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**Host Controller TCP/IP Communication  
Protocol User Manual Addendum,  
Moving Path Node**

**Host Controller TCP/IP Communication Protocol  
User Manual Addendum, Moving Path Node**



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## Purpose

This document is an addendum to the *Host Controller TCP/IP Communication Protocol User Manual* and describes the additions to the protocol for communication between the MagneMotion® HLC and a host controller (general-purpose computer) that is equipped with a TCP/IP interface.

An additional node type, the Moving Path node has been added. New commands and responses have been added to the communication protocol used between the host controller and the HLC to support the use of Moving Path nodes.

## Reference Documents

- 990000436, Host Controller TCP/IP Communication Protocol User Manual
- 990000559, QuickStick Configurator User Manual

## Definitions

*Table 1: Moving Path Node Terminology*

Term	Definition
Clearance Distance	The distance from a node where the trailing edge of a vehicle is considered cleared from the node.
Control Path	The Control Path is the path that is specified in an MP Link command from the host controller to link a junction. Once linked, this path remains the Control Path for the life of the junction until the junction transitions to the unlinked state.
Entry Gate	The position on a path associated with a node where the leading edge of a vehicle is considered cleared from the node.
Entry Path	An Entry Path is a path whose downstream end is a member of a node. A vehicle that is moving downstream enters a node on an Entry Path.
Entry Request	When the headway for a vehicle reaches an entry gate, an entry request is made. The vehicle is not granted permission to move beyond the entry gate until the state machine for the Moving Path node grants permission.
Equivalent-Route Path	A path in a set of Moving Path node member paths that all offer a route to any destination reachable via any other path in the set.
Exit Path	An Exit Path is a path whose upstream end is a member of a node. A vehicle that is moving downstream exits a node on an Exit Path.
Fixed Path	A path whose position is fixed in the track layout.

*Table 1: Moving Path Node Terminology*

<b>Term</b>	<b>Definition</b>
Headway	The space that is maintained before a vehicle to make sure that the vehicle is able to stop safely.
Link/Unlink	When a Moving Path node junction is linked, the node controller forwards motor-to-motor messages between the path ends that are linked, which allows vehicle headway to advance through the junction. When unlinked, motor-to-motor messages are not forwarded, which causes vehicles that are ordered through a junction to become obstructed until the junction is linked.
Linked Path Junction	The aligned junction between two path members of a Moving Path node where motor-to-motor communication is being forwarded.
Moving Path	A path that is moved to align with the end of another path.
Moving Path Junction	The junction where a moving path end is linked to another path end.
Moving Path Node	A node where one or more downstream path ends can align with one or more upstream path ends. A host controller controls the moving path positions to effect path end alignment.
Moving Path Node Member Path Limit	The maximum number of configured member paths for a Moving Path node.
Moving Path Node Pair	Two Moving Path nodes, one at the upstream end of a set of one or more moving paths and one at the downstream end of the same set of moving paths.
Peer Node	Reported in the Path End status. It is the node at the opposite end of a moving path.
Peer Path	The path on the opposite side of a junction from the Control Path, is the path that is specified in a link command from the host controller to link a junction. Once linked, this path remains the Peer Path for the life of the junction until the junction transitions to the unlinked state.
Platooning	When a vehicle is following another vehicle through a node, platooning allows the trailing vehicle to follow the leading vehicle while maintaining brick wall headway.
Protected Area	The area around a node that is defined by the entry gates and clearance distances. This area is used to make sure that vehicles do not collide with other vehicles in the node or with the mechanism that is related to the node.
Specific-Route Path	A path in a set of Moving Path node member paths where destinations reachable via some paths in the set are not reachable by all paths in the set.
Unlinked Path Junction	The junction between two path members of a Moving Path node where motor-to-motor communication is not being forwarded.

## Application Notes

### Moving Path Node

A Moving Path node is used to support track topologies where a user-supplied mechanism is used to move one of the guideways. The Moving Path node provides support to route vehicles across moving paths to their destination. There is a Moving Path node at each end of a moving path where vehicles move onto or off the moving path. As with other node types, the paths in the Moving Path node are identified as Entry Paths and Exit Paths. A user-supplied mechanism supports and moves the moving path and aligns the end of the moving path with a fixed guideway, which allows vehicles to move onto and off the moving path. The ends of all paths in the node must be connected to the same node controller. See [Figure 1](#) and [Figure 2](#) where the shaded areas represent Moving Path nodes.

**NOTE:** Depending upon the configuration of the Moving Path node, the moving path can be either an Entry Path or an Exit Path.

In the example in [Figure 1](#), with one Moving Path node, the vehicles move from a fixed path (defined in the Moving Path node configuration as the Entry Path) and enter the moving path (defined in the Moving Path node configuration as the Exit Path).

In the example in [Figure 2](#), with two Moving Path nodes, the vehicles move from a fixed path (defined in the Moving Path node configuration for the first node as the Entry Path) and enter the moving path (defined in the Moving Path node configuration for the first node as the Exit Path). The vehicles then move from the moving path (defined in the Moving Path node configuration for the second node as the Entry Path) and enter a fixed path (defined in the Moving Path node configuration for the second node as the Exit Path).

**NOTE:** The moving path is mounted to a user-supplied mechanism that is controlled by the host controller. This mechanism could be a MagneMotion LSM.

### Support

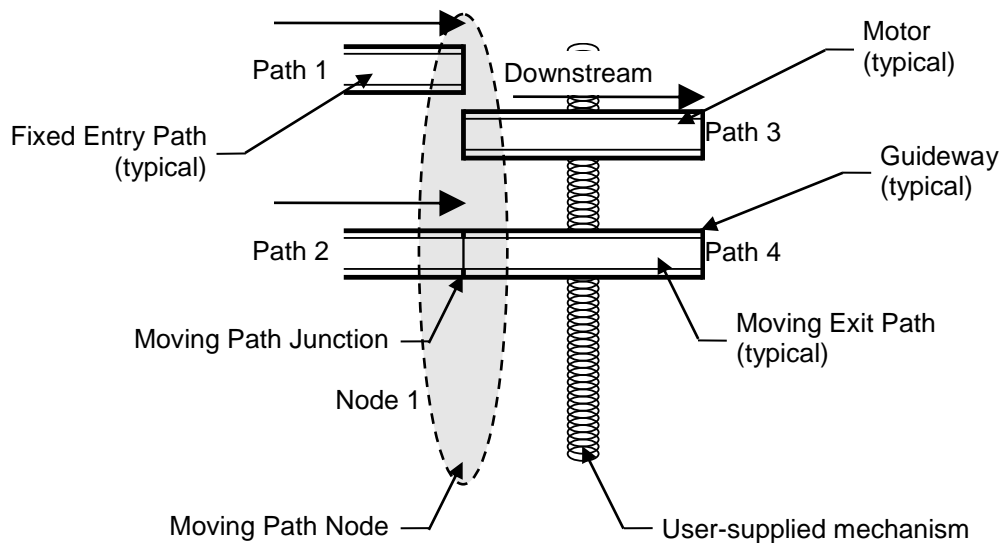
This node type is supported in the latest software release for the following product line:

- QuickStick® 100 transport systems.



## Open Ended Parallel Moving Paths

The example in [Figure 1](#) has two fixed paths, path 1 and path 2, which connect to two moving paths, path 3 and path 4. The moving paths are open ended; that is, they are the end of the line for the track layout. There could be Terminus nodes at their downstream ends, but it is not required.



*Figure 1: Single Moving Path Node*

1. To move onto either path 3 or path 4 (or exit through an optional Terminus node on either path), the host controller must order the vehicle to path 3 or path 4.

**NOTE:** Because there is no path at the downstream end of the moving paths, the host controller must command the vehicle to a destination on one of the moving paths.

2. The HLC then requests alignment of the destination path that is specified in the vehicle order, setting [MP Path End Status Report \(0xDF 09 01\)](#) for the path the vehicle is on to the [unlinked\\_alignment\\_requested](#) state.
3. The host controller then commands the mechanism to position the moving path as requested.
4. Once the moving path is positioned, the host controller notifies the HLC that the paths are aligned by issuing an [MP Link Command \(0xBF 09 02\)](#) to link the two paths and the vehicle can move across the junction between the paths.
5. Depending upon the usage of the linked paths, once the vehicle clears the junction, the paths can be unlinked, or the paths can remain linked (see [Path Linking/Unlinking](#) on page 12).

## Moving Paths Spanning Gap between Fixed Paths

This Moving Path node application allows one or more moving paths to span a gap between one or more fixed paths. [Figure 2](#) shows an example of a Moving Path node pair (node 1 and node 2). Node 1 is a Moving Path node linking the downstream end of fixed paths, path 1 and path 2, to the upstream end of moving paths, path 3 or path 4. Node 2, is a Moving Path node linking the downstream end of moving paths, path 3 and path 4, to the upstream end of fixed paths, path 5, path 6, or path 7.

Considering movement in the downstream direction (indicated by the arrows) the upstream end of Exit Paths 3 and 4 (the moving paths) offer equivalent routes for vehicles navigating node 1 to destinations on paths 5, 6, or 7. Either can satisfy a vehicle move from path 1 or path 2 to path 5, path 6, or path 7. Paths 3 and 4 are termed equivalent-route paths. At node 2, still moving downstream, the host controller must align to either path 5, path 6, or path 7 depending upon the vehicles destination. Paths 5, 6, and 7 are termed specific-route paths.

Similarly, considering movement in the upstream direction, the downstream end of path 3 or 4 offer equivalent routes to path 1 and path 2 when navigating node 2. Paths 1 and 2 require specific alignment at node 1.

Two node configuration items must be set, one for the set of Entry Paths and one for the set of Exit Paths, designating the set as specific-route or equivalent-route. The HLC assumes that any moving path in an equivalent-route set can satisfy the route. Because the host controller application chooses the path to align to satisfy an equivalent route alignment request from the HLC, the host controller can provide application-specific management strategy for utilization of moving paths.

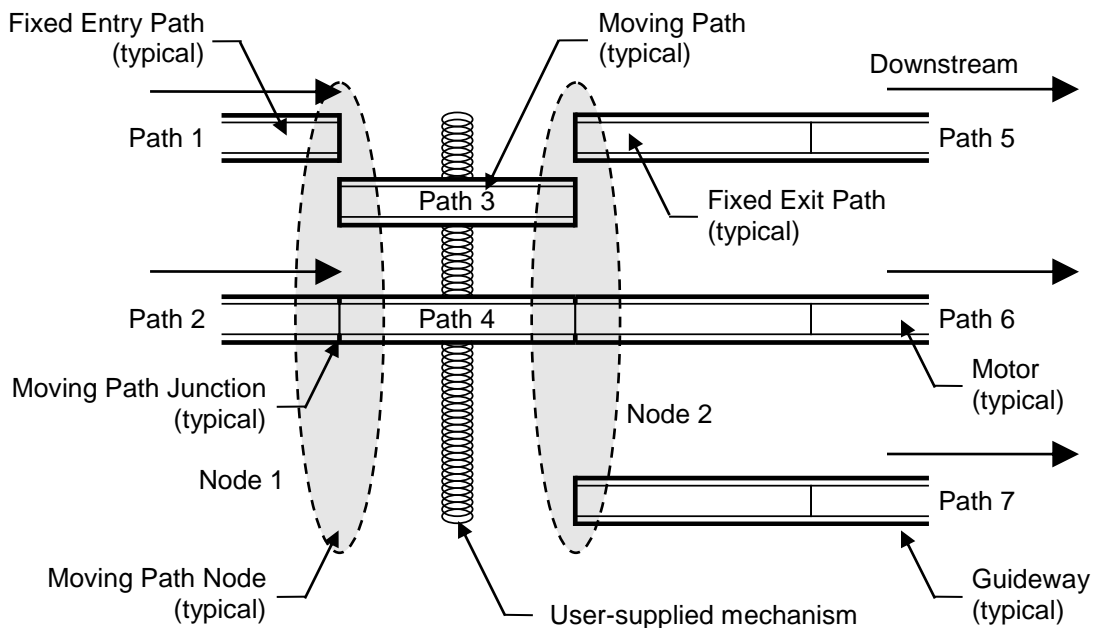


Figure 2: Moving Path Node Pair

1. To move onto one of the Exit Paths from either of the Entry Paths, path 1 or path 2, the host controller must order the vehicle to either path 5, path 6, or path 7.
2. The HLC requests alignment of a moving path to complete the vehicle order by setting [MP Path End Status Report \(0xDF 09 01\)](#) for the path the vehicle is on to the [unlinked\\_alignment\\_requested](#) state.
3. The host controller determines which path to move and align and then commands the mechanism to position the moving path as requested.
4. Once the moving path is positioned, the host controller notifies the HLC that the paths are aligned by issuing an [MP Link Command \(0xBF 09 02\)](#) to link the two paths so the vehicle can move across the junction between the paths onto the moving path.
5. Once the last allowed vehicle is granted permission to navigate the junction, the HLC sets [MP Path End Status Report \(0xDF 09 01\)](#) for the path to the [linked\\_unlinked\\_pending](#) state to notify the host controller that permission to navigate the junction is not granted to any additional vehicles.

Once all vehicles that are involved in this junction clear the junction, the paths are unlinked (see [Path Linking/Unlinking](#) on page 12).

6. The vehicle on the moving path continues to move toward the other end of the moving path and the path end state of that path end transitions to [unlinked\\_alignment\\_requested](#). The alignment request specifies the specific path end where the host controller must align the moving path.
7. The host controller commands the mechanism to position the moving path and aligns it with the Exit Path. The moving path can be moved while the vehicle is in motion.
8. Once the moving path is positioned, the host controller notifies the HLC that the paths are aligned by issuing an [MP Link Command \(0xBF 09 02\)](#) to link the two paths and the vehicle can move across the junction between the paths onto the Exit Path.
9. Depending upon the usage of the linked paths, once the vehicle clears the junction, the paths can be unlinked, or the paths can remain linked (see [Path Linking/Unlinking](#) on page 12).

## Node Operation

- The maximum number of Entry and Exit Paths that can be used for a Moving Path node is limited to the number of paths that can be connected to one node controller, which is 4 for an NC LITE and 12 for an NC-12. This limit is referred to as the Moving Path Node Member Path Limit.
- Entry gates keep vehicles from entering the protected area around the junctions unless the linked path provides the shortest route to its destination. To be granted permission to pass an entry gate, a vehicle must be under an order to a destination beyond the end of the Entry Path.
- A linked junction cannot be unlinked unless all vehicles are beyond the configured clearance distances.
- Normal vehicle-to-vehicle clearances apply across the linked junction allowing vehicles on the same route to platoon across the junction.
- Vehicles can queue on the moving path.
- Vehicles can queue across a junction.
- The move profile for the vehicle is maintained across the node so the vehicle crosses the junction at a consistent velocity and acceleration only when the move is such that the moving path does not need to move.

## Path Linking/Unlinking

When two path ends are linked to form a junction, motor-to-motor messages are forwarded by the Node Controller to allow vehicles to navigate the junction.

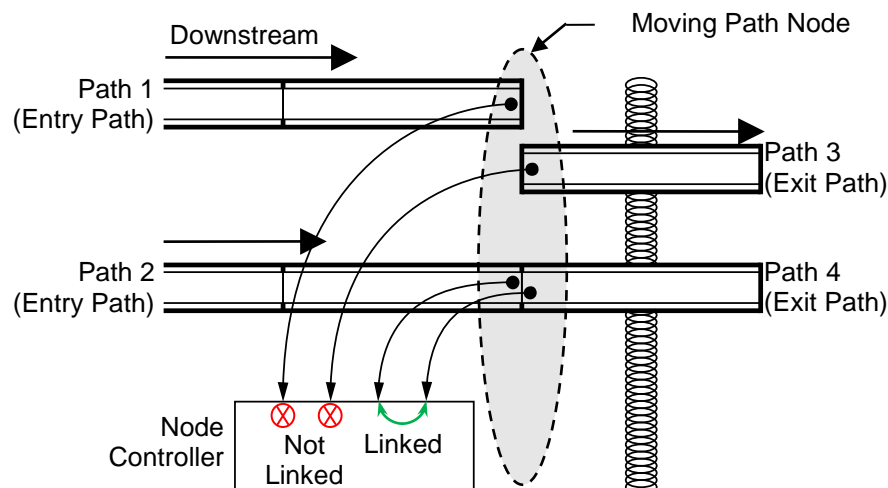


Figure 3: Path Linking/Unlinking in Moving Path Node

## Host Control of Link (Last Allowed Vehicle ID = 0)

If the host controller links the path with an [MP Link Command \(0xBF 09 02\)](#) that has [Last Allowed Vehicle ID](#) set to '0', the path end remains in the [linked](#) state until an [MP Unlink Command \(0xBF 09 03\)](#) is received. While in the linked state, vehicles are allowed to navigate the node if the linked path offers a route to the destination for the vehicle.

The host controller must send an [MP Unlink Command \(0xBF 09 03\)](#) to unlink the path. If the host controller sends the unlink command while the vehicle is navigating the junction, the junction state changes to [linked\\_unlinked\\_pending](#) and no additional vehicles are granted permission to navigate the junction. As soon as the vehicle clears the junction, the path end state transitions to the [unlinked](#) state.

## Host Control of Link (last\_allowed\_vehicle\_id = Specific Vehicle ID)

If the host controller links the path with an [MP Link Command \(0xBF 09 02\)](#) that has [Last Allowed Vehicle ID](#) set to a specific vehicle ID, the path end remains in the [linked](#) state until the specified vehicle is granted permission to enter the junction. The path end state transitions to [linked\\_unlinked\\_pending](#) as soon as the last allowed vehicle is granted permission to enter. No other vehicles are allowed permission to navigate the junction after the last allowed vehicle enters.

Once in the [linked\\_unlinked\\_pending](#) state, the path transitions to the [unlinked](#) state as soon as all vehicles are clear of the junction. The host controller does not need to send an unlink command.

**NOTE:** Additional link commands can be issued to modify the [Last Allowed Vehicle ID](#) for the linked paths but must specify the same [Control Path ID](#) and [Peer Path ID](#) used initially to establish the junction.

## Entry Gates and Clearance Distances

Configurable entry gate and clearance distances are provided for each path in the Moving Path node to set vehicle clearances. These clearances are used to protect vehicles from collisions with the node's moving mechanisms or other vehicles in the node.

### Entry Gates

The entry gate defines a location on the paths that are associated with a node where the leading edge of the vehicle (including payload) is safely located to avoid collisions with other vehicles on adjoining paths or with any mechanisms that are related to the node, regardless of vehicle movement direction. The location of the entry gate is measured from the end of the motor closest to the node.

## Clearance Distances

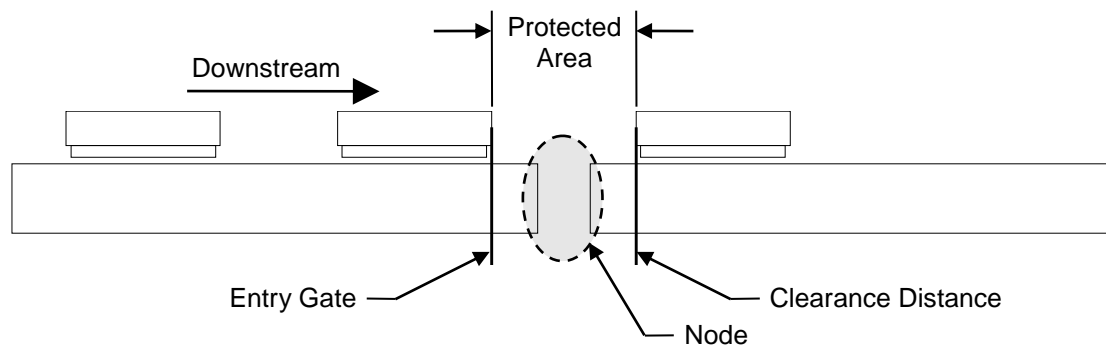
The clearance distance defines a location on the paths that are associated with a node where the vehicle's trailing edge (including payload), regardless of vehicle movement direction, is safely located to avoid collisions with other vehicles on adjoining paths or with any mechanisms that are related to the node.

## Protected Areas

The area around a node that is defined by the entry gates and clearance distances. This area is used to make sure that vehicles do not collide with other vehicles in the node or with the mechanism that is related to the node.

When entry gates and clearance distances are defined, the following conditions apply:

- When a vehicle is at an entry gate, the motor sends an entry request to the node controller and waits for permission for the vehicle to enter.
- The junction does not unlink until all vehicles have traveled beyond the clearance distance.



*Figure 4: Node Entry Gates and Clearances*

## Path Startup Considerations

During path startup, unlocated vehicles move to determine their precise location. This move is termed a 'locate move'. The node controller determines if there is room for the locate move. If there are already-located vehicles that are blocking the move, they must be moved to make room to locate the unlocated vehicle. This move is termed a 'push move'. If there is no room to locate a vehicle in the downstream direction, the node controller searches for room in the upstream direction.

If a moving path junction is linked, the locating vehicle is allowed to locate into the linked junction. If a moving path junction is unlinked, the area past the entry gate is not available for a locate move or a push move. However, vehicles that extend past an entry gate can locate in the direction of the junction if there is room. Vehicles near an entry gate at an unlinked junction can only locate away from the junction.

It is possible that, after an unlocated vehicle that was within the gate area is located, it is still within the gate area at an unlinked path end. If a vehicle is positioned this way, the path end status transitions to the [unlinked\\_vehicle\\_present](#) state and the Device Status field (bits 0-3) in the Node Status (0xD3) message is set to 'junction fault'.

The host controller can either move the vehicle clear of the gate, to cause the path end state to transition to [unlinked](#), or link the junction. Once none of the member path ends of the Moving Path node are in the [unlinked\\_vehicle\\_present](#) state, the node device status transitions to 'Operational'.

**NOTE:** A vehicle in the gate area has the potential to interfere with a path being moved to align it.

## Communication Protocol

See the Communications Protocol section in the Appendix of the *Host Controller TCP/IP Communication Protocol User Manual* for information on how the TCP/IP protocol is used between the host controller and the HLC.

## Host Controller to HLC Communications

This section describes the commands (see [Table 2](#)) that are sent from the host controller to the HLC as asynchronous requests for the transport system to perform an action. These requests are handled by the HLC by routing the command to the appropriate node controller for execution and sending responses to the host controller (listed in [Table 3](#)).

*Table 2: Host Controller to HLC Commands*

Description and Value	Use	Page
<a href="#">MP Get Path End Status (0xBF 09 01)</a>	QuickStick 100	<a href="#">17</a>
<a href="#">MP Link Command (0xBF 09 02)</a>	QuickStick 100	<a href="#">19</a>
<a href="#">MP Unlink Command (0xBF 09 03)</a>	QuickStick 100	<a href="#">23</a>



## MP Get Path End Status (0xBF 09 01)

### Type

Host Controller → HLC

### Purpose

The host controller sends an MP Get Path End Status message to the HLC to fetch the status of the path ends that are associated with the specified Moving Path node.

### Support

This command is supported in the latest software release for the following product line:

- QuickStick 100 transport systems.

### Format

Offset	Item	Bytes	Range
0	Message Header	2	0xABBA
2	Message Length	1	7
3	Message Type	1	0xBF
4	Extension Type	1	0x09
5	Extension Subtype	1	0x01
6	Node ID	2	Node ID values are: 0 – Get status for path ends of all Moving Path nodes 1–65535 – Get status for path ends of a Moving Path node
8	Message CRC	2	0–65535

### Message Header

Constant byte pattern that designates the start of a message. These bytes have a value of 0xAB followed by 0xBA.

### Message Length

Length of this message, which is given as the number of bytes following the Message Length field, including the Message CRC field.

### Message Type

Fixed message type that identifies this message as a Host Extension command message.

## Extension Type

Fixed extension type that identifies this command as a node extension command.

## Extension Subtype

Fixed extension subtype that identifies this command as an MP Get Path End Status extension command.

## Node ID

ID of the Moving Path node for which path end status is being requested.

0	The HLC gets path end status for all Moving Path nodes. An <a href="#">MP Path End Status Report (0xDF 09 01)</a> message is returned for each path end with its associated Node ID and a Command Status of Command Accepted. If no Moving Path nodes exist, the HLC rejects the command and an MP Path End Status Report (0xDF 09 01) message is returned with a Node ID of 0 and a Command Status of No record available.
1–65535	The HLC gets path end status for only the Moving Path node with a matching Node ID. If the specified Moving Path node does not exist, an <a href="#">MP Path End Status Report (0xDF 09 01)</a> message is returned with the failing Node ID and a Command Status of No record available indicating that no such Moving Path node exists in the transport system.

If the HLC rejects an MP Get Path End Status command, the Node ID and the failure status are included in the [MP Path End Status Report \(0xDF 09 01\)](#) message.

## Message CRC

A check value on the entire message (excluding the CRC) to verify integrity.

## Response

After receiving the command and verifying command parameters, the HLC sends one or more [MP Path End Status Report \(0xDF 09 01\)](#) messages for each path end that is a member of the specified Moving Path nodes.

## MP Link Command (0xBF 09 02)

### Type

Host Controller → HLC

### Purpose

The host controller sends an MP Link Command message to the HLC when the Control and Peer Paths are aligned. This message notifies the HLC that the path ends are aligned and can be ‘linked’ to allow vehicles to navigate the path junction.

The initial link command, sent to form a junction between two unlinked path ends, establishes the Control Path. Subsequent link commands can be issued to modify the Last Allowed Vehicle ID but must specify the same Control and Peer Path IDs used initially to establish the junction.

These messages can be sent asynchronously or in response to a previous [MP Alignment Request \(0xDF 09 02\)](#) message.

### Support

This command is supported in the latest software release for the following product line:

- QuickStick 100 transport systems.

### Format

Offset	Item	Bytes	Range
0	Message Header	2	0xABBA
2	Message Length	1	19
3	Message Type	1	0xBF
4	Extension Type	1	0x09
5	Extension Subtype	1	0x02
6	Node ID	2	1–65535
8	Control Path ID	2	1–65535
10	Peer Path ID	2	1–65535
12	Last Allowed Vehicle ID	2	Last Allowed Vehicle ID values are: 0 – Path junction remains linked until explicitly unlinked 1–65535 – Path junction unlinked when this vehicle clears it
14	Alignment Request Count	2	1–65535

Offset	Item	Bytes	Range
16	Host Command Count	4	0x–0xFFFFFFFF
20	Message CRC	2	0–65535

## Message Header

Constant byte pattern that designates the start of a message. These bytes have a value of 0xAB followed by 0xBA.

## Message Length

Length of this message, which is given as the number of bytes following the Message Length field, including the Message CRC field.

## Message Type

Fixed message type that identifies this message as a Host Extension command message.

## Extension Type

Fixed extension type that identifies this command as a node extension command.

## Extension Subtype

Fixed extension subtype that identifies this command as an MP Link Command extension command.

## Node ID

The ID of the Moving Path node that this link command operates on. The ID must reference a node that exists in the transport system.

## Control Path ID

The ID of the Control Path end to link to the specified Peer Path end to form a path junction. The ID must reference a path that exists in the transport system.

## Peer Path ID

The ID of the Peer Path end to link to the specified Control Path end to form a path junction. The ID must reference a path that exists in the transport system.

**NOTE:** New path junctions transition to the [linked](#) state.

## Last Allowed Vehicle ID

Used to set the conditions for unlinking the path junction.

0	The HLC keeps the Control and Peer Paths linked until the host controller sends an <a href="#">MP Unlink Command (0xBF 09 03)</a> . Vehicles approaching the junction are granted permission to navigate the junction if the Control Path offers an equivalent route to the vehicle's destination. If the approaching vehicle requires another path alignment, the junction is unlinked as soon as there are no vehicles navigating the node and a new alignment request is sent to the host controller.
1–65535	Once the last allowed vehicle begins to navigate the path junction, the Control Path end transitions to the <a href="#">linked_unlinked_pending</a> state and no other vehicles are granted permission to navigate the junction. The HLC unlinks the path junction as soon as all navigating vehicles are clear of the path junction.

## Alignment Request Count

A sequence count, unique to the most recent alignment request for a path end, which the HLC increments whenever alignment for a path end is requested using an [MP Alignment Request \(0xDF 09 02\)](#).

The host controller can use this field to track which alignment request a link command is responding to by including the [Alignment Request Count](#) from an [MP Path End Status Report \(0xDF 09 01\)](#) in the link command.

## Host Command Count

A sequence count, unique to the specified Control Path end, which is incremented by the host controller when this message is sent. It aids the host controller in tracking the execution of this command.

The host controller maintains the **Host Command Count**. It is initialized to 1 when the host controller restarts, it is then incremented for each new link/unlink command that is issued, and continues from 1 when it rolls over.

It is included in the [MP Path End Status Report \(0xDF 09 01\)](#) response message that is returned by the HLC.

## Message CRC

A check value on the entire message (excluding the CRC) to verify integrity.

## Response

After receiving the command and verifying the command parameters, the HLC sends either a 'Command Accepted' response or a 'Command Rejected' response as appropriate (see

**Command Status (0xD0)**). If the command is accepted, the HLC handles linking the specified path junctions for the selected Moving Path node.

On completion of the command, the HLC sends a ‘Command Complete’ or a ‘Command Failed’ response. If the command failed, the response identifies the reason for failure.

If the HLC is configured to report path end status changes asynchronously, the HLC responds with one or more **MP Path End Status Report (0xDF 09 01)** messages reflecting changes resulting from executing this link command.

## MP Unlink Command (0xBF 09 03)

### Type

Host Controller → HLC

### Purpose

The host controller sends an MP Unlink Command message to the HLC to unlink one or more path junctions that are associated with the specified Moving Path node.

### Support

This command is supported in the latest software release for the following product line:

- QuickStick 100 transport systems.

### Format

Offset	Item	Bytes	Range
0	Message Header	2	0xABBA
2	Message Length	1	13
3	Message Type	1	0xBF
4	Extension Type	1	0x09
5	Extension Subtype	1	0x03
6	Node ID	2	1–65535
8	Control Path ID	2	Control Path ID values are: 0 – Unlink all path ends of specified Moving Path node 1–65535 – Unlink only specified Control Path end
10	Host Command Count	4	0x–0xFFFFFFFF
14	Message CRC	2	0–65535

### Message Header

Constant byte pattern that designates the start of a message. These bytes have a value of 0xAB followed by 0xBA.

### Message Length

Length of this message, which is given as the number of bytes following the Message Length field, including the Message CRC field.

## Message Type

Fixed message type that identifies this message as a Host Extension command message.

## Extension Type

Fixed extension type that identifies this command as a node extension command.

## Extension Subtype

Fixed extension subtype that identifies this command as an MP Unlink Command extension command.

## Node ID

The ID of the Moving Path node that this unlink command operates on. The ID must reference a node that exists in the transport system.

## Control Path ID

The ID of one or more path ends to unlink from path junctions that are associated with the specified Moving Path node. The ID must reference a path that exists in the transport system.

0	All member path ends are unlinked for the specified Moving Path node.
1–65535	Only the specified Control Path end is unlinked. Additionally, the Control Path ID specified must be the same Control Path that was used initially to establish the junction.

If a vehicle is navigating a path junction, the path junction transitions to the [linked\\_unlinked\\_pending](#) state; otherwise, the path junction transitions to the [unlinked](#) state.

See [MP Path End States](#) on page 39 for detailed descriptions of the path end states.

## Host Command Count

A sequence count, unique to the specified Control Path end, which the host controller increments when this message is sent. It aids the host controller in tracking the execution of this command.

The host controller maintains the **Host Command Count**. It is initialized to 1 when the host controller restarts, it is then incremented for each new link/unlink command that is issued, and continues from 1 when it rolls over.

It is included in the [MP Path End Status Report \(0xDF 09 01\)](#) response message that is returned by the HLC.



## Message CRC

A check value on the entire message (excluding the CRC) to verify integrity.

## Response

After receiving the command and verifying the command parameters, the HLC sends either a ‘Command Accepted’ response or a ‘Command Rejected’ response as appropriate (see [Command Status \(0xD0\)](#)). If the command is accepted, the HLC handles unlinking the specified path junctions for the selected Moving Path node.

On completion of the command, the HLC sends a ‘Command Complete’ (path junction transitions to the [linked\\_unlinked\\_pending](#) state) or a ‘Command Failed’ response. If the command failed, the response identifies the reason for failure.

If the HLC is configured to report path end status changes asynchronously, the HLC responds with one or more [MP Path End Status Report \(0xDF 09 01\)](#) messages reflecting changes resulting from executing this link command.

## HLC to Host Controller Communications

This section describes the messages that are sent from the HLC to the host controller. These asynchronous responses from the transport system (listed in [Table 3](#)) are sent after performing an action requested by a command from the host controller (listed in [Table 2](#)).

Alignment requests from the HLC to align a path for a vehicle that is requesting a route to a destination beyond a path junction are listed in [Table 4](#).

[Table 3](#) lists the command responses for host controller commands that are used with Moving Path node functionality.

*Table 3: HLC to Host Controller Status Responses*

Description and Value	Use	Page
<a href="#">Command Status (0xD0)</a>	QuickStick 100	<a href="#">27</a>
<a href="#">MP Path End Status Report (0xDF 09 01)</a>	QuickStick 100	<a href="#">30</a>

[Table 4](#) lists the alignment requests that are used with the Moving Path node functionality.

*Table 4: HLC to Host Controller Command Requests*

Description and Value	Use	Page
<a href="#">MP Alignment Request (0xDF 09 02)</a>	QuickStick 100	<a href="#">36</a>

## Command Status (0xD0)

### Type

HLC → Host Controller

### Purpose

Acknowledges the reception or rejection of a command, signals command execution failure, or signals command completion to the host controller.

**NOTE:** This response is sent as an asynchronous message with the appropriate command type when certain commands complete or fail.

### Support

This response is supported in the latest software release for the following product line:

- QuickStick 100 transport systems.

### Format

Offset	Item	Bytes	Range
0	Message Header	2	0xABBA
2	Message Length	1	varies
3	Message Type	1	0xD0
4	Command	1	0xB0–0xBC, 0xBF
5	Command Status	1	0x00–0x80
6	Command Data Detail	Varies	Varies
Varies	Message CRC	2	0–65535

### Message Header

Constant byte pattern that designates the start of a message. These bytes have a value of 0xAB followed by 0xBA.

### Message Length

Length of this message, which is given as the number of bytes following the Message Length field, including the Message CRC field.

### Message Type

Fixed message type that identifies this message as a Command Status response message.

## Command

Fixed message type that identifies the command that this Command Status message acknowledges.

Cmd	Ext	Sub	Command	Command Status Values
0xBF	0x09	0x02	MP Link Command	0x00, 0x03, 0x09, 0x0C, 0x0D, 0x10, 0x19, 0x20, 0x41, 0x42, 0x80
0xBF	0x09	0x03	MP Unlink Command	0x00, 0x03, 0x0C, 0x19, 0x20, 0x41, 0x42, 0x80

## Command Status

The status of the command that this Command Status message acknowledges.

Value	Status Description
0x00	Command Accepted
0x03	Command Rejected – Invalid Path ID
0x09	Command Rejected – Startup sequence already started
0x0C	Command Rejected – Initialization not complete
0x0D	Command Rejected – Reset active
0x10	Command Rejected – Programming active
0x19	Command Rejected – Invalid Node ID
0x20	Command Rejected – Invalid node type
0x41	Command Failed – Unable to complete
0x42	Command Failed – Timed out
0x80	Command Completed Successfully

## Command Data Detail

Variable amount of data that provides the details of the command that is specified in the Command field.

Cmd	Ext	Sub	Command Description	Command Data
0xBF	0x09	0x02	MP Link Command	Extension Type (1 byte) Extension Subtype (1 byte) Node ID (2 bytes) Control Path ID (2 bytes) Peer Path ID (2 bytes) Last Allowed Vehicle ID (2 bytes) Alignment Request Count (2 bytes) Host Command Count (4 bytes)

<b>Cmd</b>	<b>Ext</b>	<b>Sub</b>	<b>Command Description</b>	<b>Command Data</b>
0xBF	0x09	0x03	MP Unlink Command	Extension Type (1 byte) Extension Subtype (1 byte) Node ID (2 bytes) Control Path ID (2 bytes) Host Command Count (4 bytes)

### **Message CRC**

A check value on the entire message (excluding the CRC) to verify integrity.

## MP Path End Status Report (0xDF 09 01)

### Type

HLC → Host Controller

### Purpose

The HLC sends an MP Path End Status Report message to the host controller in response to a previous [MP Get Path End Status \(0xBF 09 01\)](#) command or to report a path end status change in an Entry or Exit Path of a Moving Path node.

**NOTE:** Reception of an MP Get Path End Status (0xBF 09/01) command or a change in path end status on a Moving Path node when the HLC is configured to report path end status changes asynchronously is required.

MP Path End Status Report messages are delivered to active Host Status ports as well as to the Host Control port.

### Support

This response is supported in the latest software release for the following product line:

- QuickStick 100 transport systems.

### Format

Offset	Item	Bytes	Range
0	Message Header	2	0xABBA
2	Message Length	1	35
3	Message Type	1	0xDF
4	Extension Type	1	0x09
5	Extension Subtype	1	0x01
6	Command Status	1	0x00, 0x0C, 0x0E, 0x19, 0x20
7	Node ID	2	1–65535
9	Path ID	2	1–65535
11	Host Command Count	4	0x–0xFFFFFFFF

Offset	Item	Bytes	Range
15	Path End State	1	Path End State values are: 1 – unlinked 2 – linked_unlink_pending 3 – unlinked_alignment_requested 4 – linked 5 – linked_comm_loss 6 – linked_peer 7 – unlinked_vehicle_present
16	Path End Role	1	Path End Role values are: 1 – Unlinked path 2 – Control Path 3 – Peer Path
17	Path End Type	1	Path End Type values are: 1 – Fixed Path end (configured as specific-route path) 2 – Moving Path end (configured as equivalent-route path)
18	Peer Node ID	2	0–65535
20	Requested Path ID	2	0–65535
22	Linked Path ID	2	0–65535
24	Last Allowed Vehicle ID	2	Last Allowed Vehicle ID values are: 0 – Allow vehicles to navigate if the junction is a valid route to the destination 1–65535 – ID of last vehicle allowed to navigate junction
26	Requesting Vehicle ID	2	0–65535
28	Last Entered Vehicle ID	2	Last Entered Vehicle ID values are: 0 – No active vehicle 1–65535 – ID of vehicle requesting entry or ID of the last vehicle through the entry gate
30	Owner Vehicle ID	2	Owner Vehicle ID values are: 0 – No vehicle owns the junction 1–65535 – ID of vehicle that owns the junction
32	Last Exited Vehicle ID	2	Last Exited Vehicle ID values are: 0 – No vehicle has cleared the junction since it was linked 1–65535 – ID of the most recent vehicle to clear the junction

Offset	Item	Bytes	Range
34	Alignment Request Count	2	0–65535
36	Message CRC	2	0–65535

### Message Header

Constant byte pattern that designates the start of a message. These bytes have a value of 0xAB followed by 0xBA.

### Message Length

Length of this message, which is given as the number of bytes following the Message Length field, including the Message CRC field.

### Message Type

Fixed message type that identifies this message as a Host Extension message.

### Extension Type

Fixed extension type that identifies this message as a node extension message.

### Extension Subtype

Fixed extension subtype that identifies this message as an MP Path End Status Report extension message.

### Command Status

Status of the command that this MP Path End Status Report message is acknowledging.

Value	Description
0x00	Command Accepted
0x0C	Command Rejected – Initialization not complete
0x0E	Command Rejected – No record available
0x19	Command Rejected – Invalid node ID
0x20	Command Rejected – Invalid node type

### Node ID

ID of the Moving Path node for which path end status is reported in this message.



## Path ID

The ID of the path end for which status is being reported.

## Host Command Count

A sequence count, unique to the specified path end, last received in a link or unlink command. The host controller maintains the **Host Command Count**.

## Path End State

The state for this path end. See [MP Path End States](#) on page 39 for detailed descriptions of the path end states.

## Path End Role

The role for this path end.

1	<b>Unlinked Path</b> – Path is not linked to another path.
2	<b>Control Path</b> – Path specified in an MP Link command to link to a Peer Path.
3	<b>Peer Path</b> – Path specified in an MP Link command to link from a Control Path.

## Path End Type

The type of path end.

1	<b>Fixed Path End</b> – A path end that is configured as a specific-route path.
2	<b>Moving Path End</b> – A path end that is configured as an equivalent-route path.

## Peer Node ID

The ID of the node at the far end of this Moving Path node member path.

0	There is no Moving Path node at the far end of a moving path or if the member path is a fixed path (that is, configured as a specific-route path).
1–65535	The ID of the node at the far end of a moving path if the member path is a moving path (that is, configured as an equivalent-route path).

## Requested Path ID

The Requested Path ID field is written when a path end transitions to the [unlinked\\_alignment\\_requested](#) state. This is a signal to the host controller that a vehicle is requesting permission to navigate a Moving Path node as follows:

- If the Requested Path ID field is zero, the path end is not linked and the host controller can align any equivalent moving path to provide a route to the vehicle's destination.

- If the Requested Path ID field is nonzero, the requested path must be aligned to provide a route to the vehicle's destination.

The Requested Path ID persists on a Control Path from the time the Control Path enters the [unlinked\\_alignment\\_requested](#) state until the Control Path is unlinked. The Requested Path ID field is cleared on the Peer Path when linked with a Control Path to form a junction.

See [MP Path End States](#) on page 39 for detailed descriptions of the path end states.

### Linked Path ID

The ID of the Peer Path linked to this Control Path.

0	No Peer Path is linked.
1–65535	The Control Path and specified Peer Path are linked to form a path junction.

### Last Allowed Vehicle ID

The ID of the last vehicle that is allowed through the node. The HLC updates the Last Allowed Vehicle ID field only on the Control Path of a linked junction.

0	The HLC keeps the Control and Peer Paths linked until the host controller sends an <a href="#">MP Unlink Command (0xBF 09 03)</a> command. Vehicles approaching the junction are granted permission to navigate the junction if the Control Path offers an equivalent route to the vehicle's destination.
1–65535	Once the last allowed vehicle begins to navigate the path junction, the Control Path end status transitions to the <a href="#">linked_unlinked_pending</a> state and no other vehicles are granted permission to navigate the junction. The HLC unlinks the path junction as soon as all navigating vehicles are clear of the path junction

### Requesting Vehicle ID

The ID of the vehicle that is requesting permission to navigate the specified Moving Path node.

When in the [unlinked\\_alignment\\_requested](#) state, the Requesting Vehicle ID field identifies the vehicle that is requesting permission to navigate the specified Moving Path node. The Requesting Vehicle ID field is cleared once the path end is linked and the vehicle is granted permission to navigate the junction.

### Last Entered Vehicle ID

The ID of the last vehicle that was granted permission to navigate the junction. Updated by the HLC only on the Control Path of a linked junction.

- Set to zero before any vehicle is granted permission and is cleared when the last entered vehicle clears the junction.

- Updated by the HLC only on the Control Path to the entering vehicle ID when that vehicle is granted permission to enter.

### Owner Vehicle ID

The ID of the vehicle that currently owns the path junction. Updated by the HLC only on the Control Path of a linked junction.

0	There are no vehicles navigating the path junction.
1–65535	The ID of the vehicle that currently owns the path junction.

### Last Exited Vehicle ID

The ID of the most recent vehicle to clear the path junction. Updated by the HLC only on the Control Path of a linked junction.

- The Last Exited Vehicle ID field is zero when no vehicles have exited the path junction since it was linked.
- The Last Exited Vehicle ID field is zeroed when the path junction is unlinked.

### Alignment Request Count

A sequence count, unique to the most recent alignment request, which the HLC increments when an [MP Alignment Request \(0xDF 09 02\)](#) is sent.

The HLC maintains the Alignment Request Count for each path end. It is initialized to 0 when the HLC restarts and no alignment requests have been issued, it is incremented for each new alignment request, and continues from 1 when it rolls over.

### Message CRC

A check value on the entire message (excluding the CRC) to verify integrity.

## MP Alignment Request (0xDF 09 02)

### Type

HLC → Host Controller

### Purpose

The HLC sends an MP Alignment Request message to the host controller to align a path for a vehicle that is requesting a route to a destination beyond the specified path junction.

### Support

This request is supported in the latest software release for the following product line:

- QuickStick 100 transport systems.

### Format

Offset	Item	Bytes	Range
0	Message Header	2	0xABBA
2	Message Length	1	15
3	Message Type	1	0xDF
4	Extension Type	1	0x09
5	Extension Subtype	1	0x02
6	Node ID	2	1–65535
8	Control Path ID	2	1–65535
10	Requested Path ID	2	0–65535
12	Vehicle ID	2	1–65535
14	Alignment Request Count	2	1–65535
16	Message CRC	2	0–65535

### Message Header

Constant byte pattern that designates the start of a message. These bytes have a value of 0xAB followed by 0xBA.

### Message Length

Length of this message, which is given as the number of bytes following the Message Length field, including the Message CRC field.

## Message Type

Fixed message type that identifies this message as a Host Extension message.

## Extension Type

Fixed extension type that identifies this message as a node extension message.

## Extension Subtype

Fixed extension subtype that identifies this message as an MP Alignment Request extension message.

## Node ID

The ID of the Moving Path node for which this path end alignment request applies.

## Control Path ID

The ID of the path where a vehicle is requesting permission to navigate the specified Moving Path node.

## Requested Path ID

The Requested Path ID field is a signal to the host controller that a vehicle is requesting permission to navigate a Moving Path node as follows:

- If the Requested Path ID field is zero, the host controller can align any path that offers an equivalent path route to the vehicle's destination.
- If the Requested Path ID field is nonzero, the host controller must align the requested path to the Control Path to satisfy the vehicle's route to its destination.

The Requested Path ID persists on a Control Path from the time the Control Path enters the [unlinked\\_alignment\\_requested](#) state until the Control Path is unlinked. The Requested Path ID field is cleared on the Peer Path when linked with a Control Path to form a junction.

See [MP Path End States](#) on page 39 for detailed descriptions of the path end states.

## Vehicle ID

The ID of the vehicle to navigate the path junction once it is properly aligned.

## Alignment Request Count

A sequence count, unique to the most recent alignment request, which the HLC increments when an MP Alignment Request is sent. The HLC maintains the Alignment Request Count.

## **Message CRC**

A check value on the entire message (excluding the CRC) to verify integrity.

## **Response**

The host controller responds with an [MP Link Command \(0xBF 09 02\)](#) once the control and requested path ends are properly aligned.

## MP Path End States

This section describes the states of the state machine that manages each path end that is associated with a Moving Path node.

Table 5: Path End State

State	Name	Description
1	unlinked	<p>The path end is not linked.</p> <ul style="list-style-type: none"> <li>• This is the initial path end state following a node controller restart or a reset of all paths.</li> <li>• Motor-to-motor message forwarding is disabled in this state.</li> <li>• Vehicles cannot navigate the node when a path end is in this state.</li> <li>• When the headway for a vehicle approaches a path end, the motor sends an entry request to the NC responsible for the node requesting permission to move the vehicle beyond the entry gate and navigate the node. When the NC receives the entry request from a path end in the <b>unlinked</b> state, it checks the routing that is needed for the vehicle to reach its destination, updates the <b>Requested Path ID</b> and <b>Requesting Vehicle ID</b> to notify the host controller of the alignment that is required and changes the path end state to the <b>unlinked_alignment_requested</b> state. The HLC sends the updated path end status to the host controller. The host controller responds with an <b>MP Link Command (0xBF 09 02)</b> when a path that provides a route to the vehicle's destination is aligned.</li> </ul>
2	linked_unlinked_pending	<p>The path end is linked with an unlink pending.</p> <ul style="list-style-type: none"> <li>• A linked junction remains linked allowing vehicles already navigating the junction to proceed.</li> <li>• Vehicles that request entry to the junction are not granted permission to breach the entry gates.</li> <li>• When all navigating vehicles are clear of the junction, the path end transitions to the <b>unlinked</b> state.</li> </ul>

Table 5: Path End State

State	Name	Description
3	unlinked_alignment_requested	<p>The path end is not linked and a request to align it with another path is pending.</p> <ul style="list-style-type: none"> <li>• Motor-to-motor message forwarding is disabled in this state.</li> <li>• Vehicles cannot navigate the node when a path end is in this state.</li> <li>• A transition to this state indicates that a vehicle is requesting permission to navigate the node.</li> <li>• Entry requests are processed in this state to check that the requested alignment is still a valid route for the entering vehicle.</li> <li>• When an <a href="#">MP Link Command (0xBF 09 02)</a> is received from the host controller the path end transitions to the <a href="#">linked</a> state.</li> </ul>
4	linked	<p>The Control Path is linked to a Peer Path to form a path junction.</p> <ul style="list-style-type: none"> <li>• Motor-to-motor message forwarding is enabled in this state.</li> <li>• Vehicles can navigate the node from this path end.</li> <li>• In the <a href="#">linked</a> state the node controller grants entry requests if the path junction offers an equivalent route to the requesting vehicle's destination.</li> <li>• If <a href="#">Last Allowed Vehicle ID</a> is zero, entry requests are granted as long as the path junction offers a route to the vehicle's destination.</li> <li>• If <a href="#">Last Allowed Vehicle ID</a> is set, the path junction continues to let vehicles in until the Last Allowed Vehicle ID enters. When the last vehicle enters, the path junction transitions to the <a href="#">linked_unlinked_pending</a> state.</li> <li>• If the host controller sends an unlink command when the junction is in the <a href="#">linked</a> state and there are no vehicles navigating the junction, the junction is unlinked and both the Control Path and Peer Path ends transition to the <a href="#">unlinked</a> state.</li> <li>• If there is a vehicle navigating the junction, the path junction transitions to the <a href="#">linked_unlinked_pending</a> state.</li> </ul>



Table 5: Path End State

State	Name	Description
5	linked_comm_loss	<p>Communication to a linked path end is lost.</p> <ul style="list-style-type: none"> <li>• Path ends in the linked or linked_unlinked_pending states enter this state when communication between the host controller and the HLC, or communication between the HLC and an NC is lost.</li> <li>• Motor-to-motor message forwarding is enabled in this state.</li> <li>• No additional vehicles are granted permission to navigate.</li> <li>• A link command or an unlink command is required once communication is restored to transition from the linked_comm_loss state.</li> </ul>
6	linked_peer	<p>The Peer Path is linked to a Control Path to form a path junction.</p> <ul style="list-style-type: none"> <li>• The Peer Path remains in the linked_peer state until the path junction is unlinked.</li> </ul>
7	unlinked_vehicle_present	<p>There is a vehicle that is located in an unlinked junction.</p> <ul style="list-style-type: none"> <li>• A vehicle was located during startup and extends past the entry gate on a path end in the Moving Path node.</li> <li>• The host controller must either clear the vehicle by moving it away from the path end or link a path to move it through the junction.</li> </ul> <p><b>Note:</b> When any Moving Path node path end is in this state, the Device Status field (bits 0-3 in the Node Status (0xD3) message) is set to 'Junction Fault'.</p>

## HLC Error Status Codes

This section lists error status codes that are returned by the HLC when it accepts, rejects, or completes Moving Path node commands.

*Table 6: HLC Command Status Codes*

Status Value	Status Description
0x00	Command Accepted
0x01	Command Rejected – Invalid vehicle ID
0x02	Command Rejected – Invalid station ID
0x03	Command Rejected – Invalid Path ID
0x04	Command Rejected – Invalid position (off Path)
0x05	Command Rejected – E-stop signal active
0x06	Command Rejected – Interlock signal active
0x07	Command Rejected – Movement suspended
0x08	Command Rejected – Startup sequence already complete
0x09	Command Rejected – Startup sequence already started
0x0A	Command Rejected – Startup sequence not initiated/complete
0x0B	Command Rejected – Invalid parameter (acceleration, velocity, or direction)
0x0C	Command Rejected – Initialization not complete
0x0D	Command Rejected – Reset active
0x0E	Command Rejected – No record available
0x0F	Command Rejected – Terminus node busy
0x10	Command Rejected – Programming active
0x11	Command Rejected – Invalid traffic light ID
0x12	Command Rejected – Unrecognized command
0x13	Command Rejected – Vehicle lock active
0x14	Command Rejected – Duplicate record
0x15	Command Rejected – Station in use
0x16	Command Rejected – Invalid motor index
0x17	Command Rejected – Motor busy
0x18	Command Rejected – Invalid coil board index
0x19	Command Rejected – Invalid Node ID
0x20	Command Rejected – Invalid node type

Table 6: HLC Command Status Codes

Status Value	Status Description
0x21	Command Rejected – Invalid item type
0x22	Command Rejected – Invalid item index
0x23	Command Rejected – Invalid motor type
0x24	Command Rejected – FastStop active
0x25	Command Rejected – Invalid node controller ID
0x26	Command Rejected – Invalid Metric ID
0x27	Command Rejected – Item in use
0x40	Command Failed – Unable to acquire status from motor
0x41	Command Failed – Unable to complete
0x42	Command Failed – Timed out
0x43	Command Failed – Soft Start active
0x44	Command Failed – FastStop active
0x80	Command Completed Successfully

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## More Information

MagneMotion website: [www.magnemotion.com](http://www.magnemotion.com)

Questions and Comments: [www.magnemotion.com/contact/](http://www.magnemotion.com/contact/)

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## Revision History

### Ver. Change Description

00 Initial release

## Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	<a href="https://rockwellautomation.custhelp.com/">https://rockwellautomation.custhelp.com/</a>
Local Technical Support Phone Numbers	Locate the phone number for your country.	<a href="http://www.rockwellautomation.com/global/support/get-support-now.page">http://www.rockwellautomation.com/global/support/get-support-now.page</a>
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	<a href="http://www.rockwellautomation.com/global/support/direct-dial.page">http://www.rockwellautomation.com/global/support/direct-dial.page</a>
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	<a href="http://www.rockwellautomation.com/global/literature-library/overview.page">http://www.rockwellautomation.com/global/literature-library/overview.page</a>
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	<a href="http://www.rockwellautomation.com/global/support/pcdc.page">http://www.rockwellautomation.com/global/support/pcdc.page</a>

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