# EXAMINING THE EFFECTIVENESS OF EM SHIELDING MATERIALS FOR APPLICATIONS IN RC VEHICLES

## Background and issue

- Conventional shielding methods using solid metal are heavy, boxy and rigid which could negatively affect the performance of the device shielded.

*Shielding Effectiveness (SE) = Signal strength before shielding - Signal strength after shielding*

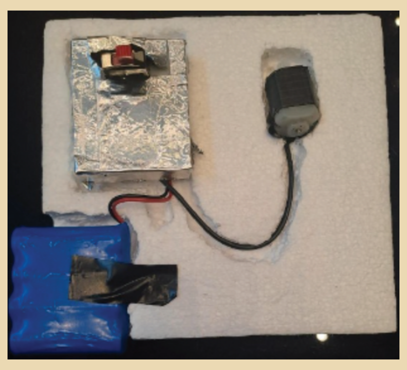
## Solution

Shielding an RC vehicle using materials with various **conductivity**, **skin depth** and **permeability** to determine the optimal shielding material and method.

## Research objective

To find out which shielding material and shielding method is the best suited to use in application when shielding an RC vehicle from a noisy environment of EM emissions.

Testing bed



## Testing method

- ✓ Placed at the same position in the GTEM cell each time to keep the distance from the antenna constant
- ✓ Isolated components for individual emission testing

GTEM cell

## Methodology overview

Source for materials with EM shielding properties (conductive) → Measure the initial SE of the RC vehicle inside a GTEM chamber → Record emissions of different shielding methods / Record emissions of different shielding materials → Determine the material and method which has the highest SE → Shield the RC vehicle and place it inside the GTEM chamber to measure the final SE

## Equipment and data collection

Emission measurements were recorded using a spectrum analyser & sniffing done using a near field probe

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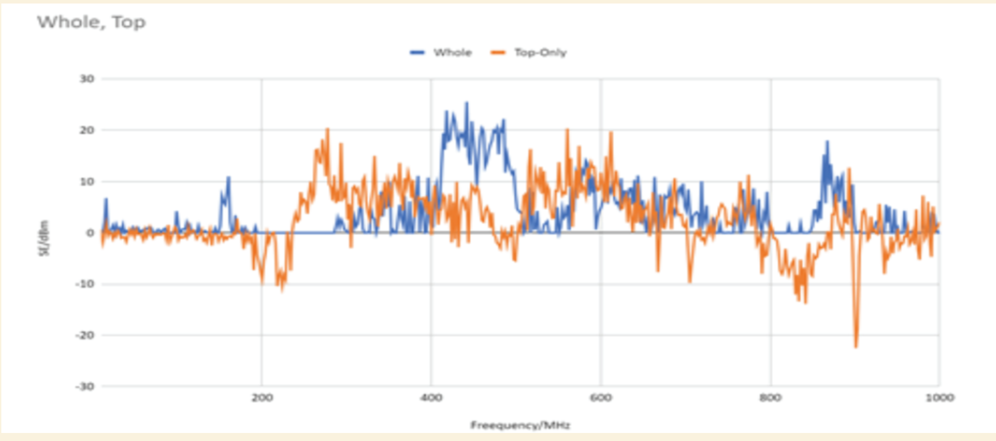
Plotted points were then translated into a graph using excel to compare trends

## Experimental Results - Best shielding method




- ✓ Whole indicates shielding around all sides of the PCB enclosed inside a 3D printed box
- ✓ Top indicates shielding of IC chips in the PCB

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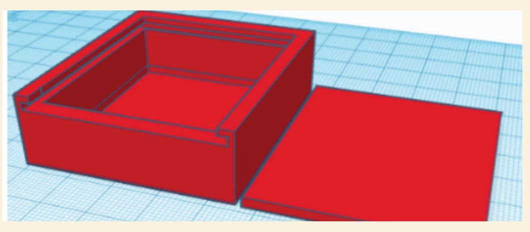
WHOLE shielding is **MORE** effective!

### PLA printed 3D box



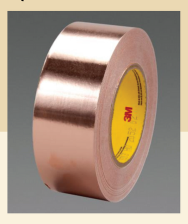
PLA is **STRONG** + **non conductive**

- ✓ Prevents short circuits
- ✓ Reduces apertures
- ✓ Standardisation of shielding material surface area

## Experimental Results - Best shielding material

### Conductive tapes

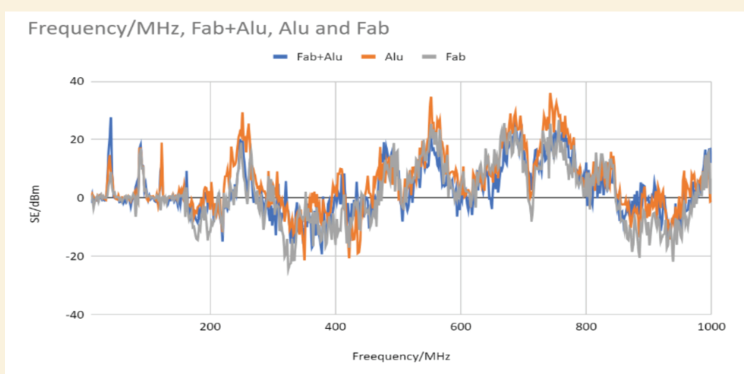
+ Good for closing apertures
+ Hassle free application
- Smaller than fabrics (hard to wrap large components)
- Costly



### Conductive fabrics

+ Flexible (easier to wrap irregularly shaped components)
- Thin, high permeability
- Poor conductivity, high skin depth

### Graphed data




After narrowing down 9 different materials,

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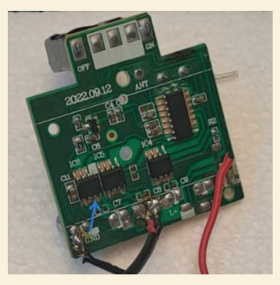
2 layers of **aluminium tape** gives the highest SE

### Components to shield



Printed Circuit Board (PCB)

Motors (1 forward, 1 backward) + Wire

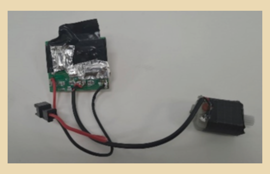
### Final performance

**47g** (shielding material + box)
**8g** (shielding material)

- Minimal effect to the speed and range of RC vehicle
- 2.4GHz bluetooth frequency communication maintained

## Considerations and Conclusion

Offers up to **36.06dBm** of shielding effectiveness at **742.6MHz**



Conductive shielding tape offers good shielding effectiveness BUT will increase the overall weight if solution is excessively applied. → Identify the source of emissions to minimize shield application → Shielding selective components is more cost and weight efficient

## Future work

- Application in Unmanned Aerial Vehicles (UAVs)
- Scalability of shielding method
- Developing a structurally strong conductive material that can be used as the primary casing material of electrical components
- Reduction of weight of PLA box (85% of weight is the PLA box)

[1] Geetha, S., Kumar, K. K. S., Rao, C. R., Vijayan, M., & Trivedi, D. (2009). EMI shielding: Methods and materials—A review. Journal of Applied Polymer Science, 112(4), 2073–2086. [2] Design Prototype Department, Design Prototype Department, & By Design Prototype Department. (2023, May 4). Designing a PCB Faraday Cage. VSE. https://www.vse.com/blog/2023/05/11/designing-a-pcb-faraday-cage/ [3] C. R. Paul, "A comparison of the contributions of common-mode and differential-mode currents in radiated emissions," in IEEE Transactions on Electromagnetic Compatibility, vol. 31, no. 2, pp. 189-193, May 1989, doi: 10.1109/15.18789. [4] James Niemann (2013, February 15) Understanding Grounding, Shielding and Guarding in high impedance applications. https://www.edn.com/understanding-grounding-shielding-and-guarding-in-high-impedance-applications/

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