APPLICATION NOTE

MagneMover LITE Tandem Puck Startup

Purpose

This application note describes the layout concerns associated with MagneMover LITE systems using tandem pucks.

Introduction

A difference between the startup functionality of the MagneMover LITE system with single pucks and tandem pucks can create a corner case where startup may fail on systems using tandem pucks.

Startup Functionality for Tandem Pucks

At startup, the system uses the Hall Effect Sensors (HES) in the motors to identify the positions of all magnet arrays to detect vehicles. For tandem pucks, the system needs to identify which magnet arrays should be "paired" as one vehicle. To do this, the system uses the space between the magnetic fields to determine if the gap between arrays that is larger than the gap between the two arrays on a tandem puck. If the gap is definitively larger than this distance, the system can properly identify that the next magnet array it detects will be the lead magnet array of a new vehicle. Once this is identified for any vehicle on the path, the system can correctly pair all vehicles on the path. Note that this is only a potential issue for tandem pucks, not single pucks.

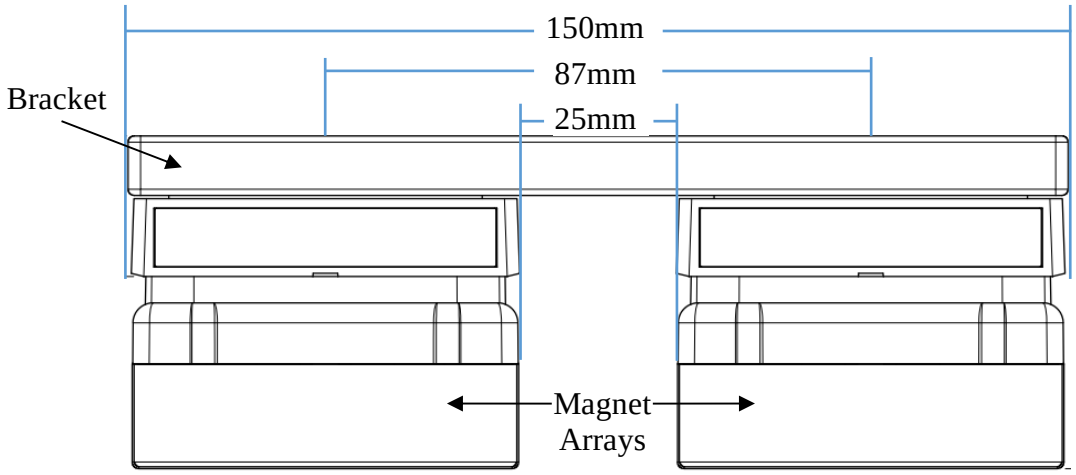

Figure 1: Tandem Puck

Recommended Tandem Spacing

The measured distance between two magnet arrays on the tandem puck is 25mm. The system can definitively differentiate that the distance between two magnet arrays is larger than this distance at a measured spacing (bracket to bracket) of 55mm. This corresponds to a center-to-center distance of 204mm. If there is any area of a path where there is a measured gap of 55mm between tandem pucks, startup will be successful. On the MagneMover LITE system, motor blocks are 16.47mm long. The measured distance of 55mm between pucks translates to a distance of 3.34 motor blocks between tandem pucks.

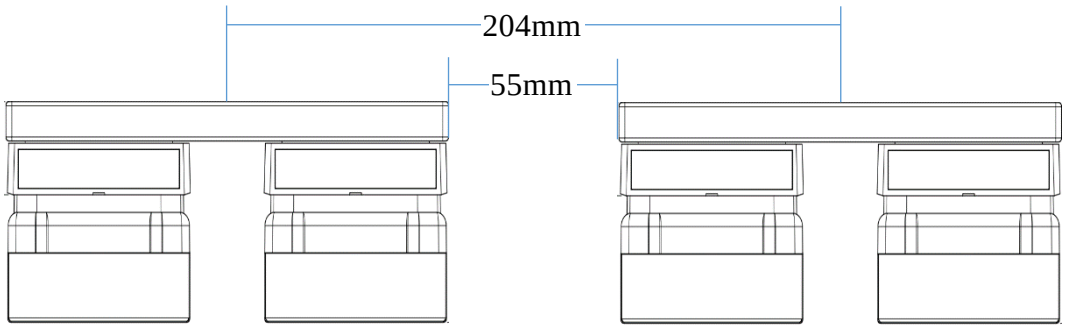

Figure 2: Recommended Tandem Spacing

Examples

Paths that consist of ¼-Meter or Curve Motors

For paths that consist of only a ¼-Meter or Curve Motor, it is possible that startup will fail if there are any tandem pucks on the path. The following examples use sensor maps to describe why this occurs.

Sensor maps are a text-based way of displaying where magnet arrays are detected over the motors. Sensor maps show all motors and motor blocks on the path, where the downstream direction is from left to right, and are displayed in the Node Controller Log File when startup fails.

Sensor map symbols:

|__| One motor block with two Hall Effect Sensors

|_| One motor block with one Hall Effect Sensor

=	Magnetic field signal above threshold value detected at that sensor, but vehicle not located yet. Indicates peak magnetic field at center of magnet array.
V	Vehicle located and array detected at that sensor
v	Vehicle overhang located at that sensor, no magnet array is present but the configured vehicle length should cover that sensor

In the following examples, Path 2 consists only of a ¼-Meter Motor. Path 1 is upstream of Path 2, and Path 3 is downstream of Path 2.

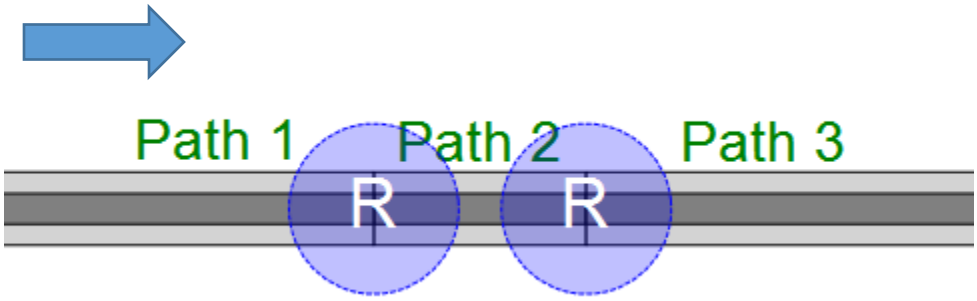

Figure 3: Example Track Layout

Startup on Path 2 failed, and the following log message was displayed:

Line 5388: Nov 04 14:44:07.292764 STARTUP,WARNING: dump_sensor_map: Path ID: 2 () sensor map: [_|_|__|=|=|=_|_|_|_=|=|=|__|_|_|=]

The sensor map displays that three magnet arrays were detected over the motor. The first and second magnet arrays (in red below) show the tandem puck's true location, and the last magnet array (blue) was from a puck located mostly on Path 3. Below is a sensor map, and an image (to scale) of a ¼-Meter Motor with the actual puck locations in red and blue. Remember that the "=" indicates peak magnetic field strength, so magnet arrays can be present over motor blocks and not marked by a "=" if the field strength is below the designated threshold value.

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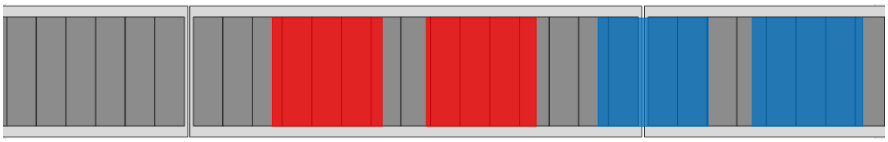

Figure 4: Magnet Arrays on Path 2 and Path 3

The startup algorithm could not definitively identify how the arrays should be paired to locate a vehicle, so startup failed. The gaps between all detected magnet arrays look very similar to the HES sensors. There are between three and four unoccupied motor blocks between the magnet arrays and path ends. We know the first and second magnet arrays displayed in red above are the

true puck, but second and third detected magnet arrays (blue) could have also been the puck because the gap between arrays was similar:

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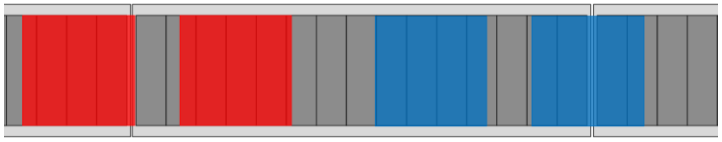

Figure 5: Alternative Magnet Arrays on Path 1, Path 2, and Path 3

This same logic holds true even with only one tandem puck over the motor (no other pucks partially on the path). Startup may still fail if the puck is located in the middle of the motor. For example, suppose the sensor map looked like this:

[_|_|__|_|=|=_|_|_|__|=|=|__|_|_|_]

This sensor map leaves two options that the system cannot distinguish between. Figure 6 shows that the two magnet arrays are part of one (red) puck. Figure 7 shows that the first magnet array is part of a tandem puck (red) that is halfway on Path 1, and that the second magnet array is part of a tandem puck (blue) this is halfway on Path 3. Since there are up to four motor blocks available (less than 55mm measured) between peak magnetic fields and path ends, there is no way to differentiate between these options, startup will fail.

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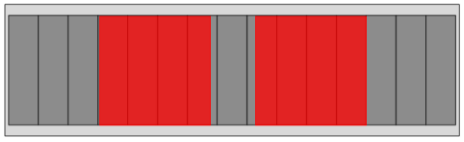

Figure 6: One Tandem Puck on Path 2

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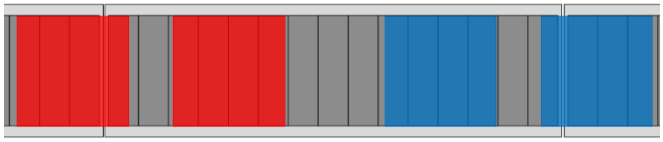

Figure 7: Alternative Tandem Pairing

For systems with short paths, startup is only guaranteed to work if the puck is very close to the beginning or very close to the end of the path. This is because in these positions, the unoccupied space is large enough for the system to determine which magnets to group as a tandem puck, as shown in Figure 8.

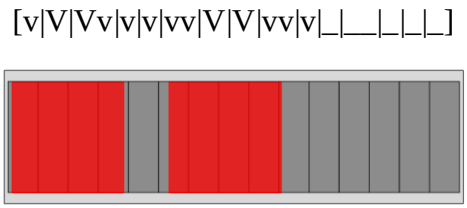

Figure 8: One Tandem Puck Justified to Upstream End of a ¼-Meter Motor

Paths that consist of only a 1-Meter Motor

The same concept described above applies to longer paths where tandem pucks are tightly spaced along the whole path. The following is a sensor map from a path that consisted of only a 1-Meter Motor with tandem pucks tightly spaced:

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The system still has no way to definitively differentiate which magnet arrays to group into tandem pucks. Either combination of blue and red magnet arrays shown in Figure 9 and Figure 10 could be how the tandem pucks should be grouped. Since there is nothing to distinguish between these options, startup fails. This is referred to as a “packed path” scenario.

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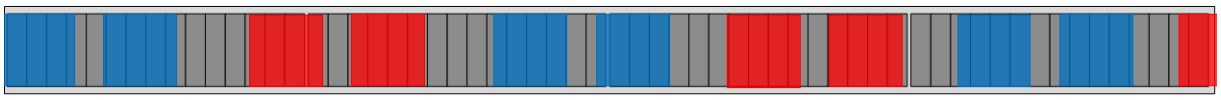

Figure 9: Packed 1-Meter Path

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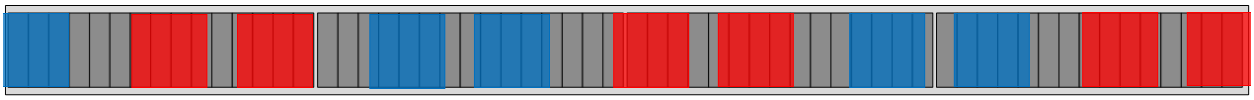

Figure 10: Alternative Packed 1-Meter Path

If there is a space of 55mm or more along the path, then startup will succeed. Even though most of the path is packed with tandem pucks, the system can definitely determine how magnet arrays should be grouped based on the large group of unoccupied motor blocks between vehicles shown in Figure 11.

[V|V|vv|v|v|vv|V|V|Vv|v|v|vV|V|V|vv|v|v|vv|V|V|Vv|v|v|vV|V|V|vv|v|v|vv|V|V|vv|v|v|vV|V|v|vv|_|_|__|_|_|_v|v|v|VV|V|v|vv|v|v|vV|V|v|vv|v|v|V]

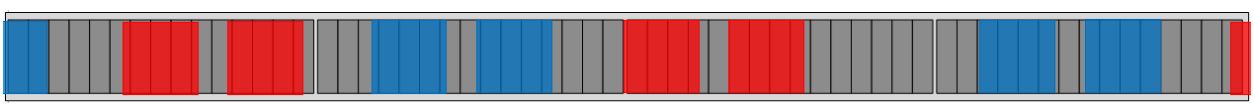

Figure 11: Successful 1-Meter Path Startup

Potential Causes & Solutions

Paths that consist of ¼-Meter or Curve Motors

The Customer Support team at MagneMotion checks all potential customer layouts using tandem pucks for paths that consist of only a ¼-Meter or Curve Motor so that this scenario should not occur. As stated above, the only way to guarantee that startup will be successful is to ensure the vehicle is justified to one path end at the time of startup. If a very short path is desired, some external equipment or operator needs to move the vehicles to one end of the path, or off the path entirely before system startup.

Packed Paths

There are three factors that can contribute to a startup failure due to a packed path; unnecessary relay nodes, vehicle length and operator intervention.

Unnecessary Relay Nodes

Nodes need to be placed at the upstream end of every path, and at path ends where vehicles leave the path. Any other node is not necessary for a system to function. In some cases, customers add relay nodes to divide paths into separate segments. The track layout example in Figure 3 shows two relay nodes creating one very short path. For that case, the nodes are not necessary and can be removed from the layout, mitigating the risk of startup issues. Although there is risk of startup failure due to packed paths on any layout using tandem pucks, the risk is exacerbated for shorter paths where many vehicles queue. It is more likely that if the path is longer, there will be 55mm between pucks at some point along the path.

Vehicle Length

The MagneMover LITE's collision avoidance feature allows vehicles to naturally queue based on a user defined vehicle length in the Node Configuration File. If this length is shorter than 204mm (the suggested center-to-center distance for tandem pucks), it is possible that vehicles could naturally queue into positions that could cause startup to fail.

This scenario can occur for a path that only consists of a 1-Meter Motor and has tandem pucks of a 150mm vehicle length queued over it (like the 1-Meter Motor example above). If the system is shut down while the path is packed, then a startup is attempted, startup will fail.

If the vehicle length for the path was defined as 204mm, there would be at least 55mm between pucks under the system's natural queueing, and startup would succeed.

If close queueing is desired, some external equipment or operator needs to move the vehicles such that there is a space of at least 55mm somewhere on the path before system startup.

Operator Intervention

MagneMotion recognizes that it is fairly common for operators or technicians to manually move pucks around the system while it is off, usually to access other equipment. It is possible for operators to manually move pucks into a packed path scenario. Even if our control system's natural queuing left the pucks spaced such that startup would succeed, operator intervention could cause startup to fail. If this is the case, we suggest you train your operators and technicians to leave at least 55mm between vehicles somewhere along every path.

Summary

When running the MagneMover LITE system with tandem pucks, it is possible for startup failures due to packed paths. There are several ways to mitigate this risk, including removing unnecessary nodes from the layout, defining a longer vehicle length, training operators, or designing external equipment to move the vehicles such that there is a space of at least 55mm somewhere on the path before system startup. To ensure a system with tandem pucks can always startup, allow for 55mm or more measured distance between pucks somewhere along every path.

Related Documents:

990000410 – MagneMover LITE User's Manual

990000377 – Node Controller Web Interface User's Manual

More Information

MagneMotion Website: www.magnemotion.com

Questions & Comments: www.magnemotion.com/about-magnemotion/contact.cfm

Revision History

Rev.	Change Description
A	Initial release