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PEAT

The Analysis of Sloshing Reduction System Performance through Implementation of Tune Mass Damper (TMD) Technology into the Fully Filled Downscaled Flexitank

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Liquid Sloshing, Downscaled Flexitank, Tune Mass Damper, Force Sensing Resistor, Sloshing Energy.

Abstract

This bachelor final year project is about the study of Tuned mass Damper (TMD) trial application into the liquid sloshing structure of Downscaled Flexitank (DF) with flexible wall and fully filled condition, a structure of supporting plate that is constructed by ellipsoid curve and undulated layer is used as the TMD support system. This fabrication processes are included prototype development and TMD design on the flexitank. The experimental testing method used by following the standard of ASTM D999-2015, Method A2. A corrugated shipping container in 8 times downscaled is designed by previous student and fabricated by MY Flexitank Sdn Bhd is utilized. The flexitank is made of Linear-Low Density Polyethylene (LLDPE) with thickness 5-mil and specific size. The dimension of flexitank and shipping container are downscaled 8 times. The data type is gained based on the force sensors used which are Force Sensing Resistor with 6 units are placed on the CTU downscaled shipping container platform and connected to the Arduino Uno R3 and Arduino Integrated Developer Environment (IDE). The result and discussion describe about the comparison of sloshing force on different speed and condition against the variation of TMD mass ratio from 1% until 5% subjected to the flexitank loaded mass.

1. Introduction

Commented [1]: Use Topic Style

Liquid sloshing refers to the dynamics of free movement of a liquid inside a container that is not completely full or forcedly fully filled. The phenomenon of sloshing frequently happens on the bulk liquid transfer especially in motion, it is due to the excitation of horizontal motion of the vehicle by acceleration or deacceleration.

The Tune Mass damper (TMD) is a passive vibration control equipment, which consists of a block of mass, a spring (tuner) and a damper. It can dissipate the vibration of a building through a process called tuned absorption. TMD vibrates out of phase, it transfers some of the vibrational energy from the building to itself. This energy is then dissipated through the damper in the TMD, which is often a viscous fluid damper. The damper converts the vibrational energy into heat, effectively reducing the overall vibration of the building. A tuned mass damper (TMD) system's bandwidth around the tuned frequency will slightly expand when a damper is added. By dissipating energy, the damper also lessens the response of the system in mistuned conditions. This implies that a TMD with a damper has a larger frequency range of vibration absorption. The effectiveness and bandwidth of a distributed tuned mass damper (DTMD) system, which consists of several tiny TMDs, can be increased in comparison to a single TMD, which can only reduce vibration in a narrow bandwidth surrounding the tune frequency. This is due to the fact that the TMDs in a DTMD system are naturally tuned at frequencies that are close to the primary structure's vibration mode. Furthermore, employing an impact damper that allows the TMD mass to move freely.

1.1 The Prototype: Sliding TMD

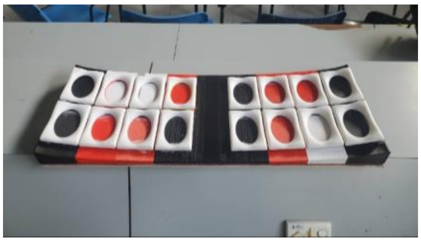

Figure 1.0: The undulated and ellipsoid layer of the TMD Platform

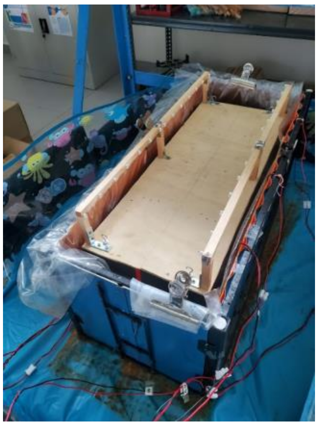

Figure 1.1: The TMD Platform on the Downscaled Flexitank

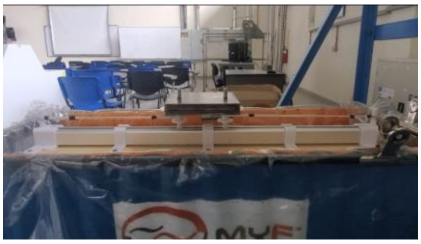

Figure 1.2: The Sliding TMD on the TMD Platform

Material Composition:

- PLA, ABS
- Plywood
- Soft wood block (15x15) mm
- Aluminium Alloy
- Steel Bracket

The structure was built in design of standard horizontal linear TMD which can handle single degree of freedom (SDOF) of the structure.

1.2 Condition Variables

The condition of the experimental testing is built up as can be referred on table 1 below:

Table 1 *Condition Variable for the Experimental Testing*

Condition	Description	TMD Mass
Control	No above load to the tank	0
A	TMD Platform on tank	0
B1%	1% TMD Ratio	W1
B2%	2% TMD Ratio	W1 + W2
B3%	3% TMD Ratio	W1 + W2 + W3
B4%	4% TMD Ratio	W1 + W2 + W3 + W4
B5%	5% TMD Ratio	W1 + W2 + W3 + W4 + W5

1.3 Data Value

The Data presentations are based on the sloshing energy in newton versus sloshing in different condition as below, significantly all the graphs are grouped into different speed.

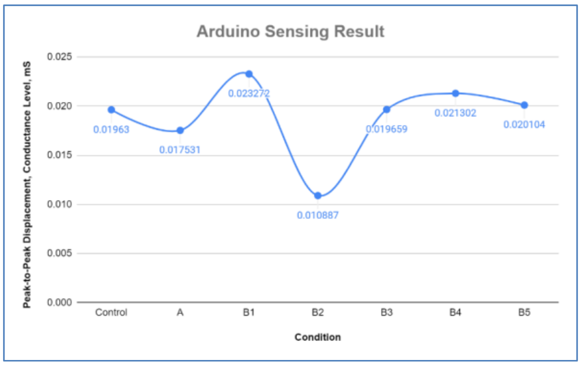

Figure 1.3: Conductance reading of maximum sloshing wave different

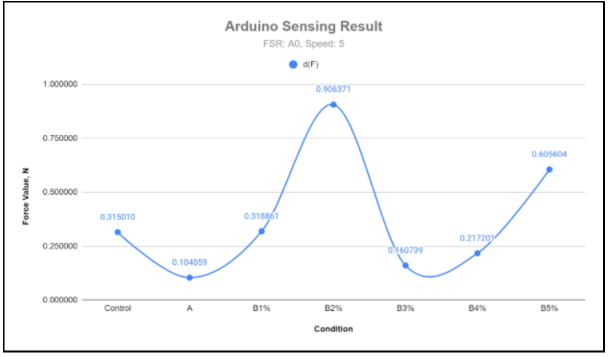

Figure 1.4: Maximum sloshing wave at speed 5

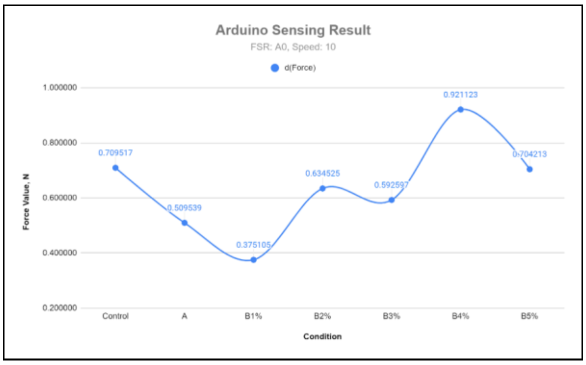

Figure 1.5: Maximum sloshing wave at speed 10

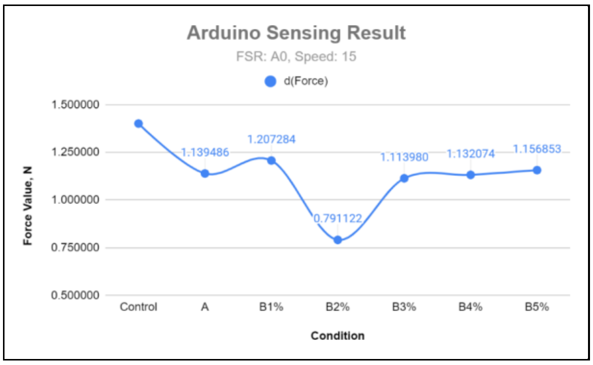

Figure 1.6: Maximum sloshing wave at speed 15

1.4 Discussion

From the data of the graphs, we can know that condition A and B3% can handle sloshing at speed 5 well. that condition B1% speed 10 well. For the condition B2% can handle sloshing at speed 15 well.

Acknowledgement

Commented [2]: Use Acknowledgement Style

The author would like to express his sincere appreciation to his supervisor, Dr Yong Tze Mi for the support given throughout the duration for this research.

The cooperation given by the MYF Myflexitank Sdn Bhd is also highly appreciated. Appreciation also goes to everyone involved directly or indirectly towards the compilation of this project.

Appendix A: An Example

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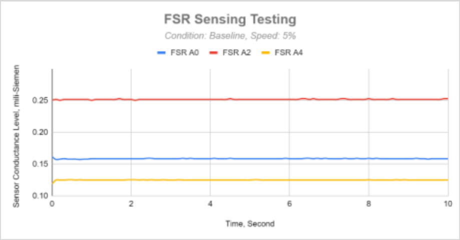
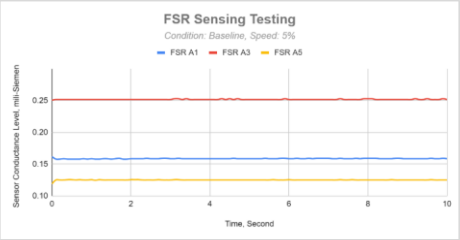
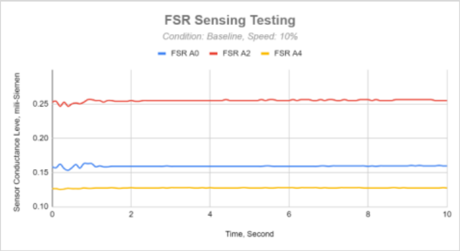
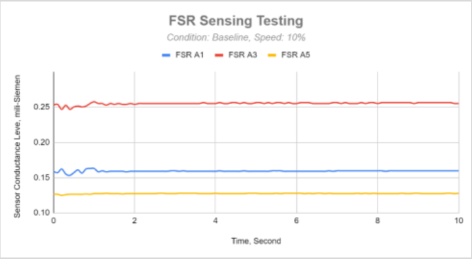
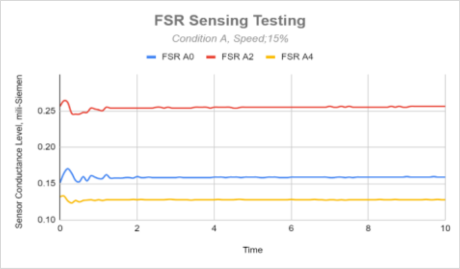
I. Control Condition:

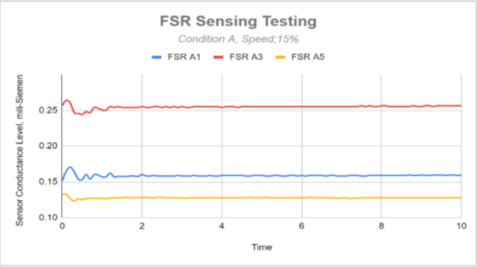




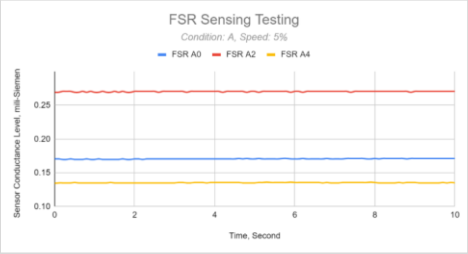


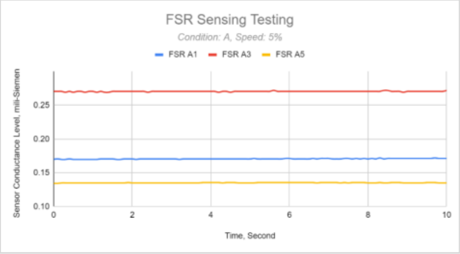


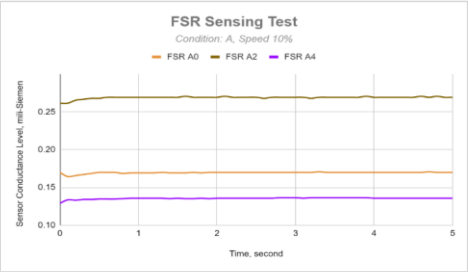


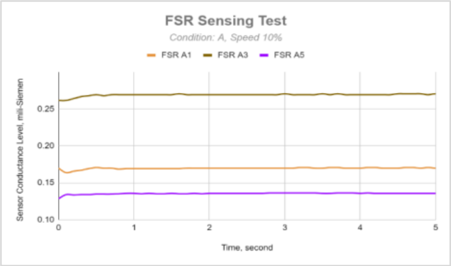


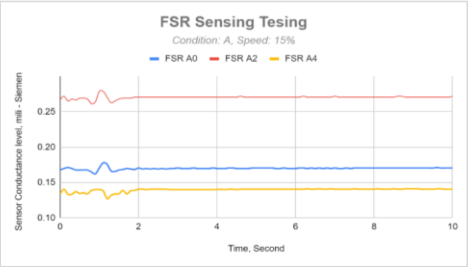
II. Condition A:

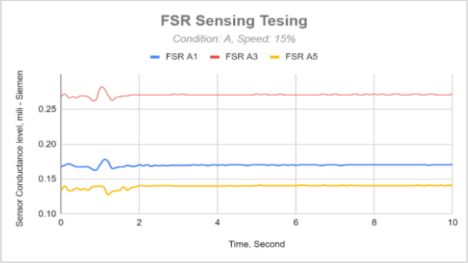




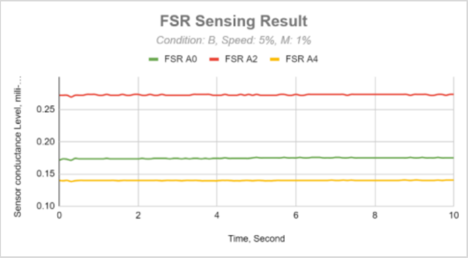


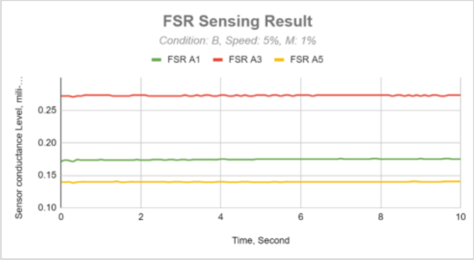


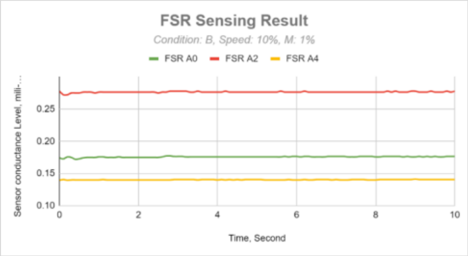




III. Condition B:



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FSR A0
FSR A2
FSR A4
Sensor conductance Level, milli-...
0.25
0.20
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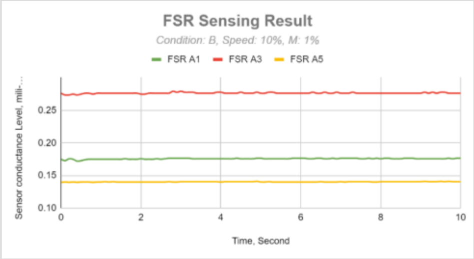
Time, Second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FSR A3
FSR A5
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0.15
0.10
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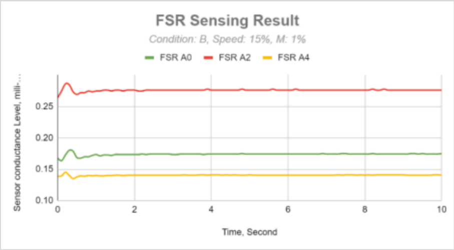
Time, Second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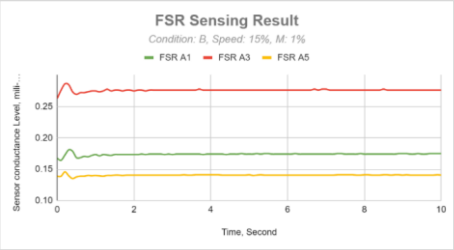
Time, Second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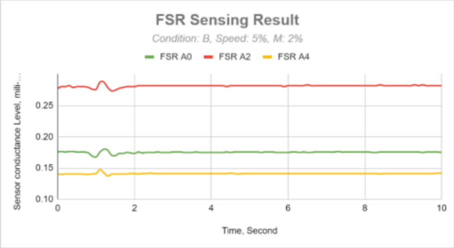
Time, Second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0.15
0.10
0
2
4
6
8
10
Time, Second


FSR Sensing Result
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FSR A1
FSR A3
FSR A5
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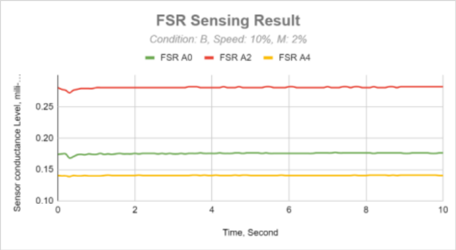
Time, Second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FSR A4
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Time, Second


FSR Sensing Result
Condition: B, Speed: 10%, M: 2%
FSR A1
FSR A3
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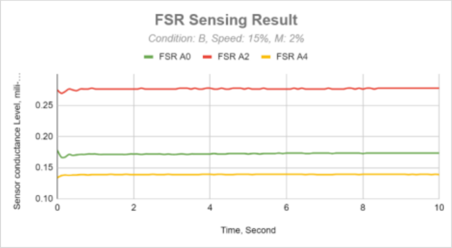
Time, Second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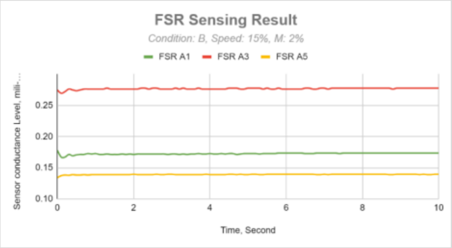
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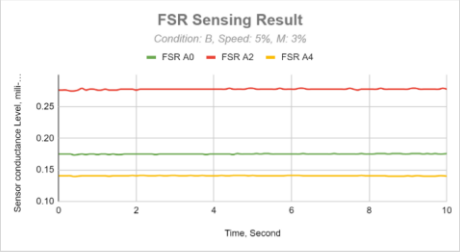
Time, Second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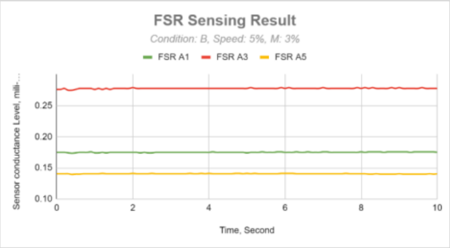
Time, Second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FSR A5
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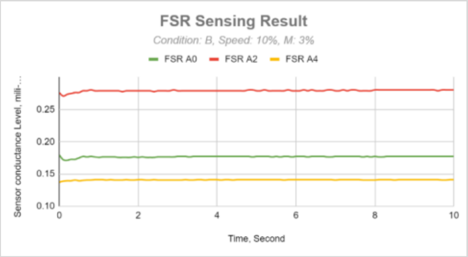
Time, Second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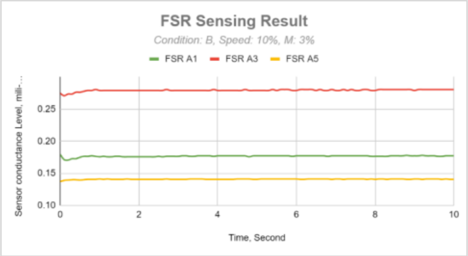
Time, Second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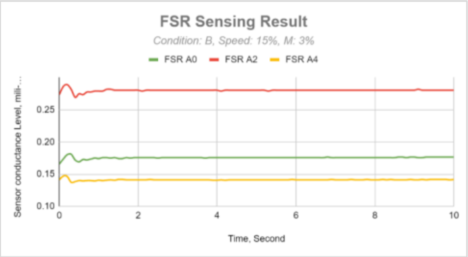
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Time, Second


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FSR A3
FSR A5
Sensor conductance Level, mili-...
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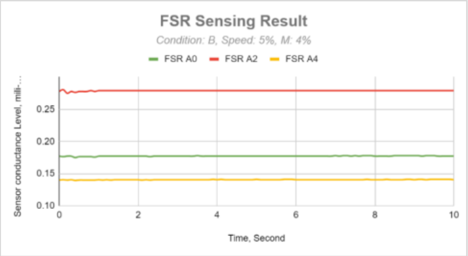
Time, Second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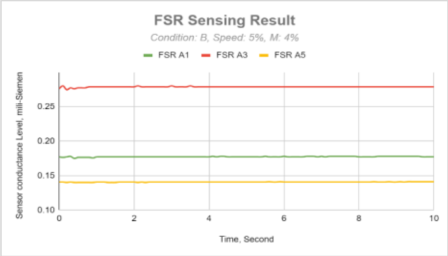
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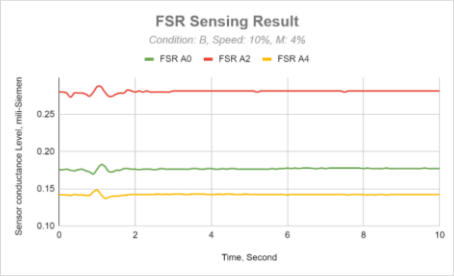
Time, Second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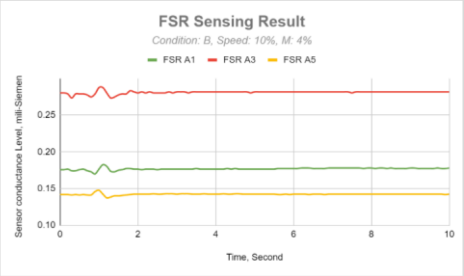
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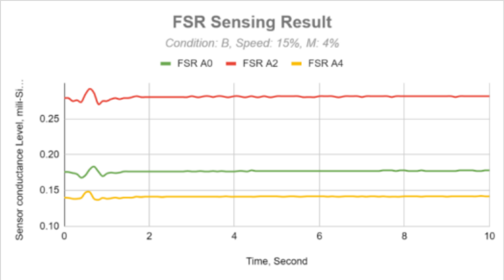

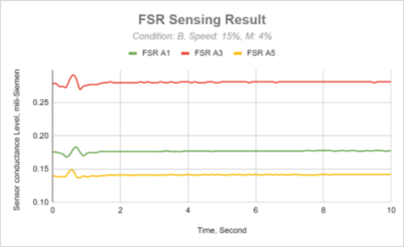

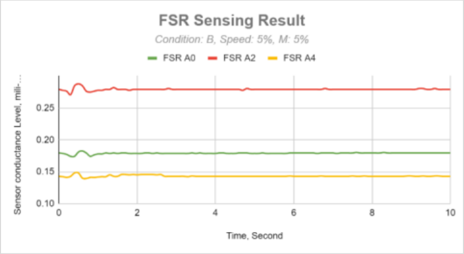

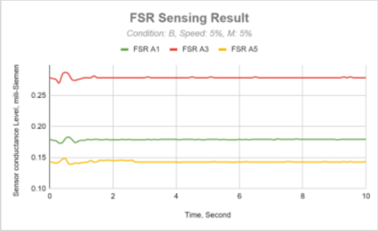

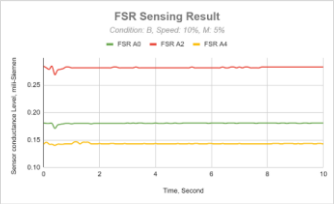

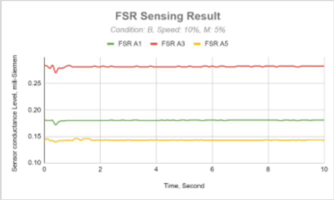

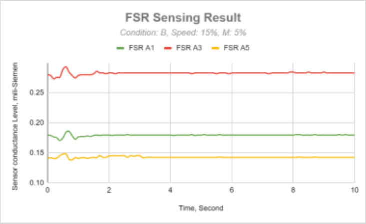

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Commented [4]: Use Acknowledgement Style

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