KSCST

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Government of India

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STUDENT PROJECT PROPOSAL FOR THE 47th SERIES OF STUDENT PROJECT PROGRAMME

1.	**Name of the College: DAYANANDA SAGAR COLLEGE OF ENGINEERING**
2.	**Project Title: DESIGN AND DEVELOPMENT OF IMMERSION COOLED BATTERY PACK FOR ELECTRIC VEHICLES.**
3.	**Branch: AUTOMOBILE ENGINEERING**
4.	**Theme: ELECTRO-CHEMICAL DEVICES**
5.	**Name(s) of project guide(s):** **1. Name: Dr. S JENORIS MUTHIYA** **Email id: jenorismuthiya-au@dayanandasagar.edu** **Contact No.: +919094411654**
6.	**Name of Team Members** **Name: VAROON MARIAN A S** **USN No.:1DS20AU029** **Email id: varoon3108@gmail.com** **Mobile No: +917338232225** **Name: GANESHA T** **USN No.:1DS21AU407** **Email id: ganesht1312@gmail.com** **Mobile No.: +919035367446** **Name: MOHAMMED HAYATH SHARIFF** **USN No.:1DS21AU413** **Email id: hayatushariff11092@gmail.com** **Mobile No.: +919972953707** **Name: SUJITH M C** **USN No.:1DS21AU421** **Email id: sujithchandramurthy@gmail.com** **Mobile No.: +917619376641**

7.	**Team Leader of the Project:** **Name: VAROON MARIAN A S** **USN No.: 1DS20AU029** **Email id: varoon3108@gmail.com** **Mobile No.: +917338232225**
8.	**Processing Fee Details (Through Online Payment only):** **(processing fee of Rs. 1000/-)** **Please furnish the payment made details provided in the last page of this proposal.** **Note:** (The student team shall furnish the details in the Google Form. It is informed to the students to 1) keep ready the project proposal and 2) make the payment made details for processing fees and 3) Enter the details in the Google Form on the same day of payment made to KSCST by NEFT / UPI payment).
9.	**Date of commencement of the Project: 2nd November, 2023**
10.	**Probable date of completion of the project:**
11.	**Scope / Objectives of the project:** **SCOPE:** • The worlds transportation is moving towards electrification. Lithium based batteries are the most widely used commercial battery in all EV segments. • Lithium-based batteries are experiencing thermal runaway, a self-perpetuating and uncontrolled increase in temperature, which may lead to overheating, fires, or even explosions. This risk is particularly heightened if the battery is damaged or subjected to extreme conditions. • This project addresses the above-mentioned problem statement • The major scope of the project is to develop a battery pack for EVs with an efficient cooling system. • Immersion cooling and phase change material cooling is a novel technique and it is much needed to control the rise in temperature of battery at difference driving conditions. **OBJECTIVES:** • To develop a novel advanced battery thermal management system for maintaining the batteries within their optimal temperature range. • To reducing thermal Runaways / battery accidents for electric vehicles. • To enhance effective battery cooling by adopting immersion cooling methods and phase change material cooling. • To design and analyze the battery pack and validate thermal efficiency by varying coolant, material flow rate & load • To design and develop and test the battery pack in different conditions.

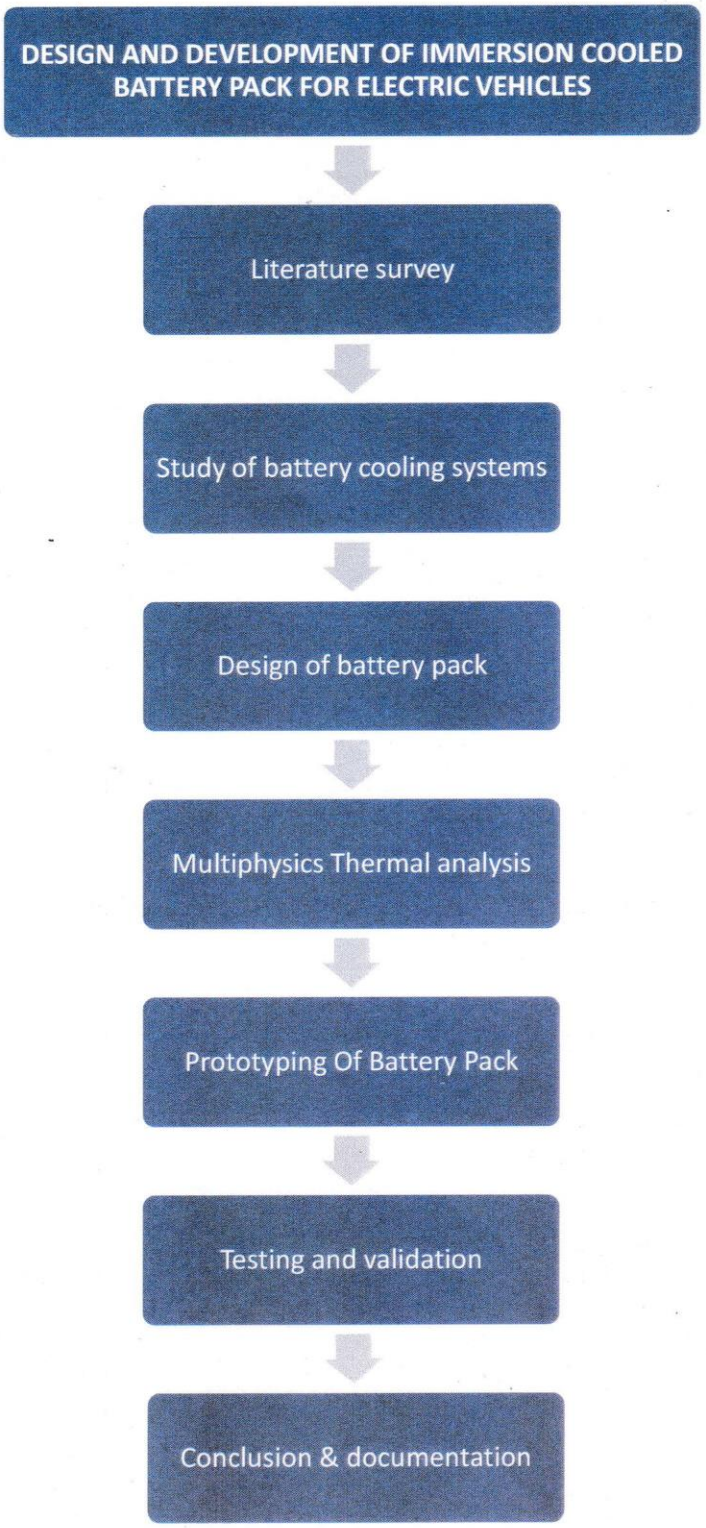
Fig 1: Thermal Runway in 2-wheeler.

The performance coefficient of lithium-ion batteries (LIB) is directly proportional to their internal & ambient temperatures.

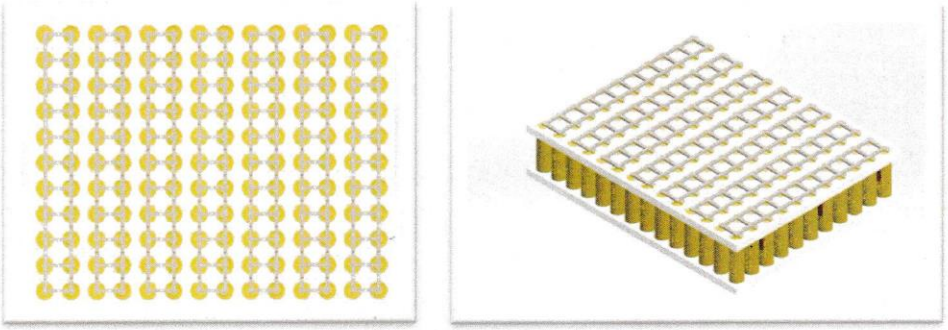
Hence maintaining the battery at an unideal working temperature can have serious consequences like thermal runaway and degrade the battery life as show above. Our project aims to address this research gap in battery technology for EVs.

Immersion cooling technology can provide two-phase cooling, low thermal contact resistance, and high cooling efficiency in comparison to existing BTMS technologies available resulting in safer EV vehicles.

12. Methodology:



BATTERY PACK DESIGN

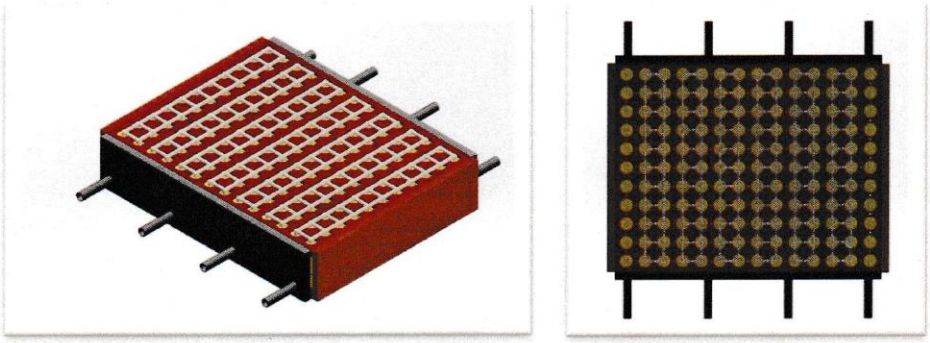


A **B**

Fig 2 (A): 18650 cell packing (Top view)

Fig 2 (B): 18650 cell packing (ISO view)

The battery pack comprises of a total of 143 lithium ion 18650 cells arranged as 14 in series and 11 in parallel for a combined battery pack specification of 51.8V and 27500 mAh resulting in capacity of 1.42Kwh.



A B

Fig 3 (A): Battery pack (ISO view)

Fig 3 (B): Battery pack (top view)

The battery pack was designed to be retrofitted in conventional Indian mopeds based on the existing average dimensions of the floorboard. It was considered with upmost priority that the battery pack was leakproof and had efficient thermal conductivity thereby ensuring an optimum battery operating temperature.

Layout of battery pack:

Fig 4: cross-sectional view of cooling channels.

Considering a thermal spike at the terminals during then operation of a cell, the objective was to arrest the heat at the terminals. This resulted in designing a complex cell holder which is made from anodized aluminum 6061 ensuring enhanced thermal conductivity and electrical insulation followed by water cooled copper channels laid over the machined aluminum sheet to ensure higher rate of heat dissipation. At last, a layer of ABS plastic was placed upon to complete the assembly and provide insulation at the terminals.

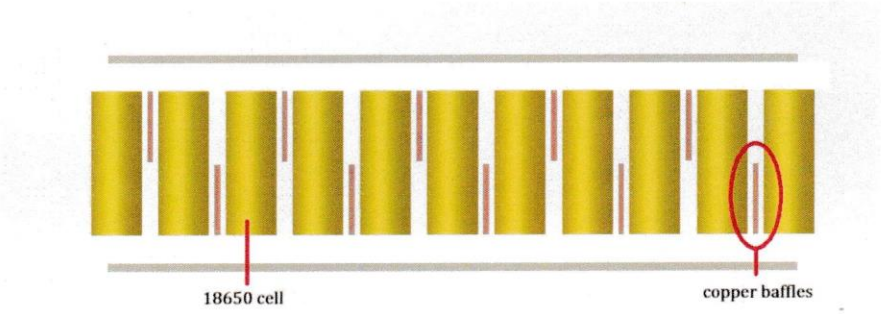


Fig 5: Cross-sectional view of battery pack.

In order to prevent turbulence in fluid motion and uneven heat distribution, copper sheets held at the cell holders are exposed to heat within the battery pack which aid in heat transfer from source to surrounding.

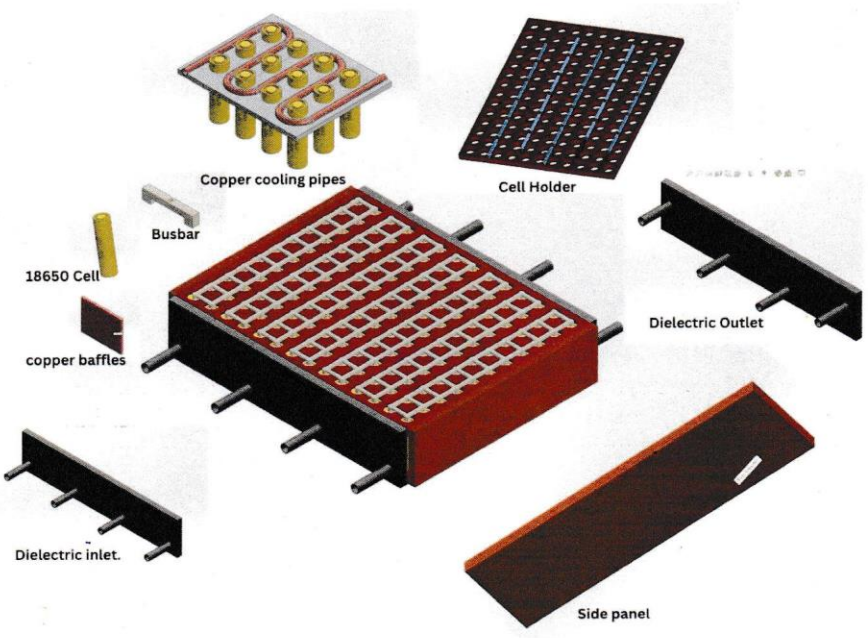


Fig 6: Battery pack layout

Above attached is the layout of the battery pack which represents each of its components.

In order to optimize cooling, we propose the utility of water cooling at the terminals and 2 phase dielectric cooling within the pack. Thermocouples are placed within the pack to detect the battery temperature. Once the battery reaches operating temperature the actuated flow rate of dielectric is initiated this setup with an optimized seal proof design ensures that the battery pack stays cool even at higher discharge rates and thermal runaways of the pack can be reduced drastically.

Graphical representation of coolant flow

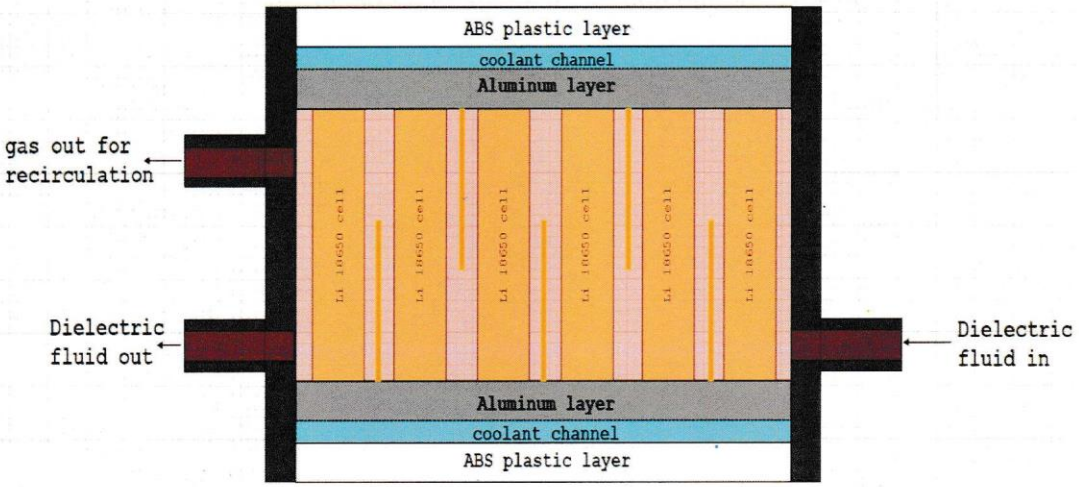


Fig 7.1: dielectric flow representation.

Graphical representation of dielectric flow

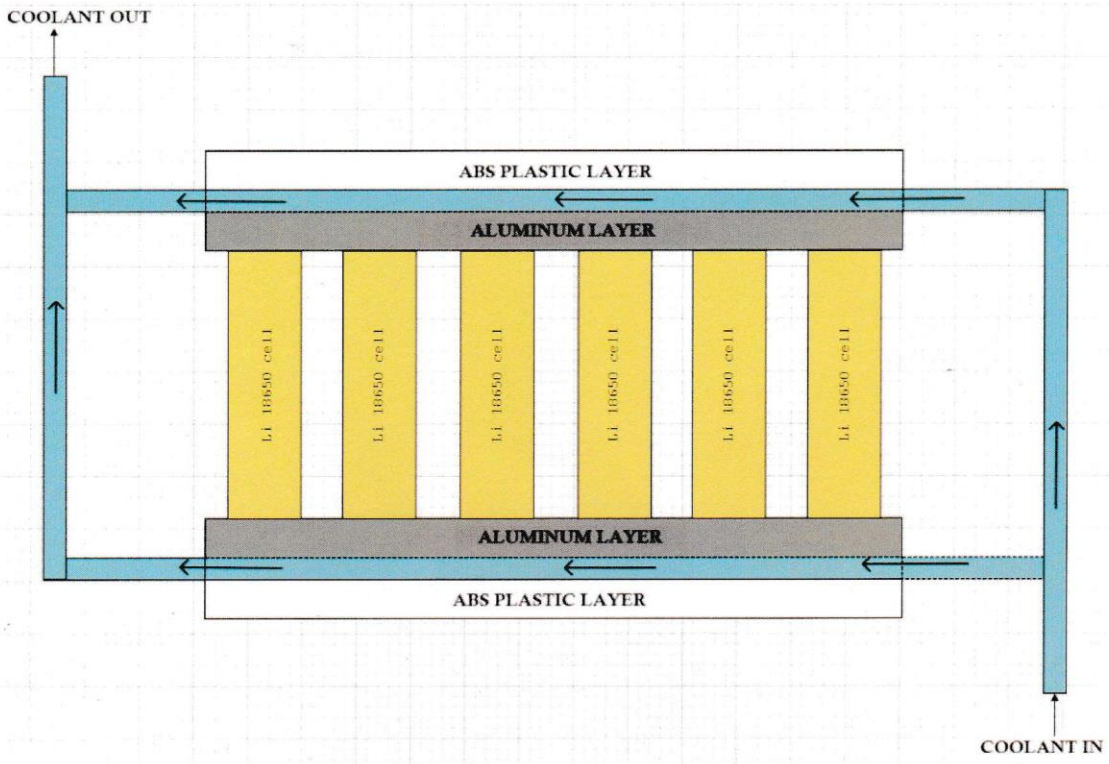


Fig 7.2: Coolant flow representation

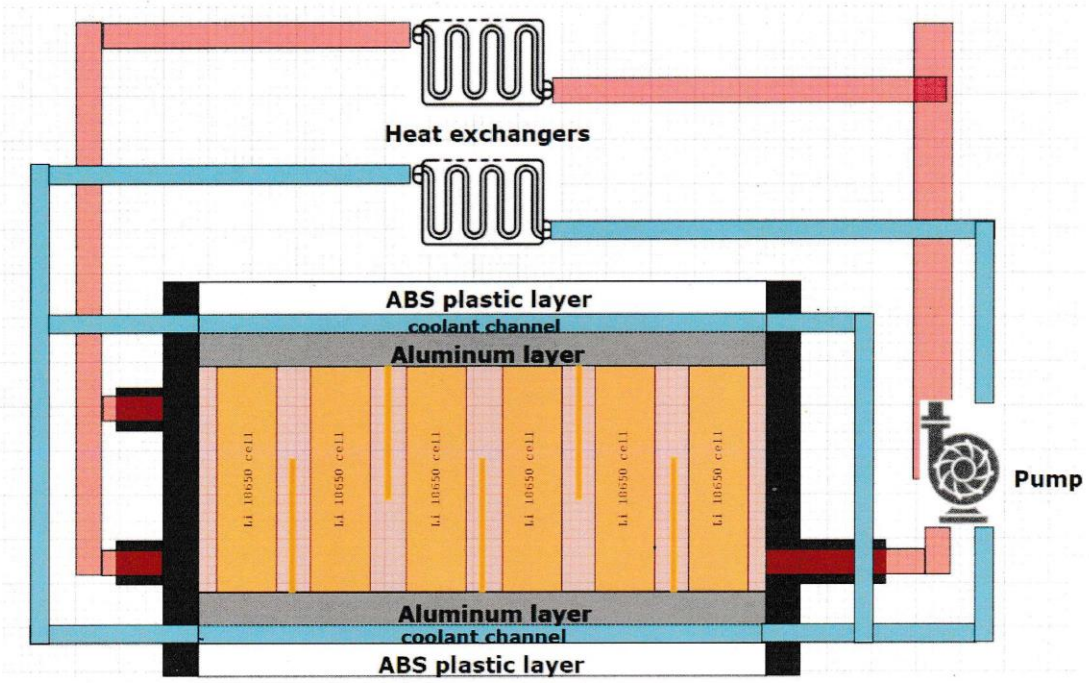


Fig 8: Battery Cooling system layout

- We have channeled water cooling through the copper tubes near top and bottom aluminum plates so that the cell battery tab remains cool. This results in extending the battery life
- The battery pack is designed to work at optimum temperature even at high discharge rates.
- Two cooling channels are used as shown in figure to cool the battery based on usage.
- During discharging the dielectric flows through the pack cooling the core
- During charging the terminals are cooled by the coolant flow in copper channels.
- During operation the dielectric fluid and Coolant are cooled using heat exchangers and a 2 in 1 pump.

Timeline Chart

Tasks	Actions to be executed	Nov	Dec	Jan	Feb	March	April	May	June
1.	Literature Survey								
2.	Design Phase								
3.	Analysis Phase								
4.	Testing and Validation								
5.	Fabrication								
6.	Assembly								
7.	Final Testing and conclusion								

We initiated our literature review researching regarding advancements in battery thermal management systems. After discussions we narrowed down to immersion cooling system. Iterations were done by various the flow rate of the dielectric and water and by varying the discharge rate of the battery pack. After simulation runs in Simscale and a few design optimizations the battery pack was finally manufactured considering all safety standards.

	Expected Outcome of the project: • A safe EV battery back will be designed and developed. • An efficient battery thermal management system will be developed for EVs • Significant reduction in thermal runaways and accidents. • Improved battery performance, range, and lifespan. • Better heat dissipation and temperature control. • Successful validation under varying coolant, flow rate, and load conditions. • By this concept EV Battery accidents will be controlled effectively. • An Indian patent has been drafted and will be applied for filling on 'Design and Development of Immersion Cooling for Electric Vehicles" • The project results will be published in a Scopus index International Journal. And also presented in international conference. • The project will be approached for EV industry collaborations for implementation in automobiles.
13.	**Is the project proposed relevant to the Industry / Society or Institution?** **Yes / No: Yes** **If yes, please provide details of the industry / institution and contact details:** Lithium-ion batteries are highly temperature sensitive and efforts have been made to optimize cooling thereby maintaining cell temperature. Currently Li-ion batteries in Electric Vehicles demand fast charging and discharging which result in steep temperature rise over limited time leading to battery health degradation and thermal runaway. Our project proposal can maintain battery temperature under varying loads and external temperatures which is the current technological gap in the industry.
14.	**Can the product or process developed in the project be taken up for filing a Patent?** **Yes / No: Yes** We have done the market survey and such a product is not available and we have simultaneously started working on the process of applying and acquiring an Indian patent for the project.

Prior Art search done?

Yes/No: Yes

Note: If your answer is "Yes", you may contact Patent Information Centre of KSCST. For more details, email: pic@kscst.org.in

15. Budget details (break-up details should be given):

Note: KSCST will provide nominal grant support for carrying out the project by students if selected by the project selection committee.

Budget	Amount
a) Materials / Consumables	
AL6061 (35x35x5)	Rs. 200
Oxalic acid for anodizing	Rs. 100
ABS plastic 5mm thickness	Rs. 2000
Copper tubing 1.5 metres (6.35mm quarter inch)	Rs. 1000
Copper busbar	Rs. 4000
18650 lithium-ion 143 cells	Rs. 18,590
Copper baffle 30mm*25mm*2mm	Rs. 1500
Aluminium (75x362x5 mm)	Rs. 1500
b) Travel	
Transportation	Rs.3000/-
c) Miscellaneous	
Battery Equipment	Rs.1000/-
Testing	Rs.3000/-
Electronics Equipment	Rs.2000/-
Other Miscellaneous Items	Rs.2000/-
Total	Rs.39890/-

16. Any other technical details (Please specify):

Battery Pack Configuration: 14S 11P

Hybrid immersion cooling system using water and dielectric fluids through separate cooling channels.

17.	**SPP Coordinator (Identified by the college):** **Note:** To be identified by the principal of the institution. The project proposals must be submitted to KSCST through SPP coordinator designated by the Principal. **Name: Dr. S JENORIS MUTHIYA** **Email id: jenorismuthiya-au@dayanandasagar.edu** **Contact No.: +919094411654**

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