also%20protects%20the%20circuit%20current

Citation:

What is a control relay? its types, function, difference between contactors and price. Electgo. (n.d.). https://electgo.com/resources/control-relay#:~:text=A%20Control%20Relay%20is%20also,also%20protects%20the%20circuit%20current.

Content:

- Solid States = perform switch operations w/o moving any parts
- Electromagnetic Relays = electrical, mechanical, and magnetic components and have operation coils
- Load = for relays with loas 10 A or less
- Auxiliary = have additional functions that he relay doesn't control

Conclusions/action items:

There are many different types of relay components that we could use in our circuit. Based on my research, we would need an Electromagnetics Auxiliary relay for our real circuit design. I did not find out if they can be used to switch between paths, so I will need to do more research on this topic.

2023/9/20: Chemical Safety Training and HIPPA Training Documentation

Daisy Lang - Sep 15, 2023, 8:58 AM CDT

Download

BMETrainingDocumentation.pdf (435 kB)

2023/10/4: Green Permit

Daisy Lang - Oct 04, 2023, 6:40 PM CDT

Download

Image_3_.jpeg (10.6 MB)

2023/10/15 LIFEPAK Data Sheet

Daisy Lang - Oct 15, 2023, 9:41 PM CDT

Title: LIFEPAK Data Sheet

Date: 10/15/2023

Content by: Daisy Lang

Present: All

Goals: Today during our team meeting I found the data sheet for the LIKEPACK 15 monitor. We will use it go get data regarding the output

Content:

- The current sent by the defibrillator is between 0-200mA
- Can charge to 310J in 10 seconds
- Biphasic 150-360J
- ±1 joule or 10% of setting, whichever is greater, into 50 ohms,
- ±2 joules or 15% of setting, whichever is greater, into 25-175 ohms
- Refractory period: 180 to 270 msec

Conclusions/action items:

The values can help us calculate the voltage output of the life pack. We need this value so we can tell what the voltage is out of the life pack when we are making the calculations for splitting the voltage. Our next step is making these calculations and simulating the circuit in LTspice.

Daisy Lang - Oct 15, 2023, 11:20 AM CDT


stryker

LIFEPAK® 15 monitor/defibrillator

Data Sheet

[Download](#)

LIFEPAK_Data_Sheet.pdf (404 kB)

2023/10/15: Defibrillator Circuits

Daisy Lang - Oct 15, 2023, 10:18 PM CDT

Title: Defibrillator Circuit

Date: 10/15/2023

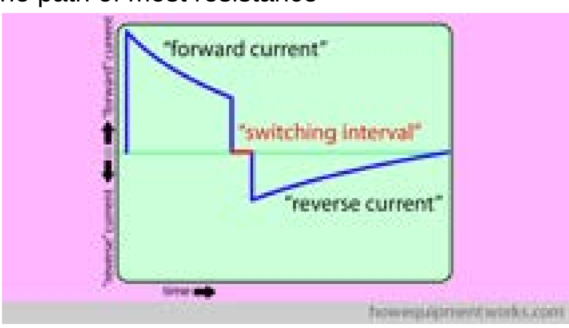
Content by: Daisy Lang

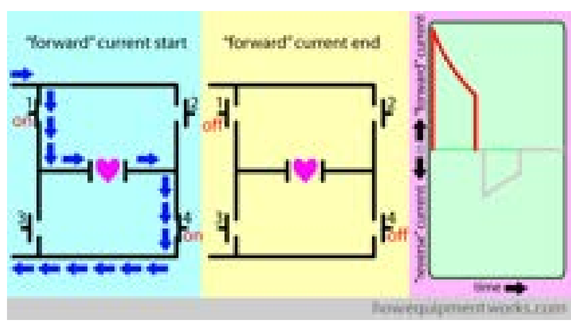
Present: All

Goals: Today I will find a better example of what the inside of a defibrillator looks like so we can get a better understanding of how the monitor works and how we can adapt it.

Website Link: https://www.howequipmentworks.com/defibrillator/

Content:

- Need 2000V (need a lot of voltage)
- Step Up Transformer: able to increase the voltage that comes into it
  - Increase the battery voltage to charge the capacitor to a high value
- Capacitor is charged up and energy is released from it
- When pads are places, the circuit is closed and the voltage can be sent through the heart
- Can't be on all at the same time otherwise the current will not pass through the heart because that would be the path of most resistance
- 



Conclusions/action items:

This website will be a really good resource for how the defibrillator will release the charge onto the heart. The main elements of the circuit will be the battery, transformer, and capacitor. The transformer is used to charge up the capacitor to a higher voltage from a smaller voltage input. I will return to this when it comes time to start building our circuit.

2023/10/15: Current Director Circuit Idea

Daisy Lang - Oct 15, 2023, 9:57 PM CDT

Title: Current Director Circuit Idea

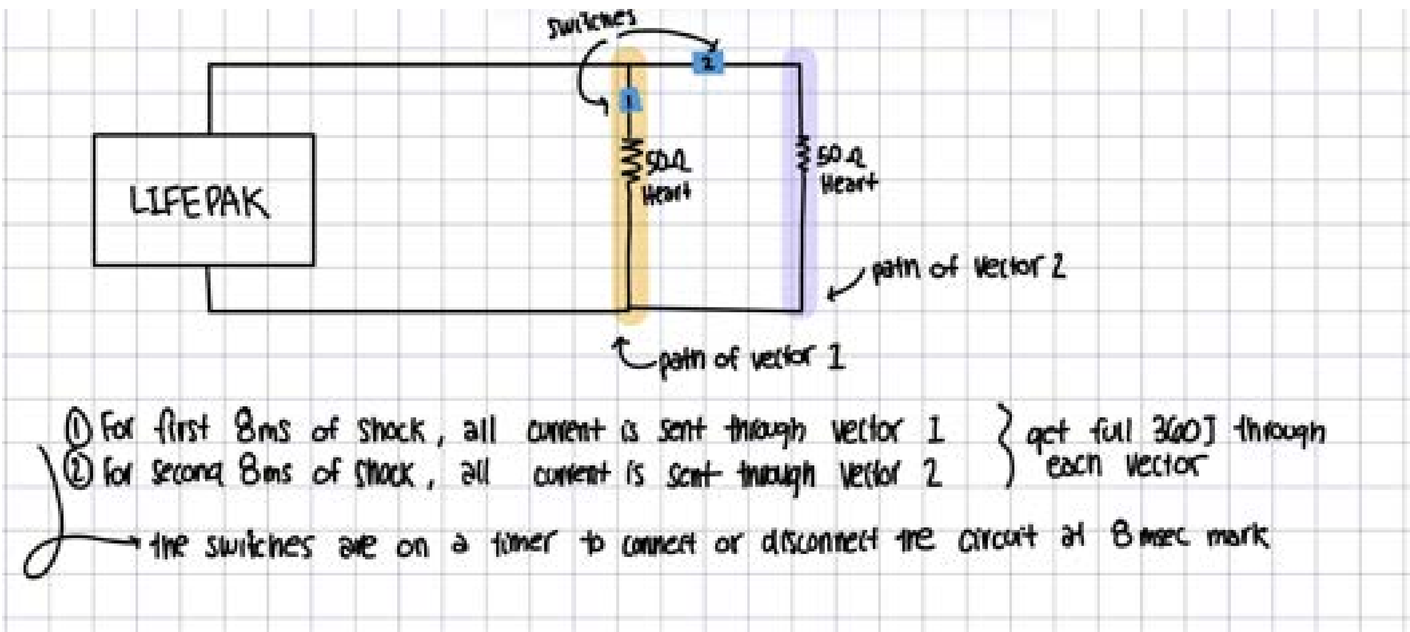
Date: 10/15/2023

Content by: Daisy Lang

Present: All

Goals: Today during our team meeting, I had an idea for a circuit that just directs the current through two different paths, but for half of the time. Each path should get the full 360J but, only for half of the time.

Content:



Concerns:

1. Would this make it monophasic? The current would switch paths half way through the shock delivery and this would mean it would miss the negative portion of the biphasic shock. I am not sure if this would impact the heart or if the negative would cause damage to the circuit.

2. The negative portion of a biphasic shock makes is less than the positive portion.

3. Would it still get 360J? Power is dependent on time, so maybe it would still only get part of the power if it is going for half of the time.

Conclusions/action items:

I want to bring this idea to our meeting with Dr. N this week so that we can discuss the options we have with the circuit. I am still partially confused on how the biphasic shock travels with time, so I will need to do more research to learn about this. I think this idea is a good starting point, but I need more guidance on what is feasible inside of our circuit.

2023/10/15: H-Bridge

Daisy Lang - Oct 15, 2023, 10:52 PM CDT

Title: H-Bridge

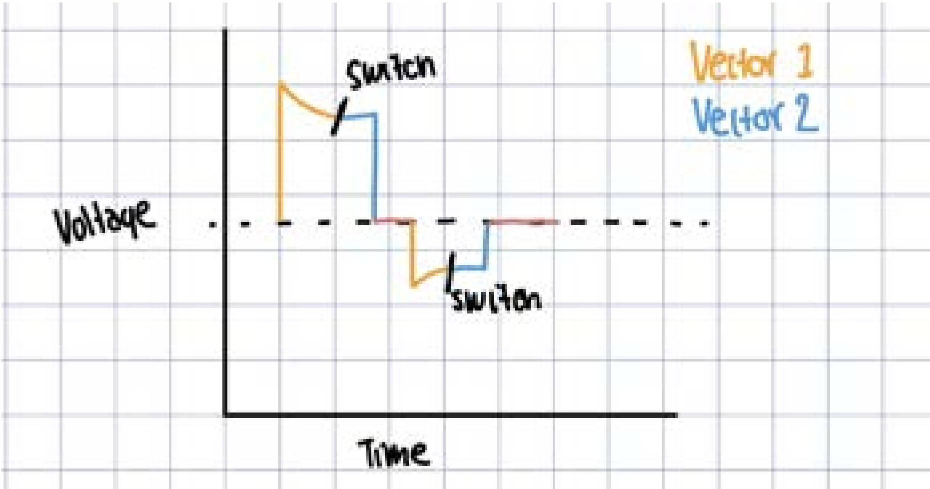
Date: 10/15/2023

Content by: Drawing by Daisy, Idea by Nick

Present: All

Goals: Today in our meeting, Nick had an idea for a circuit that implemented two H-Bridges for so that each vector got half of the positive and negative portion of the biphasic shock. I will attempt to document that idea here.

Content:

- We want each vector to get 1/2 of the positive and negative portion of the shock
- 

- The biggest problem we have is figuring out how to implement the time delay into the circuit
  - I think we would need to have two time delays
  - Need to switch back and forth between the two pathways for each vector twice
- BIG QUESTIONS: how do we best do the time delay
  - coding or resistor?

Conclusions/action items:

We will present this idea to Dr. N when we meet with him on Thursday. We feel that we are at a standstill until we get more expert advice on how to proceed with the circuit in regards to the biphasic components and how to best do the time delay. We need more guidance on the roles of different circuit elements.

2023/10/19: Brainstorm - H-Bridge Idea for Meeting with Dr. N

Daisy Lang - Oct 22, 2023, 10:05 PM CDT

Title: Brainstorm - H-Bridge Idea for Meeting with Dr. N

Date: 10/19/2023

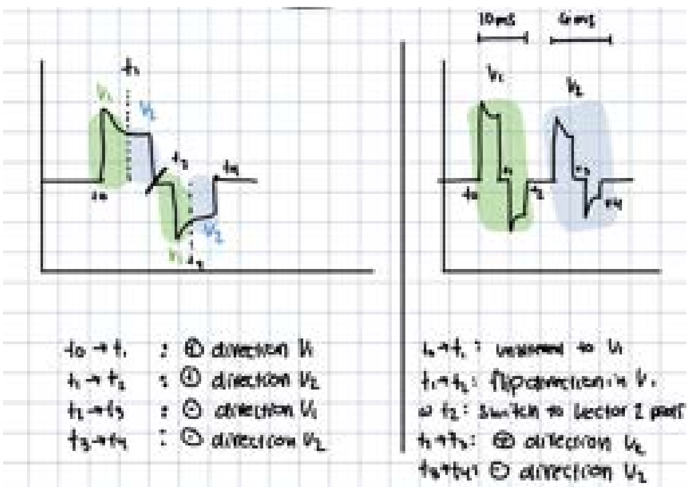
Content by: Daisy Lang

Present: Jack

Goals: Today Jack and I met prior to our meeting with Dr. N to finalize our idea and make sure we were on the same page. The goal of our discussion is to be as prepared as possible as to not waste Dr. N's time.

Content:

We have two main ideas, each involving an H-Bridge within our circuit box to switch the current between the two paths. Our goal is to keep the biphasic component of the idea in each vector.



<u>IDEA ONE:</u> Split the shock twice, the first half of the positive goes to V1, the second half of the positive goes to V2, the first half of the negative goes to V1, the second half of the negative goes to v2. The biggest problem is we don't know if we can split the time between the biphasic shock in each vector, also concerned that is will jump pads.

<u>IDEA TWO:</u> Split the positive portion of biphasic into its own biphasic through vector 1. Split the negative portion of the biphasic into its own biphasic through vector 2. The problem is that each shock will last half of the time, we don't know if this would be enough to cause sufficient depolarization.

Questions:

1. How can we do a time delay? Can we "hold" the current?

2. How do we prevent the current from jumping pads - path of least resistance?

3. Can we use H-Bridges to make our own biphasic socks from an already biphasic?

Conclusions/action items:

We will bring these graphs to Dr. N and talk to him about our ideas to use the H-Bridge. If he thinks this is doable, we will move forward with this idea and start making a circuit. If this idea is not feasible, we will look into other options for the circuit.

2023/10/22: Brainstorm - Circuit Diagram for Show and Tell

REBECCA POOR - Oct 27, 2023, 9:26 AM CDT

Title: Brainstorm - Circuit Diagram for Show and Tell

Date: 10/22/2023

Content by: Daisy

Present: Nick

Goals: Today Nick and I will work on making a circuit schematic that we can use to model our idea on a small scale for show and tell. We will use today to figure out which components we will need so we can obtain them before we meet later this week to work on creating the circuit.

Content:

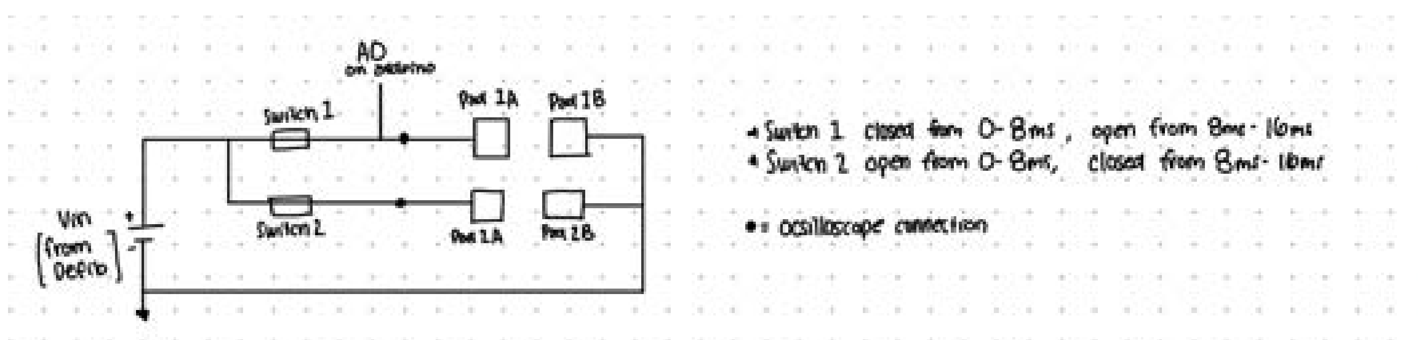
We want a circuit that can

1. Sense when the current is passing through vector 1

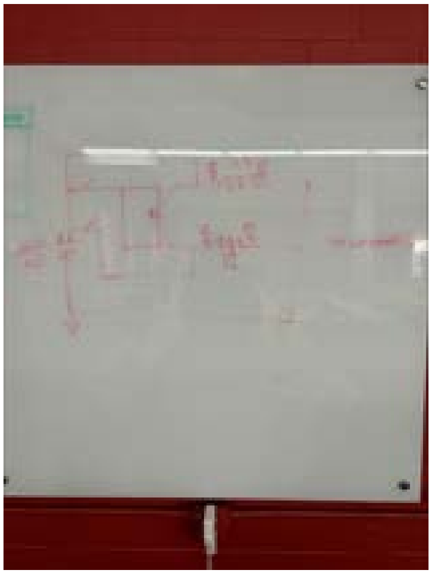
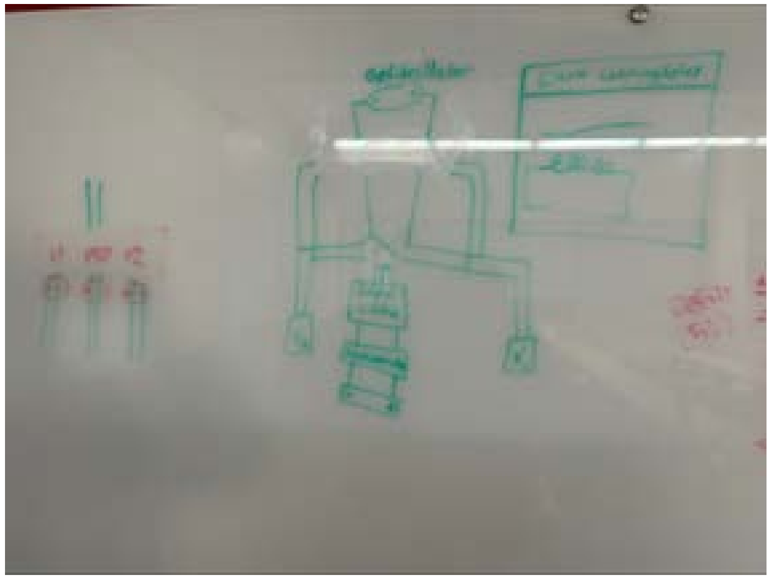
2. When there is current in vector 1, initiate a timer

3. When 8 ms has passed, close the path to vector 1 and open the path to vector 2

Below is the simple idea of what we want to make. We will use the Analog Pin on the arduino to read if there is a voltage at the point of vector 1. When the arduino uno reds that there is a voltage, the timer will start. We want to use a BeefCake Relay to control which path is on. This will allow us to switch between paths.



We also think that we can use three manual switches to control if it is just vector 1, just vector 2, or DSD. The switches would allow the desired path to be closed and bypass the undesired paths by leaving them open.

Conclusions/action items:

Before we can make our circuit, we need to get a beefcake. I will email Dr. P to see if we can borrow one from BME 201. Also, we need to learn if we can use a beefcake to switch between paths, or if we need two on separate timers. We know that the BeefCake can't take the real voltage from the defibrillator, but we want to use it for our mock up. Nick and I will meet this Tuesday to work on making a circuit and coding it through the arduino.

2023/10/30: MakerSpace Meeting with Jon Lombardo

Daisy Lang - Oct 30, 2023, 10:45 PM CDT

Title: MakerSpace Meeting with Jon Lombardo

Date: 10/30/2023

Content by: Daisy

Present: Nick

Goals: Today we will meet with Jon Lombardo (an expert in the Makerspace) to discuss our circuit design and get his input. We have very limited knowledge on circuit elements and would like to learn about the possible parts we can use.

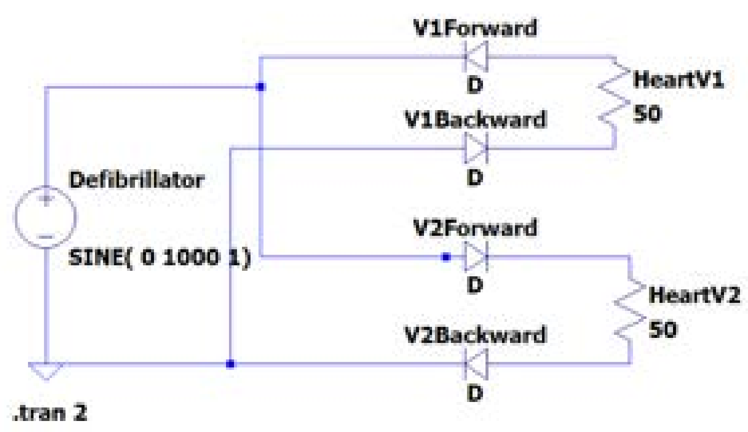
Content:

We told Jon about our idea for the Beefcake relays, and he explained that they would be too slow for the time frame we are working with. Instead, he proposed that we use diodes. Diodes only let through positive or negative voltage. If we place a diode facing one way along the path of vector 1, it will only let through the positive voltage. If we place another diode facing the opposite way along the path of vector 2, it will only let the negative voltage through. This would allow us to split the positive and negative portion of the biphasic shock without needing an arduino to hard code it.

Jon had us also had us place a diode after the resistor to stop the voltage from flowing back to the resistors. I am not sure if this is necessary as it would stop the flow back into the defibrillator machine.

We found diodes to order based on the 30 A current and the 1300 V from the defibrillator. The part number is in the photo attached to this document. For the time being, we purchased 4 small diodes from the makerspace and will use it to model this idea on a small scale this coming week.

<u>Idea for Circuit with Diodes:</u>

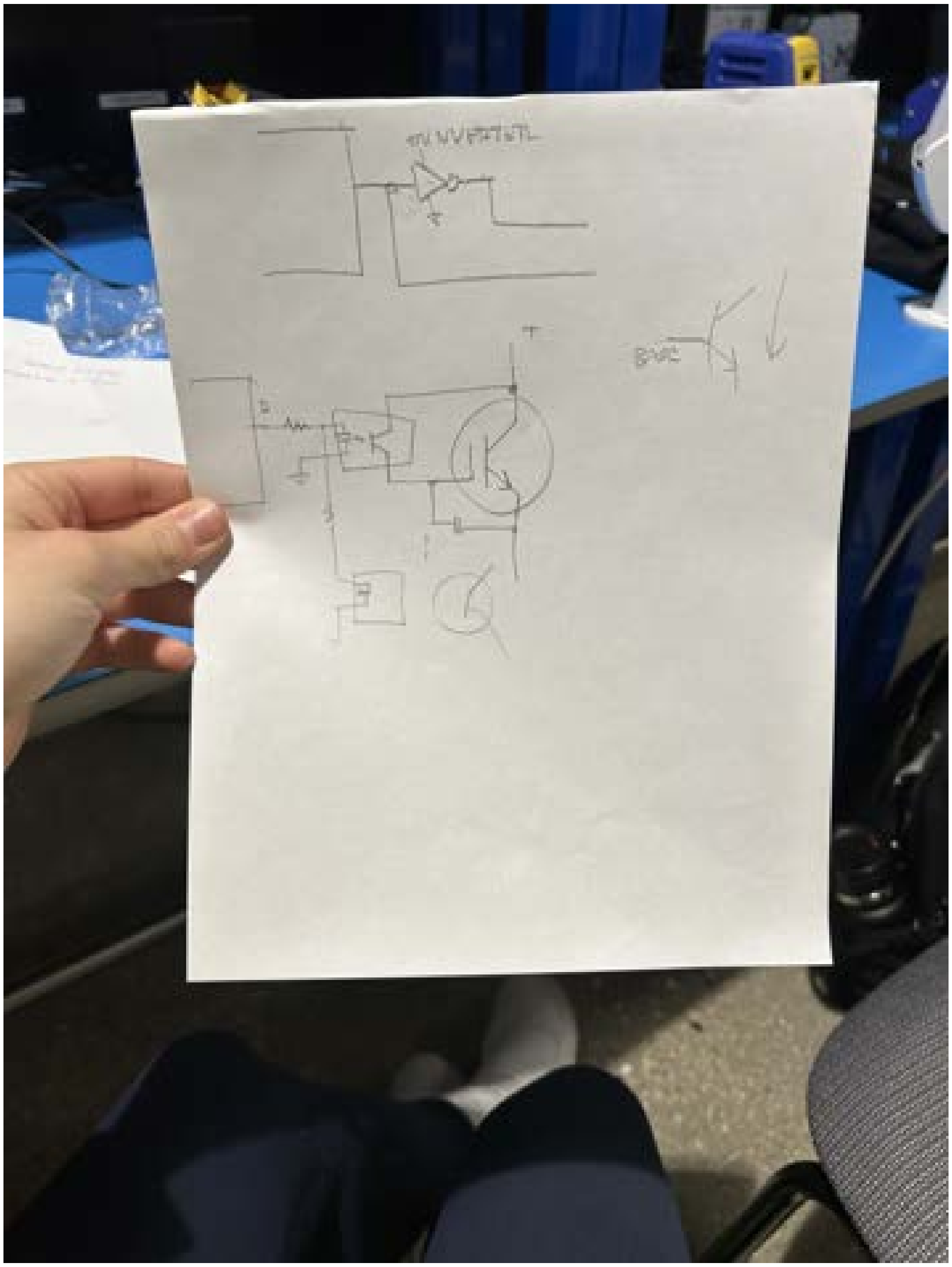


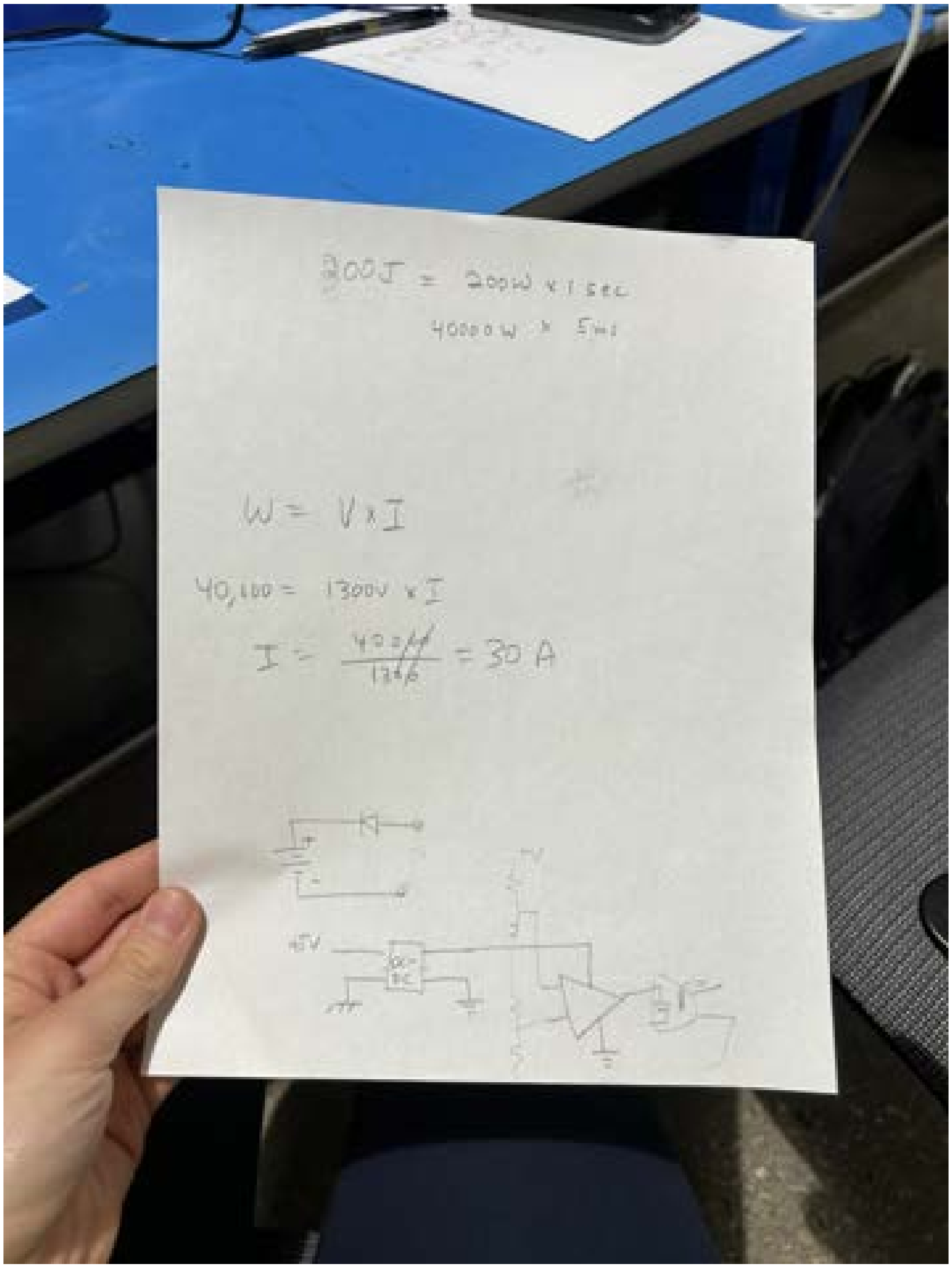
Attached to this note is the hand drawn circuit from the our meeting today.

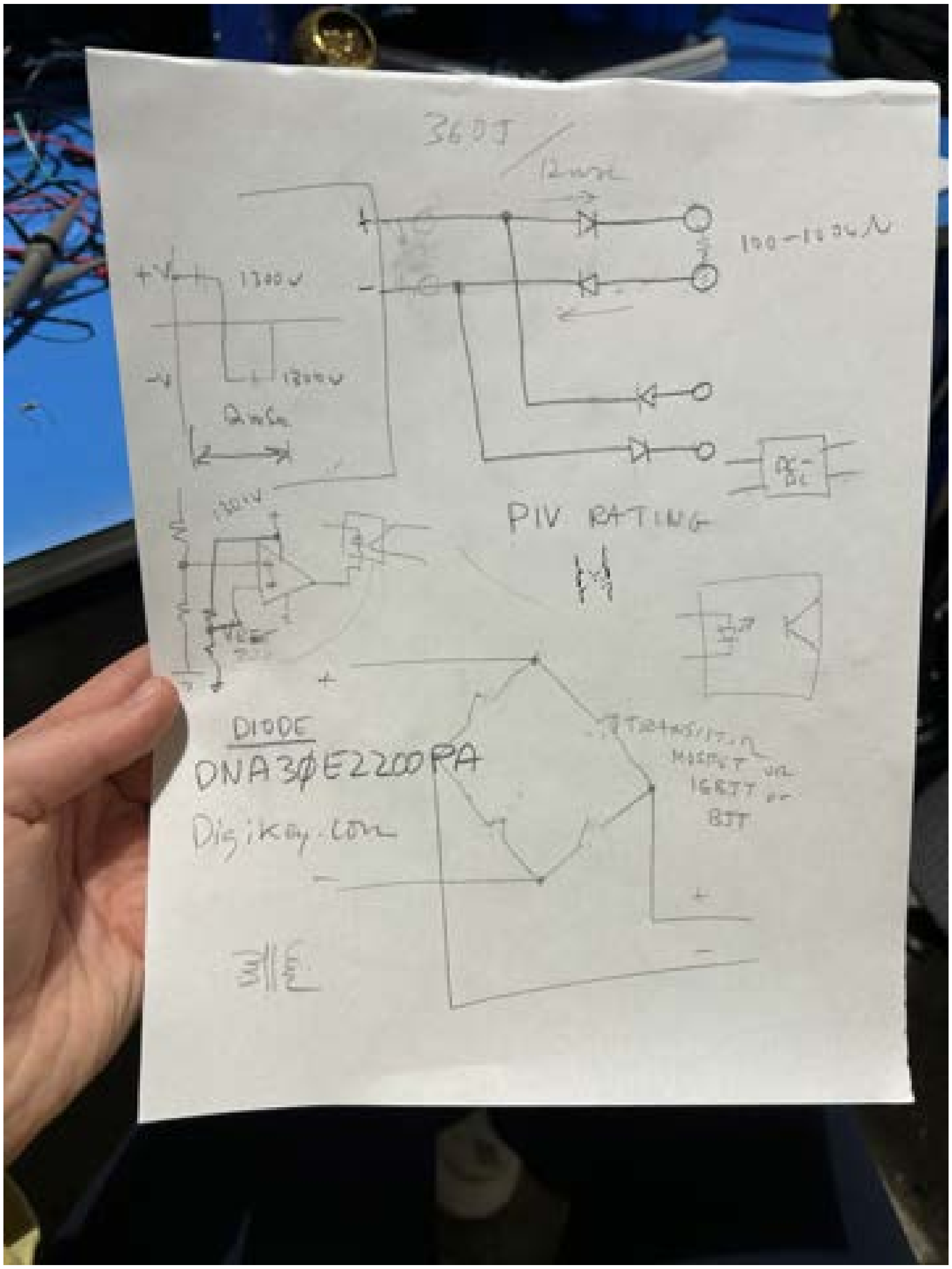
Conclusions/action items:

We purchased 4 diodes and we will build this circuit on a small scale and test it by sending a sine wave through it and measuring the output at each of the resistors. We think that we will see the only the positive voltage at the HeatV1 location and only the negative voltage a the HeartV3 location. We will test this using the oscilloscope. Additionally, Nick will place an order for the higher voltage diodes that we discussed purchasing with John.

Daisy Lang - Nov 02, 2023, 11:48 PM CDT




200J = 200W x 1 sec
40000W x 5ms
W = V x I
40,000 = 1300V x I
I = 400/13 = 30 A
+5V
DC-DC


360J
12us
100-1000Ω
1300V
1300V
PIV RATING
DC-DC
DIODE
DNA30E2200PA
Digikey.com
TRANSISTOR
MOSFET or
IGBT or
BJT

2023/9/20: Mini Pads Idea Outline

Daisy Lang - Sep 20, 2023, 1:53 PM CDT

Title: Mini Pads Idea Outline

Date: 9/20/2023

Content by: Daisy Lang

Present: None

Goals: I will document my idea to have two smaller pads connected to each other so they can both be placed in the anterior lateral position. This is a very preliminary design as I still do not know how to harness 200J to two pads from one monitor. I plan to make this design modular so it could be hooked up to two monitors.

Content:

- Design idea is attached to this entry
- Two sets of pads, but each pad will have a pad A and B
- Both Pads A and B will cover half of the position of the arterial-lateral position
- The connection to the pads will just be an insulating material to prevent electricity from flowing between the two pads
- The path of current to Pads A is always on
- Where the pads connect to the monitor, there is a switch on the cord to Pad B
- When the switch is closed, no current will flow into Pad B
- When the switch is open, current will flow into Pad B
- There will be a resistor system so that the current flowing into Pad B will lag the current flowing into Pad a by .5 second

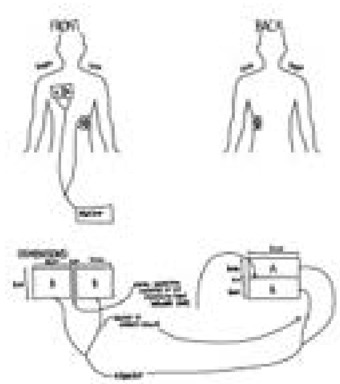
Problems:

- Still don't know how to capture 200J of energy into both pads
  - I am curious to see if the addition of a capacitor into the circuit can help store more energy to go to the second set of pads
  - I think I will contact Dr. Numinkar to see if he can provide more advice on if this would be possible
- I think we could keep this same pad design idea and provide a connection port to a second monitor
  - Monitor 1 could regulate pads A
  - Instead of a switch, there is a connector on pad B with is can connect with Monitor 2
    - This would make DSD easier because the pads are already in place and just need to be hooked up to a second monitor

Conclusions/action items:

I think this idea would work nicely because the pads will be smaller than my other idea. This design does not allow for vector change. Still the biggest problem is that I don't know how to get enough power to each pad from the one monitor. I think a consultation with Dr. N will be a good place to start for advice with this problem.

Daisy Lang - Sep 20, 2023, 1:46 PM CDT



Download

Mini_Pads.pdf (365 kB)

2023/9/17: Switch to Second Pad Idea Outline

Daisy Lang - Sep 20, 2023, 1:30 PM CDT

Title: Switch to Second Pad Idea Outline

Date: 9/19/2023

Content by: Daisy Lang

Present: None

Goals: I will outline my idea to have two pads connected together that will be connected by a switch. The switch will allow current flow into the second set of pads when it is time to start DSED.

Content:

- Design idea is attached to this entry
- Two sets of pads, but each pad will have a pad A and B
- Pads A are designed to go in the arterial- lateral position
- Pads B are designed to go in the arterial-posterior position
- The connection to the pads will just be a wire enclosed in a adhesive padding
    - This will allow for the pads to be stuck on easily and keep wires includes in the padding just like in the normal pads
- The path of current to Pads A is always on
- Where the pads connect to the monitor, there is a switch
- When the switch is closed, no current will flow into Pad B
- When the switch is open, current will flow into Pad B
- There will be a resistor system so that the current flowing into Pad B will lag the current flowing into Pad a by .5 second

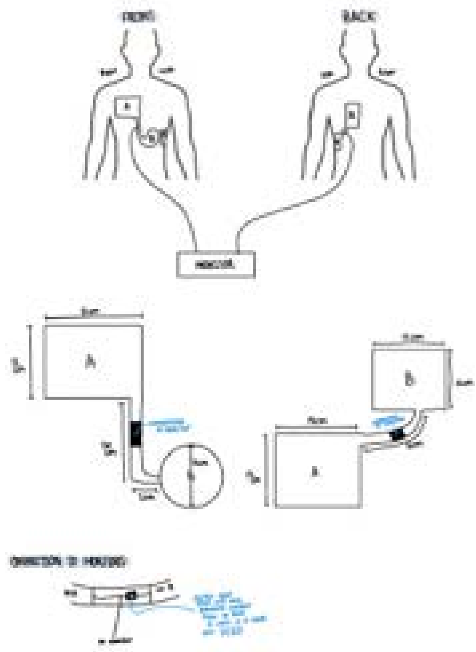
Problems:

- Still don't know how to capture 200J of energy into both pads
    - I am curious to see if the addition of a capacitor into the circuit can help store more energy to go to the second set of pads
    - I think I will contact Dr. Numinkar to see if he can provide more advice on if this would be possible
- I think we could keep this same pad design idea and provide a connection port to a second monitor
    - Monitor 1 could regulate pads A
    - Monitor 2 could regulate pads D

Conclusions/action items:

This design is very preliminary, as I am still not sure how we supply enough energy to both pads through 1 monitor. I think that this design will work well because it provides two vector options for pad placement. I would like to incorporate a switch into any of the ideas we have so that we could easily direct current to a second set of pads.

Daisy Lang - Sep 19, 2023, 9:14 PM CDT



Download

Switch_to_Second_Pad.pdf (409 kB)

2023/10/8: Testing Idea 1: Proof of Concept

Daisy Lang - Oct 08, 2023, 8:41 PM CDT

Title: Testing Idea 1: Proof of Concept

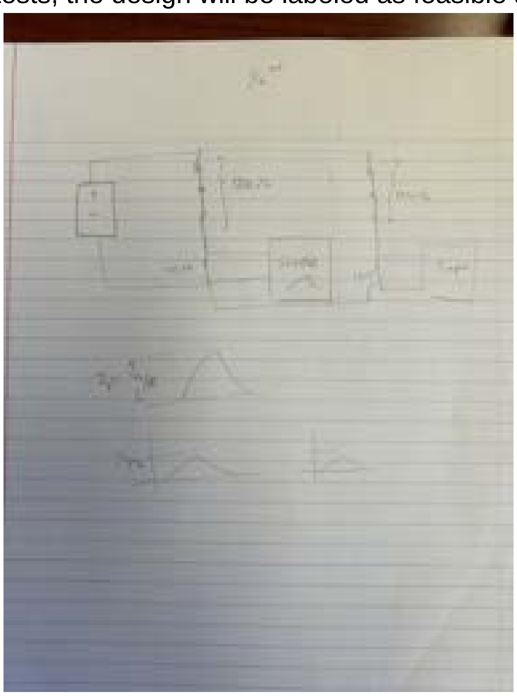
Date: 10/8/2021

Content by: Daisy

Present: NA

Goals: I want to document the testing idea presented to me by Dr. Numinkar. This testing idea will be used to prove that the power from the defibrillator can be split in half.

Content:

- Step 1:
  - A circuit will be developed to test the feasibility of dividing the power generated by the Life Pack monitor.
  - The circuit will be created with a 750 ohm resistor to replicate the resistance of the heart.
  - Attached to the Life Pack monitor and an oscilloscope will be integrated to measure the output voltage after the resistor
- Step 2:
  - Additional 750 ohm resistor will be added to the circuit in parallel with the original resistor.
  - Another oscilloscope measuring point will be attached to the circuit and the output voltage after both of the resistors will be recorded.
- GOAL: Test the hypothesis that the output voltage at both points will be the same.
- CRITERIA: This test will be performed 5 times and if both output voltages are within 2J of each other in all 5 tests, the design will be labeled as feasible and will move into the next phase of fabrication and testing
- 

Conclusions/action items:

We will use this test to prove that the power can be split into two pathways in our device. If this test succeeds, we will be able to move forward with building our circuit.

Daisy Lang - Oct 15, 2023, 11:39 AM CDT

Per Discussion in team meeting today (10/15/2023) we will use 50 ohms instead for our resistors. This is because the resistance value of 750 ohm is per volume of cardiac tissue. The actual tissue volume we are working with will match the 50 ohms.

2023/10/8: Testing Idea 2: Circuit Reliability

Daisy Lang - Oct 08, 2023, 8:48 PM CDT

Title: Testing Idea 2: Circuit Reliability

Date: 10/8/2023

Content by: Daisy

Present: NA

Goals: Today I will document our testing idea to assess the validity of our circuit using LT Spice and a hand built circuit.

Content:

- The proposed circuit for the device will be assembled in a LTSpice
- Within LTSpice, the voltage outputs and current amplitudes of the circuit will be measured to see if they match the desired values
- In this test, the desired power output from both circuit elements is a power value of 180
- The power output of the proposed circuit elements will be calculated using the equation for power
  - Power = Voltage x Current
- If the power output matches the desired value, the circuit will be assembled and tested in the same fashion as within LTSpice, but using a smaller power supply
  - A small power supply will be used in order to minimize the risk of damaging the measuring tools
- The circuit will be tested multiple times with a varying number of power supplies. For each, the predicted voltage and current outputs will be calculated and compared to the measured values. This will measure the reliability of our circuit. The circuit will be labeled as reliable if it can deliver the correct power through each element of the circuit with 99% accuracy to the predicted value of power output

Conclusions/action items:

We want our circuit to be 99% reliable, so we will use this test to measure the reliability of the circuit we make. Once we have made the circuit and know that it is delivering the desired amount of power, we move to the final test.

2023/10/8: Testing Idea 3: Mannequin Test

Daisy Lang - Oct 08, 2023, 8:52 PM CDT

Title: Testing Idea 3: Mannequin Test

Date: 10/8/2023

Content by: Daisy

Present: NA

Goals: Today I will document our plan for our final stage of testing on the mannequins at the UW Education Center.

Content:

- The assembled circuit will be attached to the Life Pack monitor and connected to the mannequin
- A shock will be delivered to the mannequin and the monitors installed within the mannequin will show if a shock was delivered and the time between the shocks.
- The mannequin is unable to detect the magnitude of the shock delivered, so this test will only be able to test the ability of the device to deliver two sequential defibrillation shocks.
- The timing between the two shocks must fall within 0.5-2.0 seconds
- If the circuit is able to meet this requirement over the course of five tests on the mannequin, it will be deemed reliable within the domain of the circuit delay.

Conclusions/action items:

This test will be used to measure the accuracy of the time delay in the circuit. We will be able to see if the mannequin resisters a shock and how far apart the shocks are.

2023/11/1: Diode Small Scale Circuit Test

Daisy Lang - Nov 02, 2023, 11:59 PM CDT

Title: Diode Small Scale Circuit Test

Date: 11/1/2023

Content by: Daisy

Present: Nick

Goals: Today we will test the output of our sample diode circuit using the oscilloscope to see if the output is what we expect.

Content:

To do this test, we connected the oscilloscope to our cricut in two places and sent a 20 Vpp Sine wave through the circuit with 100 kHz frequency.

1. After the postive diode and ground (green): we saw only the positive portion of the sine wave being sent through

2. After the negative diode and ground (yellow): we saw only the negative portion of the sine wave being sent through

We concluded that the circuit was working and one path was only sending negative voltage while the other was only sending positive.

Conclusions/action items:

We concluded that the idea behind the circuit is viable and now will move forward to building the larger circuit with larger diodes. Before we do this, we need to calculate our expected Vout at the end of each path for the defibrillator. Also, we saw that the magnitude of the voltage through the postive path was larger than the negative path. We do not have an explanation for this yet and need to look into why this is happening.

2023/11/14: Switch Testing Advising with Dr. Nimunikar

Daisy Lang - Nov 14, 2023, 11:37 AM CST

Title: Switch Testing Advising with Dr. N

Date: 11/14/2023

Content by: Daisy

Present: Hunter

Goals: Today Hunter and I will meet with Dr. N to get his advice for how we can test our switch to make sure it does not leak in the high voltage conditions of the defibrillator.

Content:

- Biggest issue is that we can't find a source with 2000V and a high current
- Dr. N thinks that if we can test with 2000V, this will be enough because the current is not what we are worried about leaking
    - We are more concerned with the voltage ARCH
- We want to test the switch when it is open to make sure no voltage arcs across the open switch
- Dr. N pointed us to the PEMPEC lab on campus that could have a 2000V source we could test with
    - Also suggested we can look into discharging a capacitor that holds 2000V and or he has electric fence in his office that we could use.

Conclusions/action items:

Dr. N thinks that we will have a hard time finding a power source that has 2000V and 12A of current, but thinks that if we can test it under the high voltage, the value of the current will not matter as much. He pointed us to the WEMPEC Power lab on campus and thinks that we can meet with them and find a power source for testing that can handle 2000V. I have sent an email to Pia Strampp, the lab manager, and will wait to hear back from her.

2023/10/25: Circuit Design Meeting 1

Daisy Lang - Oct 25, 2023, 10:56 PM CDT

Title: Circuit Design Meeting 1

Date: 10/25/2023

Content by: Daisy

Present: Nick

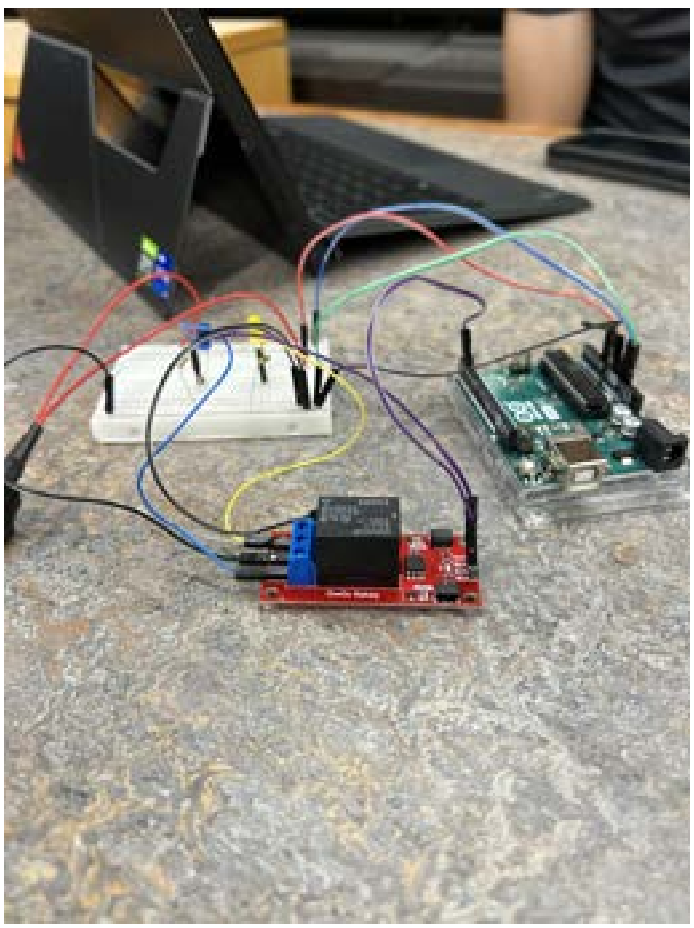
Goals: Today Nick and I will meet and start working on our circuit design now and logic for the porotype for show and tell. Out goal is to put together a circuit and write the code for the arduino.

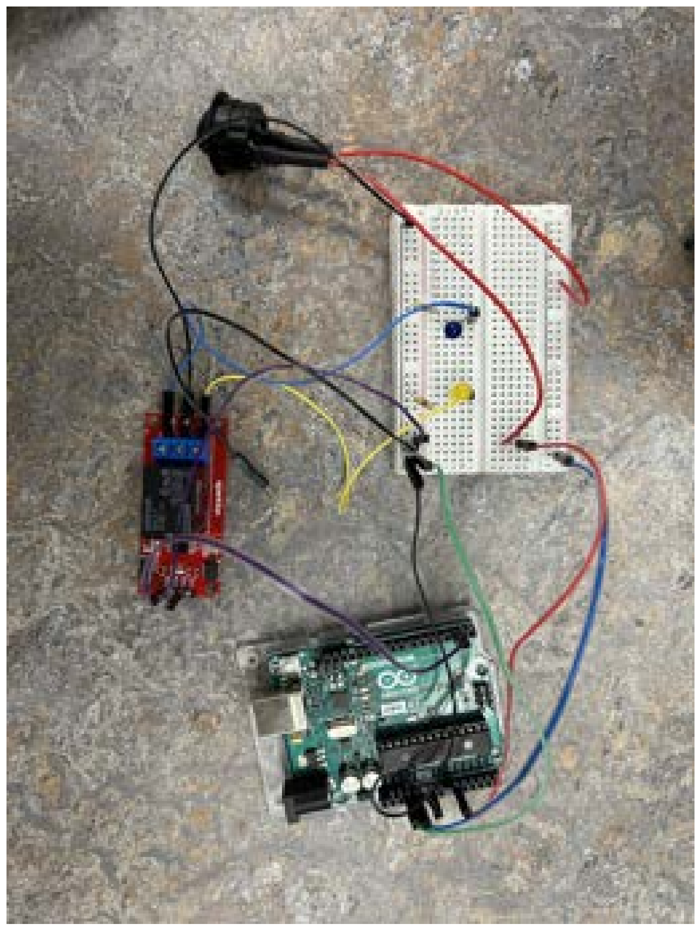
Content:

Logic for Code: The code we created is linked in this entry

- Sense when there is a voltage being send from the arduino? (we will model this with a switch)
- If there is a voltage sensed, turn on path 1 for x seconds and turn off path 2
- After x seconds, turn off path 1 for x seconds and turn on path 2
- If there is no voltages sensed, do nothing, but continue sensing for the voltage (this will be in our loop)

Circut:





BeefCake: plugged into pin 2 as its digital output, plugged into 3.3V as power source. We put one pathway into the NC and the other into the NO. We think that one path is always open and one is always closed, and we will be able to tell the beefcake when to switch between them.

We used 47 ohm resistors and an LED in each path to signify when the path had current flowing through it. The 47 ohm resistors will mimic the resistance of the heart.

Questions:

- Can we use the one beefcake relay to switch between the two paths?
- We don't want to have the voltage go through the microcontroller, how do we do this? Do we just need a sensor?

Conclusions/action items:

Today Nick and I spent a lot of time trying to learn about the BeefCake. We think we have a good understanding and are ready to test this circuit and code in our next meeting (today we were unable to because I left my arduino adaptor cord at home). Nick and I have a consultation meeting with an expert at the UW Makerspace scheduled for next Monday (11/30) so we can get advice on our future design and help with using the beefcake.

Daisy Lang - Oct 25, 2023, 10:56 PM CDT

Download

BME300_ShowTell.ino (473 B)

2023/10/25: BeefCake Instructions from BME 201

Daisy Lang - Oct 25, 2023, 10:59 PM CDT


Lab 4: Arduino I

Overview

Learning outcomes

Related materials

Materials needed for lab

Logistics

Download

Lab_04__Arduino_I.pdf (2.95 MB) This is the instruction sheet from BME 201 that Nick and I used to help guide our understanding of how to use the BeefCake Relay.

2023/10/25: BeefCake Qwiic Single Relay Data Sheet

Daisy Lang - Oct 25, 2023, 11:01 PM CDT

Title: BeefCake Qwiic Single Relay Data Sheet

Date: 10/25/2023

Content by: Daisy

Present: Nick

Goals: This is the data sheet that Nick and I used when working with the BeefCake Qwiic Single Relay. I will document it here so we can refer back to it later.

Content:

Link to Page: https://www.sparkfun.com/products/15093

Conclusions/action items:

As we continue working on our circuit, we will refer back to this data sheet when using the BeefCake.

2023/11/1: Diode Small Scale Circuit

Daisy Lang - Nov 02, 2023, 11:58 AM CDT

Title: Diode Small Scale Circuit

Date: 11/1/2023

Content by: Daisy

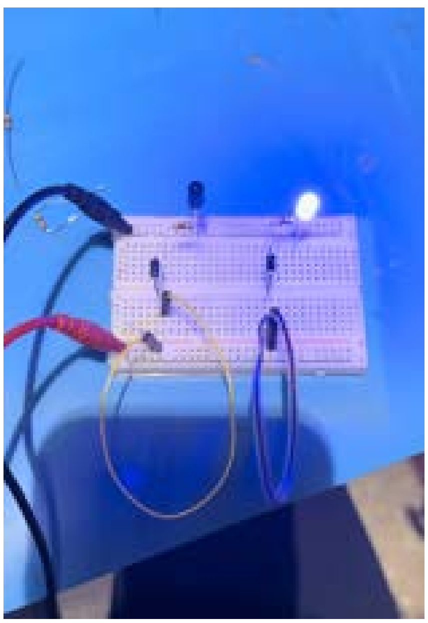
Present: Nick

Goals: Today we will use the diodes we purchased to build a small scale circuit and test our theory that the diodes will split the positive and negative voltage. We will test this using a sine wave and observe the output on the oscilloscope.

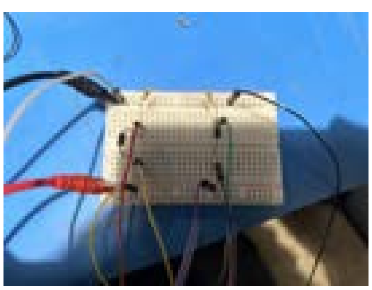
Content:

We built the following circuit using an two LEDS, 4 diodes, and two 50 ohm resistors. There are two almost identical paths in the circuit. Both are connected to the same power source. The only difference is that one has postive facing diodes and the other has negative facing. When the sine wave is sent through the circuit, the LED at the end of the postive diode path lights up during the postive phase of the sine wave and the LED at the end of the negative end of the lights up during the negative phase of the sine wave.

CIRCUIT W/ LED:



CIRCUIT W/O LED:



OUTPUT:

Green Line = output after postive diode

Yellow Line = output after negative diode

We paced the oscilloscope and read from ground to after the positive diode and from ground to the negative diode and saw the following output. This confirmed that only the postive part of the wave was passing through the postive diode and only the negative was passing through the negative diode.

Conclusions/action items:

Today was a huge success as we proved that our diode idea works for splitting the postive and negative portion of a wave. The next step is to order the heavy duty diodes and test on the defibrillator. I would like to double check our calculations for our expected outputs prior to this testing. More info on the results of the sample circuit testing can by found in my testing folder.

2023/11/1: Show and Tell Concept Circuit

Daisy Lang - Nov 02, 2023, 6:52 PM CDT

Title: Show and Tell Concept Circuit

Date: 11/1/2023

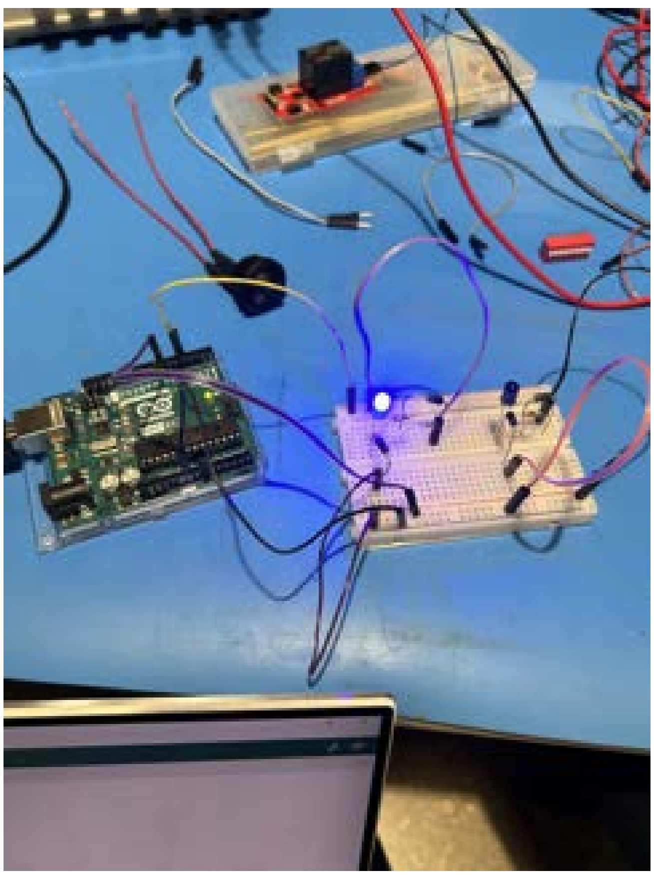
Content by: Daisy

Present: Nick

Goals: Nick and I will make a sample circuit using the diodes and connect it to the arduino so that it we can show off our idea to our peers at show and tell.

Content:

The cricut we made must be connected to an arduino because this is the only power source we will have available to us for show and tell. The problem with this is the Arduino cannot send a negative voltage. For this reason, we are hard coding the circuit so that the it sends a voltage down one path for a 2 seconds and then down the other path for 2 seconds. In this circuit, we don't technically need the diodes because there is no negative current being sent. The sole purpose of this circuit is to show how the voltage will alternate between the two paths. The code used to power the arduino is attached to this entyr.



Conclusions/action items:

We are going to present this circuit at show and tell on Friday so we can show off our concept idea. We also plan to show our results form the real test that we ran on the sample diode circuit to show how the oscilloscope shows the voltage being split .

9/14/2023 How Does Heart Defibrillation Work?

Nick Johnson - Sep 29, 2023, 12:24 AM CDT

Title: How Does Heart Defibrillation Work?

Date: 9/14/23

Content by: Nick Johnson

Present: Nick Johnson

Goals: Research how heart defibrillation works?

Citation:

[1] "Defibrillators - What are Defibrillators? | NHLBI, NIH," *www.nhlbi.nih.gov*, Jun. 06, 2023. https://www.nhlbi.nih.gov/health/defibrillators#:~:text=They%20are%20preprogramed%20to%20automatically (accessed Sep. 29, 2023).

[2] "Cardiac Arrhythmias," *www.youtube.com*. https://www.youtube.com/watch?v=6LrptveKYus

Content:

Heart defibrillators work by sending 200 joules of electrical current through a vector on plane with the heart. This is done during two main types of arrythmias. Ventricular tachycardia (V-tach) which occurs when the heart beats too fast due to abnormal electrical activity. The second main arrythmia is Ventricular fibrillation (V-fib) this occurs when the heart twitches or quivers due to abnormal electrical activity. [1]

Since both arrythmias are caused by abnormal electrical activity, a defibrillator can be used. This is because by sending an electrical current through the heart the calcium, sodium, and potassium ions are depolarized. This depolarizes the action potential within the ion channels of the heart causing the heart rhythm stop and have a chance to reset. Since the heart rhythm is stopped CPR is extremely important to getting blood flow to the brain, immediately after defibrillation. Once the heart starts to build action potential with ions again, it is able to begin electrical contractions. Hopefully in a rhythm without abnormal electrically activity. [2]

References:

https://www.nhlbi.nih.gov/health/defibrillators#:~:text=They%20are%20preprogramed%20to%20automatically,beat%20at%20a%20normal%20rhythm

https://www.youtube.com/watch?v=6LrptveKYus

Conclusions: The current method of using electricity to depolarize ions within the channels of the heart to reset the electrical activity seems to be the best method to get normal electrical activity in the heart back.

Action items:

Next research how a defibrillator works from an engineering perceptive (electrical side).

9/14/2023 Competing Designs Research

Nick Johnson - Sep 15, 2023, 1:38 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Competing Designs

Date: 9/14/23

Content by: Nick Johnson

Present: N/A

Goals: Research designs on the market today that may already accomplish the clients needs.

Search Term: "Dual sequential with Lucas Device Defibrillation Pads"

Link: https://www.ncbi.nlm.nih.gov/books/NBK544231/

Citation:

[1] M. Ramzy and P. G. Hughes, “Double Defibrillation,” *PubMed*, 2022. https://www.ncbi.nlm.nih.gov/books/NBK544231/

Content: I did multiple searches for dual sequential defibrillators and defibrillator pads on the market today. From those searches I was unable to find one machine capable of this. I then read this article in the National Library of medicine which is recent since April 27th of this year which indicated two separate machines were needed for dual sequential defibrillation. I don't believe there are any competing designs on the market. Especially not one that would be able to be compatible with current machines on the market.

It also states in the article that it is not exactly known whether the change in vector, increase, in energy, or a combination of these at the sometime is responsible for DSD success. This is consistent with what our client told us in our meeting.

Conclusions/action items: I conclude we do not have any competing designs on the market today and we should work as hard as possible to get a design by the end of the semester before someone decides to do this themselves. My action item will be to start brainstorming circuit ideas for circuit to circuit communication between the circuit we make and the circuit within the machine.

10/11/23 Dual Sequential Defibrillation Competing Design

Nick Johnson - Oct 11, 2023, 7:27 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Dual Sequential Defibrillation Competing Design

Date: 10/11/23

Content by: Nick Johnson

Present: N/A

Goals: Search Google Patents the term "Dual Sequential Defibrillation."

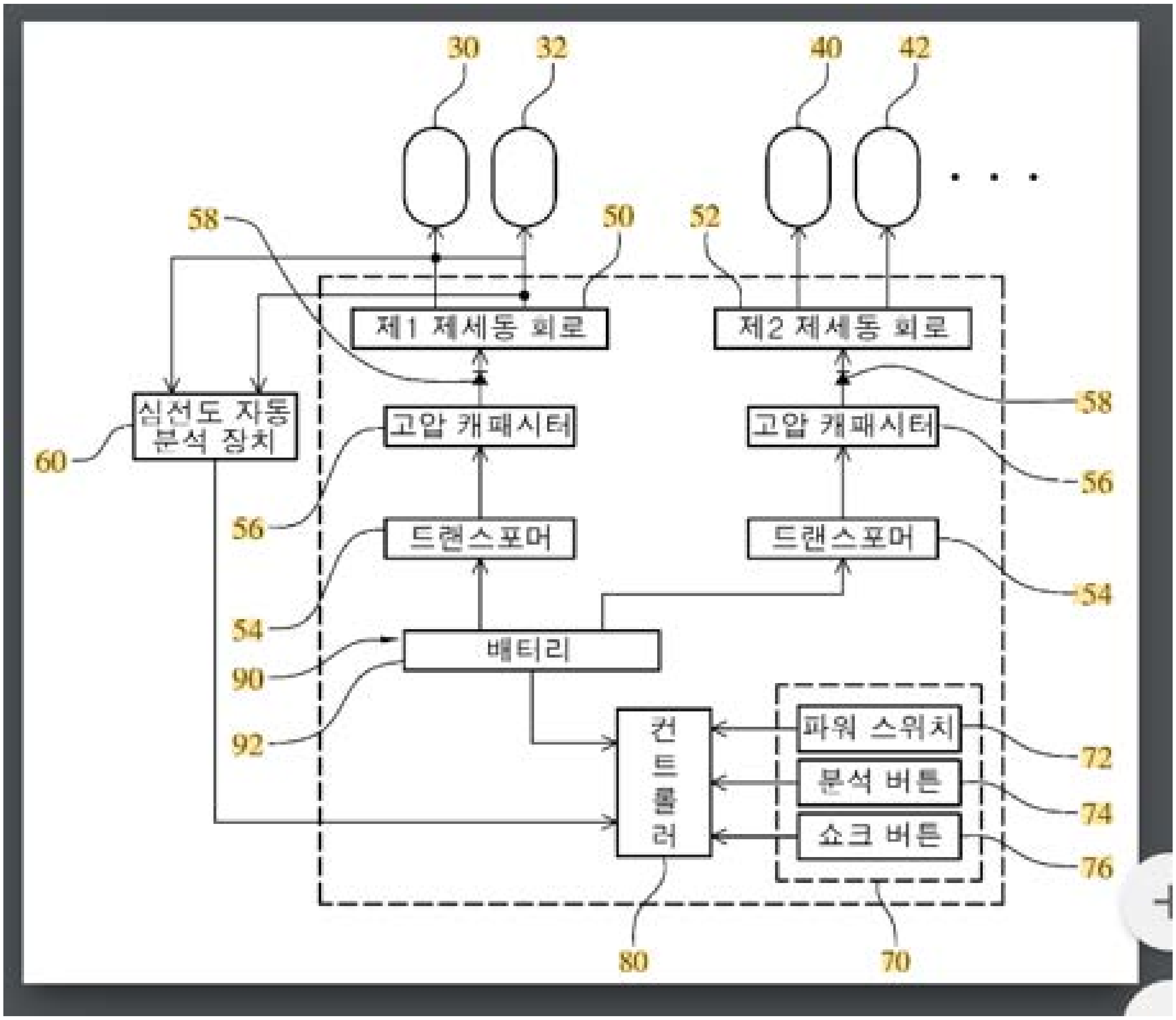
Search Term: "Dual Sequential Defibrillation."

Link: https://patents.google.com/patent/KR20210149258A/en?q=(Dual+Sequential+Defibrillation)&oq=Dual+Sequential+Defibrillation

Citation:

[1] 나학록 and 박상현, “다중 연속 쇼크 제세동기.” https://patents.google.com/patent/KR20210149258A/en?q=(Dual+Sequential+Defibrillation)&oq=Dual+Sequential+Defibrillation (accessed Oct. 12, 2023).

Content: This patent was filed out of South Korea for a dual sequential defibrillator design. They cite that a timer will control alternating shocks, "The controller may perform electric defibrillaiton simultaneously or with a time difference according to the same or different voltage through the pair of first and second defibrillaiton electrodes." This design is exactly what we are trying to accomplish. However, this design is not an accessory for an existing defibrillator it contains a defibrillator that has two circuits to distribute two shocks. Our current design if we can accomplish it will just split current from an existing defibrillator. This would be very cost effective for healthcare institutions as they would just have to buy and implement our design which should be relatively cheap versus buying an extremely expensive new defibrillator (likely $40,000)



Conclusions/action items: Begin focusing all research on splitting current with microcontrollers to allow for timing delay between shocks. And then focus on actual fabrication in an online electrical software once the details of the circuit are completed. Prove the circuit will work online, and then fabricate it to real life as a final prototype.

10/19/2023 LIFEPAK 15 Manual

Nick Johnson - Oct 19, 2023, 8:23 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: LIFEPAK 15 Manual important information

Date: 10/19/2023

Content by: Nick Johnson

Present: N/A

Goals: Take out important information from manual that can be used to calculate circuit components within our circuit so it is compatible with the LIFEPAK defibrillator.

Search Term: "LIFEPAK 15 operating manual"

Link: https://www.stryker.com/content/dam/stryker/ems/resources/operating-instructions/international/3314911-030_int-eng_lifepak_15_operating_instructions.pdf

Citation:

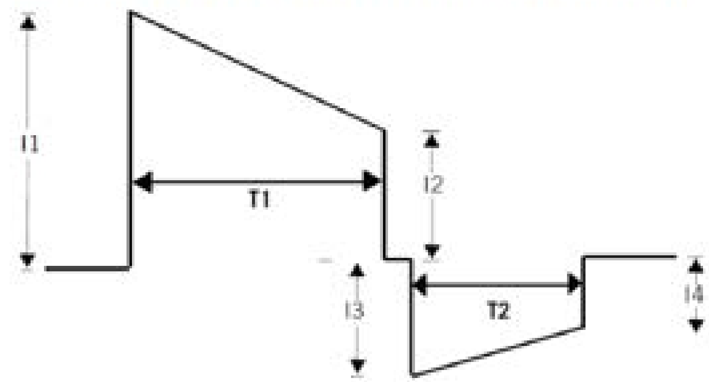
[1] “Operating Instructions.” Available: https://www.stryker.com/content/dam/stryker/ems/resources/operating-instructions/international/3314911-030_int-eng_lifepak_15_operating_instructions.pdf

Content:

Electrode Contact Determination

The Shock Advisory System measures the patient's transthoracic impedance through the therapy electrodes. If the baseline impedance is higher than a maximum limit, it determines that the electrodes do not have sufficient contact with the patient or are not properly connected to the AED. When this occurs, ECG analysis and shock delivery are inhibited. The AED advises the operator to connect electrodes when there is insufficient electrode contact.

Waveform Shape and Measured Parameters

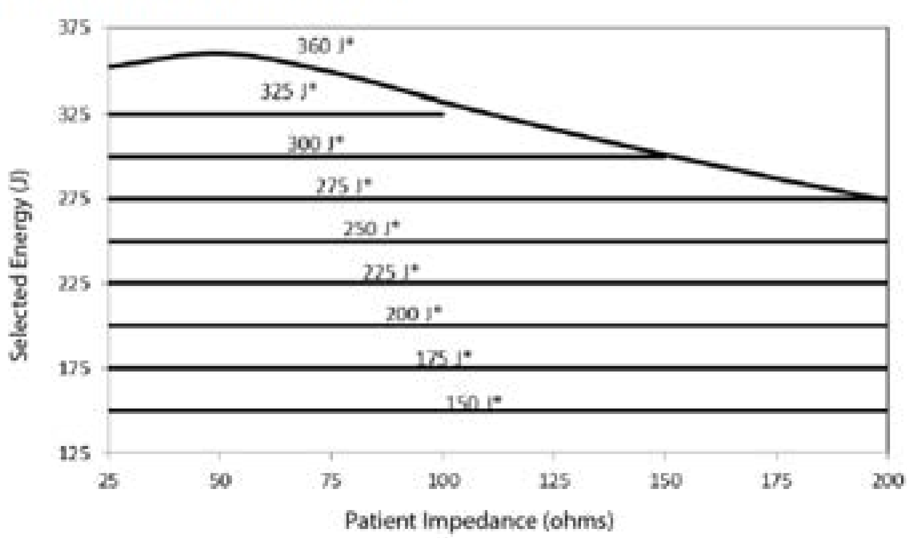


Biphasic Waveform

Patient Impedance (Ω)	Phase 1 Duration (ms)		Phase 2 Duration (ms)		Tilt (%)		Delivered Energy
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	
25	5.1	6.0	3.2	4.2	69.9	85.2	352
50	6.8	7.9	4.4	5.5	57.0	74.7	360
75	7.6	9.4	4.9	6.5	49.3	67.6	349
100	8.7	10.6	5.6	7.3	43.0	62.2	332
125	9.5	11.2	6.2	7.7	39.0	56.6	316
150	10.1	11.9	6.6	8.2	36.8	52.6	301
175	10.6	12.5	6.9	8.6	33.8	49.3	287
200	10.9	13.4	7.1	9.2	29.6	47.4	274

Rated Energy Output

Rated energy output is the nominal delivered energy based on the energy setting and patient impedance, as defined in the following chart.



*Energy setting selected

ENVIRONMENTAL—Unit meets functional requirements during exposure to the following environments unless otherwise stated.	
Operating Temperature	0° to 45°C (32° to 113°F) -20°C (-4°F) for 1 hour after storage at room temperature 60°C (140°F) for 1 hour after storage at room temperature
Storage Temperature	-20° to 65°C (-4° to 149°F) except therapy electrodes and batteries When a device stored at -20°C (-4°F) is placed at room temperature, it is ready for use after 2 hours. When a device stored at 65°C (149°F) is placed at room temperature, it is ready for use after 2 hours.
Relative Humidity, Operating	5 to 95%, non-condensing NIBP: 15 to 95%, non-condensing
Relative Humidity, Storage	10 to 95%, non-condensing
Atmospheric Pressure, Operating	-382 to 4,572 m (-1,253 to 15,000 ft) NIBP: -152 to 3,048 m (-500 to 10,000 ft)
Water Resistance, Operating	IP44 (dust and splash resistance) per IEC 60529 and EN 1789 (without accessories except for 12-lead ECG cable, hard paddles, and battery pack)
Vibration	MIL-STD-810E Method 514.4 Propeller Aircraft - category 4 (figure 514.4-7 spectrum a) Helicopter - category 6 (3.75 Grms) Ground Mobile - category 8 (3.14 Grms)
	EN 1789: Sinusoidal Sweep, 1 octave/min, 10-150 Hz, ±0.15 mm/2 g
Shock (drop)	5 drops on each side from 18 inches onto a steel surface EN 1789: 30-inch drop onto each of 6 surfaces
Shock (functional)	Meets IEC 60068-2-27 and MIL-STD-810E shock requirements 3 shocks per face at 40 g, 6 ms half-sine pulses
Bump	1000 bumps at 15 g with pulse duration of 6 msec
Impact, Non-operating	IEC 60601-1 0.5 + 0.05 joule impact UL 60601-1 6.78 Nm impact with 2-inch diameter steel ball Meets IEC 62262 protection level IK04
EMC	IEC 60601-1-2 Medical Equipment - General Requirements for Safety - Collateral Standard: Electromagnetic Compatibility - Requirements and Tests

Cleaning	Cleaning 20 times with the following: Quaternary ammonium, isopropyl alcohol, hydrogen peroxide
Chemical Resistance	60 hour exposure to specified chemicals: Betadine (10% Povidone-Iodine solution) Coffee, Cola Dextrose (5% Glucose solution) Electrode Gel/Paste (98% water, 2% Carbopol 940) HCL (0.5% solution, pH=1) Isopropyl Alcohol NaCl solution (0.9% solution) Cosmetic discoloration of the paddle well shorting bar shall be allowed following exposure to HCL (0.5% solution).

IMPORTANT! Infant/Child Reduced Energy Defibrillation Electrodes are not compatible with the LIFEPAK 15 monitor/defibrillator.

Pediatric Paddles

Pediatric paddles slide onto adult paddles. Pediatric paddles should be used for patients weighing less than 10 kg (22 lb) or for patients whose chest size cannot accommodate the adult hard paddles.

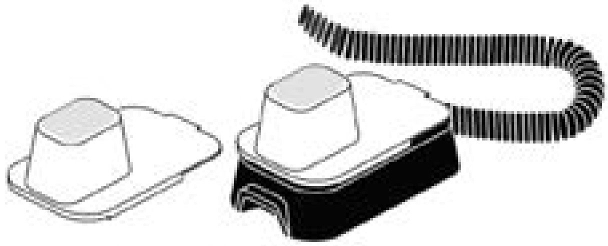


Figure 39 Pediatric Paddles

Use the adult paddle controls for selecting energy and charging. Each pediatric paddle attachment has a metal spring plate with a contact on it that transfers defibrillation energy from the adult paddle electrode to the pediatric paddle. This solid cadmium-silver contact will not scratch the adult paddle electrode.

Batteries	Rechargeable Lithium-ion battery		
	Dual battery capability with automatic switching		
	Low battery indication and message: Low battery fuel gauge indication and low battery message in status area for each battery		
	Replace battery indication and message: Replace battery fuel gauge indication, audio tones, and replace battery message in the status area for each battery. When replace battery is indicated, device auto-switches to second battery. When both batteries reach replace battery condition, a voice prompt instructs user to replace battery.		
	Input voltage range is between +8.8 and +12.6 Vdc		
Battery Capacity	For two, new fully-charged batteries, 20°C (68°F):		
	Capacity to shutdown is:		
Operating Mode	Monitoring (minutes)	Pacing (minutes)	Defibrillation (360J discharges)
Typical	360	340	420
Minimum	340	320	400
	Capacity after low battery is:		
Typical	21	20	30
Minimum	12	10	6

DEFIBRILLATOR

Charge Time (per IEC 60601-2-4)

AC Operation Only:

Maximum Time from Charge to Shock Ready (Manual Mode):

Voltage	Charge Time
90-240 Vac	360 J within 10 seconds

Maximum Time from Initiation of Analysis to Shock Ready (AED Mode):

Voltage	Charge Time
90-240 Vac	360 J within 30 seconds

Maximum Time from Power-on to Shock Ready (Manual Mode):

Voltage	Charge Time
90-240 Vac	360 J within 25 seconds

Maximum Time from Power-on to Shock Ready (AED Mode):

Voltage	Charge Time
90-240 Vac	360 J within 40 seconds

DC Operation Only:

Maximum Time from Charge to Shock Ready (Manual Mode):

Voltage	Charge Time
11-17.6 Vdc	360 J within 10 seconds

Maximum Time from Initiation of Analysis to Shock Ready (AED Mode):

Voltage	Charge Time
11-17.6 Vdc	360 J within 30 seconds

Maximum Time from Power-on to Shock Ready (Manual Mode):

Voltage	Charge Time
11-17.6 Vdc	360 J within 25 seconds

Maximum Time from Power-on to Shock Ready (AED Mode):

Voltage	Charge Time
11-17.6 Vdc	360 J within 40 seconds

Battery Operation Only:

Maximum Time from Charge to Shock Ready (Manual Mode):

Battery Status	Charge Time
Fully charged	200 J within 7 seconds, nominal
Fully charged, followed by 15 full-energy shocks	360 J within 10 seconds
Fully charged	360 J within 10 seconds

Maximum Time from Initiation of Analysis to Shock Ready (AED Mode):

Battery Status	Charge Time
Fully charged	200 J within 15 seconds, nominal
Fully charged, followed by 15 full-energy shocks	360 J within 30 seconds
Fully charged	360 J within 30 seconds

Maximum Time from Power-on to Shock Ready (Manual Mode):

Battery Status	Charge Time
Fully charged, followed by 15 full-energy shocks	360 J within 25 seconds

Maximum Time from Power-on to Shock Ready (AED Mode):

Battery Status	Charge Time
Fully charged, followed by 15 full-energy shocks	360 J within 40 seconds

Biphasic Waveform	Biphasic Truncated Exponential
	The following specifications apply from 25 to 200Ω, unless otherwise specified: Energy Accuracy: ±1 joule or 10% of setting, whichever is greater, into 50Ω; ±2 joules or 15% of setting, whichever is greater, into 25-175Ω. Voltage Compensation: Active when disposable therapy electrodes are attached. Energy output within ±5% or ±1 joule, whichever is greater, of 50Ω value, limited to the available energy which results in the delivery of 360 joules into 50Ω.

This is all the information that I thought would be necessary to calculate the components we will need in our circuit. I took screenshots because I believe primary sources leave room for less error.

Conclusions/action items: I believe after meeting with Dr. N it is all up to us to come up with the best possible solution and continuing moving even if it is not perfect.

9/14/2023 Circuit Components of a Defibrillator

Nick Johnson - Sep 15, 2023, 1:07 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Circuit Components of a Defibrillator

Date: 9/14/23

Content by: Nick Johnson

Present: N/A

Goals: Learn how a defibrillator works from an engineering and electrical point of view.

Search Term: "Heart Defibrillator Tear Down"

Link: **https://www.youtube.com/watch?v=n47u2YQytjo**

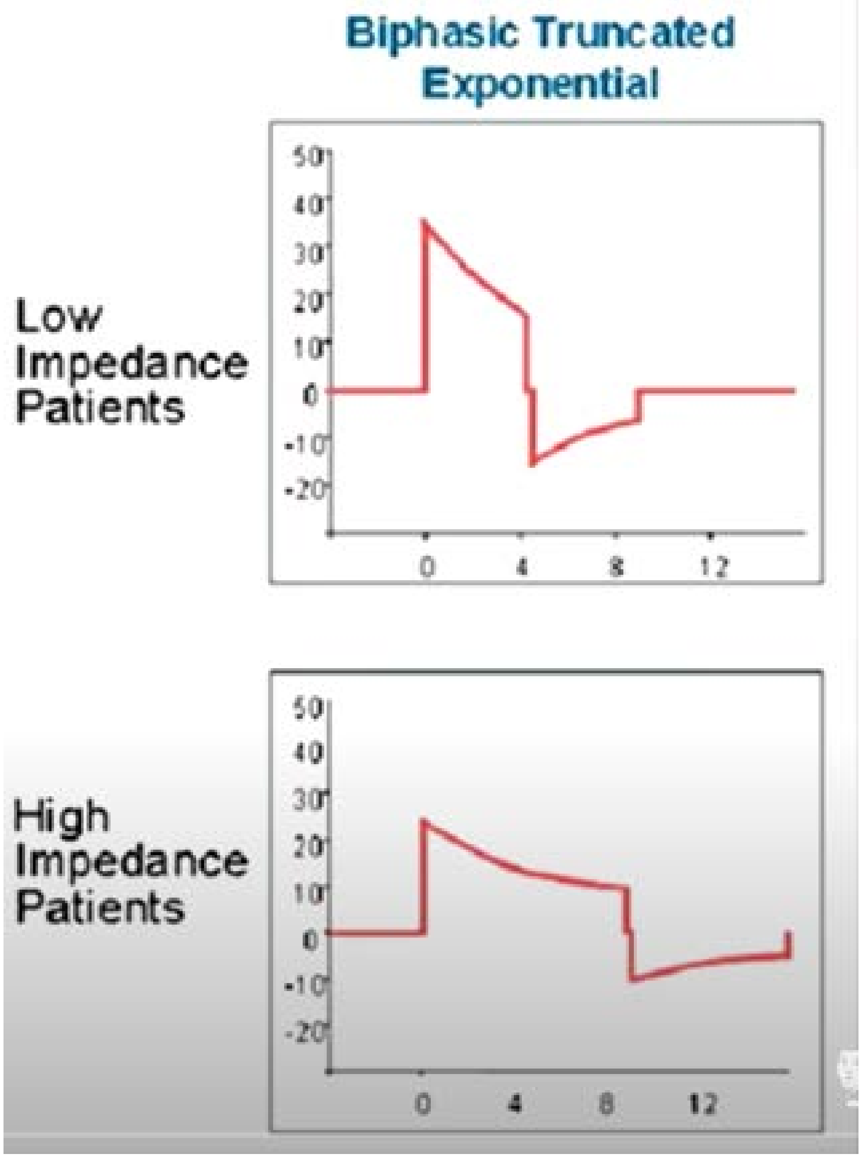
https://www.khanacademy.org/test-prep/mcat/physical-sciences-practice/physical-sciences-practice-tut/e/the-circuit-elements-of-a-simple-defibrillator

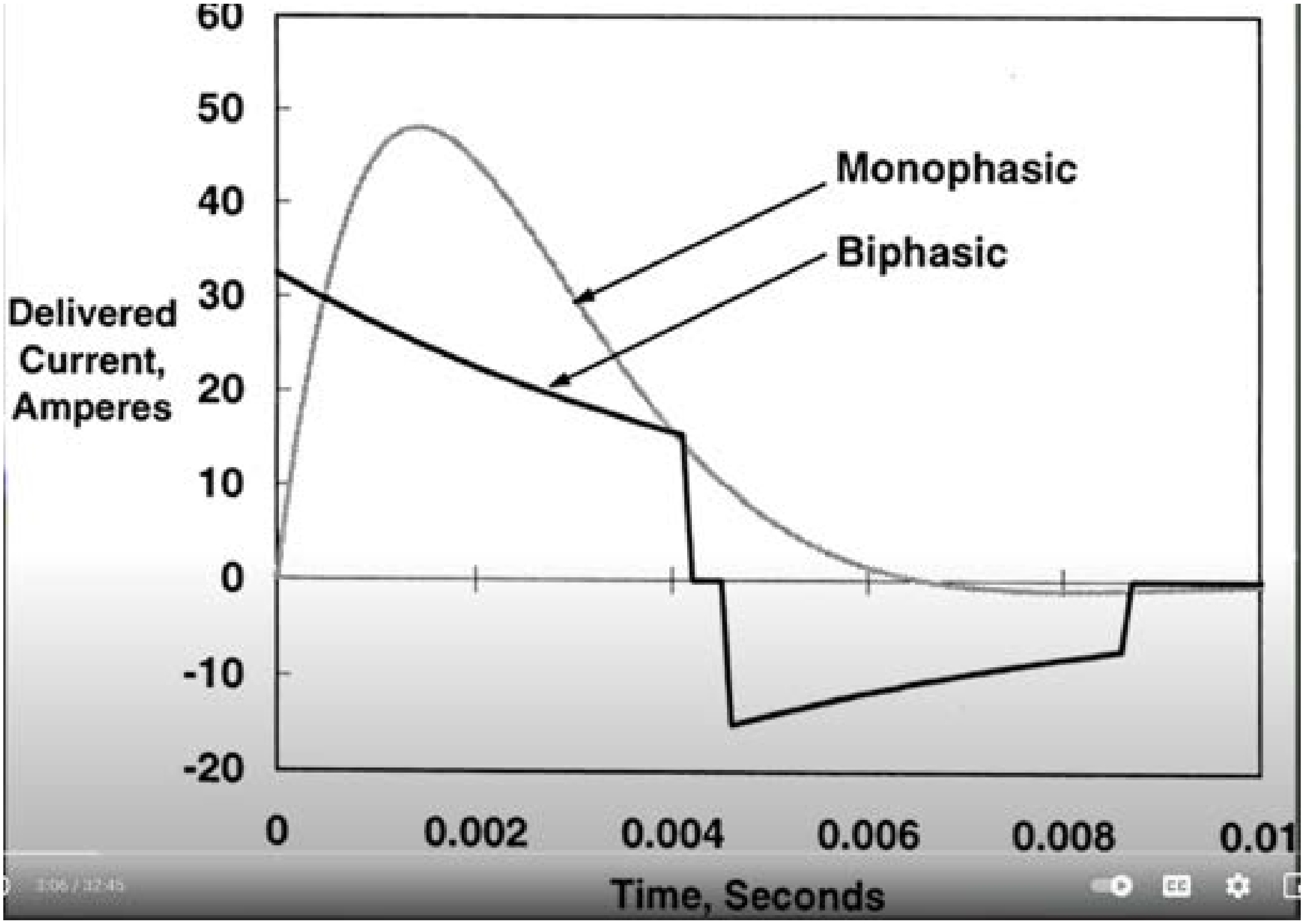
Citation:

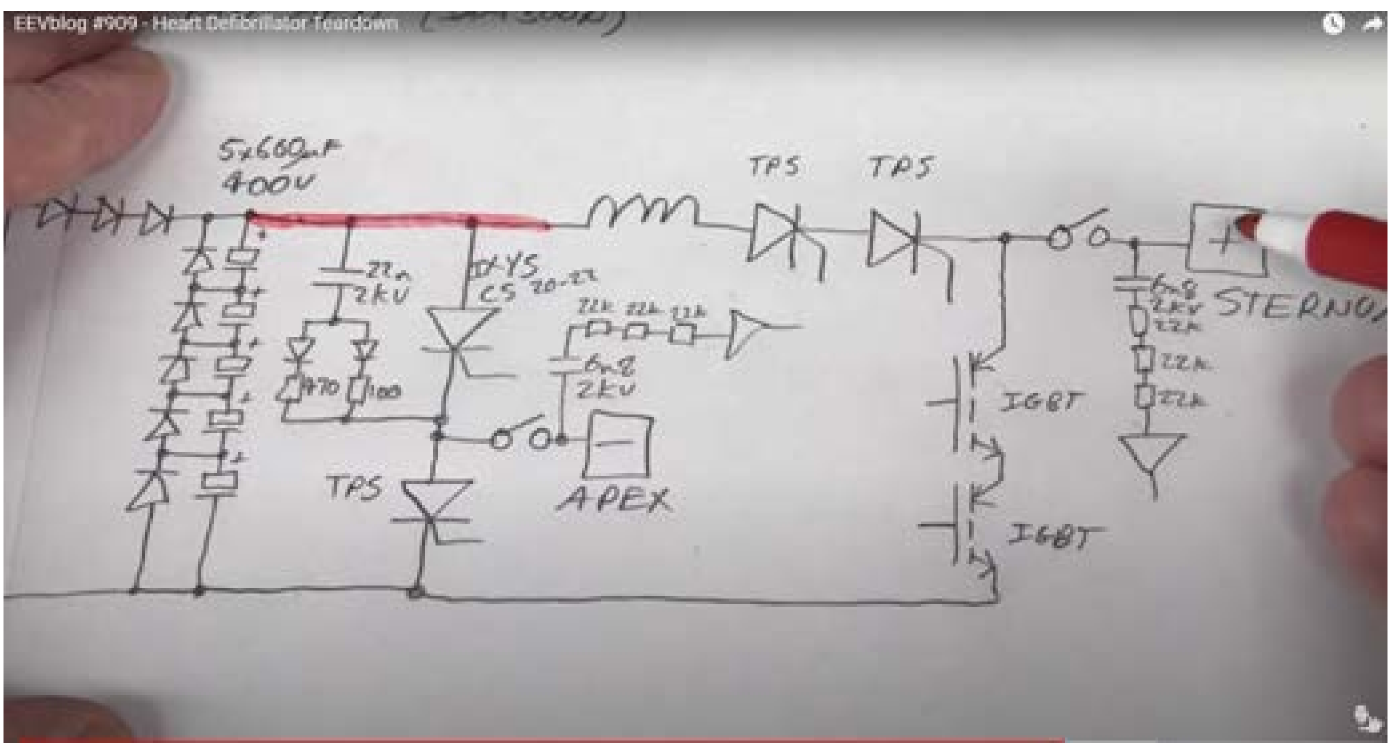
[1] “EEVblog #909 - Heart Defibrillator Teardown,” *www.youtube.com*. https://www.youtube.com/watch?v=n47u2YQytjo (accessed Sep. 15, 2023).
[2] “The circuit elements of a simple defibrillator (practice) | Khan Academy,” *Khan Academy*, 2019. https://www.khanacademy.org/test-prep/mcat/physical-sciences-practice/physical-sciences-practice-tut/e/the-circuit-elements-of-a-simple-defibrillator

Content:

[1] The basic electrical components of defibrillator include, power source (battery), capacitator, inductor, switch, and pads. [2] When the switch is closed to the battery, the capacitor charges to get store enough energy for a 200 joule shock. When the switch is flipped to be open to the pads, the capacitator discharges the current through an inductor to slow the absorption of energy transferred down. [1] The number is about 10 milliseconds of shock. The shock is also biphasic meaning it will pass once through the heart and then be send back around the other way. This is due to the inductor in the circuit. The one taken about in the video contains 5 capacitators in series? Between each capacitator connected in series is a diode to prevent reverse current and explosion. 2,000 volts of capacitator capacity in series.


Biphasic Truncated Exponential
Low Impedance Patients
50
40
30
20
10
0
-10
-20
0
4
8
12
High Impedance Patients
50
40
30
20
10
0
-10
-20
0
4
8
12





Conclusions/action items: I need to learn more about electrical components and how to calculate inductance to crate a biphasic pulse that will deliver 200 joules of energy in 10 milliseconds.

9/14/2023 Electrical Engineering Basics

Nick Johnson - Sep 15, 2023, 1:19 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Electrical Engineering Basics

Date: 9/14/23

Content by: Nick Johnson

Present: N/A

Goals: Learn the basic terms and components of circuits and electrical engineering concepts.

Search Term: "Electrical Engineering Basics"

Link: https://www.youtube.com/playlist?list=PLWv9VM947MKi_7yJ0_FCfzTBXpQU-Qd3K

(I watched all of the videos in the above playlist)

Citation:

[1] “Electrical Engineering Basics - YouTube,” *www.youtube.com*. https://www.youtube.com/playlist?list=PLWv9VM947MKi_7yJ0_FCfzTBXpQU-Qd3K

Content: Basic Electrical Terms:

Voltage: Joules divided by coulombs. Coulombs are a groups of 6.24*(10^18). In other words volts are a measure of energy in a group of electrons in a circuit. Think of water pressure.

Resistance: Resistance is a measure of difficulty to send a current through a portion of a circuit. Measured in Ohms.

Amps (Current): Measure of electrons passing through circuit per second. Ohm's Law Current (I)=Voltage/Resistance.

Resistors restrict current by dissipating it in heat energy usually made of iron wire.

Transistors act as switches by requiring a min voltage usually of 0.7v to start a secondary circuit. PNP and NPN. P less electron semiconductor material. Opposite for N.

Electromechanical relays involve a coil, a magnet, a spring to start a secondary circuit.

Diode: Allows electrons only to pass one way.

Capacitator can hold an electric charged and dissipate it by creating charge imbalance.

Inductor is a coil that applies high value of electric motor force to provide resistance to current, but then apply power to current when power source is stopped. (Stores energy in electric motor force).

Transformers allow voltage to be stepped up or down.

Direct current vs. alternating current. (Exactly what you would think.)

Series vs. parallel: Series current runs one way through a circuit, parallels can run multiple. Series increases resistance and current, but series decreases resistance and keeps same voltage.

Solid state relays often use leads to emit EM radiation and a phototransistor to receive the radiation.

Conclusions/action items: Electrical engineering is complicated and I will need to learn more about it as I stumble through brainstorming circuits that will accomplish the clients needs. Now I will research competing designs.

9/28 Calculating Voltage for Defibrillator

Nick Johnson - Sep 29, 2023, 12:22 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Calculating Voltage for Defibrillator

Date: 9/28

Content by: Nick Johnson

Present: N/A

Goals: Learn about how defibrillators send a certain amount of joules through the body.

Search Term: What voltage do defibrillators run at?

Link: https://www.aedleader.com/how-defibrillator-voltage-works/

Citation:

[1] "The Voltage of a Defibrillator & How Energy Is Delivered," *AEDs for Sale | Buy Defibrillators and Accessories*, Sep. 07, 2022. https://www.aedleader.com/how-defibrillator-voltage-works/

Content: The article explains that once the pads are applied to a person the defibrillator actually calculates how much impendence the person measure to. This allows the defibrillator to know what voltage will be required to obtain the energy setting selected by the doctor. It is stated that the average person has an impendence of about 50 ohms.

Conclusions/action items: Figuring out how to add a part to the circuit that calculates impendence and can deliver the correct voltage to achieve the selected energy level will be the next research item.

10/11/2023 Biphasic Shock Waves within Defibrillator

Nick Johnson - Oct 11, 2023, 7:12 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Biphasic Shock Waves within Defibrillator

Date: 10/11

Content by: Nick Johnson

Present: N/A

Goals: Learn all the components that currently make up the LIFEPAK defibrillator and how they could be affected by us splitting the signals into two separate pads.

Search Term: "How LIFEPAK defibrillator equipment works"

Link: https://www.howequipmentworks.com/defibrillator/

Citation:

[1] prastila, "How defibrillators work explained simply," *How Equipment Works*, 2016. https://www.howequipmentworks.com/defibrillator/

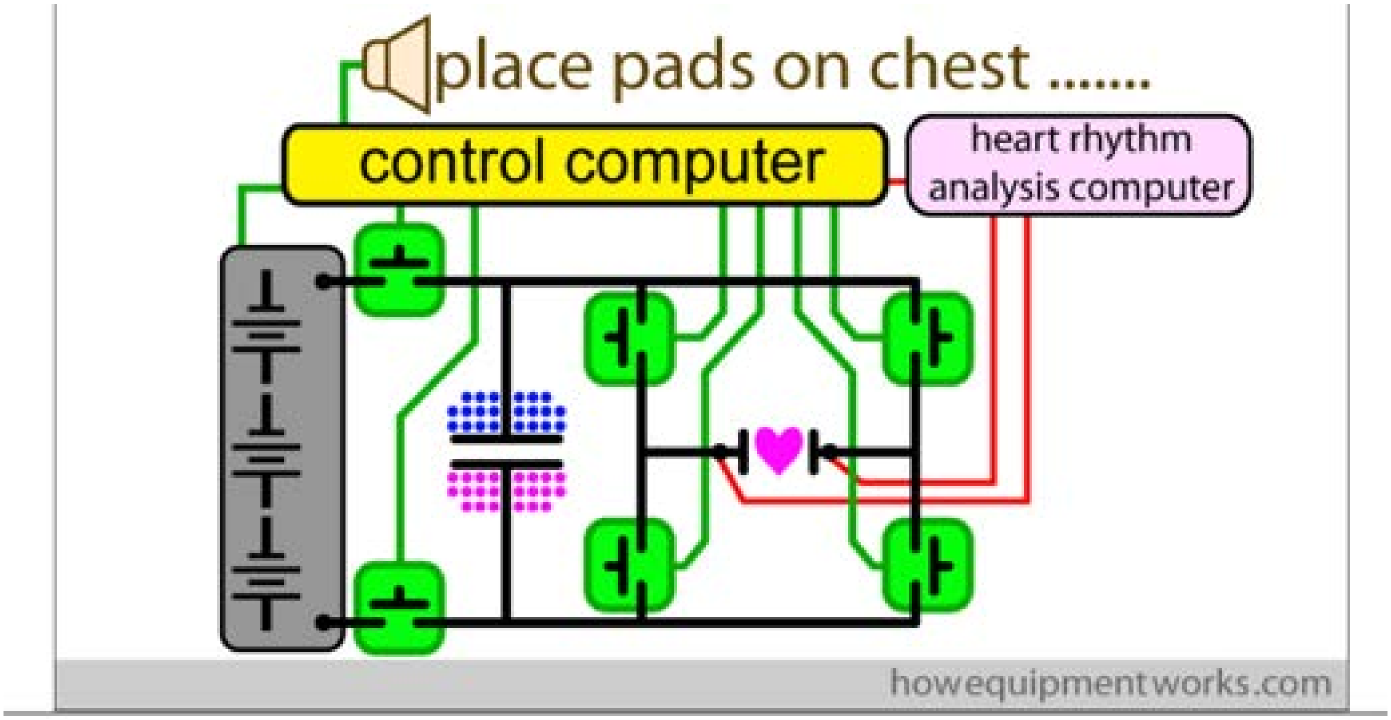
Content:

It is important our team understands all of the additional components that make up the defibrillator besides just the electrical shock itself. There are many other components including, heart rhythm analysis computer, control computer, and data collection that also communicate from the pads to the defibrillator. Since we decided to continue with the Layered Electrode design it is important we know how splitting these signals will affect the communication back to the defibrillator. The first step to doing so is to understand the other various components.

The biggest competent I see a possible issue with is the heart rhythm analysis signal. Since there will be two sets of pads this could definitely be affected by splitting current. However on the Zoll Monitor that Jack and I went to see. We hypothesized that the heart rhythm analysis signals ran through a different set of wires that connected to the pads. This would mean we would need to add a transmitter that does not affect this signal through our design which should be as simple as connecting via wires, as this article defines this signals are sent via electrical wire impulses.

The other thing I thought about when reading this article was impedance calculations from the defibrillator. The way it is explained in the article is when healthcare professionals select joules the defibrillator resets its voltage based on the joules and the current impedance between the two pads. However if we split this circuit into two this would double the impedance because we would have two vectors traveling though the patient instead of one and would therefore likely double the impedance.

However, thinking about it some more I realized this would just increase the voltage even higher which is what we would want in the first place. A maximum of 360 joules could be reached and assuming LIFEPAK monitors have this default setting that will allow them to fire even if the impedance exceeds the value needed for 360 joules, then it should still work.



Conclusions/action items: The next thing I will research is more competing designs on the market currently.

10/11/2023 5 5 5 Timer Research

Nick Johnson - Oct 11, 2023, 7:46 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: 5 5 5 Timer Research

Date: 10/11/23

Content by: Nick Johnson

Present: N/A

Goals: Learn how a 5 5 5 Timer works because it was recommended to me to use by a Professional Electrical Engineer to control the timing between shocks for our Layered Electrode Design.

Search Term: "How a 5 5 5 Timer works"

Link: https://www.build-electronic-circuits.com/how-does-a-555-timer-work/

https://www.youtube.com/watch?v=ABWU7FlM1T0

Citation:

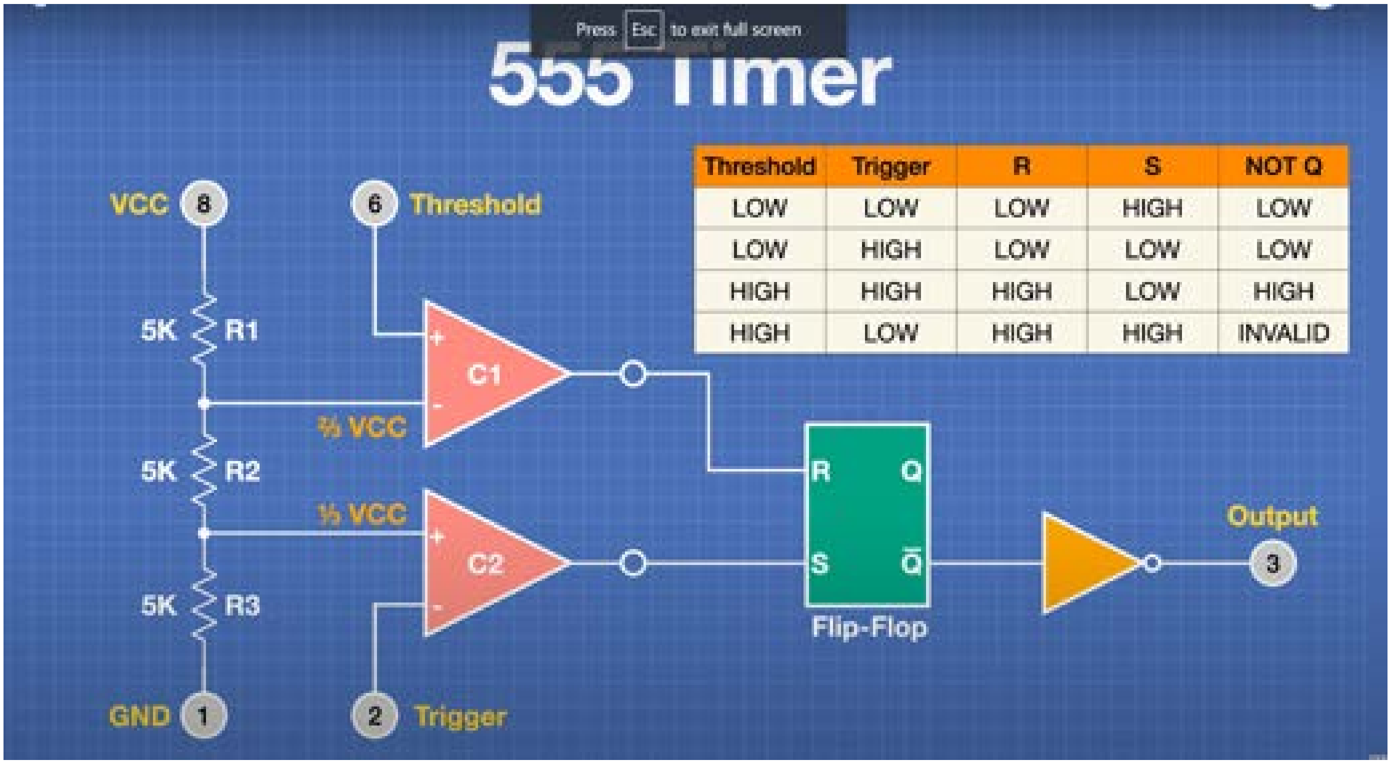
[1] "How Does a 555 Timer Work?," *Build Electronic Circuits*, Jun. 08, 2021. https://www.build-electronic-circuits.com/how-does-a-555-timer-work/

[2] "Using the 555 Timer - YouTube," *www.youtube.com*. https://www.youtube.com/watch?v=ABWU7FlM1T0

Content:

5 5 5 Timer's work through a series of resistors, diodes, and capacitors [1]. The capacitors determine the timing output of the device. This is because the amount of time it takes for a capacitor to discharge is very consistent and is taken advantage to measure time in the 5 5 5 timer.

One problem I see using a 5 5 5 timer with our circuit is that they only work between 4.5 volts and 16 volts [2]. We are planning to run a lot more than 16 volts through our circuit. So we would need the timer integrated in a secondary circuit to communicate with our primary circuit that will carry the high number of volts but not integrated with the primary circuit.



Threshold	Trigger	R	S	NOT Q
LOW	LOW	LOW	HIGH	LOW
LOW	HIGH	LOW	LOW	LOW
HIGH	HIGH	HIGH	LOW	HIGH
HIGH	LOW	HIGH	HIGH	INVALID

Conclusions/action items: My next area of research should be on microcontrollers because these were also recommended to me by the professional electrical engineer. Maybe these would be easier to trigger switches within our circuit based on time better than the 5 5 5 timer.

10/19/2023 Calculating the Capacitance of LIFEPAK

Nick Johnson - Oct 19, 2023, 7:51 PM CDT

Title: Calculating the capacitance of LIFEPAK capacitors

Date: 10/19

Content by: Nick Johnson

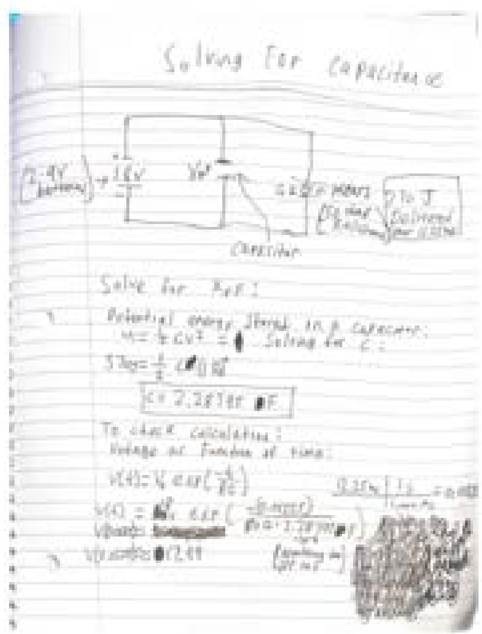
Present: Nick Johnson

Goals: To calculate the capacitance of the existing capacitors used in a LIFEPAK since this information is not located in the manual. By calculating the capacitance we can use that number to calculate the components we will need in our circuit and the change in energy delivered over time which will tells us the amount of time that needs to pass before the microcontroller/timer switches to second vector.

Content: Located in attachment at bottom.

Conclusions/action items: We will need to use this number to calculate the rest of the desired components. We will also need to create tests that we can run on the monitor to determine if our ideal circuit will work and the monitor won't freak out.

Nick Johnson - Oct 19, 2023, 7:54 PM CDT



Download

Solve_for.pdf (372 kB)

10/26/2023 Understanding a Beefcake

Nick Johnson - Oct 27, 2023, 1:12 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Understanding how a Beefcake

Date: 10/26/2023

Content by: Nick Johnson

Present: N/A

Goals: Learn how an Spark Fun Beefcake works

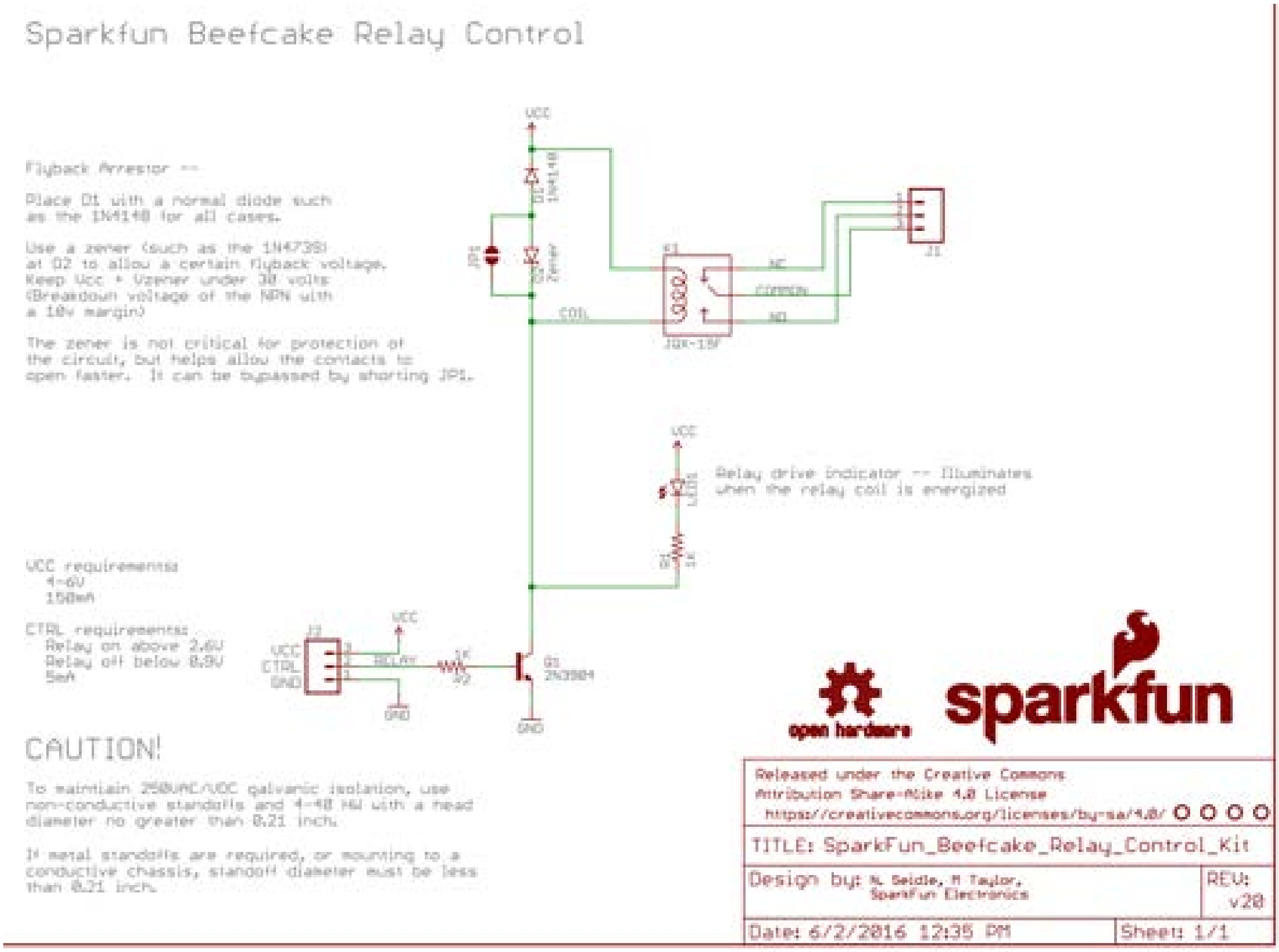
Search Term: "Spark Fun Beefcake Explained"

Link: https://learn.sparkfun.com/tutorials/beefcake-relay-control-hookup-guide/all#example-arduino-control

Citation:

[1] “Beefcake Relay Control Hookup Guide - SparkFun Learn,” *learn.sparkfun.com*. https://learn.sparkfun.com/tutorials/beefcake-relay-control-hookup-guide/all#example-arduino-control (accessed Oct. 27, 2023).

Content: By reading through the beefcake instructions on learn.sparkfun.com I was able to walk away with a deeper understanding of how the beefcake works. For example, I found a circuit diagram of the beefcake:



Reading this circuit diagram there is a low voltage circuit and a high voltage circuit. They are separated by a simple electrotechnical relay. The low voltage circuit will be connected to our Arduino and the high voltage would be connected to the defibrillator. The only thing with the beefcake is it only handles about 250v DC. We calculated the LIFEPAK defibrillator may output as much as 1300v DC. Therefore we will need to find a circuit component with the same qualities as the beefcake but higher DC capacity. If we found something similar to the beefcake would simply program the Arduino to send current after x milliseconds and this would energize the inductor coil which would cause the normally closed circuit to flip to the normally open circuit. The only thing left to figure out is how we will actually go about detecting current in the wire.

Conclusions/action items: Research Beefcake relays with much larger voltage capacity. Also research hall effect and latching relays as well as any other various techniques to detect current in a wire.

11/9/2023 Hall Effect Sensors

Nick Johnson - Nov 09, 2023, 7:40 PM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Hall Effect Sensors

Date: 11/9/2023

Content by: Nick Johnson

Present: N/A

Goals: Learn if a hall effect sensor can be used to control the two set of h-bridges instead of the transistors and opto-isolators recommended to us by John in the Makerspace. The reason I am worried about using transistors and opto-isolators is because it would be a more complex circuit and require large resistors that would be inefficient.

Search Term: "How do Hall Effect Sensors work"

Link: https://www.ti.com/lit/ml/slyt824a/slyt824a.pdf?ts=1699516811147&ref_url=https%253A%252F%252Fwww.google.com%252F

https://www.youtube.com/watch?v=RrQA_-YETJw

Citation:

[1] "Introduction to Hall-Effect Sensors." Accessed: Nov. 10, 2023. [Online]. Available: https://www.ti.com/lit/ml/slyt824a/slyt824a.pdf?ts=1699516811147&ref_url=https%253A%252F%252Fwww.google.com%252F

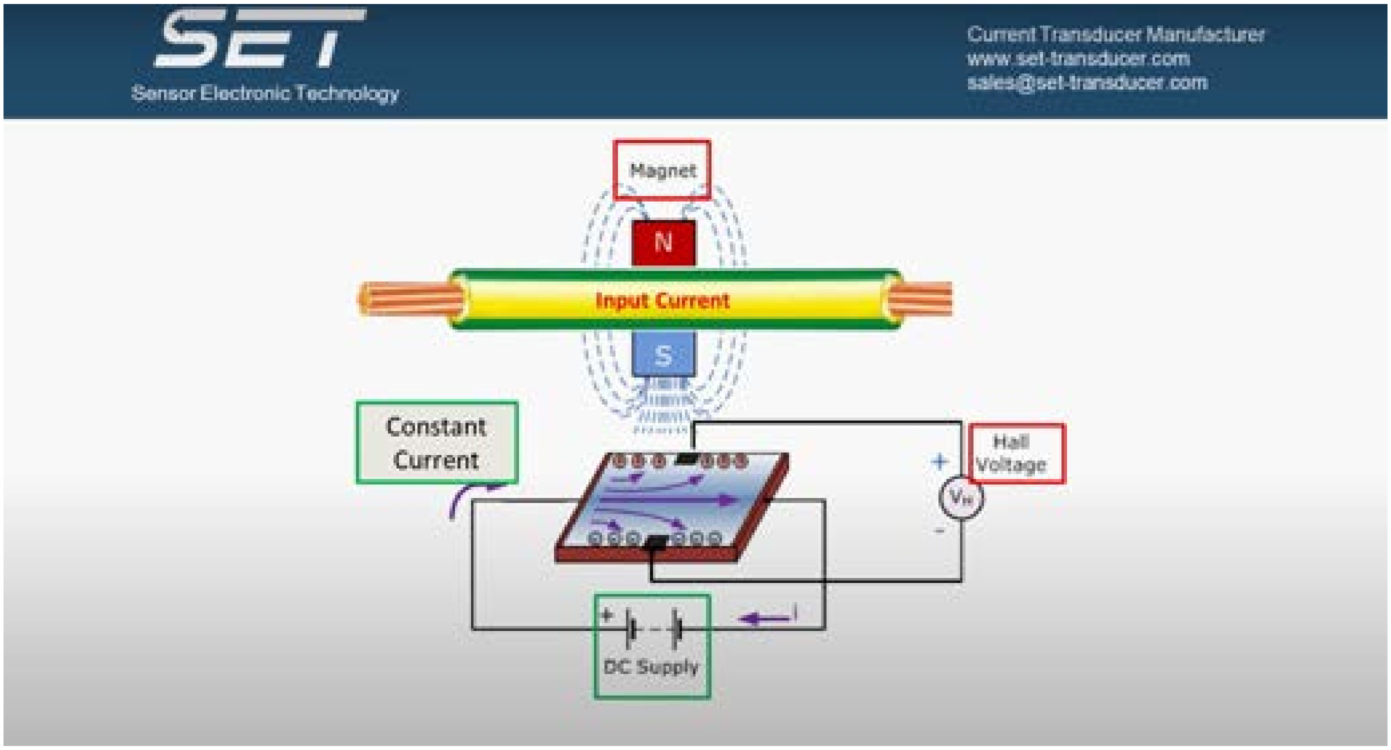
[2] "How Hall Effect Current Transducer Works," *www.youtube.com*. https://www.youtube.com/watch?v=RrQA_-YETJw (accessed Nov. 09, 2023).

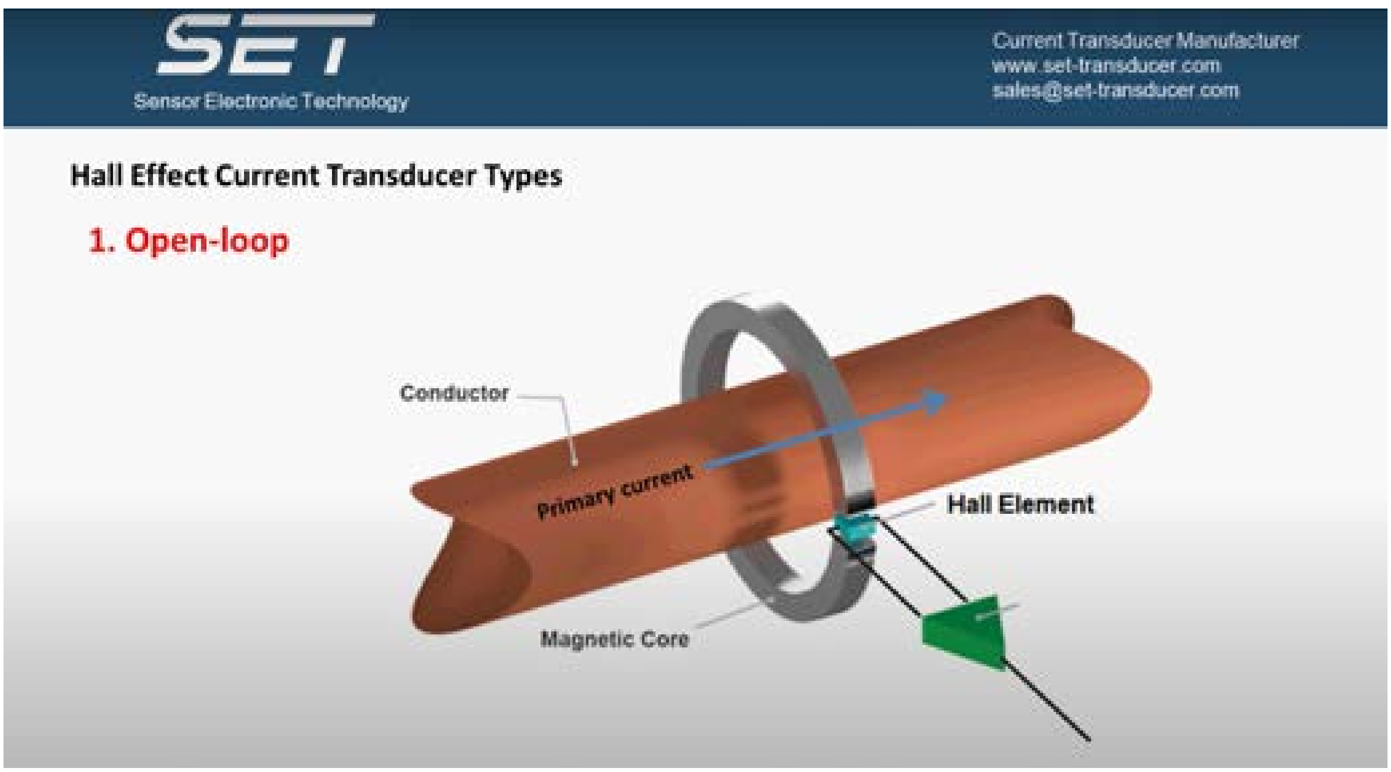
Content:

Basic of a hall effect sensor: A hall effect sensor is used to detect an change in magnetic field. This is achieved by using a semiconductor plate in which current is passed through. When an magnetic field interacts with the plate it will deflect the current in the plate which causes a voltage difference across the plate. This voltage difference then triggers current to run through a separate circuit.

Could this be used in our project: It is possible that we could use a hall effect sensor. However in order for the hall effect sensor to detect current in the defibrillator wire we might need to amplify the magnetic field produced by this wire. We would do this by using a modular design which wraps a high polarizing metal around the wire which amplifies the magnetic field. One challenge of using a hall effect sensor would be getting within the range of magnetic field force using the input current. Texas Instruments cites, "Wide voltage range: Hall-effect sensors can provide wide voltage ranges, sometimes from 1.65 V to 5.5 V, allowing for low-power applications. Additionally, for automotive applications that can require a high voltage range, we offer products that are as high as 38 V." However, it does not specify if this is the input voltage or the output hall effect sensor circuit. [1]

[2]


SET
Sensor Electronic Technology
Current Transducer Manufacturer
www.set-transducer.com
sales@set-transducer.com
Magnet
N
Input Current
S
Constant Current
Hall Voltage
+
-
DC Supply


SET
Sensor Electronic Technology
Current Transducer Manufacturer
www.set-transducer.com
sales@set-transducer.com
Hall Effect Current Transducer Types
1. Open-loop
Conductor
Primary current
Hall Element
Magnetic Core

Hall Effect Current Transducer Types

1. Open-loop

Advantages

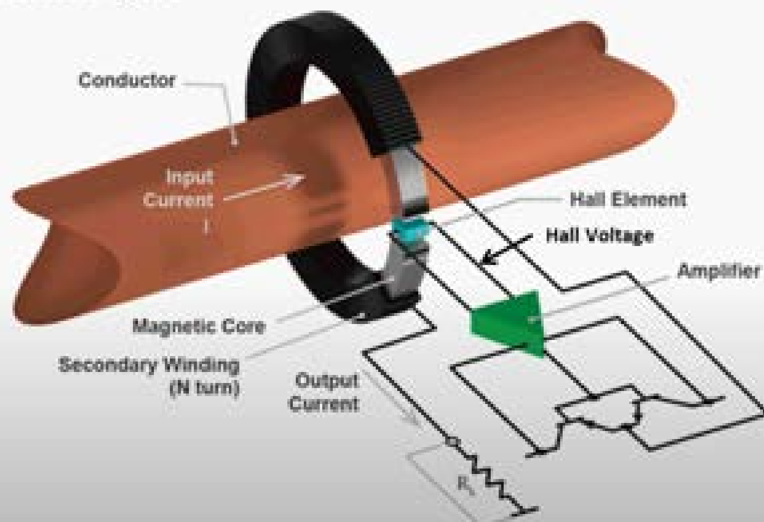
a. Simple Circuit
b. Low Cost
c. High Energy Efficiency
d. Wide Sensing Range
e. Low Power Consumption

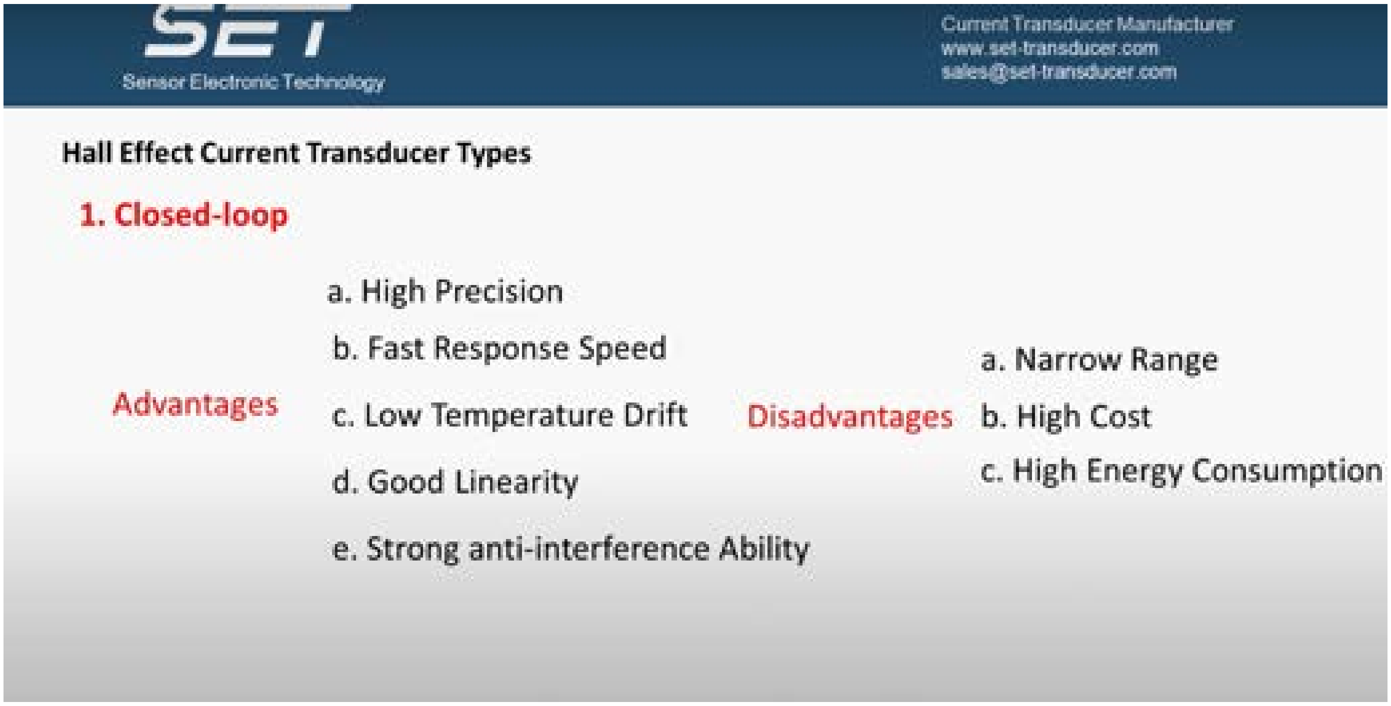
Disadvantages

a. Poor Accuracy
b. Poor Linearity
c. Slow Response Speed
d. Large Temperature Drift

Hall Effect Current Transducer Types

1. Closed-loop





Conclusions/action items: I think I will meet with John Lombardo in the Makerspace again now that I have more background knowledge on the design idea he proposed and I will get to a concrete circuit I can then bring to the team with numbers and values.

11/9/2023 Using Transistors to Control H-Bridges

Nick Johnson - Nov 09, 2023, 7:38 PM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Using Transistors to Control H-Bridges

Date: 11/9/2023

Content by: Nick Johnson

Present: N/A

Goals: Learn how transistors and an Arduino can be used to control an H-Bridge.

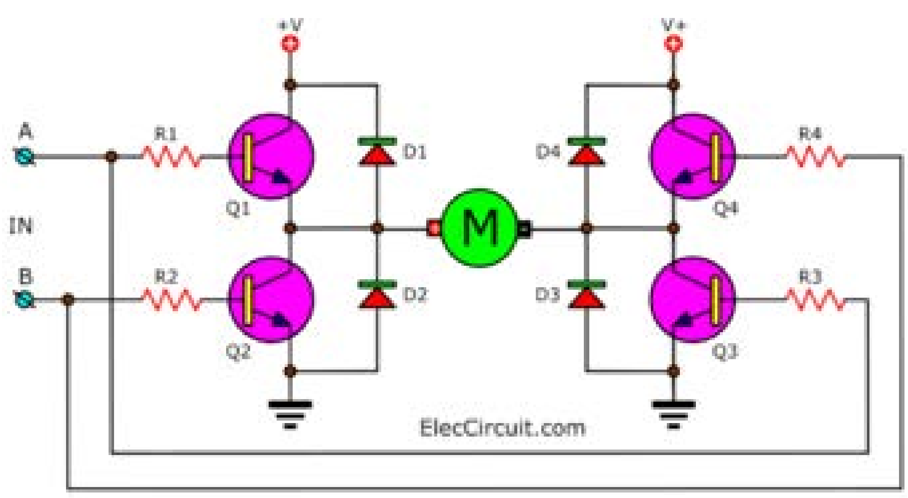
Search Term: Using Transistors to Control an H-Bridge

Link: https://www.eleccircuit.com/basic-h-bridge-motor-driver-by-bipolar-transistor/

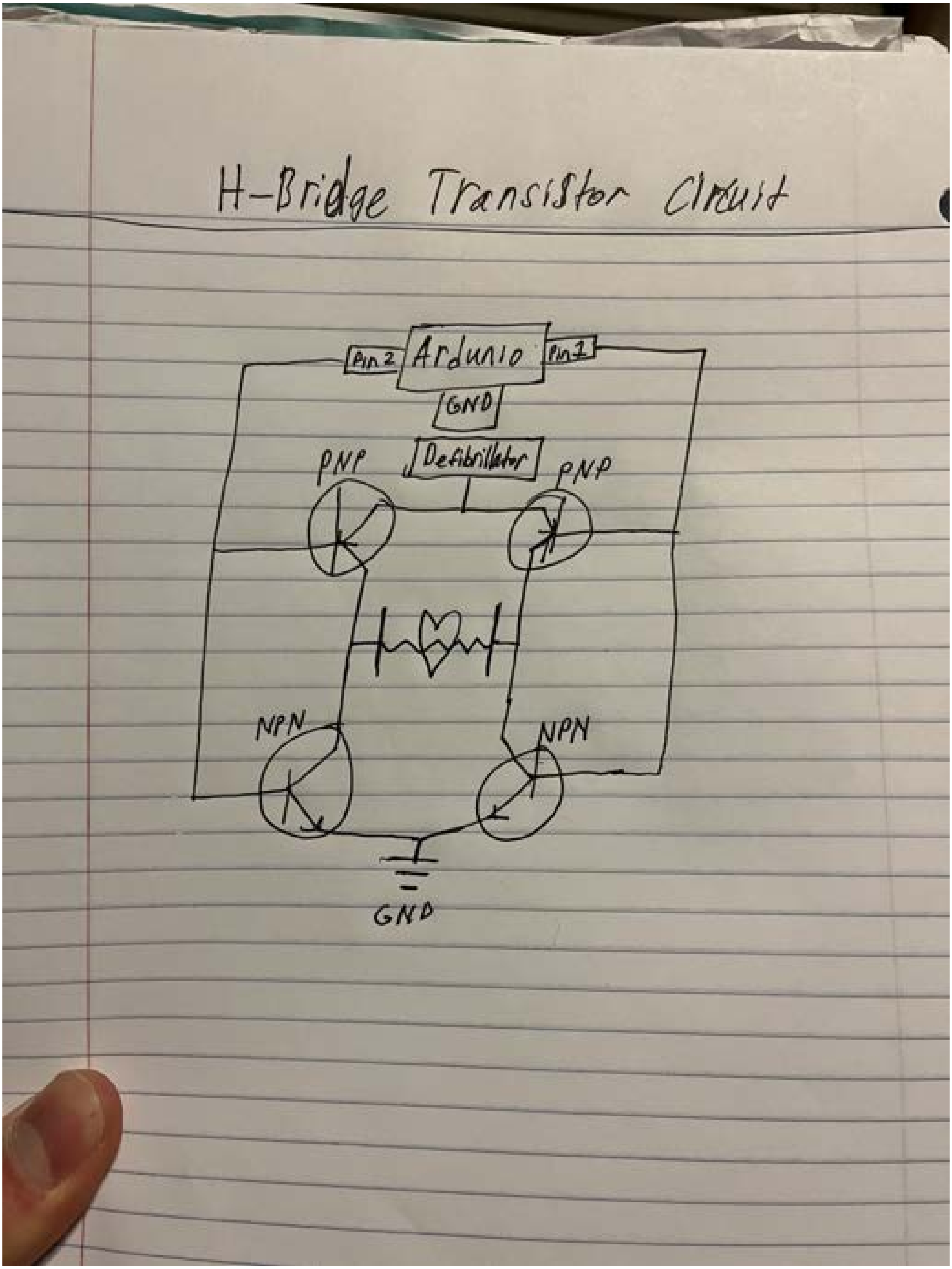
Citation:

[1] "Basic H-bridge motor driver circuit using bipolar transistor," *ElecCircuit.com*, Feb. 23, 2020. https://www.eleccircuit.com/basic-h-bridge-motor-driver-by-bipolar-transistor/

Content: In order to control an H-Bridge with transistors and an Arduino, we will need two NPN transistors and two PNP transistors. The difference between the two is that PNP transistors are on when a low voltage is sent to the base pin and off during a high voltage. And for NPN transistors they are on during high voltage and off during low voltage. Using two of each will allow us to control four total switches and therefore the H-Bridge. First of all we will connect two separate pins on the Arduino as outputs. They will each run into a circuit with connected to one NPN and one PNP. By changing which analog on the Arduino contains the high voltage and which contains the low voltage we can therefore flip both transistors to be either on or off at the same time. This will run current the opposite way when they switch. This can be seen in the following diagram:



Here is a simplified version of the circuit I drew:



Conclusions/action items: We will need to meet as a team to discuss if we plan adding H-Bridges controlled by transistors into our circuit or first fabricating our circuit with our diode design and then adding them in add the end.

9/16 Meeting with Jack

Nick Johnson - Sep 23, 2023, 10:56 AM CDT

Title: Zoll Monitor Videos

Date: 9/16

Content by: Nick Johnson

Present: Nick and Jack

Goals: Jack drove me to Belville to his ambulance station to look at the Zoll monitor and gather information as well as pick up an expired pair of pads. The goal is to see the current defibrillator and see how our device would be compatible with the Zoll Monitor.

Content: See below for the videos I took.

References: N/A

Conclusions: We concluded form the information we gathered, there are 4 distinct parts to the manual Zoll Defibrillator.

1. The Monitor itself: This is the part that displays all the information and outputs the charge and does all computations.

2. There is a cord that connects to the Zoll monitor then connects to the converter which is a gray piece.

3. The converter converts the data circuit from the pads into current that is readable by the monitor. It also transmits the shock current from the monitor to the pads.

4. The pads deliver the shock to the patient. They also have a little block that sticks onto the patient to monitor heart rhythm and various other vitals.

Action items: My next action item would be to fully understand how Biphasic current works.

Nick Johnson - Sep 23, 2023, 10:51 AM CDT

Download

IMG_4753_2_.MOV (502 MB)

Nick Johnson - Sep 23, 2023, 10:51 AM CDT

Download

IMG_4755.MOV (112 MB)

Nick Johnson - Sep 23, 2023, 10:51 AM CDT

Download

IMG_4756_1_.MOV (47.6 MB)

Nick Johnson - Sep 23, 2023, 10:51 AM CDT

Download

IMG_4754.MOV (32.4 MB)

9/13/2023 Client Meeting Notes-Nick Johnson

Nick Johnson - Sep 15, 2023, 1:50 AM CDT

Title: Client Meeting Notes

Date: 9/13

Content by: Nick Johnson

Present: Whole group and client

Goals: Write down important concepts that the client is stressing. Also make sure to document the clients needs, budget, and suggested ideas.

Content:

Client Meeting Notes 9/13/23

Nick Johnson

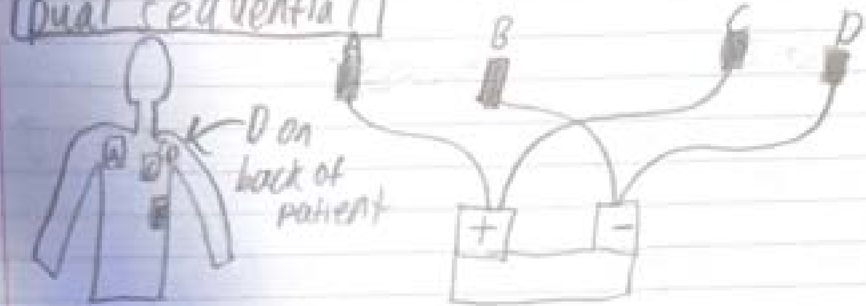
200 J each

Budget = $500 (can expand if needed)

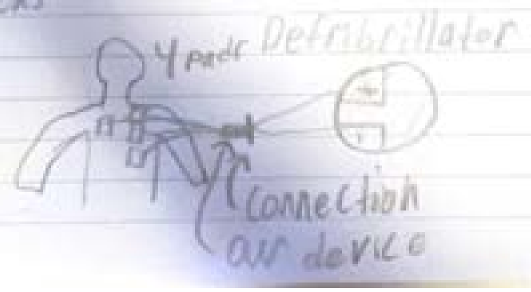
Energy ?

- Ability to change vector.

Dual sequential



- Most likely need two batteries otherwise current might not reach heart as seen in the diagram above.
- Need retired model to modify and work on.
- Tempest = new monitor built into two devices, might have a secondary power source.
- Number shocks until Dual sequential kicks in: 3-4 shocks



Conclusions/action items: Now that we have good information from the client on the real task at hand it is time to research and learn everything there is to know about circuits.

9/14/2023 Brainstorm 1 - Nick Johnson

Nick Johnson - Sep 15, 2023, 1:51 AM CDT

Title: Preliminary Brainstorming

Date: 9/14

Content by: Nick Johnson

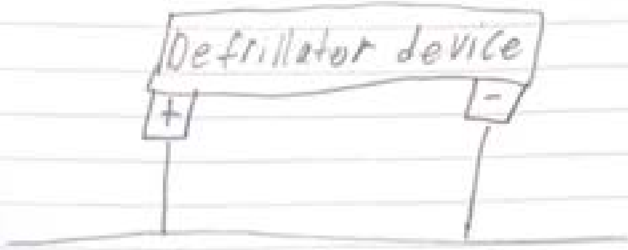
Present: N/A

Goals: Start mind mapping and getting to the core challenges of this problem the client tasked for us.

Content:

9/14/23

Preliminary Brain Storming



connector

Detects current
coil creates
Magnetic field which
turns switch to field off while
Simultaneously ~~comm~~ completing
ciruit for Dual D-fib which
charges capcitator. (Reset button required)

Switch for dual D-fib can be
selected and current will run through
resistor circuit to trigger release
of capcitor energy in sequence with
device.

Need to find way for $\boxed{\text{circuit to circuit communication}}$

Solid State relays?

Latching relays?

Conclusions/action items: Now that I have a good understanding of the core challenges with this circuit are, I would like to bring these to the group and brainstorm with them.

9/27 Biphasic Circuit

Nick Johnson - Sep 29, 2023, 12:03 AM CDT

Title: Biphasic Circuit Deign

Date: 9/27

Content by: Nick Johnson

Present: Nick Johnson

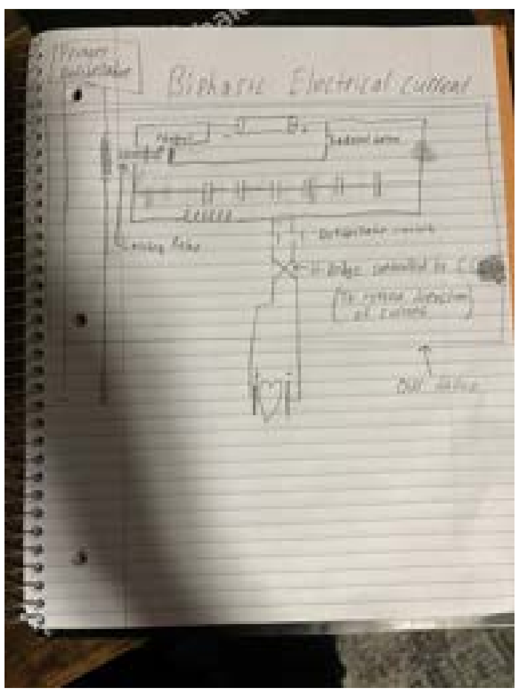
Goals: Create a biphasic circuit design capable of communicating with primary defibrillator to produce a second shock for DSD.

Content:

See below for drawing.

Conclusions/action items: We will have to research how complicated it would be to have the circuit calculate impedance and adjust for voltage to be able to send the correct number of joules through the person.

Nick Johnson - Sep 29, 2023, 12:09 AM CDT



Download

thumbnail_IMG_4799.jpg (534 kB)

10/3/2023 Modular Shock Circuit Design

Nick Johnson - Oct 03, 2023, 9:03 PM CDT

Title: Modular Shock Circuit Design

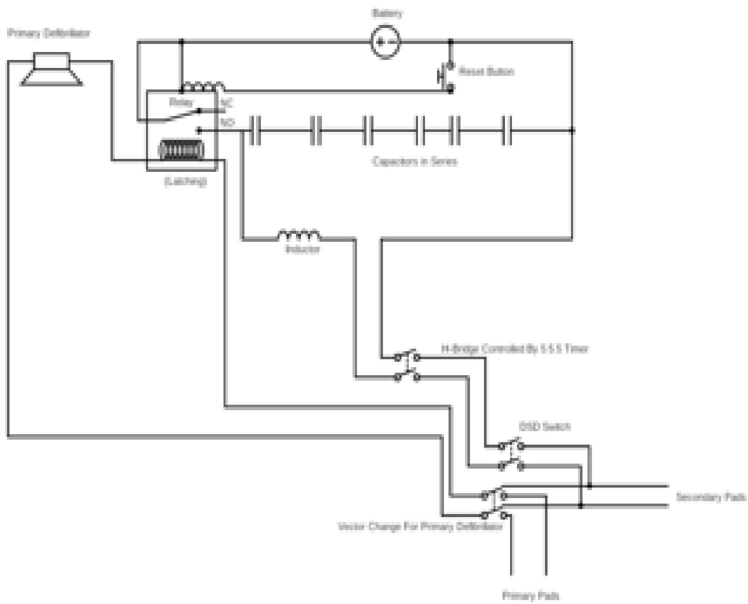
Date: 10/3

Content by: Nick Johnson

Present: Nick Johnson

Goals: Create an electronic mock up of a biphasic circuit integrated with one defibrillator.

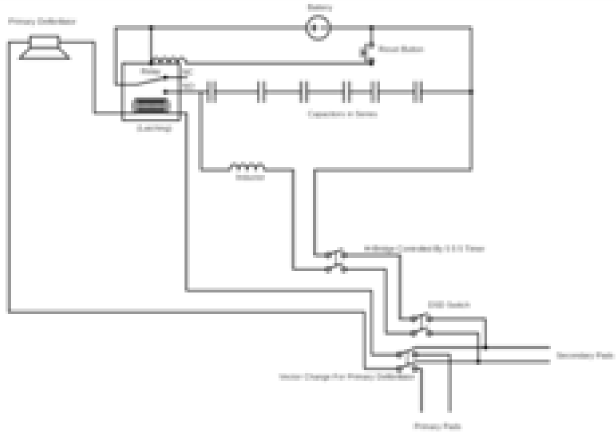
Content:



Conclusions/action items:

I will need to calculate exact values if we end up going with design.

Nick Johnson - Oct 03, 2023, 9:04 PM CDT



Download

Screenshot_2023-10-02_204834.png (65.7 kB)

10/3/2023 Layered Electrode Circuit Design Mock Up

Nick Johnson - Oct 03, 2023, 9:47 PM CDT

Title: Layered Electrode Circuit Design Mock Up

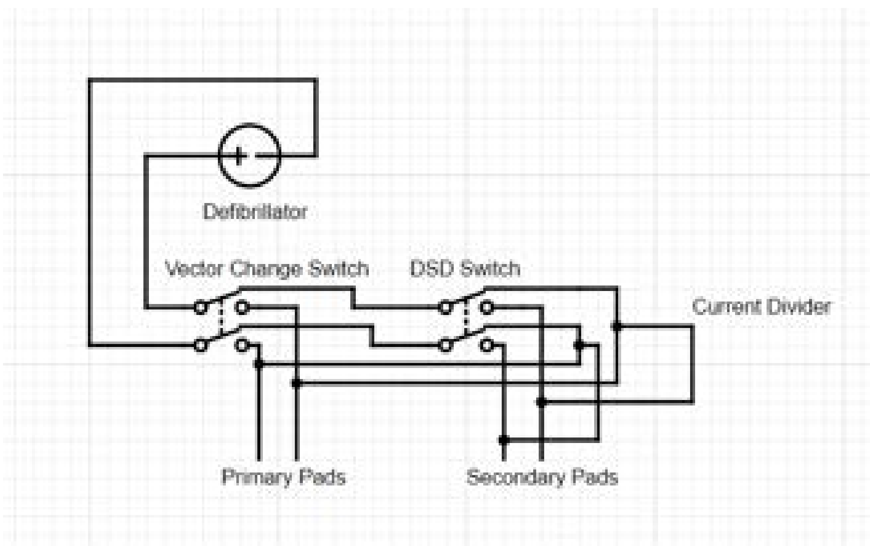
Date: 10/3

Content by: Nick Johnson

Present: Nick Johnson

Goals: Create an electronic mock up of a biphasic circuit integrated with one defibrillator.

Content:

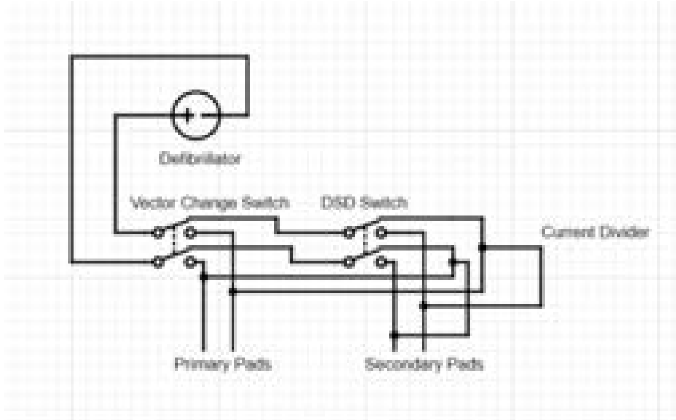


- Primary Pads: Vector Change Switch Closed, DSD Switch Closed.
- Secondary Pads: Vector Change Switch Open, DSD Switch Closed.
- DSD: Vector Change Switch Open, DSD Switch Open.

Conclusions/action items:

I will need to calculate exact values if we end up going with the design.

Nick Johnson - Oct 03, 2023, 9:14 PM CDT



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10/27/2023 Small Scale Microcontroller Design

Nick Johnson - Oct 27, 2023, 1:19 AM CDT

Title: Small Scale Microcontroller Design

Date: 10/27/23

Content by: Daisy and I

Present: Daisy and I

Goals: Begin fabricating a small scale version of our final prototype that highlights our design concept that can be presented at show and tell.

Content: The following is a small circuit that Daisy and I created to showcase how we will integrate the beefcake and Arduino into our electrical circuit design.

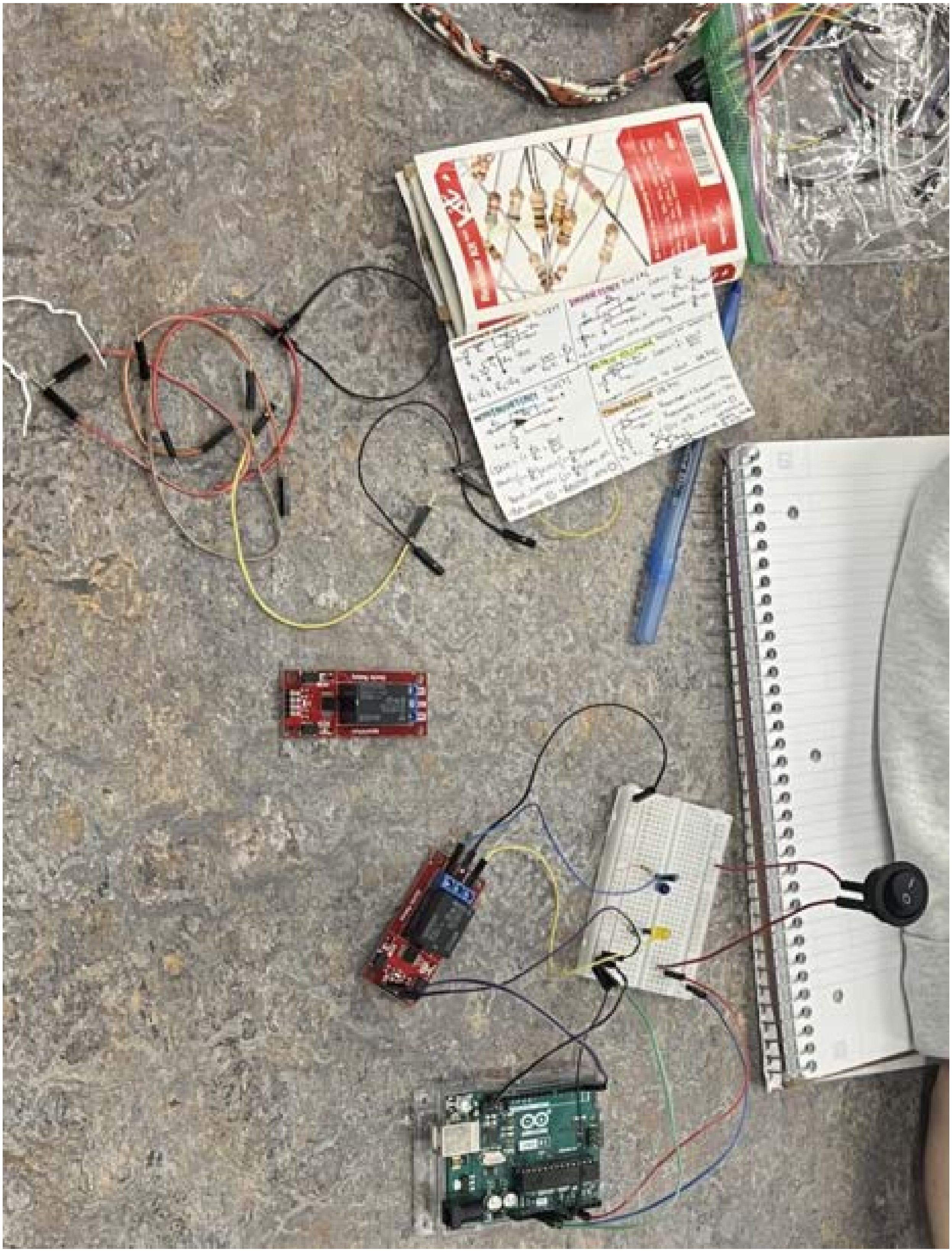


Image Caption

Conclusions/action items: We will need to test this circuit and get it prepared for show and tell to highlight the key components of our electric circuit design.

10/30/23 John Lombardo Meeting in Makerspace

Nick Johnson - Nov 02, 2023, 12:30 PM CDT

Title: John Lombardo Meeting in the Makerspace

Date: 11/2/2023

Content by: John Lombardo

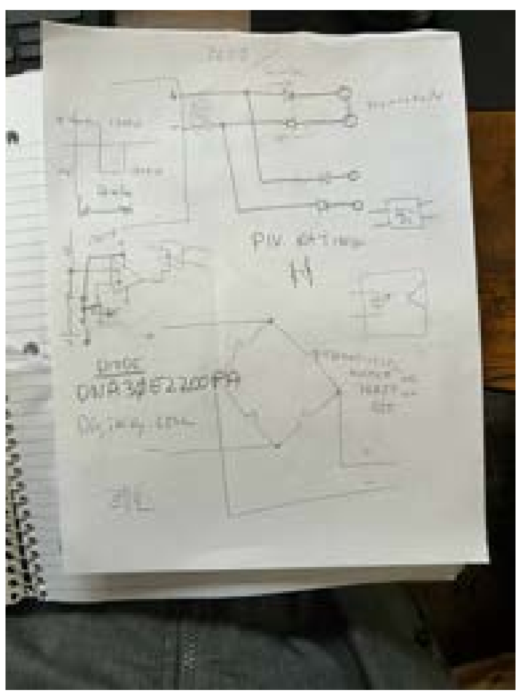
Present: Daisy, Myself, John

Goals: Discuss project with John who is an expert in electrical components since he was an electrical engineer.

Content: See below for drawings. John helped us to come up with our current circuit idea. This involves using four diodes to direct current through one vector when the defibrillator is in its first phase of shock and then when the defibrillator is in the second phase of its shock the current will be diverted through the other two diodes and through the other vector. This will create two monophasic shocks thorough each vector. The only thing left is to create a system of two H-Bridges beyond the diodes to convert each shock into biphasic shocks.

Conclusions/action items: I will need to work with the Makerspace in order to design an H-Bridge system in order to convert these two monophasic shocks to biphasic.

Nick Johnson - Nov 02, 2023, 12:32 PM CDT



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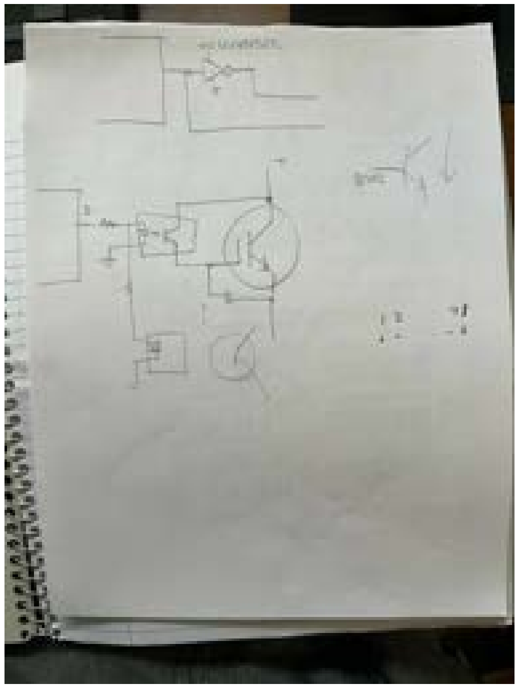
Nick Johnson - Nov 02, 2023, 12:32 PM CDT



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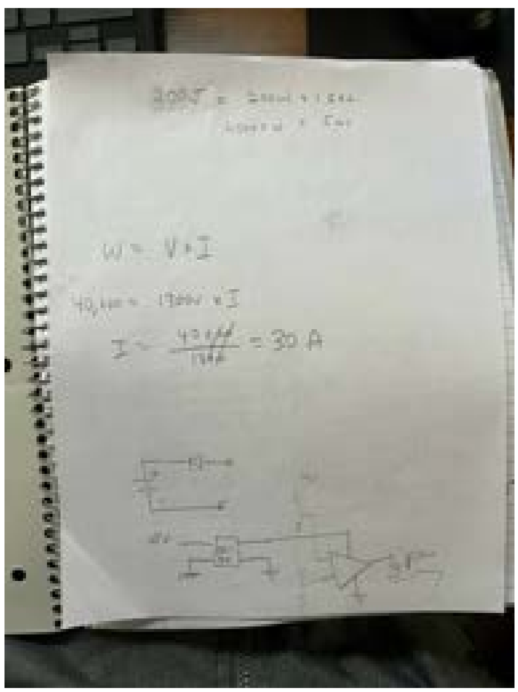
Nick Johnson - Nov 02, 2023, 12:32 PM CDT



Download

thumbnail_image0.jpg (428 kB)

11/1/2023 Diode Show and Tell Circuit

Nick Johnson - Nov 02, 2023, 12:55 PM CDT

Title: Diode Show and Tell Circuit

Date: 11/1/2023

Content by: Daisy and Myself

Present: Daisy and Myself

Goals: Create a working circuit on a breadboard that uses the diode design we talked about with John Lombardo to convert a biphasic shock from the defibrillator into two separate

Content: See below for the video. In the video we show a breadboard with two LEDs and resistors between sets of diodes. The sets of diodes are positioned in opposite directions compared to one another. One will let the positive to negative through from the power source and the other will let the negative to positive direction from the power source through. We then hooked it up to an AC power source which we set the period to be period to be one full second and the amplitude voltage to be 20v. This meant that the voltage would oscillate between -10v and positives 10v. This allowed us to see the LEDs light up alternating for a half second. This shows on a small scale that a biphasic wave form can be converted into two separate monophasic wave forms via diodes.

Conclusions/action items: The next step is adding two H-Bridges to the circuit to convert the two monophasic shocks into two biphasic shocks. This will give us our desired two biphasic shocks the client wants.

Nick Johnson - Nov 02, 2023, 12:56 PM CDT

Download

Video.mov (873 kB)

11/9/2023 H-Bridge Transistor Arduino Circuit

Nick Johnson - Nov 09, 2023, 7:43 PM CST

Title: H-Bridge Transistor Arduino Circuit

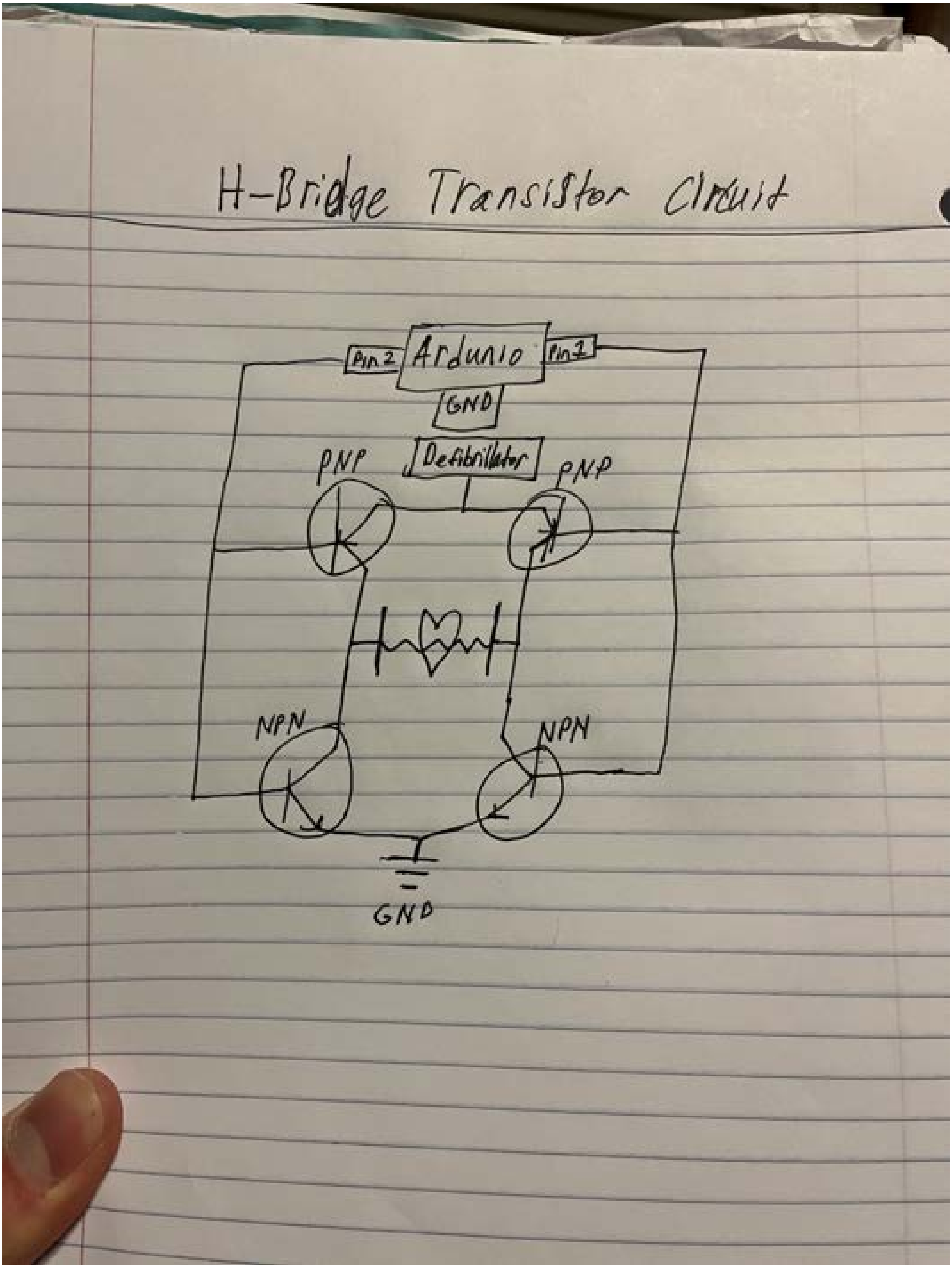
Date: 11/9/2023

Content by: Nick Johnson

Present: Nick Johnson

Goals: Diagram and understand how to control and H-Bridge with an Arduino using transistors.

Content:


H-Bridge Transistor Circuit
Pin 2
Arduino
Pin 1
GND
Defibrillator
PNP
PNP
NPN
NPN
GND

Conclusions/action items: Now that I have more background knowledge on how to control and H-Bridge I can begin creating a circuit that I can propose to the team to fabricate.

11/30 Future Work Design Idea

Nick Johnson - Nov 30, 2023, 9:19 PM CST

Title: Future Work Design Idea

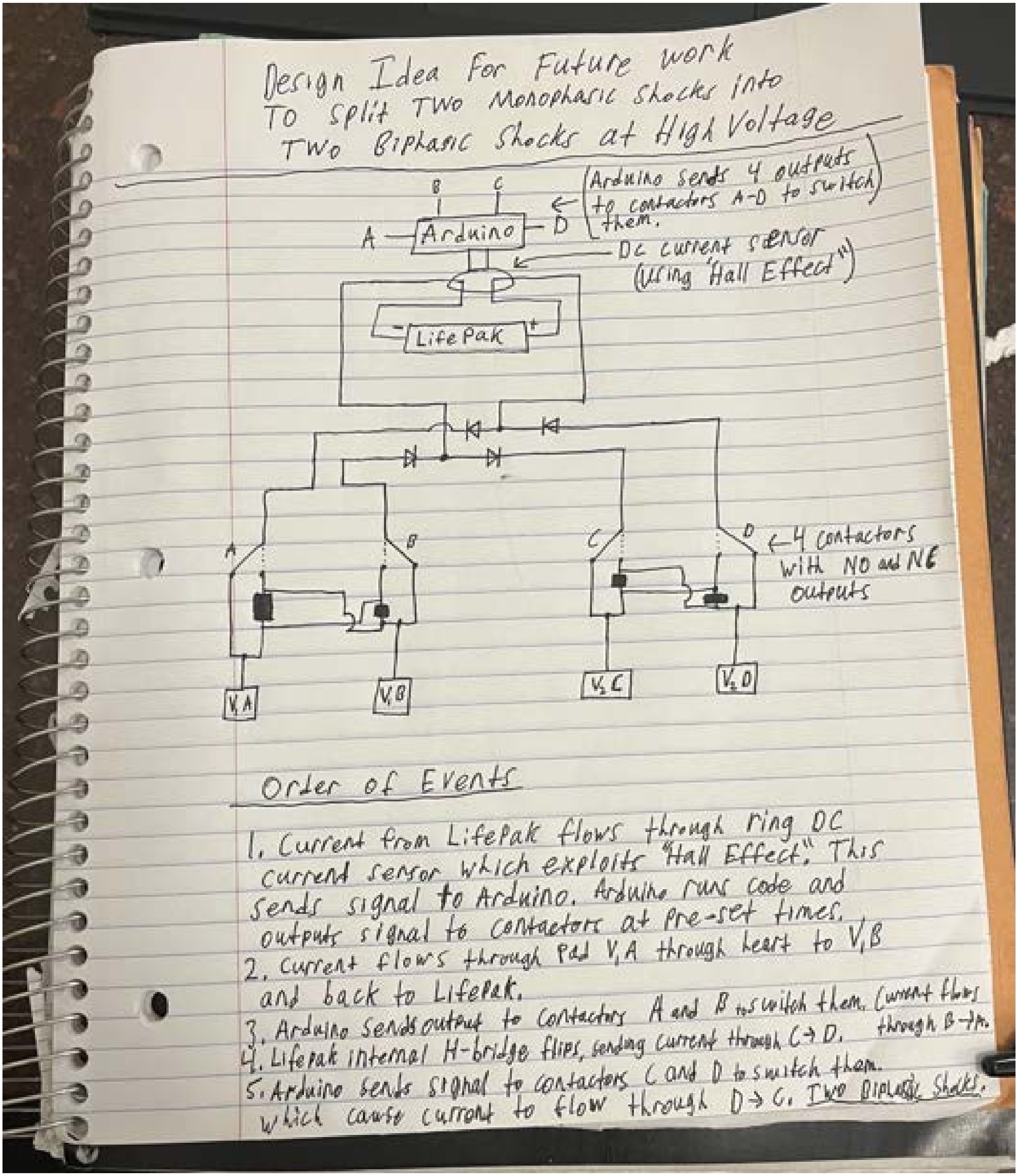
Date: 11/20/2023

Content by: Nick Johnson

Present: Nick Johnson

Goals: Create a circuit that can split two monophasic shocks into two biphasic shocks.

Content: See circuit below:



Conclusions/action items: Further research on contactors and getting the fastest possible contactors would need to be done. According to the website: https://www.wevolver.com/article/contactor-vs-relay-electrically-operated-switches-understanding-the-differences the fastest contactors on the market switch at a speeds of 20ms-250ms. This is not fast enough as the total range of the entire shock delivered by the LifePak is 12.25ms. So based on this source contactors would not switch fast enough. Further research on how H-Bridges inside defibrillators like the LifePak are able to handle such high voltage would need to done. If not contactors or relays or transistors then what is being used in order to carry such a high voltage.

9/22 Meeting Notes

Nick Johnson - Sep 22, 2023, 10:25 AM CDT

Title: Meeting Notes 9/22

Date: 9/22

Content by: Nick Johnson

Present: Whole Group

Goals: Meet with group to discuss design ideas and discuss possibilities.

Content:

Our ordinal leading idea was to connect two monitors to an adapter. The adapter would allow for circuit to circuit communication via a latching relay. We would then use time delays to set the time between the shocks through different vectors. However, I pointed out that the problem with this design is that latching and time delay relays work based on completing circuits and without the circuit completed from the defibrillator and back, the defibrillator will think the pads are not fully on the patient and will not discharge the shock from the capacitors. Dealing with this obstacle we came up with three new ideas.

Proposed ideas:

1. Jack came up with a great idea. He said to there is a third brand of monitor that actually has the shock circuit piece separate from the monitor piece. If we purchased the shock portion we would be able to wire it so that we could have the manual defibrillator and this shock portion in sync through circuitry that would allow for dual sequential defibrillation and vector change. And we wouldn't have to worry about creating a biphasic shock that delivers 200J ourselves since it is in the device we would modify. The only problem with this is we believe this device would cost $10,000. However we could create a circuit that proves this design would work even without the device.

2. Maribel proposed an idea to just create a connector piece that plugs into two sets of pads and two defibrillators. This would allow for an LED light to be timed so that the second operator would know when to press the second shock button. The connector would also allow vector change via a switch.

3. Jack also proposed an idea where we have two sets of pads where a pad from each set is connected via an adhesive. This would decrease room for error when medical professionals place pads on patient. It would also allow pads to be run through a single set of wires back to the connector instead of two.

4. My idea is to create a connector that would actually create a biphasic shock itself and this would allow for us to get all of the necessary design requirements given to us from the client. However this is a very complex task to create biphasic current. However I have an electrical engineer contact that would be very beneficial.

Conclusions/action items: Research biphasic current and how to produce that within a circuit. Meet with my electrical engineering contact this weekend and discuss possibilities. Then get back to the team with the new knowledge I have.

11/30 Fabrication Work

Nick Johnson - Nov 30, 2023, 9:26 PM CST

Title: Fabrication Work

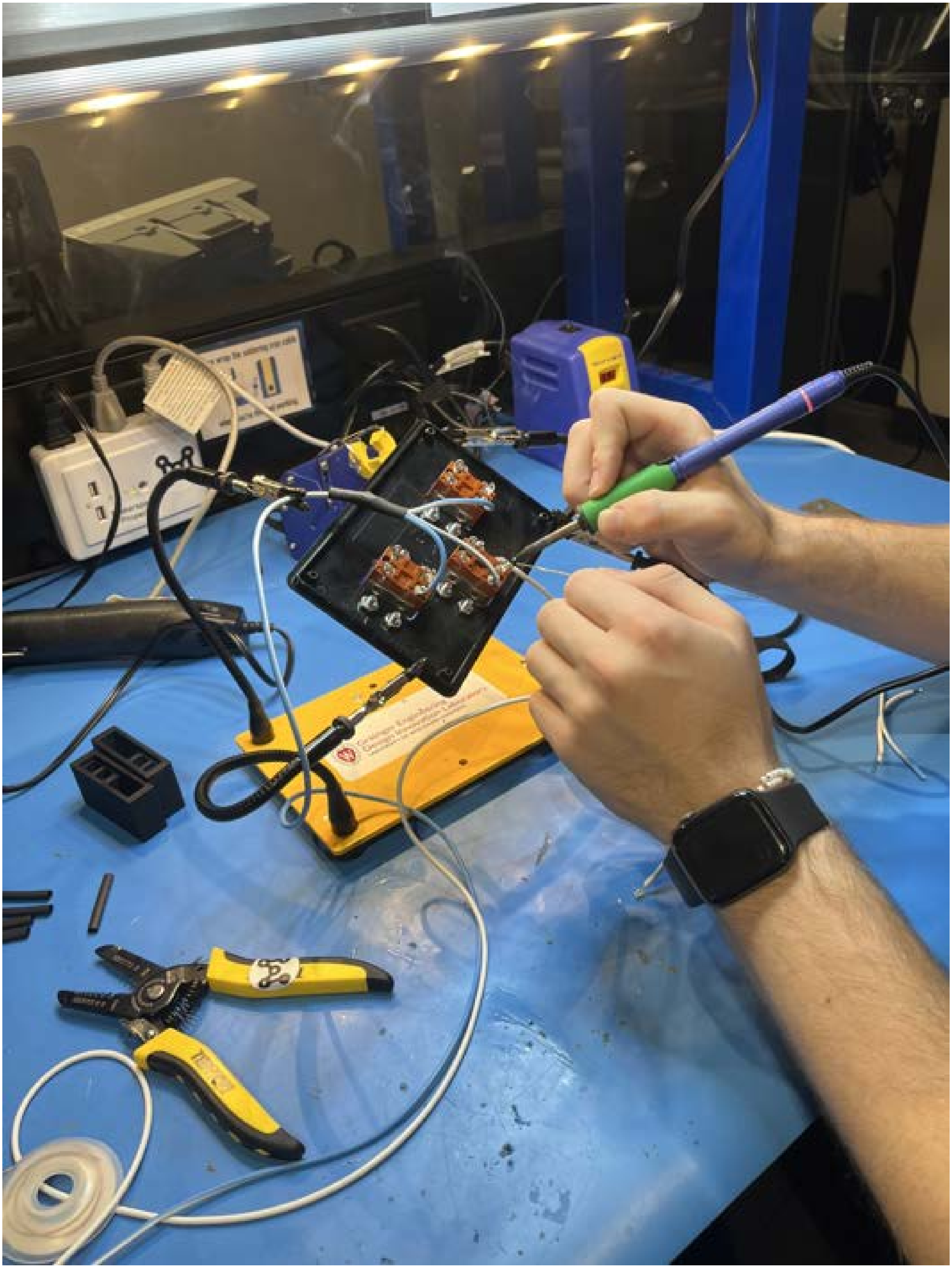
Date: 11/30

Content by: Nick and Jack

Present: Whole Team

Goals: Fabricate the design.

Content:



Conclusions/action items: Getting 2nd set of connectors for second set of pads is the priority. And testing the design is the next priority.

Nick Johnson - Nov 30, 2023, 9:25 PM CST

Download

IMG_5134.MOV (35.9 MB)

11/30/2023 Receipts

Nick Johnson - Nov 30, 2023, 9:26 PM CST

Title: Receipts from Rebecca

Date: 11/30

Content by: Nick Johnson

Present: Nick and Rebecca

Goals: Track spending and document for project.

Content:

-double--center-UW Makerspace

****
Date: 11/30/2023 Time: 18:21
Transaction #: 348
Register Name: Makerspace 2
****
Sale
10 Cent Hardw [illegible] @ 0.10 2.40

hot glue

Subtotal 2.40
Tax 0.00
Total 2.40

Wiscard Account
XXXXXXXX0040 2.40
New Balance 60.66

****
Make Good Things!
****

$18.500 for 6 hinges

-double--center-UW Makerspace

****
Date: 11/30/2023 Time: 16:26
Transaction #: 330
Register Name: Makerspace 2
****
Sale
Misc Sale Item 2.25T
screw(12) nuts(12)

Subtotal 2.25
Tax 0.12
Total 2.37

Wiscard Account
XXXXXXXX0040 2.37
New Balance 64.27

****
Make Good Things!
****

heat shrink $2.25
Perf board $1.00

Conclusions/action items: These will have to be entered into the spreadsheet.

12/13/2023 Final Expense Sheet

Nick Johnson - Dec 13, 2023, 6:36 PM CST

Title: Final Expense Sheet

Date: 12/13/2023

Content by: Nick Johnson

Present: Nick Johnson

Goals: Document the final expenses of the project.

Content:

Order Number	Item To Order	Purpose	Amount	Price Individual	Total Price
1	Adult "Leads-Out" Defib Pads for Physio Quik Combo for LifePak	TO harvest male lifepak leads	2	38.44	76.88
2	DIODE GEN PURP 2.2KV 30A TO220AC	To create two seperate shocks for DSD	4	4.55	18.2
3	ZOLL® Electrode to Physio QUIK-COMBO Adaptor	Adapter to get female end of zoll pads	3	49	147
4	Hinges	Connect Swtiches to Box	6	1.75	10.5
5	Screws and Nuts	Connect Swtiches to Box	24	0.1	2.4
6	Hot Glue	Connect Swtiches to Box	1	1.15	1.15
7	Heat Shrink	Protect wires inside circuit box	1	2.25	2.25
8	Printed Circuit Board	Solder diodes to	1	1	1
9	Black Project Box	Project Circuit from Users	1	9	9
10	Toggle Switch DPST Panel Mount	3 Switches for the design	3	29.56	88.68
			Total Price:		357.06

Conclusions/action items: The group spent a total of $357.06 of the total $500 budget. This saved the client $142.94.

11/10/2023 Tong Lecture Notes

Nick Johnson - Nov 10, 2023, 12:33 PM CST

Title: Tong Lecture Notes

Date: 11/10/2023

Content by: Nick Johnson

Present: Entire BME Design Class

Goals: Get Inspired

Content: Amazing presenter. I just came from Biology 151 listening to a very boring presenter. Professor Ellis, is has great slides and you can tell how passionate she is about what she does. She gave great advice, find your people, do the things that scare you, laugh until you cry, cry until you laugh. I connect with her when she talked about not liking how undergraduate biology classes are taught and needing more of a problem solving learning approach. This is exactly what I have been saying all along and what is wrong with the current medical field. Many doctors are not good problem solvers.

Conclusions/action items: Use my network, take risks and figure out what I am passionate about and keep chasing those interests.

2023/11/10 - Tong BME Distinguished Lecture: Notes and Reflection

MARIBEL GLODOWSKI - Nov 10, 2023, 12:44 PM CST

Title: Tong BME Distinguished Lecture: Notes and Reflection

Date: 2023/11/10

Content by: Maribel

Present: N/A

Goals: I want to take away some useful insights from this lecture.

Content:

Notes:

-Journey

-from DC

-University of Pittsburgh

-UW-Madison

- A lot happens in between

-now is at Exact Science

Takeaways:

1. Find your people
2. Do the things that scare you
3. Laugh until you cry, cry until you laugh

Conclusions: My takeaway is that plans don't always work out the way you think they will and that is okay. I think she really emphasized how important keeping people around you can get you through those pivots when your plans don't work out. I admire her balance between personal relationships and high-level achievement in her career. This balance is something I think about often. Seeing someone at this level with the same values of family and relationships is very inspiring.

2023/09/11 - "Information on defibrillation and ventilation with the LUCAS chest compression system"

MARIBEL GLODOWSKI - Sep 11, 2023, 10:15 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Information on defibrillation and ventilation with the LUCAS chest compression system"

Date: 09/11/2023

Content by: Maribel

Present: N/A

Goals: I aim to read this passage and better understand using an AED and a Lucas machine at the same time.

Search Term: Using an AED and LUCAS device

Link: https://www.lucas-cpr.com/files/8035282_LUCAS%20Ventilation%20and%20Defibrillation%20A4%20EU%203328783_B_LR.pdf

Citation:

“Information on defibrillation and ventilation with the Lucas chest compression system,” LUCAS Chest Compression System, https://www.lucas-cpr.com/files/8035282_LUCAS%20Ventilation%20and%20Defibrillation%20A4%20EU%203328783_B_LR.pdf (accessed Sep. 12, 2023).

Content:

-coronary perfusion pressure (CPP) drops rapidly when compressions are paused

-typically the heart has a pressure of 60 mmHg in the coronary arteries

-this pressure drops dramatically when compressions are stopped

-the AHA emphasizes minimizing interruptions in compressions by:

    -preventing pre and post shock pauses in compresion

    -keep pulse checks as short as possible

-Defibrillation can be done when the LUCAS device is operating
- the pads and wires cannot go under the suction cup of the LUCAS device
-LUCAS device must be paused during rhythm checks

Conclusions/action items:

This article went into detail about how a LUCAS compression device can work in unison with a typical AED or manual defibrillation device. In conclusion, the most important aspect of using both of these devices at once is defibrillator pad placement. The next step is to research how DSD (Dual Sequential Defibrillation) and the LUCAS device can work together to treat RVF (Refractory Ventricular Fibrillation).

2023/09/11 - "A comparison of biphasic and monophasic shocks for external defibrillation."

MARIBEL GLODOWSKI - Sep 17, 2023, 6:35 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "A comparison of biphasic and monophasic shocks for external defibrillation."

Date: 09/11/2023

Content by: Maribel

Present: N/A

Goals: I aim to read this journal article and create a better understanding of the types of shocks that treat Ventricular fibrillation.

Search Term: Biphasic Shocks

Link: **https://pubmed.ncbi.nlm.nih.gov/11045408/**

Citation:

S. L. Higgins *et al.*, "A Comparison of Biphasic and Monophasic shocks for External Defibrillation," *Prehospital Emergency Care*, vol. 4, no. 4, pp. 305–313, 2000. doi:10.1080/10903120090941001

Content:

- 200 J monophasic shocks had a 90% first shock success rate
- 100% of 200 J biphasic shocks were successful on first shock
- 83% of 130 J biphasic shocks were successful on first shock

Conclusions/action items:

From the information presented in this article it appears that the higher 200 J biphasic shock was the most effective at terminating VF. The next step would be researching the functions of defibrillators and how they provide these biphasic shocks.

2023/09/13 - "Double Defibrillation"

MARIBEL GLODOWSKI - Sep 15, 2023, 7:29 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Double Defibrillation"

Date: 09/13/2023

Content by: Maribel

Present: N/A

Goals: I aim to read this article and better understand the process of carrying out dual sequential defibrillation.

Search Term: Standardized ways to deliver dual sequential defibrillation

Link: **https://www.ncbi.nlm.nih.gov/books/NBK544231/**

Citation:

M. Ramzy and P. G. Hughes, “Double defibrillation,” National Library of Medicine, https://www.ncbi.nlm.nih.gov/books/NBK544231/ (accessed Sep. 13, 2023).

Content:

- RVF is when a patient remains in VF after three unsuccessful shocks

-10-25% of cardiac arrests continue onto RVF

-RVF results in 97% mortality

-Three theories of DSD:

    -power theory:

        -administration of more joules; two currents to be administered at the same time

    -setting up theory:

        -first transthoracic current lowers the defibrillation threshold

        -requires pause between the two shocks

    -multiple vector theory:

        -theory suggests that there are multiple vectors whose alternate placement might reach the heart better

-patient can receive up to 720 J safely

- pads touching each other will likely break the devices

- not covered under warranty

Conclusions/action items:

This article was very useful in creating a better understanding of the current state of practicing DSD in medicine today. The article went into depth into the methods that DSD could be used and their main challenges. The next step would be looking into any designs currently addressing this similar issue.

2023/09/15 - "Principles of External Defibrillators"

MARIBEL GLODOWSKI - Sep 15, 2023, 4:16 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Principles of External Defibrillators"

Date: 09/15/2023

Content by: Maribel

Present: N/A

Goals: I aim to better understand the functioning of defibrillators by reading this article.

Search Term: "How external defibrillators function"

Link: https://www.intechopen.com/chapters/41776

Citation:

H. Delgado, J. Toquero, C. Mitroi, V. Castro, and I. Fernandez, "Principles of external defibrillators," *Cardiac Defibrillation*, 2013. doi:10.5772/52512

Content:

-defibrillation is the most important therapy that can determine survival in VF patients

-75% survival rate if therapy is promptly done

-Types of defibrillators:

- energy-based:

-charges the capacitor to a certain voltage and delivers shock in J

-two factors affect the energy reaching the heart:

- voltage

-transthoracic impedance (TTI) (varies for each patient)

-Impedance-based defibrillators (less frequently used):

-requires selection of current based on TTI

-TTI assessed with test pulse and capacitor charges to the voltage for that TTI

-Current-based defibrillators (also less frequently used):

-delivers current independent of TTI

-30-40 amperes independent of TTI has been shown to be optimal

-seemed better before the capability of biphasic waves, but has since decreased in use

-Three waveforms:

-monophasic:

-deliver current in one polarity

-first introduced

-biphasic:

-current flows positive direction then switches to a negative

-allows for energy to be reduced

-triphasic:

-no human studies to support

-Initial energy selection:

-VT w/ pulse

-biphasic: 50-100J

-monophasic: 200 J

-V fib/VT w/o pulse

-at least 150J for biphasic

Conclusions/action items:

This article went into extreme detail about the use and operation of defibrillators. There are a variety of types of defibrillators all made up of some common aspects. The next step would be to look if any of these variations attempt DSD.

MARIBEL GLODOWSKI - Sep 15, 2023, 9:56 AM CDT


Principles of External Defibrillators

Download

Principles_of_External_Defibrillators___IntechOpen.pdf (1.8 MB)

2023/10/13 - "Sequence Control: On-Delay"

MARIBEL GLODOWSKI - Oct 16, 2023, 7:33 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Sequence Control: On-Delay"

Date: 10/13/2023

Content by: Maribel

Present: N/A

Goals: I aim to better understand the use of time delays in circuits.

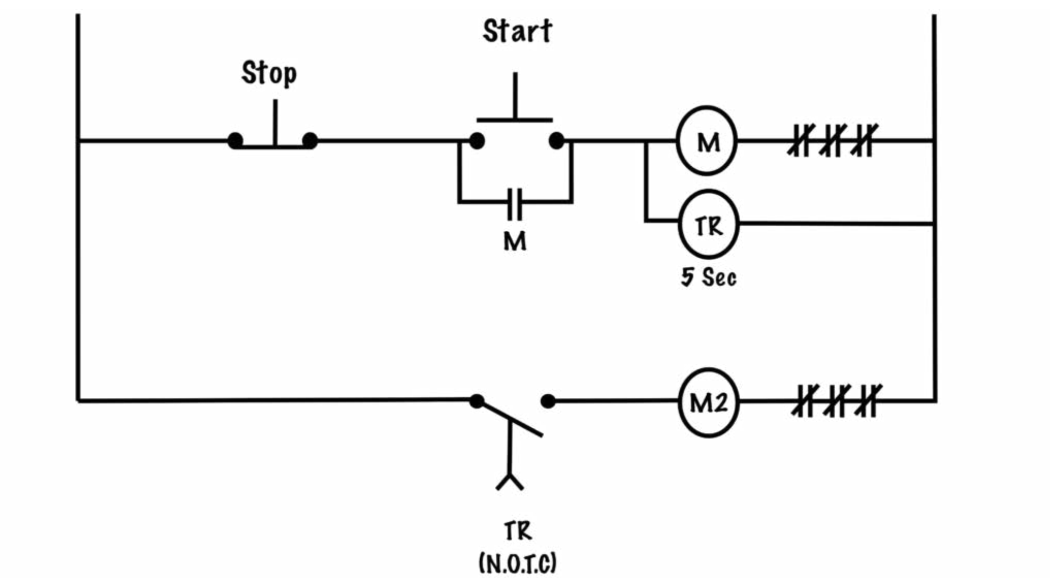
Search Term: "Time Delay Relays"

Link: https://pressbooks.bccampus.ca/basicmotorcontrol/chapter/sequence-control-on-delay/

Citation:

[1] C. Flinn and A. Lee, “Sequence control: On-delay,” Basic Motor Control, https://pressbooks.bccampus.ca/basicmotorcontrol/chapter/sequence-control-on-delay/ (accessed Oct. 16, 2023).

Content:



-the article focuses on describing the diagram of the timed relay diagram above

-three-wire circuit for a motor starter

-time-delay relay is normally open but timed to close (NOTC)

-this detail means that it is an on-delay timer

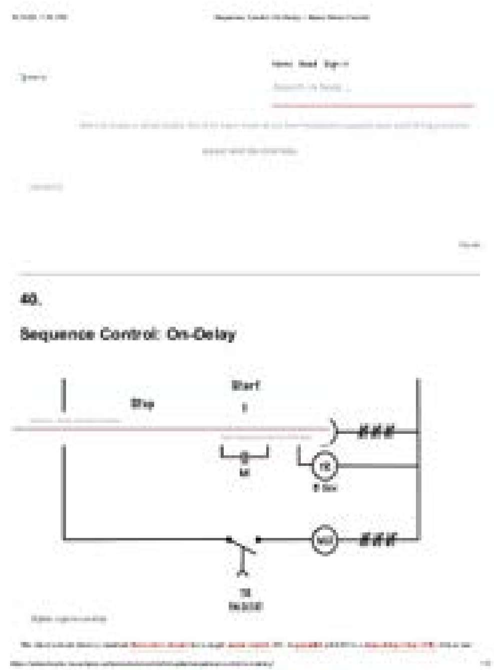
-the two motors are controlled only by the single push button

-M2 will turn on 5 sec after M1

Conclusions/action items:

While understanding this circuitry is valuable, this research is more valuable because shows us what we likely would not be able to achieve. Since the power of the shock in defibrillation is only available for a limited amount of time, this kind of time delay likely won't be a valid option. This leads to the action items that will have to be looked into. We need to look for ways to either store that energy for a short period in the circuit or to split the shock during the time of delivery.

MARIBEL GLODOWSKI - Oct 16, 2023, 7:36 PM CDT



40.

Sequence Control: On-Delay

Download

Sequence_Control__On-Delay_Basic_Motor_Control.pdf (340 kB)

2023/10/13- "H-Bridges -the Basics"

MARIBEL GLODOWSKI - Oct 16, 2023, 9:13 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "H-Bridges - the Basics"

Date: 10/13/2023

Content by: Maribel

Present: N/A

Goals: I aim to understand the use and function of H-Bridges in circuits as a whole and apply this knowledge to the prospective design of the DSD circuit.

Search Term: "H-Bridges"

Link: https://www.modularcircuits.com/blog/articles/h-bridge-secrets/h-bridges-the-basics/

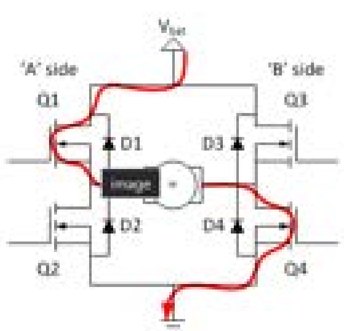
Citation:

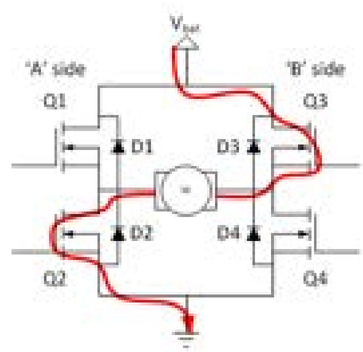
"H-Bridges - the Basics," Modular Circuits, https://www.modularcircuits.com/blog/articles/h-bridge-secrets/h-bridges-the-basics/ (accessed Oct. 16, 2023).

Content:

-circuit contains four switching elements

-top of the bridge connected to the power supply





-above are two diagrams of how the H-bring can operate

Conclusions/action items:

While this article provided a better understanding of how H-bridges operate, it did not have any specifics about how they are used in a defibrillator. The understanding of the basic concept of H-bridges is valuable, but next, I want to look into more about how they apply specifically to defibrillators and biphasic shocks.

MARIBEL GLODOWSKI - Oct 16, 2023, 9:15 PM CDT

Modular Circuits

H-Bridges – the Basics

Introduction

The Basics

Download

H-Bridges_the_Basics___Modular_Circuits.pdf (336 kB)

2023/10/19 - "Impedance to Defibrillation Countershock: Does an Optimal Impedance Exist?"

MARIBEL GLODOWSKI - Oct 27, 2023, 1:00 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Impedance to Defibrillation Countershock: Does an Optimal Impedance Exist?"

Date: 10/19/2023

Content by: Maribel

Present: N/A

Goals: I aim to get a better understanding of impedance and how it effects the practice of defibrillation

Search Term: "Defibrillation Impedance"

Link: https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1540-8159.1995.tb03869.x

Citation:

[1] B. H. KENKNIGHT, B. MURAT EYÜBOǦRLU, and R. E. IDEKER, "Impedance to defibrillation Countershock: Does an optimal impedance exist?," *Pacing and Clinical Electrophysiology*, vol. 18, no. 11, pp. 2068–2087, 1995. doi:10.1111/j.1540-8159.1995.tb03869.x

Content:

-what contributes to impedance:

- -extra-tissue sources (leads, defibrillator, and electrodes)
- -tissue sources (intracardiac and extracardiac tissue)
  - -contributes the most
- -interface between electrode and tissue

-how impedance influences defibrillation

- -determines the current(amps) that flows for the selected energy level(360 V)
- -determines the time constant of the capacitor discharge

Conclusions/action items: This article was a very comprehensive overview of how impedance may affect the efficacy and success of defibrillation. The main take away I have had from the journal article is that impedance contains many intricacies' that would have to be considered when trying to create an appropriate defibrillation shock. The next step is to look for a bit more on impedance and how current defibrillators read impedance.

MARIBEL GLODOWSKI - Oct 27, 2023, 1:01 PM CDT

Impedance to Defibrillation Countershock: Does an Optimal Impedance Exist?

Download

Pacing_Clinical_Electrophis_-_November_1995_-_KENKNIGHT_-_Impedance_to_Defibrillation_Countershock_Does_an_Optimal.pdf (9.22 MB)

2023/10/19 - "Applications of the Transthoracic Impedance signal during Resuscitation"

MARIBEL GLODOWSKI - Oct 27, 2023, 1:44 PM CDT

Title: "Applications of the Transthoracic Impedance Signal during Resuscitation"

Date: 10/19/2023

Content by: Maribel

Present: N/A

Goals: I aim to gain an even better understanding of how defibrillators use impedance measurements to alter the shock delivered.

Search Term: "Defibrillator Impedance"

Link: https://www.intechopen.com/chapters/62457

Citation:

[1] D. M. González-Otero, S. R. Gauna, J. J. Gutiérrez, P. Saiz, and J. M. Ruiz, "Applications of the transthoracic impedance signal during resuscitation," *Special Topics in Resuscitation*, 2018. doi:10.5772/intechopen.79382

Content:

-Transthoracic impedance (TI) is the impedance measured by defibrillators

-is used to adjust the energy of shock

-small changes in patient condition (redistribution and movement of fluids) can create small fluctuations in impedance

-means that the delivery of the shock is changes along with even the small condition changes of the patient

-TI is approx. 70-80 ohms in adults but can vary from 15 to 150 ohms

Conclusions/action items: This article put an emphasis on how accurate TI calculation from the defibrillation monitor could have many potential uses. It went in depth explaining how TI is attempting to be developed to make the defibrillation process more efficient and effective. The main takeaway from this article is that impedance would be worth preserving to the best of our ability in the circuit. The next action item would be to understand more about how monitors currently calculate impedance and how we can connect our circuit, pads, and machines.

Download

62457_1_.pdf (2.51 MB)

2023/10/27 - "Biphasic Technology - Impedance"

MARIBEL GLODOWSKI - Oct 27, 2023, 2:08 PM CDT

Title: "Biphasic Technology - Impedance"

Date: 10/27/2023

Content by: Maribel

Present: N/A

Goals: I aim to get a better understanding of how modern biphasic defibrillators measure impedance.

Search Term: "How defibrillators measure impedance"

Link: **https://www.zoll.com/au/medical-technology/defibrillation/rectilinear-biphasic-waveform/impedance**

Citation:

[1] "Biphasic technology - impedance," Biphasic Technology - Impedance - ZOLL Medical Australia, https://www.zoll.com/au/medical-technology/defibrillation/rectilinear-biphasic-waveform/impedance (accessed Oct. 27, 2023).

Content:

-avg impedance is approx 75 ohms

-range is between 35-150 ohms

-test pulse is sent 250 microseconds before shock is delievered

-during test pulse 70 ohms of resistors in the equipment are activated

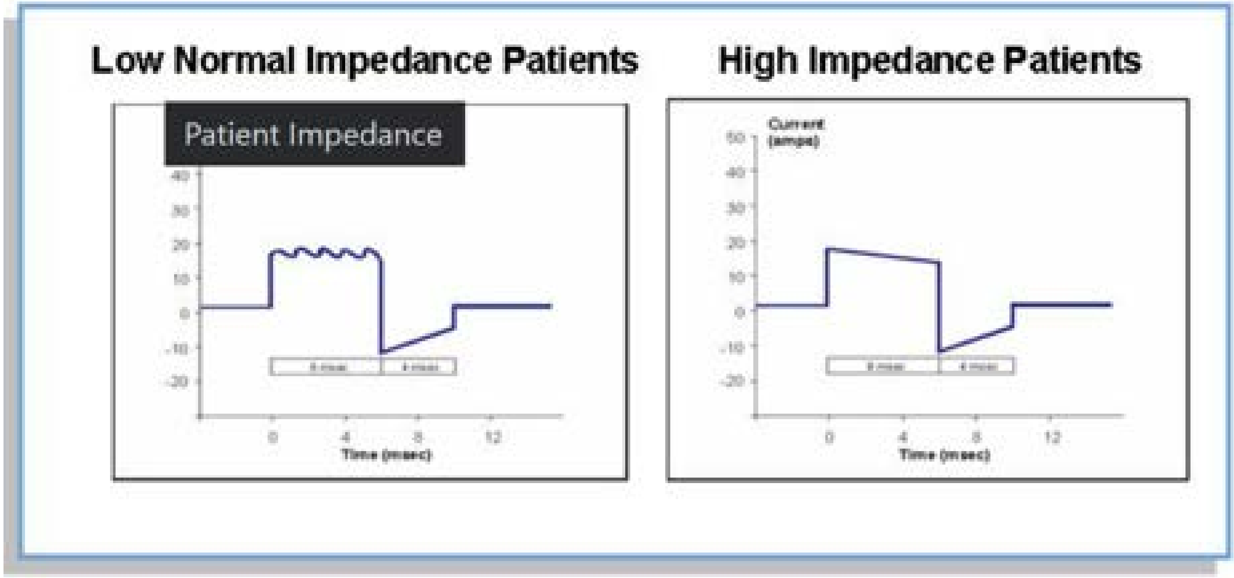
-then the current is measured, this measurement either maintains or decreases the device resistance

-decrease the resistance by deactivating resisters through the first 6 seconds of the shock

-unless the device recognizes high impedance in which case all resistors are turned off

-no matter the resistance needed the duration remains 10 ms

-below is an image of Zoll's biphasic shock graphs for Lower Impedance Patients to Higher Impedance patients



Conclusions/action items: This article brought up a very interesting topic: how defibrillators account for impedance. Although this is a Zoll defibrillator it still shows a few important details. In this model, impedance is measured and controlled for the entirety of the first phase of the biphasic shock. This will likely be something that will need to be considered through the first shock. The next step is to look at circuit design and how this understanding of impedance will contribute to that.

MARIBEL GLODOWSKI - Oct 27, 2023, 2:10 PM CDT


ZOLL

Biphasic Technology - Impedance

Download

Biphasic_Technology_-_Impedance_-_ZOLL_Medical_Australia.pdf (206 kB)

2023/09/15 - "Refractory Ventricular Fibrillation in Traumatic Cardiac Arrest: A Case Report and Review of the Literature"

MARIBEL GLODOWSKI - Sep 15, 2023, 8:14 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Refractory Ventricular Fibrillation in Traumatic Cardiac Arrest: A Case Report and Review of the Literature"

Date: 09/15/2023

Content by: Maribel

Present: N/A

Goals: My aim is to read this article and better understand refractory ventricular fibrillation. RVF is the condition that the DSD pads aim to treat.

Search Term: Understanding Refractory Ventricular Fibrillation

Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8703203/

Citation:

M. Alageel *et al.*, “Refractory ventricular fibrillation in traumatic cardiac arrest: A case report and review of the literature,” *Cureus*, 2021. doi:10.7759/cureus.19851

Content:

-VF is lethal cardiac arrhythmia

-disorganized and irregular electrical activity that does not have a pattern

-RVF is characterized by the inability to resuscitate after 10 minutes with 3 defibrillation shocks

-the current standard progression of treatment for best outcomes:

-high-quality CPR

-accurate recognition of the heart rhythm

-early defibrillation

-iv epinephrine and antiarrhythmic drugs

-incidence of RVF: 0.5-0.6 per every 100,000 persons

-mortality rate: 85-97%

Conclusions/action items:

This article gave valuable insight into the specifics of RVF and the current practice of treating a patient with RVF. While this journal article did not reference DSD directly, it expressed a need for a more diverse pool of options on how to treat RVF. The next step is to understand more about how a defibrillator works to treat VF and RVF and to look for any other products that might address similar issues.

2023/09/27 - "Electrode pad system and defibrillator electrode pad that reduces the risk of peripheral shock"

MARIBEL GLODOWSKI - Oct 02, 2023, 10:27 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Electrode pad system and defibrillator electrode pad that reduces the risk of peripheral shock"

Date: 09/27/2023

Content by: Maribel

Present: N/A

Goals: I aim to better understand what is already on the market, and to understand the current design and components of a defibrillator pad.

Search Term: Defibrillator Pad

Link: https://patents.google.com/patent/US6178357B1/en?q=(%22defibrillator+pad%22)&oq=%22defibrillator+pad%22

Citation:

[1] B. E. Gliner, S. M. Dillon, and K. W. Leyde, “Electrode pad system and defibrillator electrode pad that reduces the risk of peripheral shock,” Jan. 21, 2001

Content:

-includes two electrodes connected with a CPR monitor in the middle that measures rate and pressure

-includes adjustable length

-below is a sketch of the design applied to the patient

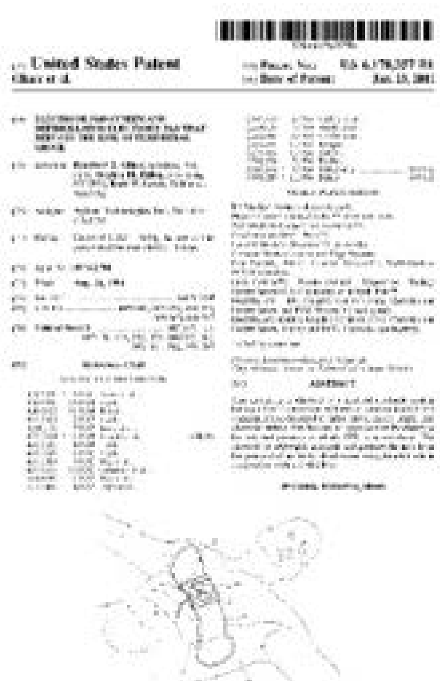
-aims to guide use through the steps of use by assuring proper placement, adequate chest compressions, and user safety features

-uses folds in the connectors to adjust the length of the pad set

Conclusions/action items:

This patent gave a good overview of a type of defibrillator pad that focuses mainly on reducing the risks of the user. This patent goes into depth on the ways this design can walk a user through how the device works from correct placement to preventing the shock of the user. This makes interesting connections to how we could structure some designs in our product to focus on making user functions of the device as simple and safe as possible.

MARIBEL GLODOWSKI - Oct 01, 2023, 9:48 PM CDT



Download

Competing_designs_Patent_1.pdf (745 kB)

2023/09/27 - "Automated External Defibrillator Pad System"

MARIBEL GLODOWSKI - Oct 02, 2023, 10:28 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: Automated External Defibrillator Pad System

Date: 09/27/2023

Content by: Maribel

Present: N/A

Goals: I aim to read about the product in this patent and understand more about the structure of the current defibrillator pads in use.

Search Term: "Defibrillator pads"

Link: https://patents.google.com/patent/US20120265265A1/en?q=(dual+sequential+defibrillation+pads)&oq=dual+sequential+defibrillation+pads

Citation:

[1] M. O. J. J. N. L. Razavi, R. F. Ramos, J. Christabel, and N. Bradley, “Automated External Defibrillator Pad System”

Content:

-meant to address pads that are misapplied

-aims to deliver a second shock along a different vector

-wants to deliver two shocks not for DSD but for simple use for layperson user

-three electrodes via one connection

-switch with three positions

- -first positon of switch allows for first vector of shock
- -second position allows for another shock at a different vector
- -below is the intend process with each step

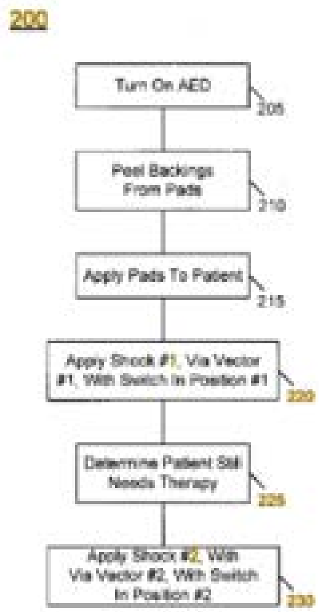


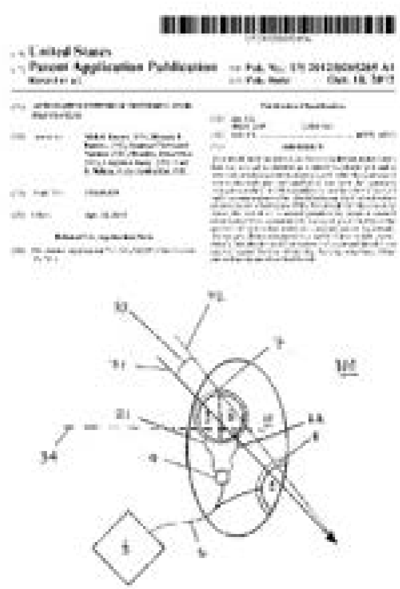
FIG. 2

-

Conclusions/action items:

While this patent focuses on a different problem than the project, it has a very similar result and solution. It aims to apply two shocks to the patient in short succession with the assumption that the first shock was ineffective because of user error. DSD does not assume user error but aims to do the same thing. Overall our product will likely aim to achieve a similar effect with more automation. The next step is to look at each design and assess which is the best and if any changes need to be made.

MARIBEL GLODOWSKI - Oct 01, 2023, 9:51 PM CDT



Download

Competing_Designs_Patent_2.pdf (1.14 MB)

2023/09/29 - "Electrode-pad package that is removable from an electrode-pad lead and method for opening the package"

MARIBEL GLODOWSKI - Oct 02, 2023, 9:23 AM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Electrode-pad package that is removable from an electrode-pad lead and method for opening the package"

Date: 09/29/2023

Content by: Maribel

Present: N/A

Goals: I aim to better understand how possible designs for this project can incorporate aspects of designs that are already commonly used on the market.

Search Term: "Lifepack Defibrillator Pads"

Link: https://patents.google.com/patent/US6935889

Citation:

[1] A. G. Picardo, C. Janae, and T. Solosko, “Electrode-pad package that is removable from an electrode-pad lead and method for opening the package,” Aug. 30, 2005

Content:

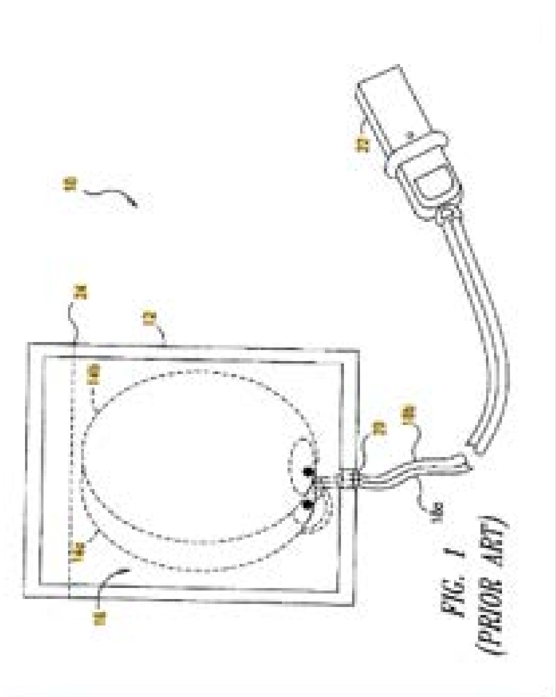
-this patent is for the packaging and adhesive system that effectively adheres to the patient for proper treatment

-meant to make the user base broader to people without extensive training

-suggest that these pads can be preconnected to the patient to make use faster when needed

-aim to make this pre-connecting phase of use easier by making safe packaging that is easy to remove

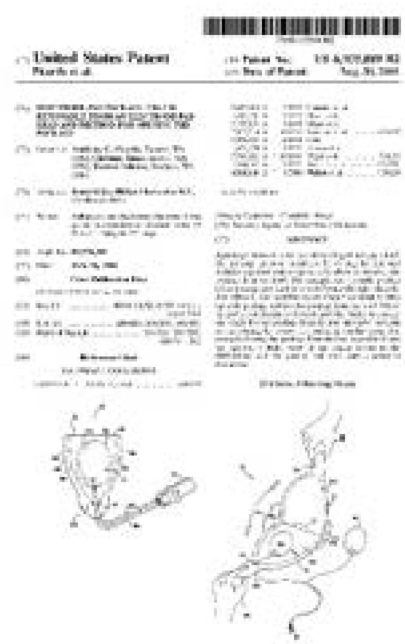
A figure of this packaging is shown below:



Conclusions/action items:

While this pad design does not address the problem of this project, it does include critical factors to consider when creating pads to address the issues of this project. This design focuses on safety and ease of use. Aspects of this pad should be used in the designs for this project. The next step is to look at each brainstormed design and understand how they can be improved and assessed.

MARIBEL GLODOWSKI - Oct 01, 2023, 9:51 PM CDT


United States Patent

Download

Competing_designs_Patent_3.pdf (945 kB)

2023/10/26- "Philips FRx/FR2/FR2+ Electrode Pads Adapter to Physio-Control LIFEPAK"

Title: "Philips FRx/FR2/FR2+ Electrode Pads Adapter to Physio-Control LIFEPAK"

Date: 10/26/2023

Content by: Maribel

Present: N/A

Goals: I aim to search for a potential adapter to connect the project box to the pads.

Search Term: "LIFEPAK female adapter"

Link: https://www.aedsuperstore.com/philips-frx-fr2-fr2-electrode-pads-adapter-to-physio-control-lifepak.html?utm_source=google&utm_medium=cpc&utm_campaign=PMax%3A%20%5BROI%5D%20Shopping%20-%20AED%20Accessories%20-%20Smart&utm_id=17824392711&utm_content=&utm_term=&gad_source=1&gclid=Cj0KCQiAmNeqBhD4ARIsADsYfTenjMjNXAbxugyFvwmu1l(

Citation:

[1] “Physio-control adapter quik-combo electrode pads to zoll ALS monitor/defibrillators - aed superstore - 11103-000005, 3009623-00,” AED Superstore, h electrode-adapter-quik-combo-zoll.html (accessed Nov. 17, 2023).

Content:

-this is a listing for an adapter that connects Philips pads to the LIFEPAK monitor

-reusable

-cannot be used for infant/pediatric

Conclusions/action items:

This item is not what we are looking for, but it shows that there may be adapters on the market like the one we are looking for. This adapter has a male co female connector. Further action will need to be taken to continue to search for a product that fits our needs.

MARIBEL GLODOWSKI - Nov 17, 2023, 12:32 AM CST

Download

Screenshot_2023-11-17_002804.png (33.6 kB)

2023/10/29 - "Physio-Control Adapter QUIK-COMBO Electro Pads to Zoll ALS Monitor/Defibrillators"

MARIBEL GLODOWSKI - Nov 17, 2023, 12:18 AM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Physio-Control Adapter QUIK-COMBO Electro Pads to Zoll ALS Monitor/Defibrillators"

Date: 10/29/2023

Content by: Maribel

Present: N/A

Goals: I aim to search for a potential adapter to connect the project box to the pads.

Search Term: "LIFEPAK female adapter"

Link: https://www.aedsuperstore.com/physio-control-medtronic-forward-electrode-adapter-quik-combo-zoll.html

Citation:

[1] “Physio-control adapter quik-combo electrode pads to zoll ALS monitor/defibrillators - aed superstore - 11103-000005, 3009623-00,” AED Superstore, https://www.aedsuperstore.com/physio-control-medtronic-forward-electrode-adapter-quik-combo-zoll.html (accessed Nov. 17, 2023).

Content:

-this is a listing for an adapter that connects LIFEPAK pads to a Zoll monitor

-this product is discontinued

Conclusions/action items:

In conclusion, this item shows that there have been products used in the past that resemble the item that we are looking for. We now need to look for more products similar to this one that are not discontinued.

MARIBEL GLODOWSKI - Nov 17, 2023, 12:19 AM CST

Download

Screenshot_2023-11-17_001711.png (118 kB)

2023/11/15 - "Automated External Defibrillators": FDA Regulation of AED Products

MARIBEL GLODOWSKI - Nov 15, 2023, 12:54 PM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: "Automated External Defibrillators": FDA Regulation of AED Products

Date: 11/15/2023

Content by: Maribel Glodowski

Present: N/A

Goals: I aim to have a better understanding of why the connectors we are searching for are discontinued.

Search Term: "FDA Discontinued AED adaptors"

Link: https://www.fda.gov/medical-devices/cardiovascular-devices/automated-external-defibrillators-aeds#:~:text=Be%20aware%20that%20if%20your,voluntary%20report%20online%20at%20MedWatch.

Citation:

[1] Center for Devices and Radiological Health, "Automated External Defibrillators (aeds)," U.S. Food and Drug Administration, https://www.fda.gov/medical-devices/cardiovascular-devices/automated-external-defibrillators-aeds#:~:text=Be%20aware%20that%20if%20your,voluntary%20report%20online%20at%20MedWatch. (accessed Nov. 15, 2023).

Content:

-the FDA first had a public meeting on AEDs (the whole device) in January 2011

-the overall decision was that more stringent rules should be put in place for the devices

    -decided that premarket approval (PMA) would be required

-companies decided what to submit for PMA

-on Feb 3 of 2022, any AED accessories were required to be filed for PMA otherwise they were discontinued

Conclusions/action items:

Since the items we are looking for are discontinued, we have some work to do with the adapters to find an effective solution for our device. The next option is either to find another viable option or to model an adaptor ourselves through CAD and fabricate by 3D printing.

2023/11/16 - ConMed Multifunctional PadPro Electrode and Adapters

MARIBEL GLODOWSKI - Nov 17, 2023, 10:18 AM CST

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title: ConMed Multifunctional PadPro Electrode and Adapters

Date: 11/16/2023

Content by: Maribel

Present: N/A

Goals: My main goal is to look for any potentially useful adapter that is FDA-approved.

Search Term: "FDA-approved AED adapter"

Link: https://www.fda.gov/medical-devices/recently-approved-devices/conmed-padpro-multifunction-electrodes-conmed-padpro-multifunction-electrode-adapters-p200004

Citation:

[1] Center for Devices and Radiological Health, “ConMed PadPro multifunction electrodes and adapters – P200004,” U.S. Food and Drug Administration, https://www.fda.gov/medical-devices/recently-approved-devices/conmed-padpro-multifunction-electrodes-conmed-padpro-multifunction-electrode-adapters-p200004 (accessed Nov. 17, 2023).

Content:

-Brief overview of an FDA-approved set of pads and adapters

-Pads are similar to brand-specific electrodes

-the adapters are reusable and aim to provide versatility in what brand defibrillator can be used

-adapters and pads are sold as one product

Conclusions/action items:

This could be an interesting item to look more into since it is the only FDA-approved adapter on the market that I could find. If we are unable to model a Zoll female connection this might be an interesting avenue to explore. The action items currently are to see if modeling the Zoll female connection is possible.

MARIBEL GLODOWSKI - Nov 17, 2023, 10:20 AM CST

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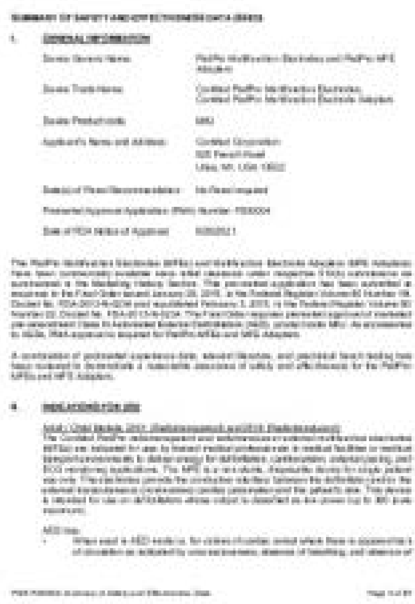
Screenshot_2023-11-17_100904.png (874 kB)

MARIBEL GLODOWSKI - Nov 17, 2023, 10:22 AM CST



Download

P200004B.pdf (623 kB) Summary of Safety and Effectiveness Data (SSED) from FDA for the MFE PadPro products

2023/09/22 - Light Indicator Method

MARIBEL GLODOWSKI - Sep 22, 2023, 10:42 AM CDT

Title: Light Indicator Method

Date: 09/22/2023

Content by: Maribel

Present: N/A

Goals: My aim is to lay out one possible approach to solve the issues presented in this project.

Content:

Main features:

- plug-in for each pad
  - this allows each pad to be plugged into a power source whether that be two monitors, a monitor and an AED, or a monitor and a separate power source we create
  - this also allows for a vector change without DSD by switching one plug-in to the power source
- Project box w/ light indicator
  - perhaps we could build a circuit in a project box that starts when a shock is detected going through the first lead or when the first shock is sent
  - This could time out and turn on a light to indicate that a second shock can be sent and then can turn off after 4.5 seconds (or however long the window for DSD is)
- Switch for the dual shock
  - When the light is on there could be a switch to send the second shock

Benefits

- doesn't mess with the signal to monitor or AED
- doesn't risk disrupting the initial shock or taking away power from that shock

Limitations

- Needs a second power source
- room for user error

Conclusions/action items:

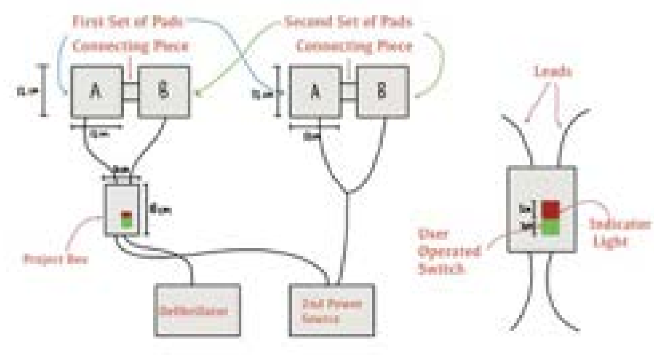
A second power sources would be needed for this design to function. Working around this issue might prove to be difficult. The next step is to think of a way to either create a power source for a second shock or to work with the power of one monitor.

MARIBEL GLODOWSKI - Sep 22, 2023, 10:42 AM CDT

Download

Light_Indicator_Method_Design.pdf (511 kB)

MARIBEL GLODOWSKI - Oct 01, 2023, 10:09 PM CDT



Download

Light_Indicator_Design_Drawing.jpeg (223 kB)

2023/09/22 - Single Plug Switch Method

MARIBEL GLODOWSKI - Sep 22, 2023, 11:01 AM CDT

Title: Single Plug Switch Method

Date: 09/22/23

Content by: Maribel

Present: N/A

Goals: I am to show a design that could potentially some of the issues presented in this project.

Content:

Main Features

- Single Plug
    - only allows to be plugged into one monitor, but simplifies for user
- Switches on each branch
    - this would allow for simple vector change or DSD by opening both switches at the same time

Benefits

- less room for user error
- allows for simple vector change easily

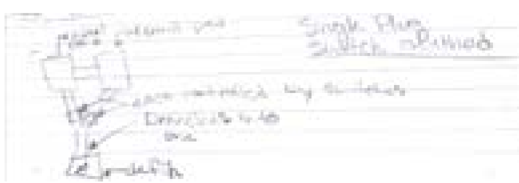
Limitations

- cannot add an additional power source

Conclusions/action items:

Working around not having a second power source still seems to be an issue. This design aims to give the user options as to what you can do with the pads and shocks. The next step is meeting with the client and discussing which aspects of these designs are most appealing to him.

MARIBEL GLODOWSKI - Sep 22, 2023, 10:54 AM CDT



Download

Single_Plug_Switch_Method.pdf (293 kB)

2023/10/25 - Biosafety Training

MARIBEL GLODOWSKI - Nov 10, 2023, 2:14 AM CST


VCRGE Training Information Lookup Tool University of Wisconsin-Madison

WISCONSIN

Course	Assignment	Completion	Expiration
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	

Download

Screenshot_2023-11-10_021301.png (69 kB)

2023/10/18 - Chemical Safety

MARIBEL GLODOWSKI - Nov 10, 2023, 2:16 AM CST

VCRGE Training Information Lookup Tool

University of Wisconsin-Madison

WISCONSIN

This certifies that Maribel Glodowski has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	[illegible]	[illegible]	[illegible]
Chemical Safety: The OSHA Lab Standard	Final Quiz	[illegible]	
Performing a Risk Assessment	Survey	[illegible]	

[illegible]

Download

Screenshot_2023-11-10_021301.png (69 kB)

2023/10/16 - Risk Assessment Training

MARIBEL GLODOWSKI - Nov 10, 2023, 2:18 AM CST

Download

Screenshot_2023-11-10_021301.png (69 kB)

2023/10/25 - Adapter Flowchart

MARIBEL GLODOWSKI - Oct 25, 2023, 11:28 PM CDT

Title: Adapter Flowchart

Date: 10/25/2023

Content by: Maribel

Present: N/A

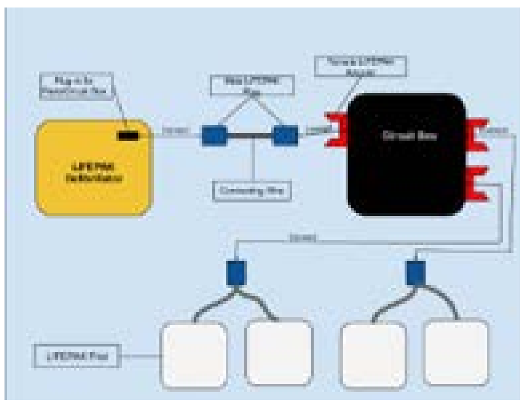
Goals: The aim of this entry is to depict the concept of the adaptors in a visually appealing way.

Content:

See the attachment below.

Conclusions/action items: We need to find the adapter that can achieve the design shown below and that is within the budget.

MARIBEL GLODOWSKI - Oct 25, 2023, 11:31 PM CDT



Download

Adapter_Flowchart.pdf (43.5 kB)

2023/11/02 - Updated Adapter Flowchart

MARIBEL GLODOWSKI - Nov 02, 2023, 3:23 PM CDT

Title: Adapter Flowchart

Date: 10/25/2023

Content by: Maribel

Present: N/A

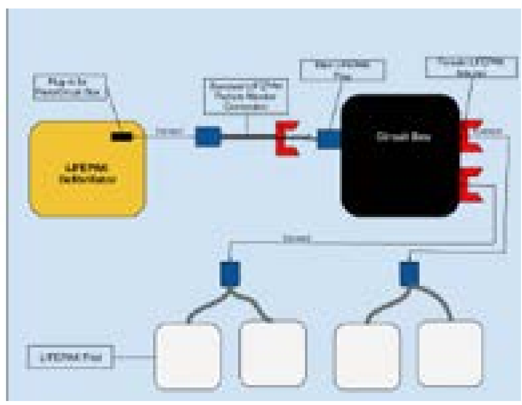
Goals: The aim of this entry is to update the previous flowchart with new idea.

Content:

See the attachment below.

Conclusions/action items: We need to find the adapter that can achieve the design shown below and that is within the budget.

MARIBEL GLODOWSKI - Nov 02, 2023, 3:23 PM CDT



Download

Adapter_Flowchart_1_.pdf (43.6 kB)

9/14/23 - Double Sequential External Defibrillation for Refractory Ventricular Fibrillation.

Jack Sperling - Sep 14, 2023, 12:58 PM CDT

Title: :"Double Sequential External Defibrillation for Refractory Ventricular Fibrillation."

Date: 09/14/2023

Content by: Jack

Present: N/A

Goals: What the success rate and reasoning behind DSD is

Search Term: "dual sequential defibrillation"

Link: https://www.acc.org/Latest-in-Cardiology/Clinical-Trials/2022/11/05/02/59/dose-vf

Citation:

“Double Sequential External Defibrillation for Refractory Ventricular Fibrillation.” *American College of Cardiology*, https://www.acc.org/Latest-in-Cardiology/Clinical-Trials/2022/11/05/02/59/dose-vf. Accessed 14 Sept. 2023.

Content:

- "The primary outcome, survival to hospital discharge, for standard vs. VC vs. DSED defibrillation, was: 13.3% vs. 21.7% vs. 30.4% (p = 0.009)."
- DSD was only performed on patients who had refractory v-fib or pulselss v-tach after 3 successful rhythm checks and standard defibrillations

Conclusions/action items:

This article suggests that DSD increased odds to neurologically intact patient discharge compared to vector change alone. This technique is only used on those patients who are unresponsive to high performance CPR, ACLS medications, and continue to remain in shock-refractory arythmias

9/14/23 - Varying Connectors

Jack Sperling - Sep 14, 2023, 5:47 PM CDT

Title: Varying Connectors used by Different Brands of Monitors

Date: 09/14/2023

Content by: Jack

Present: N/A

Goals: Identify the number of unique connectors that we must take into account when designing our electrical circut

Link:

https://www.aedsuperstore.com/zoll-statpadz-ii.html --> Pads for Zoll AEDs and Zoll Cardiac Monitors that most of Dane County EMS systems use as well as MFD

https://www.aedbrands.com/product/lifepak-aed-pads-11996-000017/ --> Pads for Physio-Control's LIFEPACK 500 & 1000 that is used by some Dane County and Green County EMS systems.

https://www.altramedical.com/heartstart-to-zoll-pads-adapter-05-10100/ --> Commercially available adapter that allows LIFEPACK cardiac pads to connect to Zoll monitors

Citation: Web stores, see links above

Content:

- Multiple departments use different brands, each have separate connector
- Zoll cardiac monitors and AEDs use the pads pictured below (from link #1) with a yellow and grey 2-piece connector

-
- Physio-Control's LIFEPACK cardiac monitors use the pads pictured below (from link #2) with a grey 1-piece connector

- 

- Note: There is a converter that is readily available that converts LIFEPACK pads to be able to connect to Zoll monitors (pictured below from link #3)

- 

Conclusions/action items:

Creating one set of pads that are based on Zoll's electrical design is ideal to maximize compatibility. With the prevalince of the commercially available adapter for LIFEPACK pads, compatibility should not be too much of a problem.

Action items: Identify the most commonly used types of Zoll monitors used in the Madison and Dane County area to ensure that we are designing around the correct interface.

9/14/23 - Optimal Power for Shocks Given by Cardiac Monitors

Jack Sperling - Sep 14, 2023, 5:56 PM CDT

Title: Comparison of the efficacy and safety of two biphasic defibrillator waveforms for the conversion of atrial fibrillation to sinus rhythm

Date: 09/14/2023

Content by: Jack

Present: N/A

Goals: Identify the most common energy used to defibrillate a patient to better understand what our circuit must handle

Link: **https://pubmed.ncbi.nlm.nih.gov/14516881/**

Citation: Neal S, Ngarmukos T, Lessard D, Rosenthal L. Comparison of the efficacy and safety of two biphasic defibrillator waveforms for the conversion of atrial fibrillation to sinus rhythm. Am J Cardiol. 2003 Oct 1;92(7):810-4. doi: 10.1016/s0002-9149(03)00888-9. PMID: 14516881.

Content:

- As patient size and chest circumference increases, energy required to successfully convert the patient increased
- A maximum of 360J was required for a subset of the patients, using a special monitor that is able to deliver that much energy
- Type of shock delivered also matters in determining how much electricity is required to convert the patient

Conclusions/action items:

There is a trend of needing increasing electricity for larger people and already documented cases where up to 360J are required. However, we still do not know what type of shock the cardiac monitors that UW, MFD, and Dane County EMS systems use.

9/14/23 - Can This Procedure Cause Harm to the Cardiac Monitor?

Jack Sperling - Sep 14, 2023, 6:01 PM CDT

Title: Is performing DSD putting cardiac monitors at risk?

Date: 09/14/2023

Content by: Jack

Present: N/A

Goals: Identify how common documented cases of monitors being damaged during DSD procedure

Link: https://www.sciencedirect.com/science/article/pii/S266652042200087X

Citation:

Ian R. Drennan, Dustin Seidler, Sheldon Cheskes,

A survey of the incidence of defibrillator damage during double sequential external defibrillation for refractory ventricular fibrillation,

Resuscitation Plus,

Volume 11,

2022,

100287,

ISSN 2666-5204,

https://doi.org/10.1016/j.resplu.2022.100287.

(https://www.sciencedirect.com/science/article/pii/S266652042200087X)

Content:

- Occurrence of defibrillator damage was estimated at between (0.11% - 0.22%)
- All device damages occurred during simultaneous discharge of both devices instead of what our client is suggesting, in which the charges would be separated by approximately 0.5 seconds.

Conclusions/action items:

There is literature that identifies situations where expensive cardiac monitors have been damaged during DSD, however due to the methods outlines in the paper as well as our client's specifications, this damage is not something that we need to be concerned about. We can proceed with our project.

9/27/23 - Pad Placement and Connector

Jack Sperling - Sep 27, 2023, 9:04 PM CDT

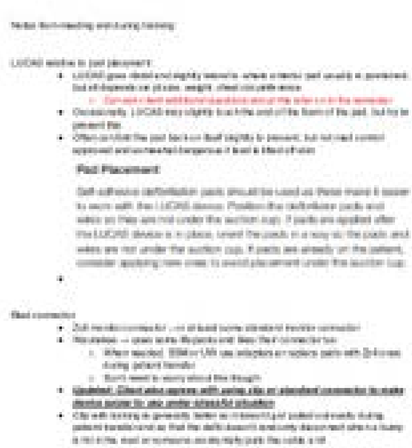
Spoke with various EMTs and paramedics throughout the past week about best connector style for users and safe placement of pads.

Summary:

Cardiac pad placement is generally proximal to LUCAS contact position so as long as our pads do not interfere with the LUCAS suction cup, we are ok.

Additionally, best way to connect pads is using current Zoll method -- it is the most commonly known and easiest to use

Jack Sperling - Sep 29, 2023, 8:04 AM CDT



Pad Placement

Download

BAEMS_Design_Notes.pdf (132 kB)

9-14-23 Potential Competing Design

Jack Sperling - Sep 14, 2023, 6:02 PM CDT

https://www.zoll.com/medical-products/defibrillator-electrodes/cpr-d-padz-aed

Similar but different --> takes both pads into one. May be able to understand how it works to help us

9/14/23 - Zoll Combined Pad

Jack Sperling - Oct 08, 2023, 8:20 PM CDT

Title: Zoll potential competing design

Date: 9/14/23 ------- updated to correctly match template on 10/8/23

Content by: Jack

Present: N/A

Goals: Understand if this product from Zoll is competing or not

Content: From the product's image it appears that this device is not directly competing in our market. This device only intends to increase the speed and decrease complexity of placing cardiac pads in the standard anterior/anterior approach and does not have the ability to place pads in anterior/posterior.

Citeation:

[1] “Zoll Medical Corporation,” Electrodes for AEDs - ZOLL Medical, https://www.zoll.com/medical-products/defibrillator-electrodes/cpr-d-padz-aed (accessed Oct. 8, 2023).

Conclusions/action items: This device is not a direct competitor, however we might be able to use concepts from this device and incorporate them into our modified pads.

Jack Sperling - Oct 08, 2023, 8:20 PM CDT

Download

CPR_D-PADZ_Thumb_119x160.jpg (39.8 kB)

11/19/23 - Amperage and Voltage from Defib Shock

Jack Sperling - Oct 19, 2023, 9:39 PM CDT

Title: Amperage and Voltage of Defibrillator Shock along with Waveform

Date: 10/19/23

Content by: Jack

Present: N/A

Goals: Understand the electrical potential and design goes into delivering the shock and exactly what power the shock is delivering

Search Term: Biphasic cardiac monitor waveform

Link: https://www.zoll.com/uk/core-technologies/rectilinear-biphasic-technology

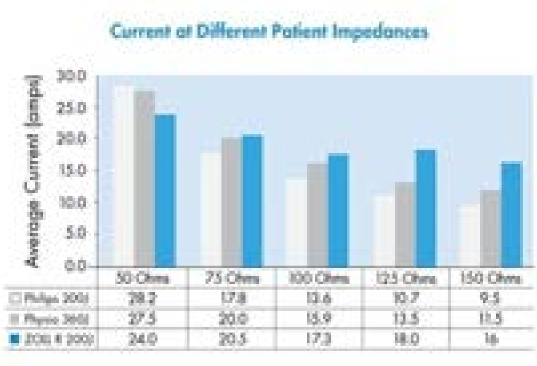
https://s3.amazonaws.com/HMP/hmp_ln/imported/files/base/image/EMSR/2004/02/1130872803561_10324830.png from https://www.hmpgloballearningnetwork.com/site/emsworld/article/10324825/biphasic-defibrillation-shape-resuscitation-today

Content:

Images from these websites are attached below and provide important metrics of how much energy the shock is delivering and how.

Conclusions/action items: Continue researching if splitting the shock is viable and next steps.

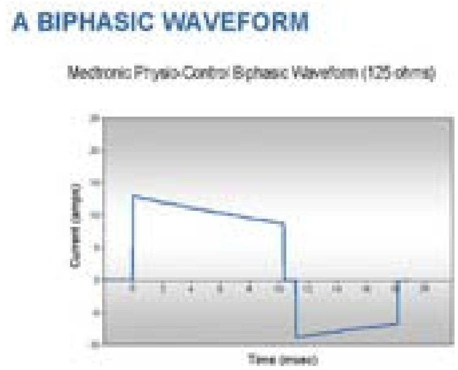
Jack Sperling - Oct 19, 2023, 9:34 PM CDT



[Download]()

RBW_Graphic.jpg (45 kB)

Jack Sperling - Oct 19, 2023, 9:34 PM CDT



[Download]

1130872803561_10324830.png (28.8 kB)

9/17/23 - Design Ideas #1

Jack Sperling - Sep 22, 2023, 9:08 AM CDT

Just pads:

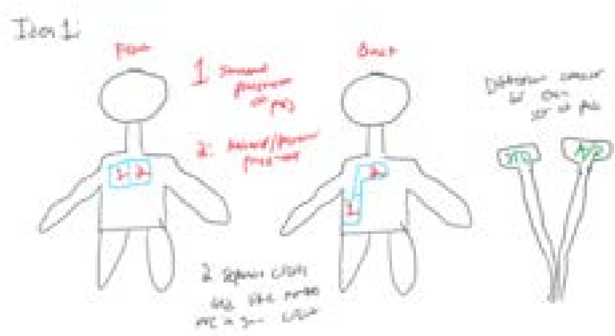
Make 2 sets of pads, each with one contact for the main 2 sets of placement locations. From there, have 2 connectors for the pads, one for each of the 2 main placement location sets. This allows standard approach, change of vector, and DSD all in one set of pads that can be preplaced. Be careful of where LUCAS needs to go though.

Try to utilize an AED as the second monitor and ensure that it has the ability to plug in as well.

Second idea is to try and replicate the modular idea of making a small defib with battery pack that is not a monitor, all it does is shock. Have replaceable battery pack and can register when the main monitor shocks and then shock a predetermined time after that. Only has charge button and then shocks set time after main monitor does.

Use modular defib

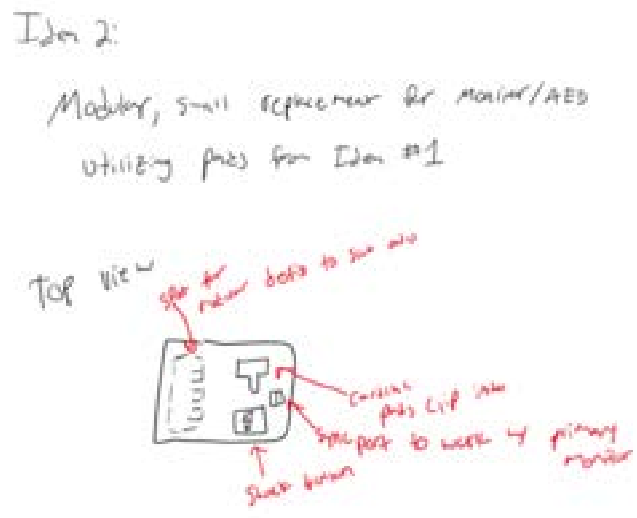
Jack Sperling - Sep 22, 2023, 2:05 PM CDT



Download

Idea_1.png (192 kB)

Jack Sperling - Sep 22, 2023, 2:05 PM CDT



Download

Idea_2.png (131 kB)

10/8/23 - Updated Solidworks Files for current LED Design

Jack Sperling - Oct 08, 2023, 8:11 PM CDT

Title: : LED solidworks design

Date: 10/8/2023

Content by: Jack

Present: N/A

Goals: Update the current solidworks model for the LED

Content: Update was completed by ensuring all sketches were fully defined and model was updated. Files will be attached below

Conclusions/action items:

Continue to update model as requested by team.

Jack Sperling - Oct 08, 2023, 8:11 PM CDT

Download

LED_PDP_Draft.SLDPRT (1.24 MB)

10/8/23 - Potential LED design PDF with dimensions

Jack Sperling - Oct 08, 2023, 8:14 PM CDT

Title: Solidworks produced PDF of new LED design

Date: 10/8/23

Content by: Jack

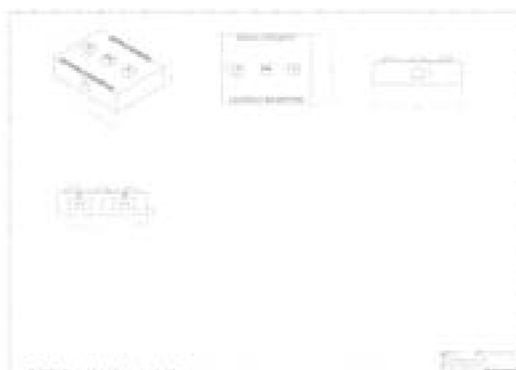
Present: N/A

Goals: Upload a copy of the PDF produced by solidworks for the current dimensions of the LED box

Content: Attached is the updated PDF but does not have all dimensions labeled due to this being a first round look at the box

Conclusions/action items: Continue to update the part file as well as this drawing file as updates to the LED device continue

Jack Sperling - Oct 08, 2023, 8:14 PM CDT



Download

LED_PDP_PicDraft.pdf (76.3 kB)

10/15/23 - Length of Shock and Impedence

Jack Sperling - Oct 19, 2023, 9:36 PM CDT

Title: Length of Standard Shock and Impedance

Date: 10-15-23

Content by: Jack Sperling

Present: Whole Team

Goals: Identify the average impedance of the body during defibrillation and time the shock is delivered

Content: The average impedance of the path between the two cardiac pads is around 70-80 ohms and the average time to deliver the shock over is 17 milliseconds

https://www.aedleader.com/how-defibrillator-voltage-works/

https://www.intechopen.com/chapters/62457

Conclusions/action items: This information is crucial for delivering our shock correctly

Jack Sperling - Oct 19, 2023, 9:37 PM CDT

Additional link that may provide extra information about impedance.

Average impedance is 76.7 ohms, but range is 51 to 112 ohms.

https://www.mdpi.com/1424-8220/22/7/2808

11/10/2023 - Tong Lecture Notes

Jack Sperling - Nov 10, 2023, 12:55 PM CST

Title: Tong Distinguished Lecture Series

Date: 11/10/2023

Content by: Jack

Present: N/A

Content:

- Each person's story is different and we form our own path in life
- Excited to get hands on but need to learn basics first
    - Able to channel energy into completing these classes to define path
    - Finding success in problem based learning
- Take the inspiration from the LVAD and take that into changing a patient's life
    - Find passion --- using technology to assist people with better lives
    - Be engaged in the community to help others
- Life is not always a straight line and may be forwards or backwards
- Everything is part of your story, no matter what
    - Do 3 things
        - Find your people
            - Going to meet really cool people who may not be engineers
            - Exposed to things that you don't get exposed to normally in engineering
            - Open the door for the person behind you
        - Do things that scare you (just a little bit)
            - If too comfortable, they are too easy
            - Same people who supported you before will continue to support you
            - May not be engineering or science, it was real world big impact
            - There are people there with you
            - Lean into your dreams or you won't know what you're capable of
        - Laugh until you cry, cry until you laugh
            - Lots of sacrifices
            - Need resilience
                - She didn't match for residency
                - Had to lean into that -- pivot and lean into strengths and not in this alone
                - Use people you know to support this
                - Someone is counting on you
        - Everyone is counting on you
- Now, living the dream
    - Working at exact sciences seeking to eradicate cancer
    - How to do this for all people, not just for those with insurance
- Passions today will not leave tomorrow
    - Use experience and opportunities to tell your story
    - Doing things in the past propels us forward
- Having a bigger purpose and finding your people
- "It's just practice" -- lean into the practice. It's ok if you fail.
    - There are people counting on you
- Embrace the suck
    - Get to point to laugh about the past

    - Lean into enjoyable moments
    - Don't forget incredible moments in your life
- Check in with what you like and don't like and how that will change your life
- Learn to accept help
    - You are strong but learn to accept help
    - Learn to not sweat everything

Conclusions/action items:

12/11/2023 -- Images from testing the prototype

Jack Sperling - Dec 11, 2023, 5:30 PM CST

Title: Image of Testing the Final Device

Date: 12/11/2023

Content by: Jack

Present: Hunter (for final final testing) and Becca (for bypass testing)

Goals: Determine if the final device correctly functions by testing both the bypass circuit and DSD functionality

Content:

Image 1: Testing the DSD functionality of the device with the rhythm generator and the smart manakin (Sim-man)

Image 2: Testing the bypass function of the device with the Sim-man

Conclusions/action items:

The results of the bypass and DSD tests are in the team section of the notebook and in the final poster. In summary, the bypass circuit worked flawlessly providing a direct connection from the pads to the lifepak. The DSD circuit was tested in the BME lab, which was found to be working and correctly with the diodes directing the electricity depending on the phase. The DSD circuit did not cooperate with the lifepak's logic and therefore the lifepak did not recognize any rhythm and was unable to test.

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

HUNTER BELTING - Sep 14, 2023, 9:47 PM CDT

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

2014/11/03 - Research Template

REBECCA POOR - Sep 09, 2023, 2:48 PM CDT

REBECCA POOR - Jan 24, 2023, 7:53 PM CST

Title:

Date:

Content by:

Present: N/A

Goals:

Search Term:

Link:

Citation:

Content:

Conclusions/action items: