



# Magnetic Levitation Rail System

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## Introduction

Magnetic Levitation (Maglev) technology is not well understood in the United States. Most Americans with the mention of Maglev only think about the bullet trains in Japan and Europe when Maglev technology could be applied to a variety of industries.

The Maglev team has designed and constructed a Maglev rail system using two different concepts. Solenoids for propulsion, permanent magnets for levitation. The Maglev team's goal with this rail system is to demonstrate and educate others on Maglev technology. And how Maglev technology can be implemented to a wide variety of uses.

## House of Quality

Using our engineering characteristics and customer requirements, the team created a house of quality shown in Table 1. This made clear what's most important when coming up with the designs.

Customer Requirements	Engineering Characteristics									
	Importance	Impact								
Performance of Product	100	8	8	8	8	8	8	8	8	8
Cost	7	5	5	5	5	5	5	5	5	5
Safety	8	5	5	5	5	5	5	5	5	5
Reliability	7	5	5	5	5	5	5	5	5	5
Usability	8	5	5	5	5	5	5	5	5	5
Portability	8	5	5	5	5	5	5	5	5	5
Space	8	5	5	5	5	5	5	5	5	5
Lightweight	8	5	5	5	5	5	5	5	5	5
New Feature (100%)	100	100	100	100	100	100	100	100	100	100
Importance %	63.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Impact %	6.7	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2

Table 1. House of Quality

## Project Design Specifications

A product design specification (PDS) is a statement of how a design is made, what said design is intended to do, and how far the design should comply with the requirements

### Product Identification

Product Name: Mag Lev Demo

Basic Functions of the Product: The function of the product is to Demonstrate the effects of magnetic levitation.

### Special Features of the Product:

Photosensor control  
Produces magnetism in two different methods  
Designed for educational purposes

### Key Performance Criteria:

System needs to be repeatable  
System needs to be scalable  
System needs to be directional (move back and forth)

### Physical Description

#### Material:

Wood  
Electrical components  
permanent magnets  
PLA or ABS filaments

#### Weight/Tapers:

40lb  
External Dimensions: 4ftx1.5ft

#### Financial Requirements

Target Manufacturing Cost: \$700 to \$800

#### Life Cycle Targets

Useful Life: 5 to 10 years

#### Social, Political, and Legal Requirements

Standards: NSPE, IEEE, ANSI, ASME

#### Manufacturing Specifications

Suppliers: Amazon, Mouser, Lowes, eBay

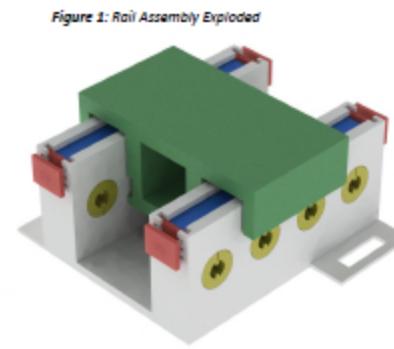


Figure 3. Cart and Rail

## Circuit Diagram

Figure 5 shows a breakdown of the Circuit

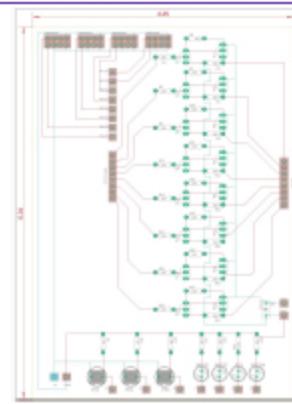


Figure 5. Circuit Diagram

## Acknowledgements

Special thanks to an anonymous donor for their donation and support for this project.

## Design Renderings

Figure 1 shows an exploded view of the propulsion section of the rail system. Figure 2 shows an exploded view of the cart. Figure 3 shows the cart and the propulsion section of the rail. Design Parameters are located in Section III of the Final Report.

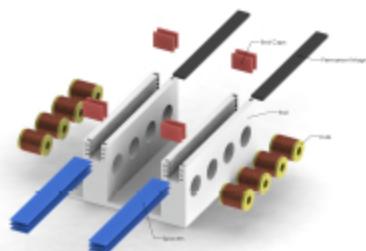


Figure 1: Rail Assembly Exploded

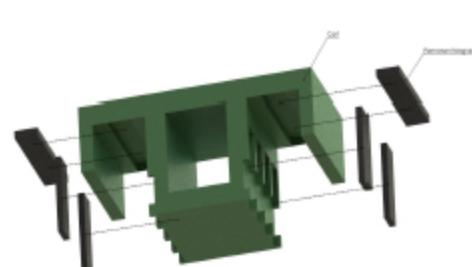


Figure 2. Exploded Cart

## Schematic Diagram

Figure 4 is a representation of how the electrical components fit together.

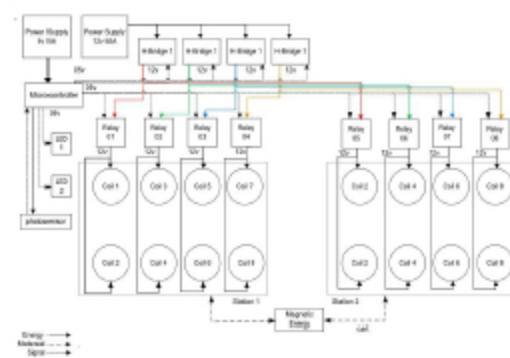


Figure 4. Schematic Diagram

## Failure Mode and Effect Analysis

Table 3 is used to brainstorm on possible ways the rail system could fail. Rate the severity (S), likelihood of occurrence (O), and the chance of detection (D) of the failure. Develop a Recommended action to stop the failure or reduce the S or O of the failure. And reassess the S, O, and D for after applying the recommended corrective action.

Failure	Failure Mode	Effect of Failure	Cause of Failure	Failure Modes and Effect Analysis (Table 3)				Recommended Corrective Action
				S	O	D	SOD	
Propulsion Section	New coil(s) of rail	Attraction of coils	Attraction of coils that are not the rail	8	8	8	64	Replace coil(s) of rail with correct coil(s)
Propulsion Section	Attraction of rail	Attraction of rail	Attraction of rail that is not the rail	2	4	1	8	Replace rail(s) that are not the rail
Cart	Cart moving right	Cart to move right	Cart to move right	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart moving left	Cart to move left	Cart to move left	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart not moving	Cart not to move	Cart not to move	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart moving	Cart to move	Cart to move	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart not moving	Cart not to move	Cart not to move	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart moving right	Cart to move right	Cart to move right	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart moving left	Cart to move left	Cart to move left	8	8	8	64	Replace photosensor, change code for detection range
Cart	Cart not moving	Cart not to move	Cart not to move	8	8	8	64	Replace photosensor, change code for detection range
Power	Loss of power	Complete loss of power	Loss of power supply, loss of power from solar	8	8	8	64	Replace solar panel, replace solar panel with another

Table 3. FMEA Table

## Parts List

The Table 2 below show the items, part numbers, and quantity of the parts used in the rail system.

Engineering Parts List (Team 03) - MagLev Project		
Item Description	Part No.	Quantity
Arduino Mega 2560	752-A000067	1
Magnets	10x20x2 (mm)	40
Magnets	10x20x2 (mm)	48
Photo Sensors	-	2
LED lights (green)	-	1
LED lights (red)	-	1
LED lights (White)	-	2
Switch power supply adapter (12V 50A)	12V 50A 600W	1
Relay	JD2812-1H-12VDC 40A	8
H-bridges	BT57960 43A	4
Half H-Bridge	-	8
Solenoids	-	16
Cart	-	1
Rail	-	2
Support Rails	-	4
Spacers	-	10
End Caps	-	12

Table 2: Engineering Parts List

## Results/Conclusion

The Maglev team was able to successfully design and build a working demonstration of a magnetic levitation rail system using solenoids for propulsion and permanent magnets for levitation. Using these two different methods, the cart successfully travels from one end of the track to the other in a controlled system.

## Recommendations For Redesign

- Redesign coils
  - Coils need to be keyed (for easier replacement)
  - Heatsink for coils (add ventilation)
- More sensors for relays
  - Result in less coding and more accuracy
- Run system off one power supply (12V)
  - Simplifies circuit
  - Reduces cost