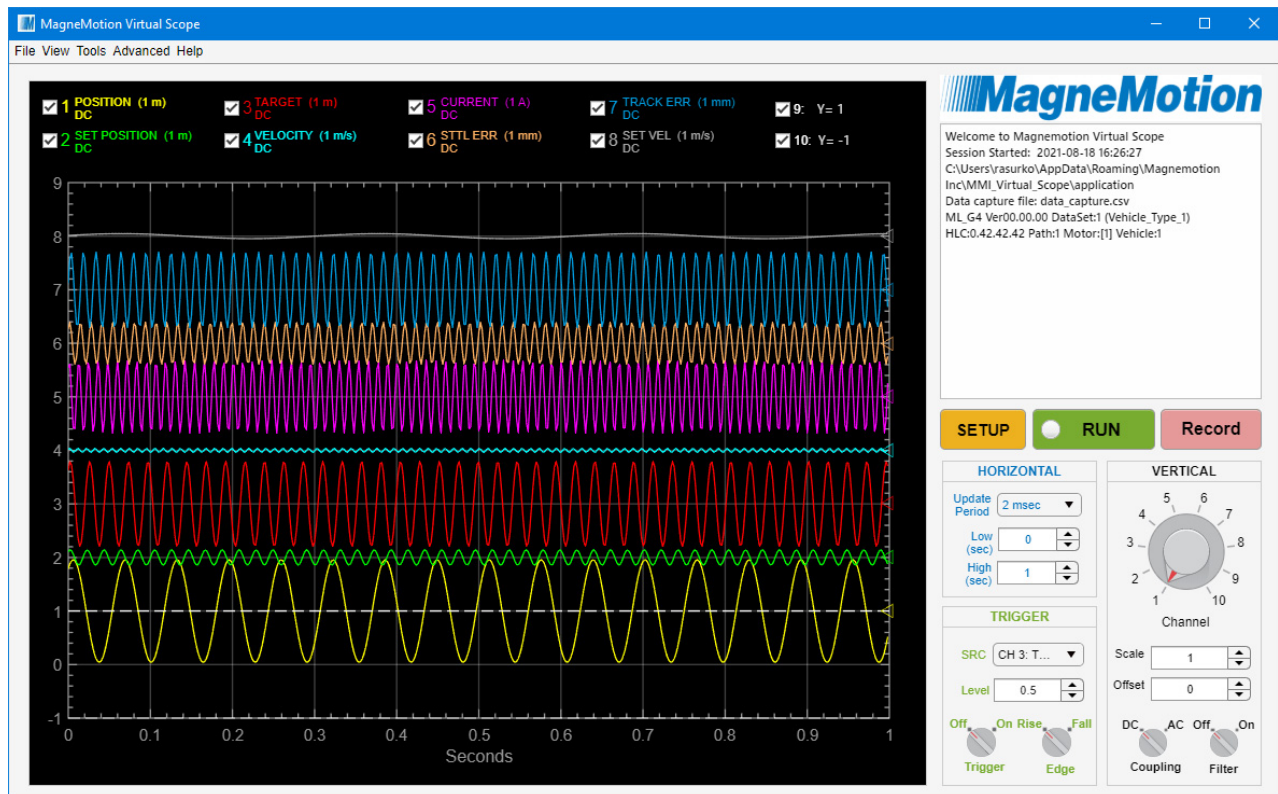




A Rockwell Automation Company

# Virtual Scope Utility User Manual



Original Instructions

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# Changes

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## Overview

This manual is changed as required to keep it accurate and up-to-date to provide the most complete documentation possible for the MagneMotion® Virtual Scope utility. This section provides a brief description of each significant change.

**NOTE:** Distribution of this manual and all addenda and attachments is not controlled. To identify the current revision, see the [Literature Library](#) on the Rockwell Automation website.

### Rev. A

Initial release to support MMI\_Virtual\_Scope version 1.0.0.

### Rev. B

Revised to support MMI\_Virtual\_Scope version 1.0.1.

Updated the following:

- [Chapter 5, Troubleshooting](#).

### Ver. 03/C

Revised to support MMI\_Virtual\_Scope version 1.0.14.

Added the following:

- Added the [Back Cover](#).

Updated the following:

- The revision from alpha (Rev. C) to numeric (Ver. 03).
- Trademark, copyright, and contact information.
- The structure of these changes descriptions.

- In the *Appendix*, updated the *Transport System Limits*.
- Updated the *Glossary*.

## Rev. D

Revised to support MMI\_Virtual\_Scope version 2.0.6.

Added the following:

- In *Chapter 1, Introduction*, added descriptions of new utilities and new file types to the *Transport System Software Overview*.
- Added *Chapter 3, Application Notes*, which includes *Tuning Motor Performance* and *System Diagnosis*. Renumbered all remaining chapters.

Updated the following:

- Updated all trademark, copyright, and support information and moved to the *Back Cover*.
- Updated the part numbers for all referenced manuals.
- Updated the appearance of the safety notices to match Rockwell Automation standards.
- Updated all UI images to reflect the current version of software.
- In *Chapter 1, Introduction*, updated the *Transport System Components Overview*, the *Transport System Software Overview*, and *Getting Started with the Virtual Scope Utility*.
- In *Chapter 2, Using the Virtual Scope Utility*, updated the *Scope Controls Configuration* and the *Zoom* operation.
- In *Chapter 4, UI Reference*, updated all descriptions to reflect the new UI.
- In *Chapter 5, Troubleshooting*, added how to *Contact Rockwell Automation Technical Support*.
- In the *Appendix*, updated the *Transport System Limits*.
- Updated the *Glossary* and the *Index*.

Removed the following:

- Removed all references to the Mitsubishi PLC TCP/IP Library User Manual as that interface is no longer supported.
- Updated the manual to remove references to PLCs and PCs, which are now referred to generically as controllers.
- Removed all references to ICT Customer Support> Support now refers to the Rockwell Automation Technical Support Center and TechConnect<sup>SM</sup>.

# About This Manual

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## Overview

This section provides information about the use of this manual, including the manual structure, related documentation, format conventions, and safety conventions.

## Purpose

This manual explains how to install and use the MagneMotion® Virtual Scope utility. This utility provides real-time feedback of the change in MagneMotion Linear Synchronous Motor performance parameters, which are displayed as waveforms to analyze transport system performance. This manual also provides basic troubleshooting information.

Use this manual in combination with the other manuals and documentation that accompanies the transport system to install, configure, test, and operate a MagneMotion transport system.

## Audience

This manual is intended for all users of MagneMotion transport systems that are using the Virtual Scope utility to monitor and record the change in LSM performance parameters.

**NOTE:** Depending on software version, user access privileges, and application configuration, certain operations that are described in this manual may not be available.

## Prerequisites

The information and procedures that are provided in this manual assume the following:

- Basic familiarity with general-purpose computers and with the Windows® operating system.
- The transport system has already been installed and that full documentation for the transport system is available.
- All personnel who configure, operate, or service the transport system are properly trained.

## MagneMotion Documentation

The documentation that is provided with the MagneMotion transport system includes this manual, which provides complete documentation for the use of the Virtual Scope utility. Other manuals in the document set, which are listed in the [Related Documentation](#) section, support installation, configuration, and operation of the transport system.

The examples in this manual are included solely for illustrative purposes. Because of the many variables and requirements that are associated with any LSM system installation, MagneMotion cannot assume responsibility or liability for actual use that is based on these examples.

### Manual Conventions

The following conventions are used throughout this manual:

- Bulleted lists provide information in no specific order, they are not procedural steps.
- Numbered lists provide procedural steps or hierarchical information.
- Keyboard keys and key combinations (pressing multiple keys at a time) are shown enclosed in angle brackets. Examples: <F2>, <Enter>, <Ctrl>, <Ctrl-x>.
- Dialog box titles or headers are shown in bold type, capitalized exactly as they appear in the software. Example: the **Open XML Configuration File** dialog box.
- Responses to user actions are shown in italics. Example: *Motion on all specified paths is enabled.*
- Selectable menu choices, option titles, function titles, and area or field titles in dialog boxes are shown in bold type and are capitalized exactly as they appear in the software. Examples: **Add to End...**, **Paths**, **Path Details**, **OK**.
- **Dialog Box** – A window that solicits a user response.
- **Click** or **Left-click** – Press and release the left mouse button<sup>1</sup>.
- **Right-click** – Press and release the right mouse button.
- **Double-click** – Press and release the left mouse button twice in quick succession.
- **Control-click** – Hold down <Ctrl> and press and release the left mouse button.
- **Click-and-hold** – Press down the left mouse button and hold it down while moving the mouse.
- **Select** – Highlight a menu item with the mouse or the tab or arrow keys.
- **Code Samples** – Shown in monospaced text. Example: `Paths`.

---

1. Mouse usage terms assume typical “right-hand” mouse configuration.

- **Data Entry** – There are several conventions for data entry:
  - **Exact** – The text is shown in single quotes. Example: Enter the name “Origin” in the text field.
  - **Variable** – The text is shown in italics. Example: Save the file as *file\_name.xml*.
- **Numbers** – All numbers are assumed to be decimal unless otherwise noted and use the US number format; that is, one thousand = 1000.00. Non-decimal numbers (binary or hexadecimal) are explicitly stated.
  - **Binary** – Followed by <sub>2</sub>, for example, 1100 0001 0101<sub>2</sub>, 1111 1111 1111 1111<sub>2</sub>.
  - **Hex** – Preceded by 0x, for example, 0xC15, 0xFFFF.
- **Measurements** – All measurements are SI (International System of Units). The format for dual dimensions is *SI\_units* [*English\_units*]; for example, 250 mm [9.8 in].
- **Part Numbers** – All part numbers that are shown are the catalog numbers for ordering the item being referenced. These numbers are shown in different formats, for example; 700-1483-00, MMI-HT-C2198-D032, 2198-KITCON-D032-L.
- Text in blue is a hyperlink. These links are active when viewing the manual as a PDF. Select a hyperlink to change the manual view to the page of the item referenced. In some cases, the item that is referenced is on the same page, so no change in the view occurs.

## Notes, Safety Notices, and Symbols

Notes, Safety Notices, and Symbols that are used in this manual have specific meanings and formats. Examples of notes, the different types of safety notices and their general meanings, and symbols and their meanings are provided in this section. Adhere to all safety notices provided throughout this manual to help achieve safe installation and use.

### Notes

Notes are set apart from other text and provide additional or explanatory information. The text for Notes is in standard type as shown in this section.

**NOTE:** A note provides additional or explanatory information.

### Safety Notices

Safety Notices are set apart from other text. The symbol on the left of the notice identifies the type of hazard. The text in the message panel identifies the hazard, methods to avoid the hazard, and the consequences of not avoiding the hazard.

Examples of the standard safety notices that are used in this manual are provided in this section. Each example includes a description of the hazard indicated. Labels may also be on or inside the equipment to provide specific precautions.

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<b>NOTICE</b>	Identifies an informational notice that indicates practices that are not related to personal injury that could result in equipment or property damage.
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<b>IMPORTANT</b>	Identifies information that is critical for the successful application and understanding of the product.
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<b>ATTENTION:</b>	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help to identify a hazard, avoid a hazard, and recognize the consequence.
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## Manual Structure

This manual contains the following chapters:

- ***Introduction:*** Provides an overview of the Virtual Scope utility, which is used to monitor and record the change of performance parameters for MagneMotion LSM transport systems.
- ***Using the Virtual Scope Utility:*** Describes how to use the Virtual Scope utility for performance parameter verification.
- ***UI Reference:*** Provides an overview of the Virtual Scope utility user interface and a description of each option available through the UI.
- ***Troubleshooting:*** Provides identification of errors that may be encountered when using the Virtual Scope utility, their meaning, and how to resolve them.
- ***Appendix:*** Provides additional information that is related to the Virtual Scope utility and MagneMotion transport systems.
- ***Glossary:*** A list of terms and definitions that are used in this manual and for the transport system and its components.
- ***Index:*** A cross-reference to this manual organized by subject.

**NOTE:** The version of the Virtual Scope utility that is supplied by MagneMotion may be newer than the version that is described in this manual (indicated in [Changes on page 11](#)). All features that are documented in this manual are supported as indicated. Specific builds of the Virtual Scope utility may not implement all features that are described in this manual.



## Related Documentation

Before configuring or running the transport system, consult the following documentation:

- *MagneMover LITE Configurator User Manual*, [MMI-UM008](#).  
or  
*QuickStick Configurator User Manual*, [MMI-UM009](#).
- *Node Controller Interface User Manual*, [MMI-UM001](#).
- *NCHost TCP Interface Utility User Manual*, [MMI-UM010](#).
- *Host Controller TCP/IP Communication Protocol User Manual*, [MMI-UM003](#).  
or  
*Host Controller EtherNet/IP Communication Protocol User Manual*, [MMI-UM004](#).
- *MagneMover LITE User Manual*, [MMI-UM002](#).  
*QuickStick 100 User Manual*, [MMI-UM006](#).  
or  
*QuickStick HT User Manual*, [MMI-UM007](#).
- *Node Controller Hardware User Manual*, [MMI-UM013](#).
- *LSM Synchronization Option User Manual*, [MMI-UM005](#).
- *Virtual Scope Utility User Manual*, [MMI-UM011](#) (this manual).

**NOTE:** Distribution of this manual and all addenda and attachments are not controlled. Changes to the document set or the software can be made at any time. To identify the current revisions or to obtain a current version, see [Rockwell Automation Support on page 114](#).

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## Overview

This chapter provides an overview of the Virtual Scope utility that is used analyze transport system performance. The Virtual Scope utility displays waveforms to provide real-time feedback of the change in MagneMotion<sup>®</sup> LSM performance parameters. This chapter also provides a basic overview of the transport system hardware and software. Additionally, the basic set of tasks that are required to use the Virtual Scope utility with a MagneMotion transport system are described.

Use this manual when analyzing the performance of the transport system using the Virtual Scope utility by monitoring the change in LSM performance parameters that are displayed as waveforms. Some procedures may vary based on the transport system configuration, communications, and other variables.

This manual supports:

- MagneMover<sup>®</sup> LITE motors.
- QuickStick<sup>®</sup> motors.

**NOTE:** Make sure that complete design specifications, including the physical layout of the transport system, are available before starting to analyze transport system operation.

Included in this chapter are overviews of:

- The Virtual Scope utility.
- The transport system components.
- The transport system software.
- Getting started with the Virtual Scope utility.

## Virtual Scope Utility Overview

The Virtual Scope utility is a Windows<sup>®</sup> software application that is provided by MagneMotion to provide real-time feedback of the change of LSM performance parameters. All parameters are displayed as waveforms to analyze transport system performance.

The transport system is a configuration of linear synchronous motors that are placed end-to-end to form long chains or paths. These chains are used to move and position vehicles in a controlled manner at various acceleration/deceleration and velocity profiles while carrying a wide range of payloads with high precision. The transport system consists of the following components at a minimum:

- MagneMover LITE or QuickStick motors.
- Vehicles with magnet arrays.
- Node controllers.
- Power supplies.
- Configuration file defining paths and nodes.
- User-supplied host controller.

Each of the components of the transport system must be fully defined in the Node Controller Configuration File to make sure of proper operation of the transport system. Once the transport system is fully defined, the motor performance can be analyzed using the Virtual Scope utility.

**NOTE:** Additional testing and refinement may be necessary if any aspect of the transport system changes, such as vehicle length, payload weight, or other physical factors.

The Virtual Scope utility provides a window with sections for the different functions available. These functions include the scope display and scope configuration. Some functions open dialog boxes for data entry. Using the Virtual Scope to monitor the motion of a vehicle on a MagneMotion Linear Synchronous Motor provides:

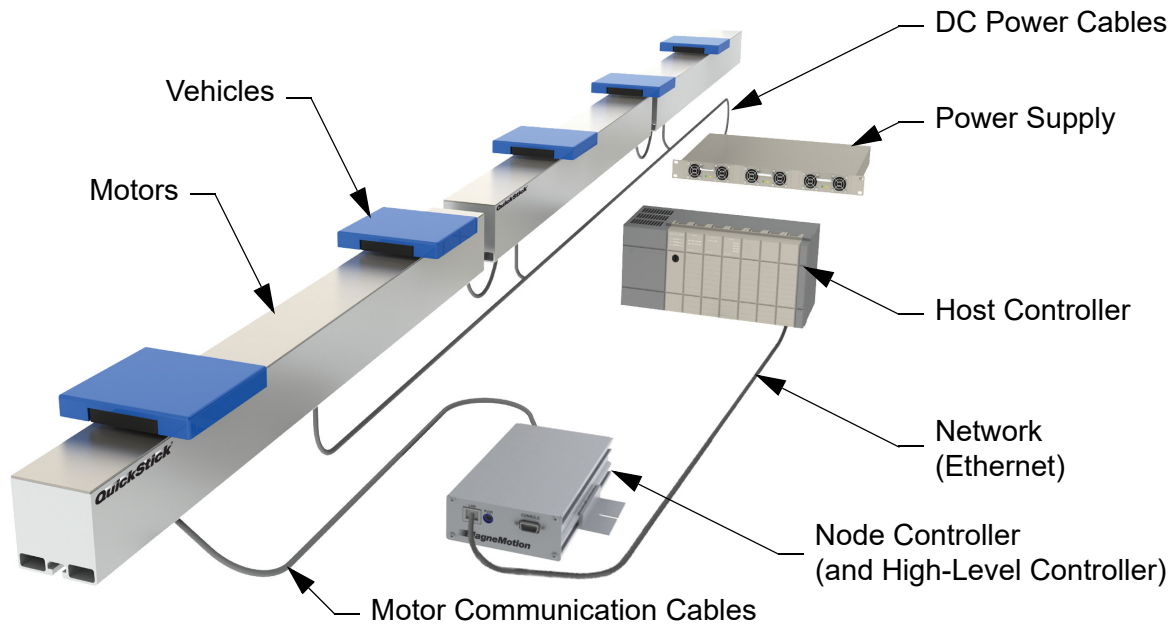
- Real-time feedback on MagneMotion transport system performance parameters (including profile position, velocity, and acceleration) and actual measurements (including position, velocity, and acceleration).
- The ability to monitor, measure, and evaluate system settling performance at a station, including settling time, move time, settling errors, and overshoot.
- The ability to monitor, measure, and evaluate system performance during moves, including tracking errors, real-time position, and velocity.
- The ability to monitor, measure, and evaluate system operating condition parameters, including motor current, voltage, and operating temperatures.

The data that is collected using the Virtual Scope can be used for:

- Collecting performance data from MagneMotion transport systems.
- Assisting the PID tuning of MagneMotion transport systems.
- Assisting the troubleshooting of MagneMotion transport systems.

## Transport System Components Overview

This section identifies the components of a MagneMotion transport system as shown in [Figure 1-1](#) and described after the figure.



*Figure 1-1: Simplified View of the Transport System using RS-422 Communication*

- **DC Power Cables and Communication Cables** – Distributes DC power to the motors and carries communications, such as RS-422 or Ethernet, between the components of the transport system.
- **High-Level Controller (HLC)** – Software application that is enabled on one node controller. This application handles all communication with the user-supplied host controller and directs communication as appropriate to individual node controllers.
- **Host Controller** – User-supplied controller for control and monitoring of the MagneMotion transport system using either TCP/IP or EtherNet/IP™ communication.
- **Motor/Stator** – Refers to a MagneMotion linear synchronous motor (LSM).
- **Network** – Ethernet network providing communication (TCP/IP or EtherNet/IP) between the host controller and the HLC (TCP/IP is used between node controllers).
- **Node Controller (NC)** – Coordinates motor operations and communicates with the HLC. Several types of node controllers are available. All node controllers support Ethernet communication with the host controller and the motors, and depending on the model, provide up to 12 RS-422 ports for communication with the motors. Some node controller models also provide digital I/O and/or serial I/O for external devices such as switches, E-stops, light stacks, and interlocks.
- **Power Supply** – Provides DC power to the motors.
- **Vehicle with Magnet Array** – Carries a payload through the MagneMotion transport system as directed. The magnet array is mounted to the vehicle facing the motors and interacts with the motors, which move each vehicle independently.

## Transport System Software Overview

Several software applications are used to configure, test, and administer a MagneMotion transport system as shown in [Figure 1-2](#) and described after the figure. See [Related Documentation on page 17](#) for the reference manuals for these applications.

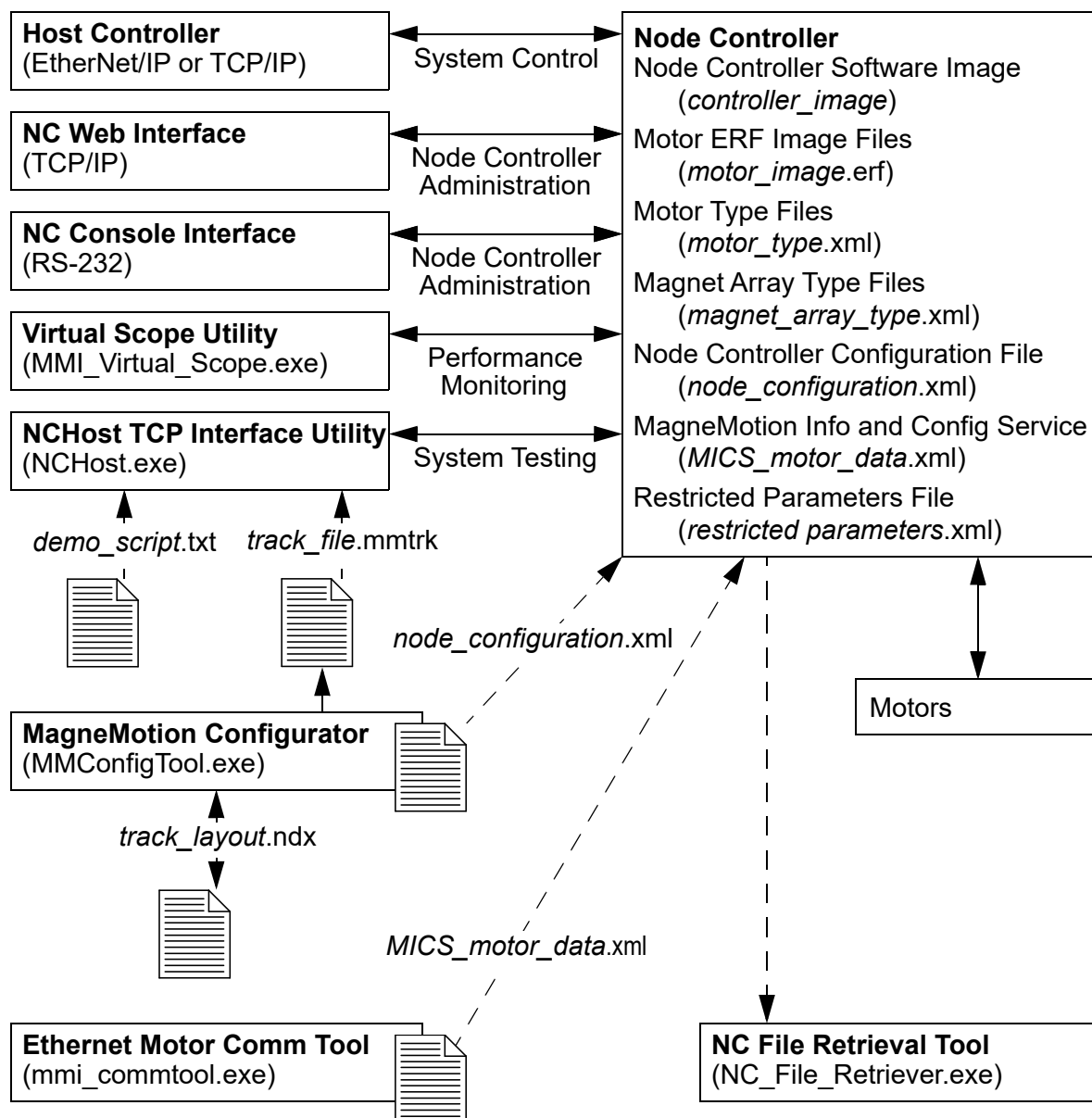


Figure 1-2: Simplified View of Transport System Software Relationships

### Utilities

- **NC Web Interface** – A web-based software application that is supplied by MagneMotion and resident on the node controllers, for administration of the transport system components.

- **NC Console Interface** – A serial communication software application that is supplied by MagneMotion and resident on the node controllers, for administration of the node controller.
- **Virtual Scope Utility** – A Windows software application that is supplied by MagneMotion to monitor and record the change of motor performance parameters. These parameters are displayed as waveforms to analyze the performance of the motors.
- **NCHost TCP Interface Utility** – A Windows<sup>®</sup> software application that is supplied by MagneMotion to move vehicles for test or demonstration purposes. This application supports system testing without the host controller to verify that vehicles move correctly before integrating the transport system into a production environment.
- **MagneMotion Configurator Utility (Configurator)** – A Windows software application that is supplied by MagneMotion to create or change the Node Controller Configuration File. This utility is available in both MagneMover LITE and QuickStick versions. The MM LITE™ version is also used to create or change the Track File and Track Layout File for MagneMover LITE transport systems.
- **Ethernet Motor Commissioning Tool** – A Windows software application that is supplied by MagneMotion to create and edit MagneMotion Information and Configuration Service (MICS) files.
- **NC File Retrieval Tool** – A Windows software application that is supplied by MagneMotion to download configuration and operation files from the specified HLC and all node controllers in the transport system.

## File Types

- **Node Controller Software Image File (IMG file)** – The software file for the node controllers (*controller\_image*), includes the node controller and HLC applications. The Node Controller Software Image file is uploaded to all node controllers in the transport system.
- **Motor ERF Image Files (ERF file)** – The software files for the MagneMotion motors (*motor\_image.erf*). The Motor ERF Image files are uploaded to all node controllers in the transport system and then programmed into all motors.
- **Motor Type Files** – XML files (*motor\_type.xml*) that contain basic information about the specific MagneMotion motor types being used. The Motor Type files are uploaded to all node controllers in the transport system.
- **Magnet Array Type File** – An XML file (*magnet\_array\_type.xml*) that contains basic information about the specific MagneMotion magnet array type that is used on the vehicles in the transport system. The Magnet Array Type file is uploaded to all node controllers in the transport system.
- **Node Controller Configuration Files (Configuration file)** – An XML file (*node\_configuration.xml*) that contains all parameters for the components in the transport system. Multiple Node Controller Configuration Files can be uploaded to all node controllers in the transport system, but only one is active.

- **MagneMotion Information and Configuration Service (MICS) File** – An XML file (*MICS\_motor\_data.xml*) that contains the network topology parameters for the transport system when using Ethernet communication with the motors. The file includes the MAC address of each motor and the location of each motor on a path. The MICS file is uploaded to all node controllers in the transport system.
- **Restricted Parameters File** – An XML file (*restricted\_parameters.xml*) that provides access to restricted configuration elements for specific transport systems. The Restricted Parameters file is uploaded to the HLC. For the development of a custom Restricted Parameters file for a specific transport system, see [Rockwell Automation Support on page 114](#).
- **Demo Script** – A text file (*demo\_script.txt*) uploaded to the NCHost TCP Interface Utility to move vehicles on the transport system for test or demonstration purposes.
- **Track File** – A text file (*track\_file.mmtrk*) that contains graphical path and motor information about the transport system. The Track file is used by the NCHost TCP Interface Utility to provide a graphical representation of the transport system to monitor system operation. The Track file is created for MagneMover LITE transport systems using the MagneMover LITE Configurator. See [Rockwell Automation Support on page 114](#) for questions regarding the development of Track files for QuickStick transport systems.
- **Track Layout File** – An XML file (*track\_layout.ndx*) that contains the parameters for the graphical representation of a MagneMover LITE transport system. The Track Layout file is used by the MagneMover LITE Configurator to generate the Node Controller Configuration File and the Track file for MagneMover LITE systems.
- **Scope Config File** – An XML file (*scope\_config.xml*) that contains basic information about the configuration of the Virtual Scope (for example, update period and limits, trigger definition, and channel settings).
- **Data Stream Config File** – An XML file (*data\_stream\_config.xml*) that contains basic information about the configuration of the data stream that is displayed by the Virtual Scope. This configuration includes the motor type, vehicle ID, path ID, motor ID, and the parameters to monitor. The name of the file identifies the type of motor and the data set.
- **Screen Data Files** – XML and text files (*screen\_data.vsdata* and *screen\_data.csv*) that contain the data points for each of the eight channels for the period of the display. All data points are included, even if they are not being displayed. The *screen\_data.vsdata* file is used by the Virtual Scope and the *screen\_data.csv* file is used by other applications such as Excel.
- **Data Capture File** – A text file (*data\_capture.csv*) that contains the data points for each of the eight channels as a running log, even if they are not being displayed. Applications such as Excel can use the *data\_capture.csv* file.

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<b>NOTICE</b>	Modifications to the Image or Type files could cause improper operation of the transport system.
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## Getting Started with the Virtual Scope Utility

Use this manual as a guide and reference when performing tasks with the Virtual Scope utility. Follow the steps in this section to get the entire transport system operational quickly with the aid of the other MagneMotion manuals (see [Related Documentation on page 17](#)).

**NOTE:** Make sure that all components and complete design specifications, including the physical layout of the transport system, are available before starting to test transport system operation.

### Transport System Quick Start Reference

1. Download the software for the appropriate MagneMotion transport system and the MagneMotion Utilities from [rok.auto/pcdc](http://rok.auto/pcdc).

2. Contact your Motion Solution Consultant for the Virtual Scope installer.

**NOTE:** The minimum requirements for running the MagneMotion Virtual Scope utility are a 64-bit general-purpose computer running Microsoft® Windows 7 SP1 or Windows 10, with MathWorks® MATLAB® Compiler™ Runtime 9.10. An Ethernet port (web interface) and an optional RS-232 port (console interface) are required to connect to the node controllers.

The user must have read/write permission to the folder where the Virtual Scope utility is installed (C:\Users\user\_name\AppData\Roaming\Mag-nemotion Inc\MMI\_Virtual\_Scope\).

3. Install the components of the MagneMotion transport system as described in the *Node Controller Hardware User Manual*, [MMI-UM013](#), and either the *MagneMover LITE User Manual*, [MMI-UM002](#), the *QuickStick 100 User Manual*, [MMI-UM006](#), or the *QuickStick HT User Manual*, [MMI-UM007](#).
4. Install the MagneMotion Configurator on a computer for user access (see either the *MagneMover LITE Configurator User Manual*, [MMI-UM008](#), or the *QuickStick Configurator User Manual*, [MMI-UM009](#)).
  - A. For MM LITE™ systems, define the motors and paths and their relationships in the transport system graphically to create the Track Layout File (*track\_layout.ndx*) and the Track File (*track\_file.mmtrk*).
  - B. For all transport systems, create the Node Controller Configuration File (*node\_configuration.xml*) to define the components and operating parameters of the transport system.
5. Set the IP address for each node controller and specify the node controller to be used as the high-level controller (see the *Node Controller Interface User Manual*, [MMI-UM001](#)).

6. Upload the configuration, image, and type files to each node controller using the node controller web interface (see the *Node Controller Interface User Manual*, [MMI-UM001](#)).
7. When using motors with Ethernet communication, create the MICS file and provision the motors (see either the *MagneMover LITE User Manual*, [MMI-UM002](#), or the *QuickStick HT User Manual*, [MMI-UM007](#), and the *Node Controller Interface User Manual*, [MMI-UM001](#)).
8. Program the motors using the Motor ERF Image files (see the *Node Controller Interface User Manual*, [MMI-UM001](#), and the *NCHost TCP Interface Utility User Manual*, [MMI-UM010](#)).
9. Test and debug the transport system by using the NCHost TCP Interface Utility and Demo Scripts (see the *NCHost TCP Interface Utility User Manual*, [MMI-UM010](#)). NCHost provides an easy method to verify proper operation and make adjustments such as refining the control loop tuning.  
  
**NOTE:** The NCHost TCP Interface Utility is for test and verification trials only. The host controller must be used to control the transport system after verification of functionality.
10. Configure the host controller for transport system control as required to meet the material movement needs of the facility where the system is installed. When using TCP/IP communication, see the *Host Controller TCP/IP Communication Protocol User Manual*, [MMI-UM003](#). When using EtherNet/IP communication, see the *Host Controller EtherNet/IP Communication Protocol User Manual*, [MMI-UM004](#).

## Monitoring the Transport System

Monitor transport system operation using the host controller or the NCHost TCP Interface Utility to move a vehicle on a specified motor or motors while observing the motor performance parameters displayed on the Virtual Scope.

1. [Run the Virtual Scope Utility on page 32.](#)
2. [Connect to the Transport System on page 35.](#)
3. [Configure the Virtual Scope on page 40.](#)
4. [View Data on page 46.](#)
5. [Save and Review Data on page 50.](#)

## Overview

This chapter describes how to use the Virtual Scope utility to monitor and record the change of LSM performance parameters that are displayed as waveforms. This information is used to analyze the performance of the transport system.

Included in this chapter are instructions for:

- Installing the Virtual Scope utility.
- Running the Virtual Scope utility.
- Connecting to the transport system.
- Configure the Virtual Scope.
- View Data.
- Save and Review Data.

## Using the Virtual Scope Utility

These steps provide an overview to get started quickly with the Virtual Scope utility.

1. Install the Virtual Scope software (see [Install the Virtual Scope Utility on page 29](#)).
2. Configure the scope for either Single Motor Mode or Multiple Motor Mode from the **Advanced** menu (see [Single Motor Monitoring on page 35](#)).
3. Load the appropriate Data Stream file from the **Advanced** menu (see [Load Data Stream Configuration on page 40](#)) if needed.
4. Select **Setup** and configure the scope for the high-level controller (HLC), vehicle, path, and motor in the dialog box (see [Connect to the Transport System on page 35](#)).
  - If using Multiple Motor Mode, load the Node Controller Configuration File for the transport system (see [Multiple Motor Monitoring on page 37](#)).
5. Configure a Data Capture Log file from the **Tools** menu to log all data being displayed to a file (*data\_capture.csv*) (see [Save Virtual Scope Data to a Log File on page 51](#)).
  - Select **Record** to append all Virtual Scope data to the currently defined data capture log file and enter any descriptive notes that are related to the data being captured.
  - Select **Stop REC** to stop capturing data to the log file.
6. Adjust the horizontal display update period (see [Horizontal Controls on page 43](#)).
7. Adjust the horizontal display lower and upper limits (see [Horizontal Controls on page 43](#)).
8. Select **Run** to start data collection and display the data.
9. Define the data to be displayed on the scope (see [Channel Controls on page 42](#)).
10. Select a channel and configure a trigger (see [Trigger Control on page 44](#)).
11. Adjust the vertical display limits for each channel as needed (see [Vertical Controls on page 45](#)).
12. Select **Stop** to stop data collection and hold the data display.
13. Print or save the trace data for later analysis (see [Save Screen Capture of the Virtual Scope Utility on page 50](#) and [Save Current Virtual Scope Data on page 51](#)).

## Install the Virtual Scope Utility

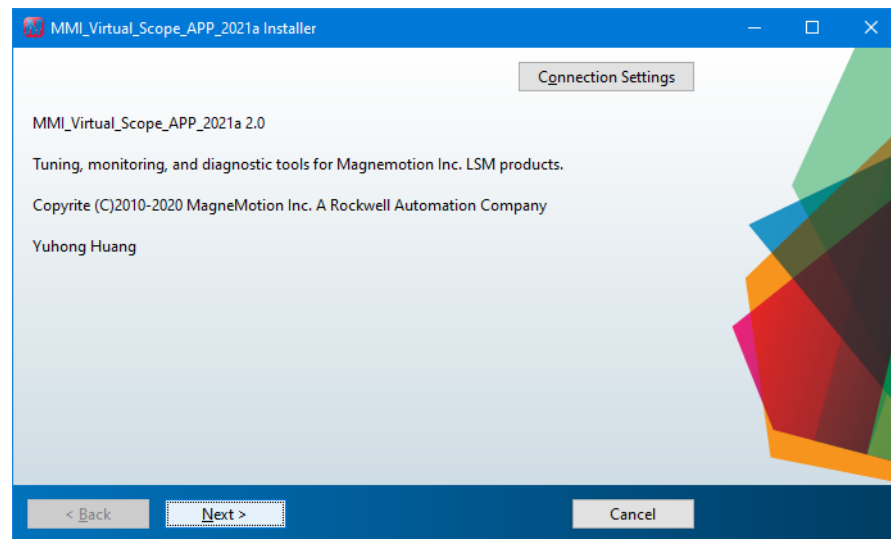
The MagneMotion® Virtual Scope utility must be installed before use. During the installation process, the computer is checked to make sure that all required software components are installed on the computer. The minimum software requirements for installing and running the Virtual Scope utility are:

- Microsoft® Windows® 7 SP1 or Windows® 10.
  - MathWorks® MATLAB® Compiler™ Runtime 2021a (9.10).
1. Using a PC, access the folder where the MagneMotion software files were copied and run `Virtual_Scope_APP_Installer_v2.0.0_Standard_win10`. The security settings on the computer may require adjustment to allow this installation.

**NOTE:** The user must have administrator rights when installing the Virtual Scope.

The user must have read/write permission to the folder where the Virtual Scope utility is installed (`C:\Users\user_name\AppData\Roaming\Magnemotion Inc\MMI_Virtual_Scope\`).

*The MagneMotion Virtual Scope utility setup wizard is opened as shown in [Figure 2-1](#).*



*Figure 2-1: MagneMotion Virtual Scope Utility Installer*

2. Select **Connection Settings** to configure a proxy server if necessary (this is not normal) and enter the server information.
3. Select **Next**.

*The MagneMotion Virtual Scope utility setup wizard prompts for an installation location as shown in [Figure 2-2](#).*

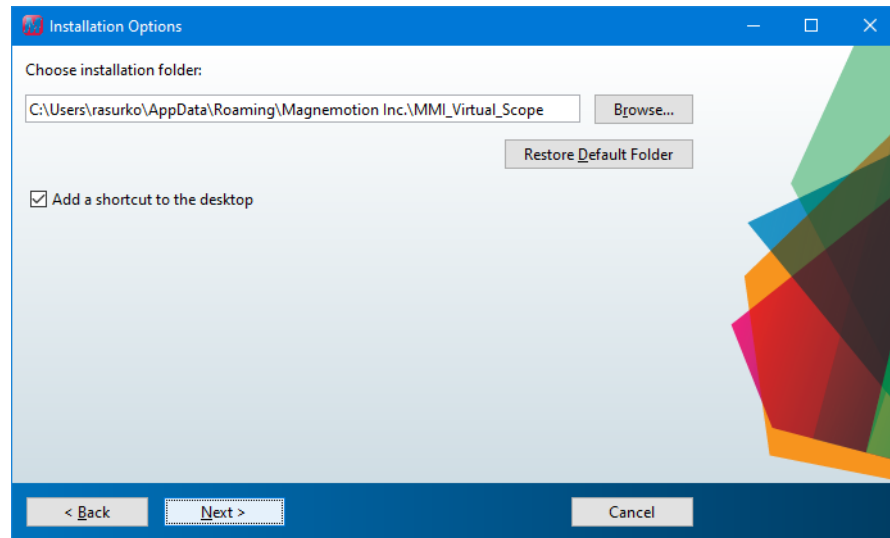


Figure 2-2: MagneMotion Virtual Scope Utility Installation Setup

4. Accept the default installation folder, or specify a folder where the utility will have write permission, select **Add a shortcut to the desktop** if desired, then select **Next**.

*If the correct version of the MATLAB Runtime Compiler is not installed on the computer where the Virtual Scope is being installed, the alert that is shown in Figure 2-3 is displayed.*

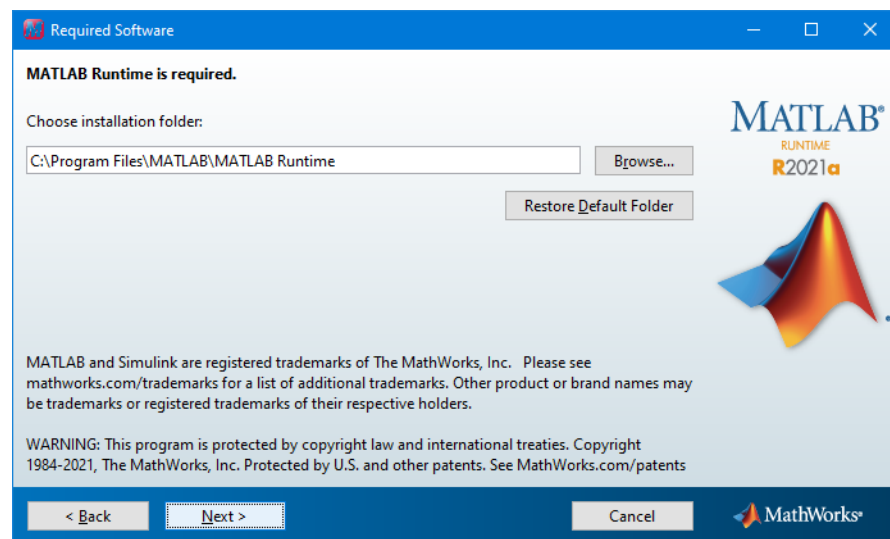


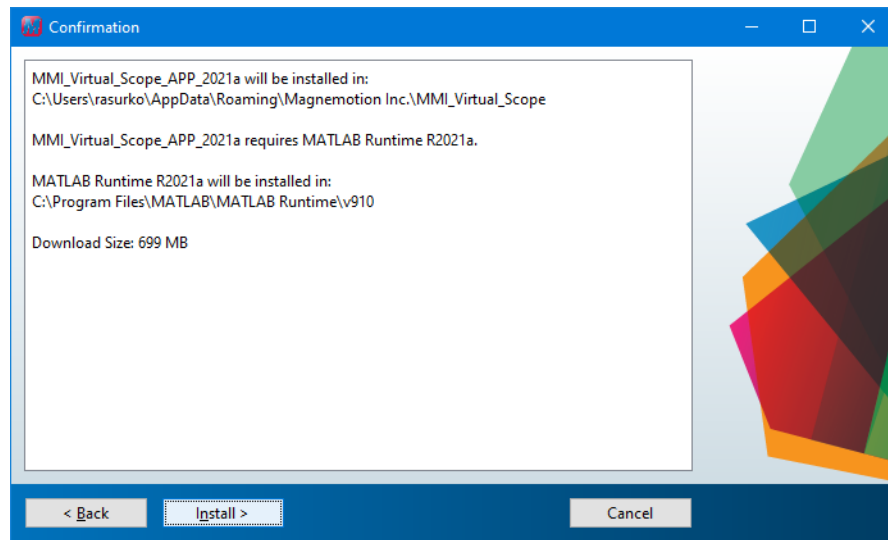
Figure 2-3: MATLAB Runtime Compiler Alert

- A. If the MATLAB Runtime Compiler alert is displayed, accept the default installation folder and select **Next**.

*The MathWorks License Agreement is displayed.*

- B. Accept the license agreement and select **Next**.

*The installer prepares to download the MATLAB Runtime Compiler and identifies the components of the installation as shown in Figure 2-4.*



*Figure 2-4: MATLAB Runtime Compiler Download*

5. Select **Install**.

*The installer shows the download and installation progress. Once the installation is complete, the installer places an Icon on the desktop for access if **Add a shortcut to the desktop** was selected.*

## Run the Virtual Scope Utility

This section describes how to start and stop the Virtual Scope utility to analyze operation of a MagneMotion transport system using basic vehicle movements.

1. Select the **MagneMotion Virtual Scope** utility icon, which is shown in [Figure 2-5](#), on the desktop or start the program from the Windows **Start** menu; select **MMI\_Virtual\_Scope\_APP\_2021a**.



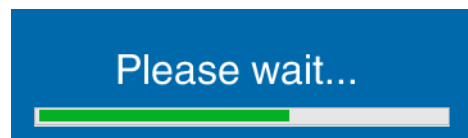
*Figure 2-5: MagneMotion Virtual Scope Utility Icon*

The **Virtual Scope** splash screen is displayed as shown in [Figure 2-6](#).



*Figure 2-6: Virtual Scope Splash Screen*

Depending on the computer running the Virtual Scope, it can take several minutes from the time the splash screen is displayed to when the Virtual Scope utility window opens. The startup status is displayed as shown in [Figure 2-7](#).



*Figure 2-7: Virtual Scope Startup Status*

Once startup completes, the **Virtual Scope** utility window is opened as shown in [Figure 2-8](#).



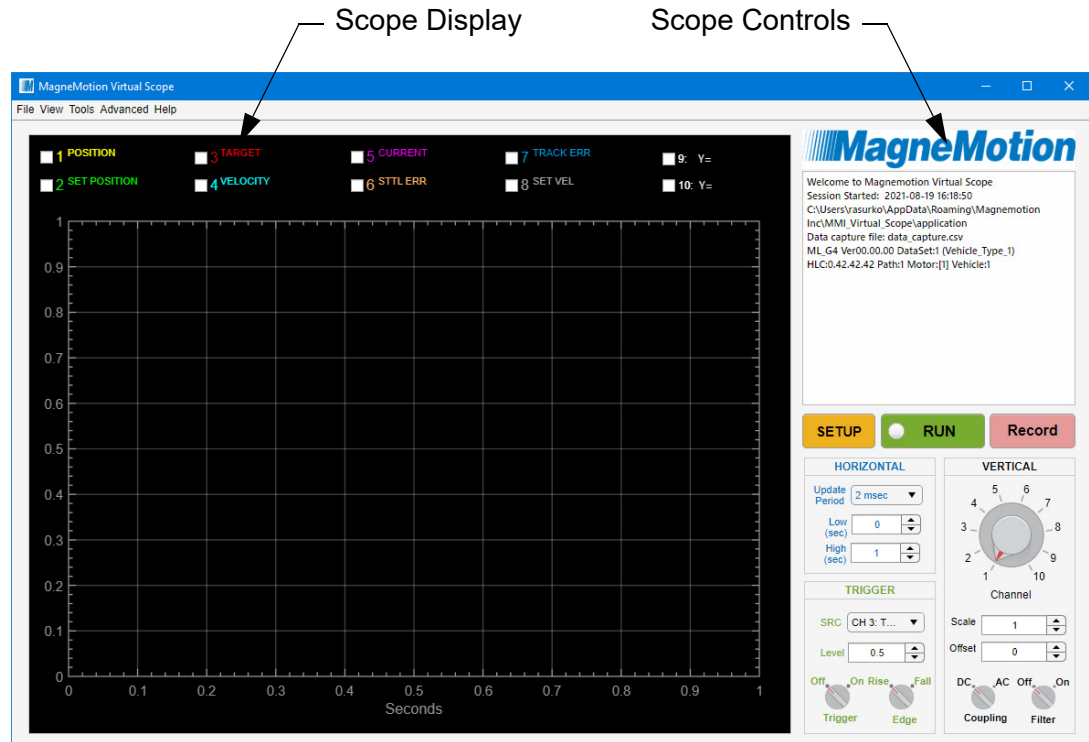


Figure 2-8: The Virtual Scope Utility Window

2. See [Connect to the Transport System on page 35](#) to connect to the transport system and enable all functions to begin testing.

## Stop the Virtual Scope Utility

1. Make sure that data collection has completed or has been stopped.
2. Disconnect from the HLC by selecting **Stop** in the **Run Controls** section of the Scope Controls pane.
3. Stop the Virtual Scope utility.
  - Select **Exit** from the **File** menu or by selecting the **X** in the upper-right corner to close the window.

**NOTE:** If the Virtual Scope utility is collecting data when Exit is selected, a warning message (shown in [Figure 2-9](#)) is displayed notifying the user that the data collection must be stopped before exiting.

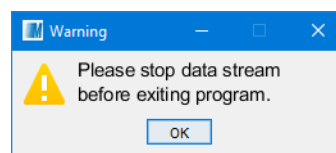


Figure 2-9: Exit Warning

- Select **Quit** from the **File** menu.

**NOTE:** If the Virtual Scope utility is collecting data when Quit is selected, all collected data is discarded.

*The **Virtual Scope** utility window is closed.*

## Connect to the Transport System

This section describes how to connect the Virtual Scope utility to the transport system to monitor the change of performance parameters during motor operation. Both the HLC and the PC running the Virtual Scope utility must be on the same network.

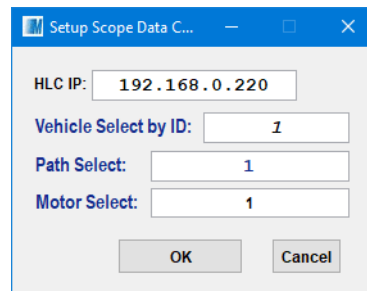
### Single Motor Monitoring

The Virtual Scope session provides a connection to the HLC to monitor and record operation of one motor through the Virtual Scope utility. A Node Controller Configuration File is not required to identify the path and the motor.

1. To monitor single motor operation, make sure that **Single Motor Mode** is selected (checked) on the **Advanced** menu.
2. Select **Setup** from the **Run Controls** section in the **Scope Controls**.

**NOTE:** The scope can only be configured when it is not collecting data.

*The **Setup Scope Data Collection** dialog box for one motor opens as shown in [Figure 2-10](#).*



*Figure 2-10: Setup Scope Data Collection Dialog Box, Single Motor Mode*

3. Enter the IP address of the high-level controller in the **HLC IP** text field.
4. Enter the ID of the vehicle, path, and motor to be monitored in the appropriate text fields.

---

**IMPORTANT** Only the motor activity that is related to the specified motor and vehicle is displayed on the Virtual Scope. If other vehicles are on the motor, any activity that is related to them is not displayed. If the specified vehicle is on another motor, any activity that is related to that motor is not displayed.

---

5. Select **OK** to save the configuration.

6. Select **RUN** in the **Run Controls** to begin monitoring the operation of the motor.

**NOTE:** Only one Virtual Scope session can be connected to an HLC at a time. Connecting a second Virtual Scope session causes the first Virtual Scope session to be disconnected and a warning message to be displayed in the Information Panel of the first Virtual Scope session.

*If a connection is made to the motor specified, the **Status Indicator** turns green and all functions of the Virtual Scope utility are enabled. The status of each active channel is shown as a waveform on the Scope Display.*

*If a connection is made to the motor specified but no data is received (vehicle is not on the motor), a diagnostic message that describes the error is displayed in the **Information Panel** above the **Run Controls** section as shown in [Figure 2-11](#).*

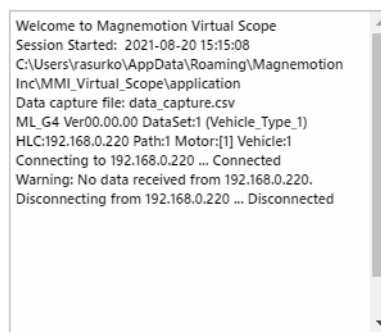


Figure 2-11: Connection Error, No Data

*If no connection is made to the HLC specified, a diagnostic message that describes the error is displayed in the **Information Panel** above the **Run Controls** section as shown in [Figure 2-12](#).*

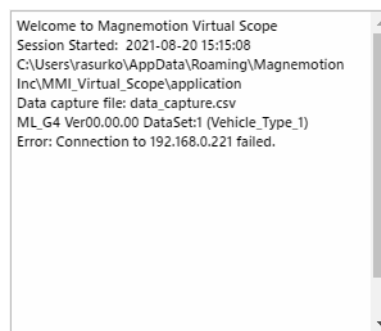


Figure 2-12: Connection Error, No Connection

7. Use the other functions, as described in this chapter, to use the Virtual Scope.
8. Select **STOP** in the **Run Controls** to stop monitoring the operation of the motor and hold the data of the current display.

## Multiple Motor Monitoring

The Virtual Scope session provides a connection to the HLC to monitor and record the operation of multiple motors through the Virtual Scope utility. The Node Controller Configuration File for the transport system is used to identify the paths and the motors on those paths. Single motors can be monitored if desired.

1. To monitor operation on multiple motors, make sure that **Single Motor Mode** is cleared (unchecked) on the **Advanced** menu.
2. Select **Setup** from the **Run Controls** section in the **Scope Controls**.

**NOTE:** The scope can only be configured when it is not collecting data.

*The **Setup Scope Data Collection** dialog box for multiple motors opens as shown in Figure 2-13.*

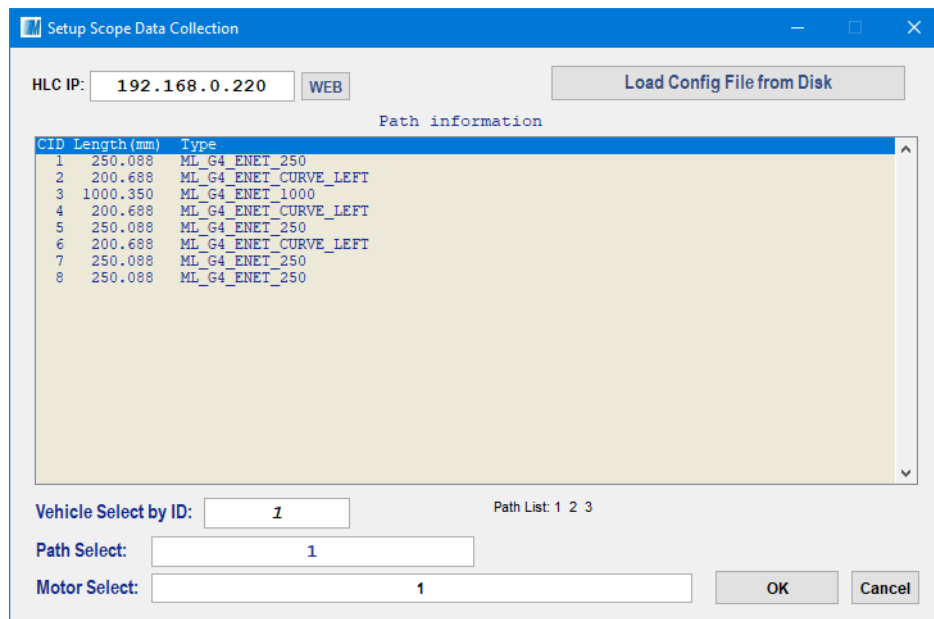


Figure 2-13: Setup Scope Data Collection Dialog Box, Multiple Motor Mode

3. Enter the IP address of the high-level controller in the **HLC IP** text field.
4. If the current Node Controller Configuration File is not easily accessible, download it from the node controller.
  - A. Select **Web**.  
*The default browser for the computer is opened with a connection to the node controller specified in **HLC IP**.*
  - B. Log into the node controller using the Web Interface.  
*The node controller Web Interface opens with the **General Status** page displayed.*
  - C. Select **Configuration Files** on the Main Menu.  
*The **Configuration Files** page is displayed.*

- D. Under **Node Controller Configuration File**, select **Download**.  
*The file is downloaded as determined by the browser. The options for saving this file vary by web browser.*
- E. Log out of the node controller Web Interface and close the browser window.
- 5. Select **Load Config File from Disk**.  
*The **Select Configuration** dialog box is displayed.*
- 6. Use the dialog box controls to select the Node Controller Configuration File for the HLC downloaded in [Step 4](#).  
*The **Path Information** for the path that is specified in the **Path Select** text field is displayed.*
- 7. Enter the ID of the vehicle and path to be monitored in the appropriate text fields.
- 8. Enter the IDs of the motors to be monitored in the **Motor Select** text field separated by spaces. Entering “0” selects all motors on the path that is specified in **Path Select**.

---

**IMPORTANT** Only the motor activity that is related to the specified motors and vehicle is displayed on the Virtual Scope. If there are other vehicles on the motors, any activity that is related to them is not displayed. If the specified vehicle is on another motor, any activity that is related to that motor is not displayed.

---

- 9. Select **OK** to save the configuration.
- 10. Select **RUN** in the **Run Controls** to begin monitoring the operation of the motors.  
**NOTE:** Only one Virtual Scope session can be connected to an HLC at a time. Connecting a second Virtual Scope session causes the first Virtual Scope session to be disconnected and a warning message is displayed in the Information Panel of the first Virtual Scope session.  
*If a connection is made to the motors specified, the **Status Indicator** turns green and all functions of the Virtual Scope utility are enabled. The status of each active channel is shown as a waveform on the Scope Display.*  
*If a connection is made to the motors specified but no data is received (vehicle is not on the motor), a diagnostic message that describes the error is displayed in the **Information Panel** above the **Run Controls** section as shown in [Figure 2-14](#).*



Figure 2-14: Connection Error, No Data

If no connection is made to the HLC specified, a diagnostic message that describes the error is displayed in the **Information Panel** above the **Run Controls** section as shown in [Figure 2-15](#).

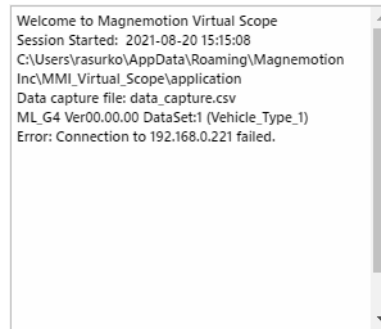


Figure 2-15: Connection Error, No Connection

11. Use the other functions, as described in this chapter, to use the Virtual Scope.
12. Select **STOP** in the **Run Controls** to stop monitoring the operation of the motors and hold the data of the current display.

## Configure the Virtual Scope

This section describes how to configure the Virtual Scope for operation.

### Change Scope Configuration

To change the basic configuration parameters of the Virtual Scope, including the Horizontal control settings, the Trigger settings, the Vertical control settings, and Channel selection settings, another *scope\_config.xml* file can be loaded. This file is automatically loaded each time that the scope is started and saved each time that the scope is shut down. This automatic saving of the configuration file preserves any configuration changes (for example, update period and limits, trigger definition, and channel settings).

**NOTE:** Any scope configuration changes made while the scope is running are saved to the *Scope\_Config.xml* file in the folder where the Virtual Scope is installed when the scope is shut down.

Directly modifying the configuration file could cause improper operation of the scope.

1. Select **Load** from the **File** menu.  
*The **Select configuration file** dialog box is displayed.*
2. Use the dialog box controls to select a new *scope\_config.xml* file and select **Open**.  
*The new configuration is loaded and the **Information Panel** is updated to show the new configuration.*

**NOTE:** The file can have any name, but it is automatically renamed *Scope\_Config.xml* when it is uploaded.

### Load Data Stream Configuration

To change the Data Stream configuration to monitor different types of data, or to specify another motor type another *data\_stream\_config.xml* file can be loaded. This file is automatically loaded each time that the scope is started and saved each time that the scope is shut down. This automatic saving of the data stream configuration file preserves any configuration changes (for example, HLC IP address, vehicle ID, path ID, motor ID). See [Table A-1, Data Stream Configuration File Data Set Identification, on page 97](#) for descriptions of the standard Data Stream files.

**NOTE:** Any configuration changes made while the scope is running are saved to the *Data\_Stream\_Config.xml* file in the folder where the Virtual Scope is installed when the scope is shut down.

Directly modifying the configuration file could cause improper operation of the scope.



1. Select **Load Data Stream...** from the **Advanced** menu.

**NOTE:** The Data Stream file can only be loaded when the scope is not collecting data.

*The **Data Stream Configuration** dialog box is displayed.*

2. Select **Load Stream Configuration from Disk**.

*The **Select Stream Configuration File** dialog box is displayed.*

3. Use the dialog box controls to select a new Data\_Stream\_Config.xml file and select **Open**.

*The new **Data Stream Information** is displayed in the **Data Stream Configuration** dialog box.*

**NOTE:** The file can have any name, but it is automatically renamed Data\_Stream\_Config.xml after it is uploaded when the Virtual Scope is shut down.

4. Select **OK** to accept the changes and close the dialog box, or **Cancel** to cancel the changes and close the dialog box.

*If OK was selected, the **Information Panel** is updated to show the new Data Stream. The **Signal Information** at the top of the scope display (see [Figure 4-15 on page 78](#)) is updated to show the new signal configuration.*

## Scope Controls Configuration

All controls for the scope are displayed in the **Scope Controls** pane (see [Figure 4-7 on page 71](#)). See the following sections for detailed operation:

- [Channel Controls](#)
- [Horizontal Controls](#)
- [Trigger Control](#)
- [Vertical Controls](#)

### Channel Controls

Select the channels and reference lines to be displayed on the scope. Data is collected for all channels even if they are not being displayed. Use the Vertical Controls to adjust the display of any signals that are off the display.

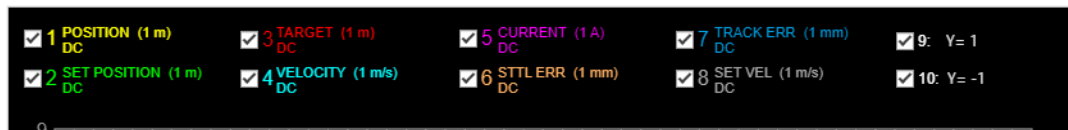


Figure 2-16: Channel Controls

- Select (check) the desired channel or reference line in the **Channel** controls at the top of the scope display to show that signal.

*The **Signal Information** at the top of the scope display is updated to show the channel settings. All channel data is displayed on the scope.*

- Clear (uncheck) the desired channel or reference line in the **Channel** controls to hide that signal.

*The **Signal Information** at the top of the scope display is updated to remove the channel settings. No channel data is displayed on the scope.*

## Horizontal Controls

Adjust the horizontal update period.

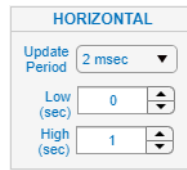


Figure 2-17: Horizontal Controls

1. In the **Horizontal** controls section, select the desired update rate from the **Update Period** menu.

*The selected **Update Period** is displayed.*

**NOTE:** The maximum amount of data that can be collected for display is 10,000 points per channel at the specified update rate.

The **Update Period** determines the maximum time for display of collected data (that is, an **Update Period** of 1 ms is limited to data collection for 10 seconds, once every 1 ms). If the maximum time entered exceeds the range that is specified by the **Low** and **High** limits, the **High** limit is reduced.

2. Select the desired lower limit for the horizontal axis minimum in seconds (data collection start point) by selecting the arrow controls on the **Low** limit control or enter a value directly into the text box.

**NOTE:** If the lower limit entered or selected would cause the total display to be larger than the 10,000 points per channel limit, the **Low** limit setting is automatically reduced and the new value is displayed.

*The specified lower limit is displayed.*

3. Select the desired upper limit in seconds (horizontal axis maximum) by selecting the arrow controls on the **High** limit control or enter an upper limit value directly into the text box.

**NOTE:** If the upper limit entered or selected would cause the total display to be larger than the 10,000 points per channel limit, the **High** limit setting is automatically reduced and the new value is displayed.

*The specified or adjusted upper limit is displayed.*

## Trigger Control

Adjust the type of trigger (if selected), channel, and level.

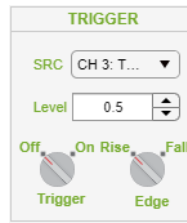


Figure 2-18: Trigger Controls

1. In the **Trigger** controls section, select the channel to use as a trigger from the **SRC** menu.  
*The selected channel is displayed.*
2. Select the level to be used for triggering by selecting the arrow controls on the **Level** control or enter a trigger value directly into the text box.  
*The specified trigger level is displayed.*

---

**IMPORTANT** Make sure the trigger level that is specified is within the limits of the signal.

---

3. Enable the **Trigger** for the channel if needed by clicking the **Trigger** setting or move the rotary control to that setting.
  - **Off** – No trigger is used for the scope display.
  - **On** – The specified channel and level are used to trigger the scope display.
4. Specify **Trigger Type** if a trigger is being used, by clicking the **Edge** setting or move the rotary control to that setting.
  - **Rise** – Data on all selected channels is displayed when the signal rises above the specified level.
  - **Fall** – Data on all selected channels is displayed when the signal falls below the specified level.

## Vertical Controls

Adjust the vertical position and signal conditioning of each channel and the vertical positions of the reference lines.

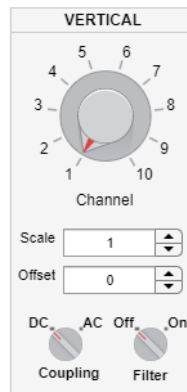


Figure 2-19: Vertical Controls

1. In the **Vertical** controls section, select the desired **Channel** by clicking the channel number or moving the rotary control to that channel.
2. Select the desired vertical scale for the channel by selecting the arrow controls on the **Scale** control or enter a scale value directly into the text box.

*The **Signal Information** at the top of the scope display is updated to show the specified scale and the scope display is updated to show the signal at the new scale.*

3. Select the desired vertical offset for the channel or reference line by selecting the arrow controls on the **Offset** control or enter an offset value directly into the text box.

*The **Signal Information** at the top of the scope display is updated to show the specified offset and the scope display is updated to show the signal at the new offset.*

4. Select the desired **Signal Coupling** for the channel in the **Vertical** controls by clicking the coupling setting or move the rotary control to that setting.

- **AC** – Blocks the DC component of the signal, centering the waveform at 0.
- **DC** – Shows the input signal with any DC offset.

*The **Signal Information** at the top of the scope display is updated to show the coupling type.*

5. Enable the signal **Filter** for the channel in the **Vertical** controls if needed by clicking the filter setting or move the rotary control to that setting.

- **Off** – Filtering is not used for the selected channel.
- **On** – Shows the input signal with the filter that is defined for that channel (see [Noise Reduction Filter](#) to configure the filter).

*The **Signal Information** at the top of the scope display is updated to show the filtering status.*

## View Data

This section describes the options for viewing the data that is currently displayed on the scope for performance monitoring.

### Zoom

The Virtual Scope provides several options to zoom in or out on the data being displayed. In each case, the **Zoom** option must first be selected from the **View** menu.

- To enter Zoom mode, select **Zoom** from the **View** menu.

*The **Zoom** menu item is checked and the zoom controls, which are shown in [Figure 2-20](#), are displayed on the upper-right corner of the plot area in the scope display.*

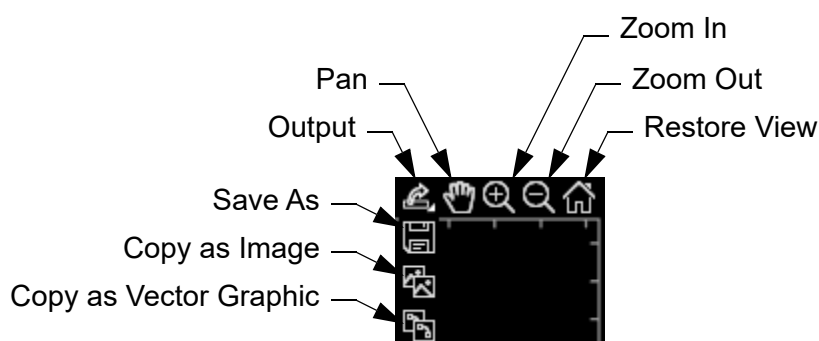


Figure 2-20: Zoom Controls

- To exit Zoom mode, select **Zoom** from the **View** menu.  
*The **Zoom** menu item is cleared and the zoom controls stop being displayed.*
- To save an image of the plot area, select the output icon from the zoom controls and scroll down to the desired option.
  - To save the current plot area display as a bitmap image (PNG, JPG, or TIF, or as a vector image in a PDF), select **Save As** (the disk icon).
  - To copy the current plot area display as a bitmap image to the clipboard, select **Copy as Image** (the picture icon).
  - To copy the current plot area display as a vector image to the clipboard, select **Copy as Vector Graphic** (the drawing icon).
- To move the display, select **Pan** (the hand icon) from the zoom controls. Place the hand cursor on the plot and click-and-drag the mouse to move the display. When done, select **Pan** to deselect it.
- To zoom in, select **Zoom In** (the magnifying glass icon with a plus sign) from the zoom controls. Place the magnifying glass cursor where the center of the plot should be once enlarged and left-click the mouse or rotate the mouse scroll wheel forwards/up. When done, select **Zoom In** to deselect it.

*Each mouse click or scroll wheel click zooms in the display and recenters the display where the cursor is located.*

- To zoom in to a specific region, select **Zoom In** (the magnifying glass icon with a plus sign) from the zoom controls. Place the cross-hair cursor at one corner of the area to be enlarged then click-and-drag the mouse to create a box. Release the mouse button, to zoom to the specified area. When done, select **Zoom In** to deselect it.

*The display is recentered and zooms in to the region enclosed by the box.*

- To zoom out, select **Zoom Out** (the magnifying glass icon with a minus sign) from the zoom controls. Place the magnifying glass cursor where the center of the plot should be once reduced and left-click the mouse or rotate the mouse scroll wheel backward/down. When done, select **Zoom Out** to deselect it.

*Each mouse click or scroll wheel click zooms out the display and recenters the display where the cursor is located.*

- To restore the display to its original state while in Zoom mode, select **Restore View** (the house icon) from the zoom controls.

*The display is returned to its original settings and Zoom mode stays enabled.*

## Measurement

The Virtual Scope provides a tool to identify the value of a specific signal at a specific location.

1. To enter Measurement mode, select **Measurement** from the **View** menu.

*The **Measurement** menu item is checked and the cursor changes to a cross hair each time it is placed over a signal.*

2. To make a measurement, click the desired signal at the required time.

*The data point is identified with a marker and a popup is displayed showing the time and amplitude of the signal.*

- The data point marker can be dragged along the signal by selecting it and dragging it to a new location. Selecting another signal moves the data point marker to that signal.

3. To exit Measurement mode, select **Measurement** from the **View** menu.

*The **Measurement** menu item is cleared, the data popup is closed, and the cursor stays a pointer when placed over a signal.*

## Set Y-Axis Limit

The Y-axis limits can be either user-defined or automatically defined by the data being displayed.

- To select automatic sizing of the Y-axis, select **Auto Limit** from the **View** menu.

The **Auto Limit** menu item is checked and the display is constantly updated to make sure that all data is displayed within the Y-axis boundaries.

- To configure fixed sizing of the Y-axis, select **Set Fixed Limit...** from the **View** menu.

The **Set Fixed Limit...** menu item is checked, the **Auto Limit** menu item is cleared, and the **Setup Y-Axis Limit** dialog box is displayed as shown in [Figure 2-21](#).

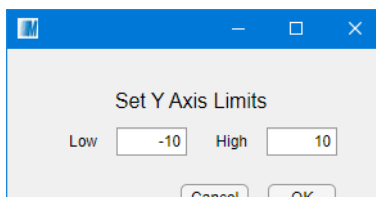


Figure 2-21: Setup Y-Axis Limit Dialog Box

1. Specify the limit to be used. The value that is entered is used as both the upper and lower Y-axis limits.
2. Select **OK** to accept the change or **Cancel** to discard the change.

*The display is updated with the Y-axis boundaries set as specified.*

## Grid Lines

Grid lines can be displayed or removed from the display by selecting **Grid Lines** from the **View** menu. When **Grid Lines** is checked, the background grid is displayed. When **Grid Lines** is cleared, the background grid is not displayed.

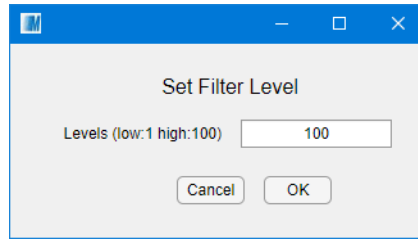
## Noise Reduction Filter

The noise reduction filter used to smooth the vertical amplitude of any signals that have **Filtering** turned on can be adjusted to provide different amounts of smoothing. Each channel can have a unique filter configured.

1. Specify the channel to be filtered by selecting it in the **Vertical Controls**.
2. Select **Set Filter Level...** from the **View** menu to configure the Y-axis filter.



The **Set Filter Level** dialog box is displayed as shown in [Figure 2-22](#).



*Figure 2-22: Setup Noise Reduction Filter Dialog Box*

3. Specify the filter level to be used. The value that is entered specifies the number of samples to use.
4. Select **OK** to accept the change or **Cancel** to discard the change.

*The filter for the channel is updated with the level set as specified.*

Any signals that have **Filter** turned on in the **Vertical Controls** section has each point being displayed filtered using a Median Filter. This filter uses the raw data from the points ahead of and behind each point by the amount that is specified in the dialog box.

**NOTE:** When the filter is turned on, the number of points that are specified in the **Set Filter Level** dialog box are not displayed at the beginning or end of the trace since the required number of points for filtering are not available.

## Save and Review Data

This section describes how to save and review the data that is displayed on the scope. Only the data for the data range currently being displayed (not affected by zoom) can be saved.

### Save Screen Capture of the Virtual Scope Utility

A screen capture of the Virtual Scope display can be saved as a graphics file at a specified location. All standard graphics formats are supported.

**NOTE:** Screen captures can only be saved when the scope is not collecting data.

- To save a screen capture of the full scope display in a bit-mapped format:
  1. Stop the scope when the appropriate data is being displayed by selecting **Stop**.
  2. Stop any data recording by selecting **Stop REC**.
  3. Select **Save Screen...** from the **Tools** menu.  
*The **Save screen capture as** dialog box is displayed.*
  4. Use the dialog box controls to select the location for the screen capture file.
  5. Use the dialog box controls to specify the file type.
  6. Enter a name for the file and select **Save**.  
*The screen capture is saved in the specified format and location.*
- To save a screen capture of just a selected portion of the scope plot area as either a bit-mapped or vector format image:
  1. Stop the scope when the appropriate data is being displayed by selecting **Stop**.
  2. Select **Zoom** from the **View** menu.  
*The **Zoom Controls** are displayed when the cursor is placed in plot area.*
  3. Adjust the scope display using the zoom tools.
  4. Save the scope plot area using the Output icons:
    - **Save As** (the disk icon), opens a dialog box to save the scope plot area to the selected location in the selected file format (PNG, JPG, TIF, PDF).
    - **Copy as Image** (the picture icon), copies the scope plot area to the Windows clipboard as a bit-mapped image.
    - **Copy as Vector Graphic** (the drawing icon), copies the scope plot area to the Windows clipboard as a vector image.

## Save Current Virtual Scope Data

Data files that contain the data points for each of the eight channels, even if they are not being displayed, can be saved at a specified location. This saves both a *screen\_data.vsdata* file (for use by the Virtual Scope) and a comma-separated text file (*screen\_data.csv*) for use in other documents or as historical reference. Both files are always exported. The signal data for each channel is exported even if it is not being displayed.

The CSV file is exported as a text file organized into nine columns. The first column is the time that the data was recorded. The remaining columns are the signal data (starting at the left of the screen).

**NOTE:** Data is only captured for the current data set. To capture data as it is received while the scope is collecting data, see [Save Virtual Scope Data to a Log File](#).

1. Stop the scope when the appropriate data is being displayed by selecting **Stop**.
2. Stop capturing data to the log file by selecting **Stop REC**.
3. Select **Export Screen Data...** from the **Tools** menu.

**NOTE:** The screen data files can only be saved when the scope is not collecting data. *The **Save Screen Data as** dialog box is displayed.*

4. Use the dialog box controls to select the location for the data files.
5. Enter a name for the files and select **Save**.  
*The **Screen Export** dialog box is opened to allow entry of descriptive information that is related to the data export.*
6. Enter a description of the data being saved.
  - Select **OK** to add the notes into the *screen\_data.vsdata* and the *screen\_data.csv* files and start the data export.
  - Select **Cancel** to start the data export without any notes.

*The data is saved as both a vsdata file and a CSV file in the specified location.*

## Save Virtual Scope Data to a Log File

A running log that contains the data points for each of the eight channels, even if they are not being displayed, can be saved at a specified location.

**NOTE:** If a data capture log file is not defined, the Virtual Scope uses the default *data\_capture.csv* file that is in the folder where the Virtual Scope executable is located.

Data is only captured as it is received while the scope is collecting data. To capture the data for the current screen image, see [Save Current Virtual Scope Data](#).

1. Select **Setup Data Capture...** from the **Tools** menu.

**NOTE:** The log file can only be defined when the scope is not collecting data.

*The **Pick a data capture file** dialog box is displayed.*

2. Use the dialog box controls to select the location for the data file.

3. Enter a name for the file and select **Save**.

*The name of the data capture log file is displayed in the **Information Panel** and the data is saved as a CSV file in the specified location.*

4. Capture data to the log file as required.

- Select **Record** to append all Virtual Scope data to the currently defined data capture log file as the data is captured.

*The **Screen Export** dialog box is opened to allow entry of descriptive information that is related to the data capture.*

1. Enter a description of the data being saved.

- Select **OK** to add the notes into the *screen\_data.vsdata* file and the *screen\_data.csv* file and start the data export.
- Select **Cancel** to start the data export without any notes.

*The data is appended to the *data\_capture.csv* file in the specified location.*

- Select **Stop REC** to stop capturing data to the log file.

## Review Data Using the Virtual Scope Utility

To review a previously saved *screen\_data.vsdata* file using the Virtual Scope utility, load the desired file into the scope.

1. Select **Load Screen Data...** from the **Tools** menu.

**NOTE:** The screen data files can only be loaded when the scope is not collecting data.

*The **Select Screen Data** dialog box is displayed.*

2. Use the dialog box controls to select the desired *screen\_data.vsdata* file and select **Open**.

*The previously saved scope data is loaded and displayed as a scope plot. Information about the plot, including any descriptive information added when the data was saved is displayed in the **Information Panel**.*

3. Review the data as required by adjusting the **Horizontal** controls, the **Vertical** controls, the **Channel** controls, and the **Zoom**.

## Review Data Using an External Application

To review a previously saved *screen\_data.csv* file or a *data\_capture.csv* file using Excel or any other application, load the desired file into the application.

1. Start the desired application.
2. Select **Open**.  
*The **Open** dialog box is displayed.*
3. Use the dialog box controls to select the desired *screen\_data.csv* file and select **Open**.  
*The previously saved scope data with any descriptive information is loaded. If the file is a *data\_capture.csv* file, descriptive information that is related to the capture is included.*
4. Review the data as required.

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## Overview

This chapter provides examples and step-by-step procedures that are related to specific tasks using MagneMotion® Virtual Scope.

Application Notes are provided for specific tasks in the operation of the Virtual Scope. Simple step-by-step procedures and examples for each application that is covered are provided. These procedures reference detailed information about the steps that is located elsewhere in this manual.

Included in this chapter are:

- Tuning Motor Performance.
- System diagnosis.

## Tuning Motor Performance

### Tuning Overview

This section describes how to use the Virtual Scope to help when tuning the control loop for the LSM motors in a MagneMotion transport system. The motors use a Proportional Integral Derivative (PID) controller for closed loop feedback to control motion. The equation is shown in [Figure 3-1](#).

$$\text{Output} = P e + I \int_0^t e + D \frac{de}{dt}$$

Figure 3-1: PID Controller Equation

The control loop can be tuned for specific movement characteristics by adjusting the constants P, I, and D as shown in [Figure 3-2](#) and described after the figure.

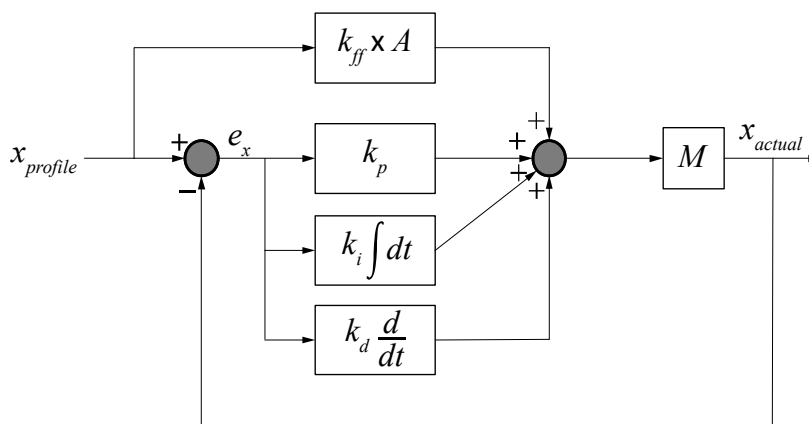


Figure 3-2: PID Controller Diagram

1. At the start of a move, the initial profile,  $X_{profile}$ , is fed into the controller.
2. The acceleration,  $A$ , is multiplied by a feed forward constant,  $K_{ff}$ .
3. The position error,  $e_x$ , is the discrepancy between the current position and the current destination. This error goes through the Proportional, Integral, and Derivative operations.
4. The feed forward and PID results are combined and multiplied by the mass constant,  $M$ .
5. The result is used to generate the appropriate movement to decrease the position error.
6. The new position,  $X_{actual}$ , is fed back into the control loop. It is then subtracted from the destination position to generate the new position error to be operated upon.

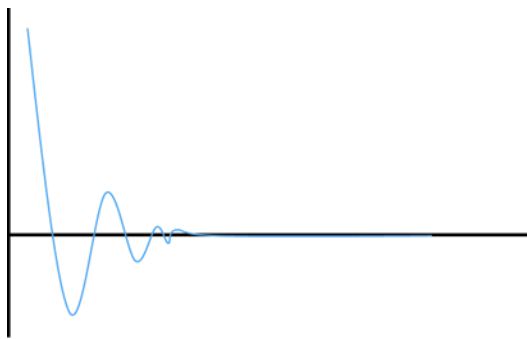


## Tuning Goals

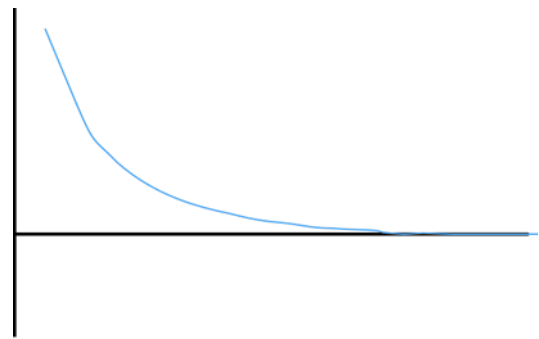
The PID loop settings, and therefore the waveform being displayed can vary based on the goals of the system. There are four common tuning goals:

- **Fast Settling Time** – Valuable in high throughput or high precision applications.
- **Low Overshoot** – Valuable in applications involving delicate materials or specific hardware configurations.
- **Low Steady State Error or High Stability** – Valuable in high precision applications.
- **Fast Rise Time** – Valuable in high throughput applications.

It is not possible to tune for all four goals. For example, when tuning for fast settling time, high stability, and fast rise time, the resulting wave form (and PID loop) has a high overshoot as shown on the left in [Figure 3-3](#). Similarly, tuning for fast settling time, low overshoot, and high stability, the resulting wave form (and PID loop) has a slow rise time as shown on the right in [Figure 3-3](#).



Fast Settling, High Stability, Fast Rise  
High Overshoot



Fast Settling, Low Overshoot, High Stability  
Slow Rise

*Figure 3-3: Tuning Goals*

[Table 3-1](#) shows the general effects that each PID parameter has on the waveform that vehicle motion generates. The mass parameter amplifies the effect of each of the PID parameters, and can be thought of as a scaling factor.

*Table 3-1: PID Parameter Waveform Effects*

Parameter	Rise Time	Overshoot	Settling Time	Steady-State Error
<b>Proportional Gain (<math>K_p</math>)</b>	Decrease	Increase	No Trend	Decrease
<b>Integral Gain (<math>K_i</math>)</b>	Decrease	Increase	Increase	Eliminate
<b>Derivative Gain (<math>K_d</math>)</b>	No Trend	Decrease	Decrease	No Trend

## Tuning Process

To tune the PID controller, start with the default set of PID values in the Configuration File. Create a host controller task or an NCHost demo script to have a vehicle repeatedly replicate the desired vehicle motion that is being tuned. That is, vehicle payload, velocity, acceleration, direction, and destination should be the same as during system operation.

Adjust the PID parameters and gauge their effect on the vehicle motion by reviewing the waveforms on the Virtual Scope. Continue to adjust the PID parameters until a PID set that gives the desired motion performance is determined. When tuning the PID loop, vary the mass parameter to reflect the mass of the vehicle and load. Additionally, change only one parameter at a time, which makes it easier to track and adjust the effect that the change produces. For example, if P and I are changed simultaneously and vehicle movement becomes unfavorable, it is not obvious whether that behavior came from the change to P, I, or both.

It is easier and faster to tune the PID loop by using NCHost to adjust the PID values temporarily rather than repeatedly changing and reuploading the Configuration File.

This procedure provides an overview of the tuning process.

1. Run the MagneMotion Configurator and load the system Node Controller Configuration File (see either the *MagneMover LITE Configurator User Manual*, [MMI-UM008](#), or the *QuickStick Configurator User Manual*, [MMI-UM009](#)).
  - Record the vehicle mass for both loaded and unloaded vehicles.
  - Record the control loop PID values for the path being monitored for both loaded and unloaded vehicles and any other PID Sets to be tested.
2. Exit from the Configurator.
3. Run the NCHost TCP Interface Utility (see the *NCHost TCP Interface Utility User Manual*, [MMI-UM010](#)).
  - A. Connect to the HLC for the transport system.
  - B. Startup or reset the motors.
4. Run the Virtual Scope utility.
  - A. Select the appropriate Motor Mode (see [Single Motor Monitoring on page 35](#) or [Multiple Motor Monitoring on page 37](#)).
  - B. Monitor the waveforms that are displayed (see [View Data on page 46](#)).
5. Enter the original PID values from the Node Controller Configuration File and observe the behavior of the vehicle.
  - A. In the NCHost TCP Utility window, select **Control Loop** under **Engineering Tools**.

*The **Tune Control Loop Parameters** dialog box open.*

- B. Select a PID Set Index for the values.
- C. Enter the Path ID where the motors are located, the current PID values from the Configuration File, the mass value for the current state of the vehicle, and select **Test New Parameters** to enter the values.
- D. Move a vehicle on the monitored motors by running either a task on the host controller or a Demo Script using NCHost.

*The channels show the default behavior of the motors.*

- 6. Adjust the PID values and observe the changes to the behavior of the vehicle.

- A. In the NCHost TCP Utility Tune Control Loop Parameters dialog box, enter the new PID values and select **Test New Parameters** to test the values.
- B. Move a vehicle on the monitored motors by running either a task on the host controller or a Demo Script using NCHost.

*The channels show the new behavior of the motors.*

- 7. To reset the PID values to their defaults, enter the defaults values from the Node Controller Configuration File or restart the node controller.
- 8. To save the new PID values, run the MagneMotion Configurator and load the system Node Controller Configuration File.
  - A. Enter the new control loop PID values using the values from the PID Sets tested.
  - B. Upload the revised Node Controller Configuration File to all node controllers in the transport system.

## Tuning Waveforms

The waveform example in [Figure 3-4](#) shows the relationship between vehicle velocity and position as the vehicle moves from a stop to full velocity, then slows to a stop.

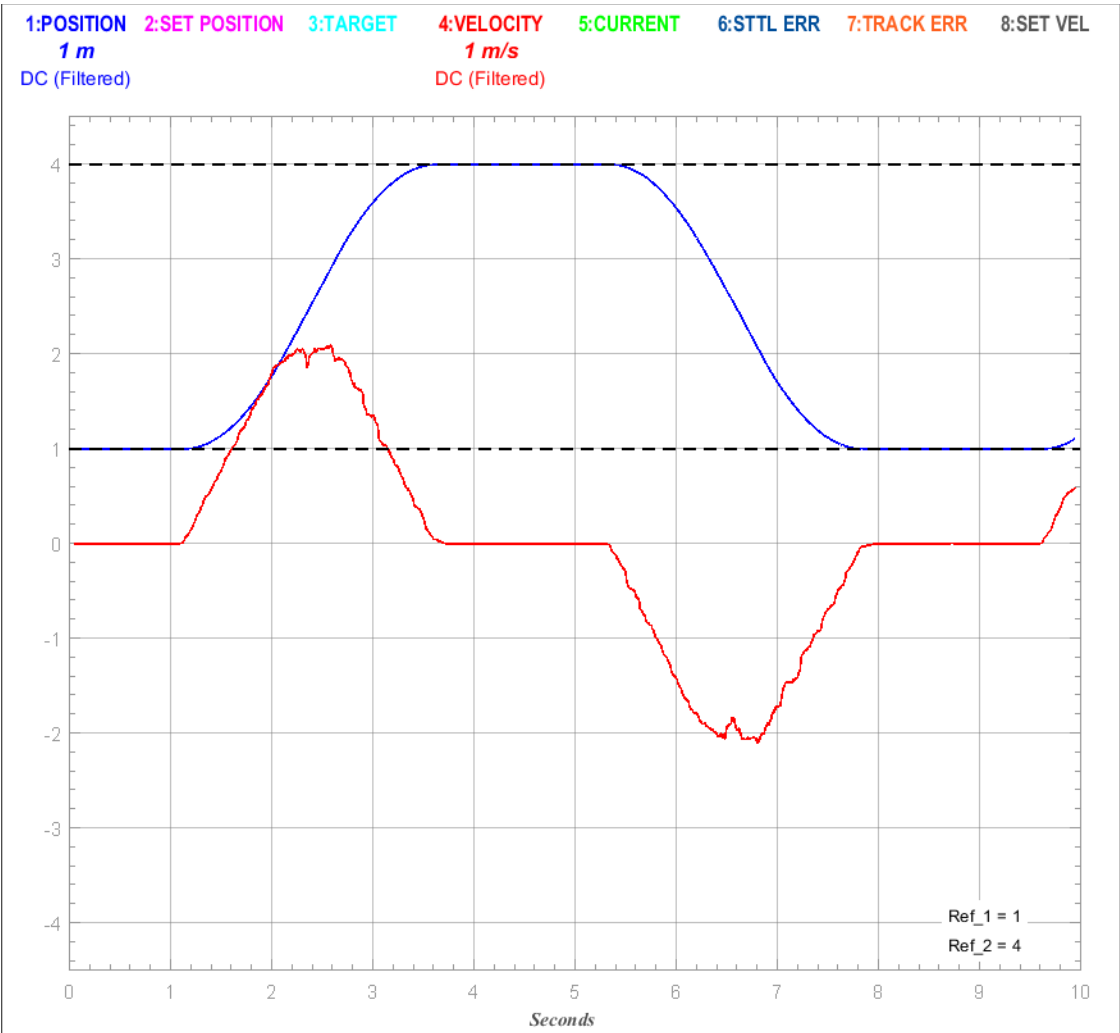
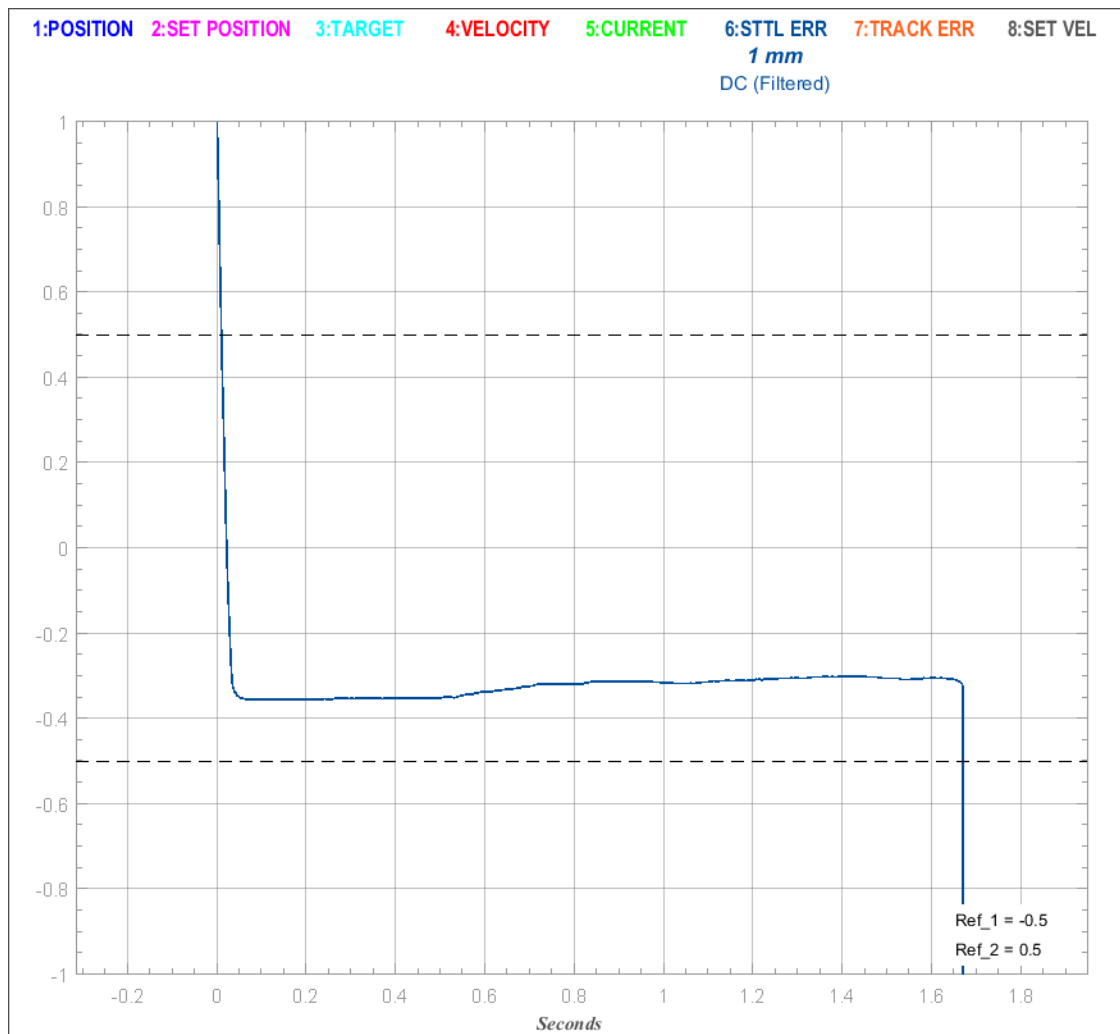


Figure 3-4: Position and Velocity Waveform

The waveform example in [Figure 3-5](#) shows the settling performance at a station or destination position by triggering on the edge of the Settling Error.

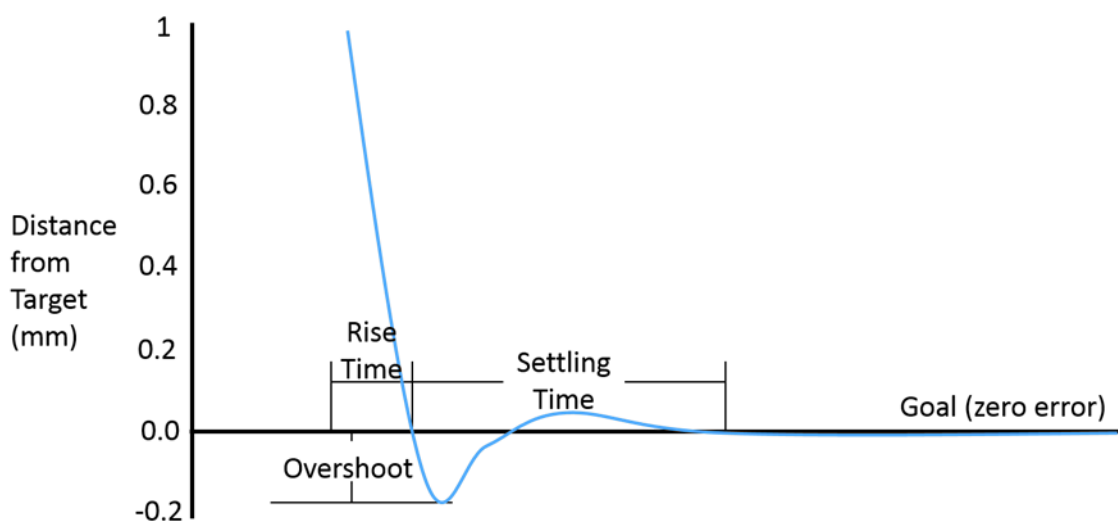


*Figure 3-5: Edge Trigger Waveform*

## Tuning Reactions

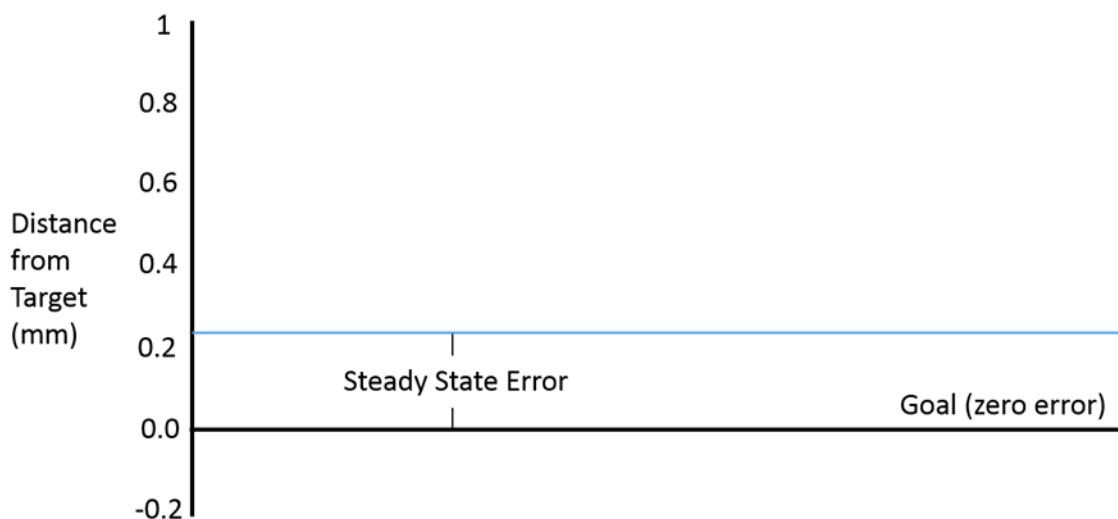
PID tuning using the Virtual Scope involves increasing or decreasing certain wave form elements. These elements are shown in [Figure 3-6](#).

- **Rise time** – The time it takes for the vehicle to go from moving to being within tolerance of its goal position.
- **Overshoot** – The maximum distance by which the vehicle passes the goal position before returning.
- **Settling time** – The time between crossing the goal position and settling at the goal.



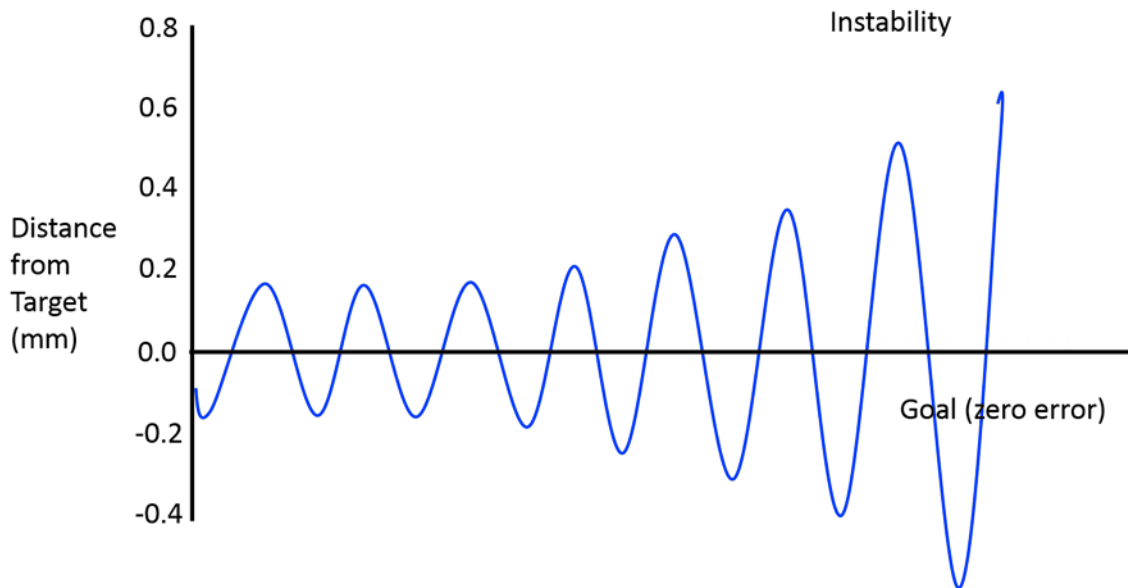
*Figure 3-6: Waveform Elements*

Steady state error is another common wave form element as shown in [Figure 3-7](#). It is the distance that the vehicle maintains from its goal position.



*Figure 3-7: Steady State Waveform*

The ability to remain at the goal position indicates stability. Significant instability can result in a resonant wave form, or wave of increasing amplitude as shown in [Figure 3-8](#). Instability may occur if the Proportional and/or Integral parameters are too high.



*Figure 3-8: Waveform Showing Instability*

## Additional Tuning Options

When creating the Node Controller Configuration File using the Configurator, the state of the  $K_i$  parameter, or integrator, can be configured. The integrator options are; always on, off when the velocity of a vehicle is above a defined value, or off when the position of the vehicle is within a defined threshold as shown in [Figure 3-9](#). These options are only available through the Advanced Parameters section of the Motor Defaults or for specific motors on each path. **Show Advanced Parameters** must be selected in the **Options** menu of the Configurator to display the Integrator options. See either the *MagneMover LITE Configurator User Manual*, [MMI-UM008](#), or the *QuickStick Configurator User Manual*, [MMI-UM009](#) for detailed information on these configuration options.

ADVANCED PARAMETERS		
Thrust Constant:	<input type="text" value="8.0"/>	N/A/cycle Thrust constant in Newtons per Amps per cycle of magnet array
Integrator Always On:	<input checked="" type="checkbox"/>	on/off The PID integrator is always on
Integrator Velocity Threshold:	<input type="text" value="0.1"/>	m/s Velocity above which the PID integrator is disabled
Integrator Distance Threshold:	<input type="text" value="-1.0"/>	meters Position tolerance to disable PID integrator: -1.0 is always on
Physical Gap after the motor downstream end		

*Figure 3-9: Integrator Configuration*

## System Diagnosis

### Diagnosis Overview

This section describes how to use the Virtual Scope to help detect and identify problems with drive coils, position sensors, or position magnets. As a vehicle moves over a motor, signals corresponding to the position of the vehicle and to the current commanded in each drive coil are monitored and stored using the Virtual Scope. Analysis of these signals identifies whether one of the position sensors on the motor or one of the drive coils on the motor, used to propel the vehicle along the track, has failed.

#### Detecting Coil Failure

A linear motor includes a number of coils that are spaced along the motor body. The coils are activated to cause a vehicle to travel along the motor. Each coil is activated only when a vehicle passes over the coil. The momentum of the vehicle allows the vehicle to continue traveling across any one coil that may fail, and coils that are adjacent to a failed coil may compensate, at least in part, for a failed coil. However, the extra current applied to the adjacent coils to compensate for a failed coil may result in accelerated failure of those coils.

Monitor the current drawn by each coil to move the vehicle as commanded as a vehicle passes over the motor. Compare that current data from the motor to historical current data from that motor or the data from all other motors in the transport system. Use that comparison to identify those coils that are drawing extra current, or those that are not drawing enough current and generate a fault signal.

#### Detecting Position Sensor Failure

A linear motor may employ one or more position magnets on each vehicle and an array of position sensors that are spaced along the motor to detect the position magnets on each vehicle as it passes. Failure of one position sensor may go undetected as adjacent position sensors are able to compensate and provide position information for each vehicle. However, failure of a position sensor results in positioning errors, which leads to unwanted vehicle motion.

Monitor the position feedback signal from each of the position sensors on a motor as a vehicle passes over the motor. Compare that sensor data from the motor to historical sensor data from that motor or from all other motors in the transport system. Use that comparison to identify those sensors that are not detecting the magnet array correctly and generate a fault signal.

#### Detecting Magnet Array Failure

A linear motor may employ one or more position magnets on each vehicle and an array of position sensors that are spaced along the motor to detect the position magnets on each vehicle as it passes. In MagneMotion motors, the propulsion magnet array is also used as the position magnet array. Failure of one magnet on a vehicle may go undetected as the position sensors in the motor are able to compensate and provide position information for each vehicle. However,



failure of magnet array results in from reduced motion performance up to interruption of motion.

Monitor the position feedback signal from each of the position sensors on a motor as a vehicle passes over the motor. Compare the position feedback signal from the motor for that vehicle to historical feedback signal data for that vehicle or from all other vehicles in the transport system. Use that comparison to identify those magnet arrays where the position signal differs and generate a fault signal.

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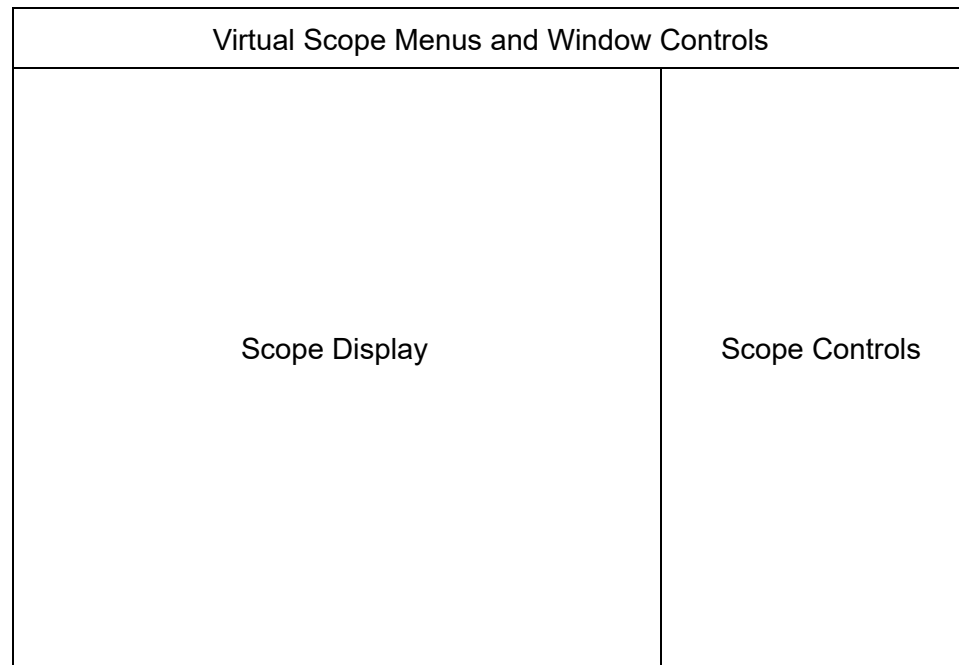
## Overview

This chapter provides an overview of the User Interface (UI) for the Virtual Scope utility with examples of each window, page, and dialog in the UI and a complete description of their features. The following parts of the User Interface are covered:

- User Interface Window Layout.
- User Interface Features.
- Window and Dialog Box Reference.

## Window Layout

All User Interface (UI) elements that are presented through the Virtual Scope utility window follow the guidelines that are described here. The UI consists of two main areas that are always visible as shown in [Figure 4-1](#), and temporary dialog boxes that are displayed over the main UI window.



*Figure 4-1: Window Layout*

### Window Behavior

- **Window Size** – The window can be enlarged as required to change the size of the scope display without affecting the size of the scope controls. The window opens at its default size and location each time the Virtual Scope utility is run.
- **Pane Size** – None of the sections of the window can be moved or resized.

# User Interface Features

## Dialog Boxes

Dialog boxes (shown in [Figure 4-2](#)) are used to select options, input information, and start operations. Dialog boxes are displayed when certain functions (for example, buttons that allow user input) are selected in the current window or dialog box. The dialog box that is displayed depends on the type of input that is required.

To close a dialog box and save the selection, select the button for the dialog box's action (**Open**, **OK**, and so forth). To close a dialog box without saving, select **Cancel**.

**NOTE:** When certain dialog boxes are open, no actions are permitted until the dialog box is closed.

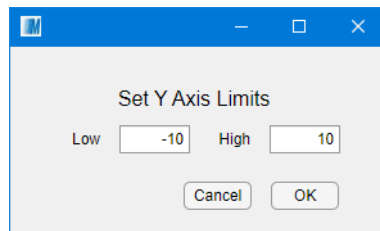


Figure 4-2: Dialog Box Example

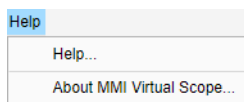
## Dialog Box and Window Elements

Checkboxes (shown in [Figure 4-3](#)) are used to enable or disable an option. Placing the cursor over the checkbox and selecting it, either displays a check mark in the box (selected), or removes the check mark from the box (cleared). In those areas where multiple checkboxes are presented, multiple checkboxes can be selected.

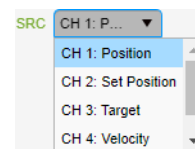


Figure 4-3: Checkbox Example

Drop-down menus or list boxes, similar to the ones shown in [Figure 4-4](#), are used to select one option from a list of available options. A drop-down menu or list box is used when no confirmation of the selection is required; once an option is selected, it is immediately activated.



Drop-Down Menu



Drop-Down List Box

Figure 4-4: Drop-Down Menu Examples

Text fields (shown in Figure 4-5) are used to enter variable information, such as names, set-points, and position values. Display fields (shown in Figure 4-5) are used to display fixed and variable information, such as menu selections, property names, and values returned from the controlled components.

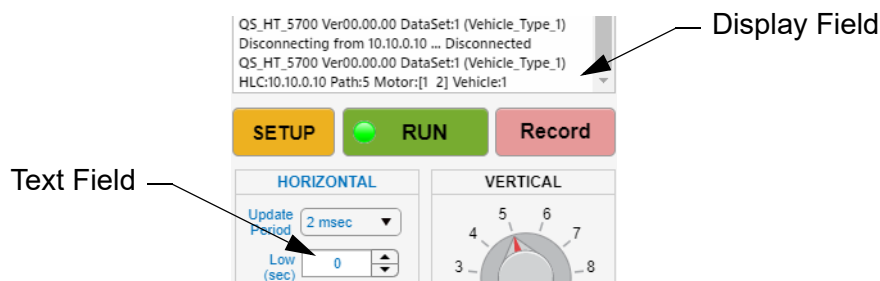


Figure 4-5: Text and Display Field Example

Each window and dialog box contains graphical buttons (shown in Figure 4-6) that are used to perform various actions, including:

- Initiating an action.
- Selecting values.
- Opening dialogs or menus.

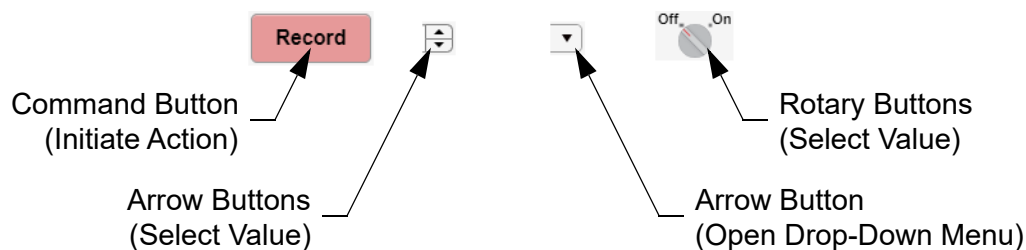


Figure 4-6: Button Examples

# Window and Dialog Box Reference

This reference provides a detailed description of each window, page, and dialog box displayed by the Virtual Scope utility. All windows, menus, and dialog boxes within this reference are listed in functional order.

## Main Window

The Window for the Virtual Scope utility is shown in [Figure 4-7](#). All window functions are described after the figure. All functions that are accessed through this window are discussed following the Main Window.

This Window provides access to all functions of the utility. The function of each item in the window and the properties for those items are described in this chapter.

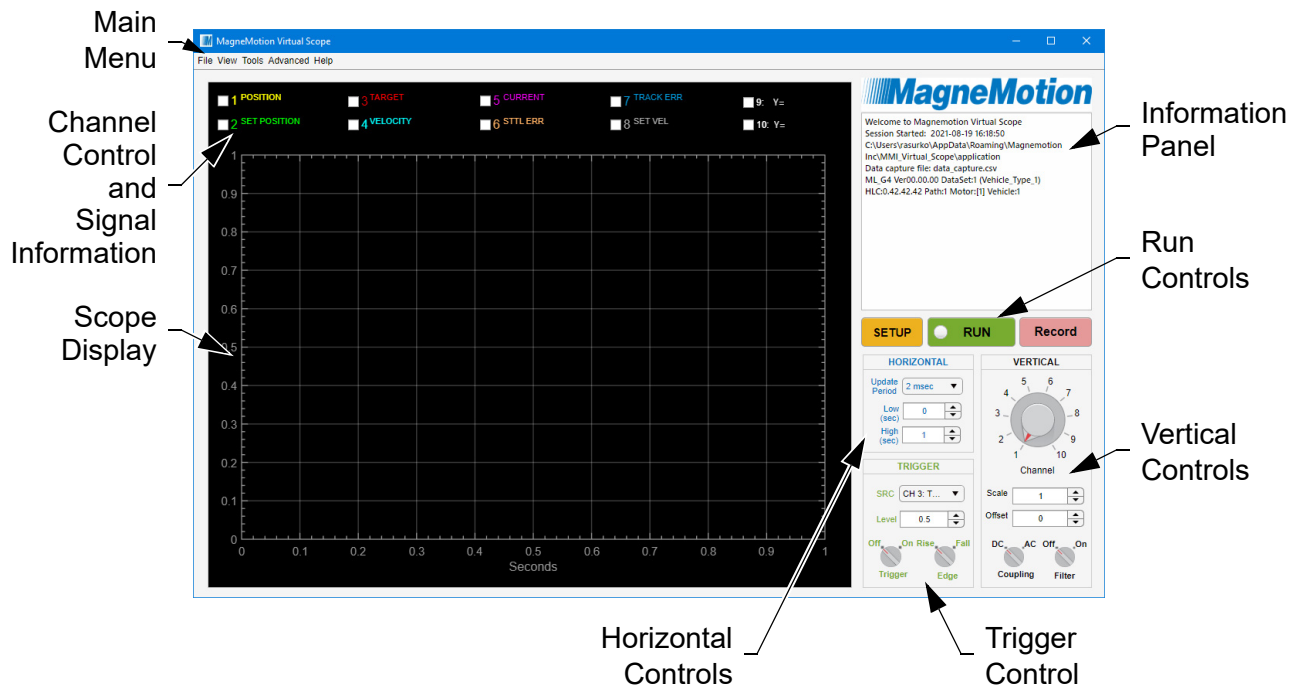


Figure 4-7: Virtual Scope Utility Window Overview

- **Main Menu** – Provides drop-down menus for various Virtual Scope utility options.
- **Channel Control and Signal Information** – Provides a tool for selecting the signals to be displayed and identifies their display settings.
- **Scope Display** – Displays the signal traces and axis information.
- **Information Panel** – Provides scope status.
- **Run Controls** – Provides access to the setup and operating functions.
- **Horizontal Controls** – Provides tools for configuring the horizontal axis (X) of the scope display.

- **Trigger Control** – Provides tools for configuring the scope trigger.
- **Vertical Controls** – Provides tools for configuring the vertical axis (Y) for each signal being displayed.



## Main Menu

The Main Menu (see [Figure 4-8](#)), at the top of the Virtual Scope utility as shown in [Figure 4-7](#), provides the drop-down menus that are shown in [Figure 4-9](#) for access to various functions.



Figure 4-8: Main Menu

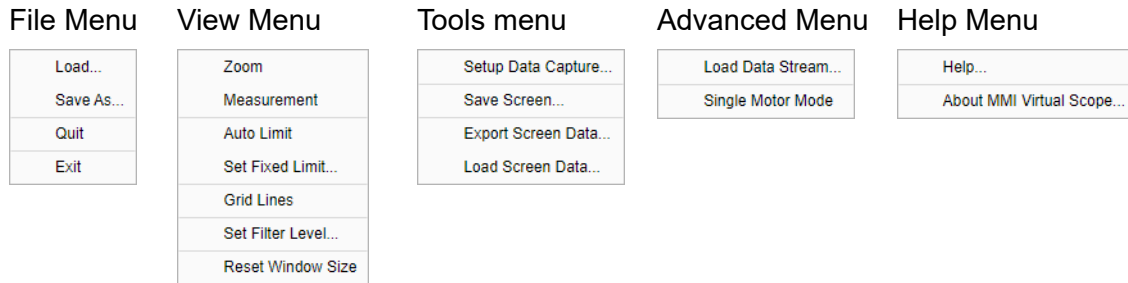


Figure 4-9: Virtual Scope Menus

### File

- **Load...** – Opens a dialog box to locate and open an existing *scope\_config.xml* file.
- **Save As...** – Saves the current scope configuration to a new *scope\_config.xml* file with a user specified name at the specified location.
- **Quit** – Closes the Virtual Scope window without saving any data.
- **Exit** – Closes the Virtual Scope window after any data collection is stopped.

### View

- **Zoom** – When selected (checked), turns on Zoom mode and displays the zoom controls, which are shown in [Figure 4-10](#), on the upper-right corner of the plot area in the scope display when the cursor is placed in the plot area. The **Low Limit** and **High Limit** text fields in the Horizontal controls turn red to indicate that those values do not apply while in zoom mode. Must be cleared (unchecked) to exit Zoom mode.

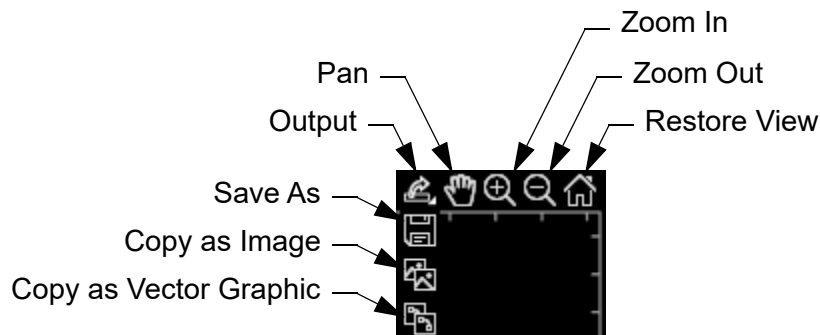
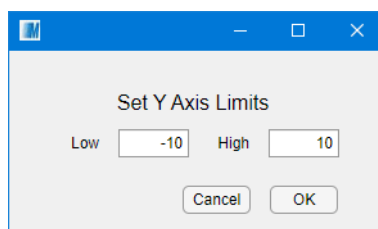


Figure 4-10: Zoom Controls

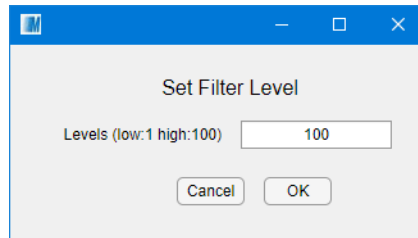
- **Output** – Saves an image of the plot area.
  - **Save As** – Opens a dialog box to save the current plot area display as a bitmap image as either a PNG, JPG, or TIF file or as a vector image as a PDF file.
  - **Copy as Image** – Copies the current plot area display as a bitmap image to the clipboard.
  - **Copy as Vector Image** – Copies the current plot area display as a vector image to the clipboard.
- **Pan** – When selected, the icon highlights and the cursor changes to a hand. Click and drag the image in the plot area to another position. Click the icon to deselect.
- **Zoom In** – When selected, the icon highlights and the cursor changes to a cross hair. Click in the plot area to zoom in centered on the cross hair. Click and draw a box in the plot area to define an area to zoom into. Roll the mouse wheel to zoom in or out. Click the icon to deselect.
- **Zoom Out** – When selected, the icon highlights and the cursor changes to a magnifying glass. Click in the plot area to zoom out. Roll the mouse wheel to zoom in or out. Click the icon to deselect.
- **Restore View** – Restores the display in the plot area to its default zoom and position.
- **Measurement** – When selected (checked), the cursor changes to a cross hair, which allows selection of a point on any of the signals being displayed. Once the trace is selected, a data point marker is placed at that location and a popup is displayed showing the value of that signal at the time point selected. Once a signal is selected, the data point marker can be dragged to anywhere on the signal.
- **Auto Limit** – When selected (checked), continually sizes the vertical axis (Y) of the scope display to fit all data. When cleared, the vertical axis of the scope display is sized to the limit specified in **Fixed Limit**.
- **Set Fixed Limit...** – Opens a dialog box for setting the vertical (Y) axis limits as shown in [Figure 4-11](#).



*Figure 4-11: Setup Y-Axis Limit Dialog Box*

- **Low** – Text field for the entry of the lower Y-axis limit.
- **High** – Text field for the entry of the upper Y-axis limit.
- **OK** – Accepts the axis change and closes the dialog box.

- **Cancel** – Cancels the axis change and closes the dialog box.
- **Grid Lines** – When selected (checked), turns the grid lines on the scope display ON. When cleared, turns the grid lines on the scope display OFF.
- **Set Filter Level...** – Opens a dialog box for setting the Noise Reduction Filter as shown in [Figure 4-12](#).



*Figure 4-12: Setup Noise Reduction Filter Dialog Box*

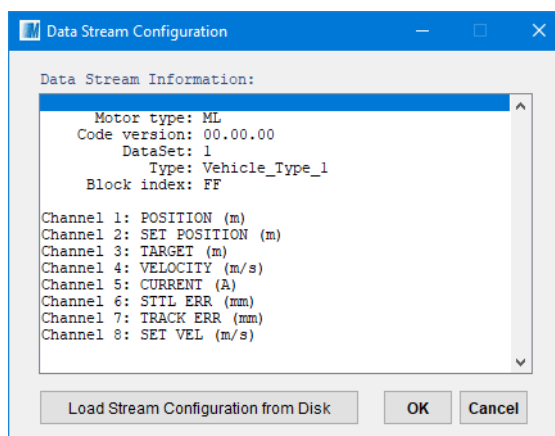
- **Levels** – Text field for entry of an integer value to use for the noise reduction filter used in the Vertical Control. If a non-integer value is entered, a value as close to the entered value as possible is used.
- **OK** – Accepts the filter change and closes the dialog box.
- **Cancel** – Cancels the filter change and closes the dialog box.
- **Reset Window Size** – Returns the Virtual Scope window to its default size and location.

## Tools

- **Setup Data Capture...** – Opens a dialog box to define the name and location of the data capture log (*data\_capture.csv*). This log contains the data points for each of the eight channels even if they are not being displayed. Recording data to the log is controlled through the **Record** button. Data is appended to the log each time Record is selected.
- **Save Screen...** – Opens a dialog box to save a screen capture of the Virtual Scope display as a graphics file at the specified location. All standard bitmap graphic formats are supported.
- **Export Screen Data...** – Opens a dialog box to save the data from all channels in the current display, including any channels that are not being displayed. The data is saved in two formats:
  - **CSV** – A comma delineated text file that contains the data points for each of the eight channels. This file can be imported into other applications such as Excel for review.
  - **vsdata** – An XML file that contains the data points for each of the eight channels. This file can be imported into the Virtual Scope utility for review.
- **Load Screen Data...** – Opens a dialog box to locate and open an existing Screen Data file (\*.vsdata) for display.

## Advanced

- **Load Data Stream...** – Opens a dialog box to review the existing Data Stream configuration and load another configuration as shown in [Figure 4-13](#).



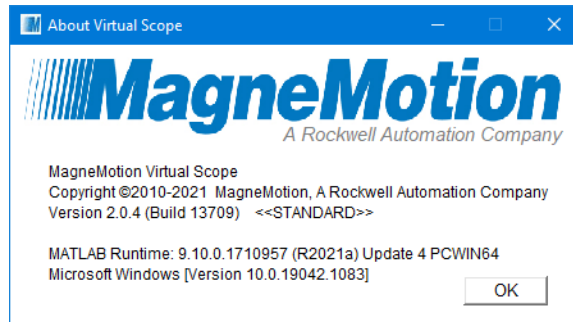
*Figure 4-13: Data Stream Configuration Dialog Box*

- **Data Stream Information** – Displays the current motor type, motor code version, stream data type, block index, and channel definitions.
- **Load Stream Configuration from Disk** – Opens a dialog box to locate and open an existing Data Stream Configuration file.
- **OK** – Accepts the loaded Data Stream Configuration file and closes the dialog box.
- **Cancel** – Cancels loading the Data Stream Configuration file and closes the dialog box.
- **Single Motor Mode** – When selected (checked) configures the scope to monitor the change of performance parameters of one motor on a specified path. When cleared (unchecked) configures the scope to monitor the change of performance parameters of multiple motors on a specified path. This selection determines the options available in the **Setup Scope Data Collection** dialog box (see [Figure 4-18](#)).

## Help

- **Help...** – Displays the help information system.

- **About MMI Virtual Scope...** – Displays version information for the Virtual Scope as shown in [Figure 4-14](#).



*Figure 4-14: About MagneMotion Virtual Scope Message*

## Scope Display

The Scope Display (see [Figure 4-15](#)), on the left of the Virtual Scope window as shown in [Figure 4-7](#), displays the signal traces, identifies the signals being displayed, and displays axis information.

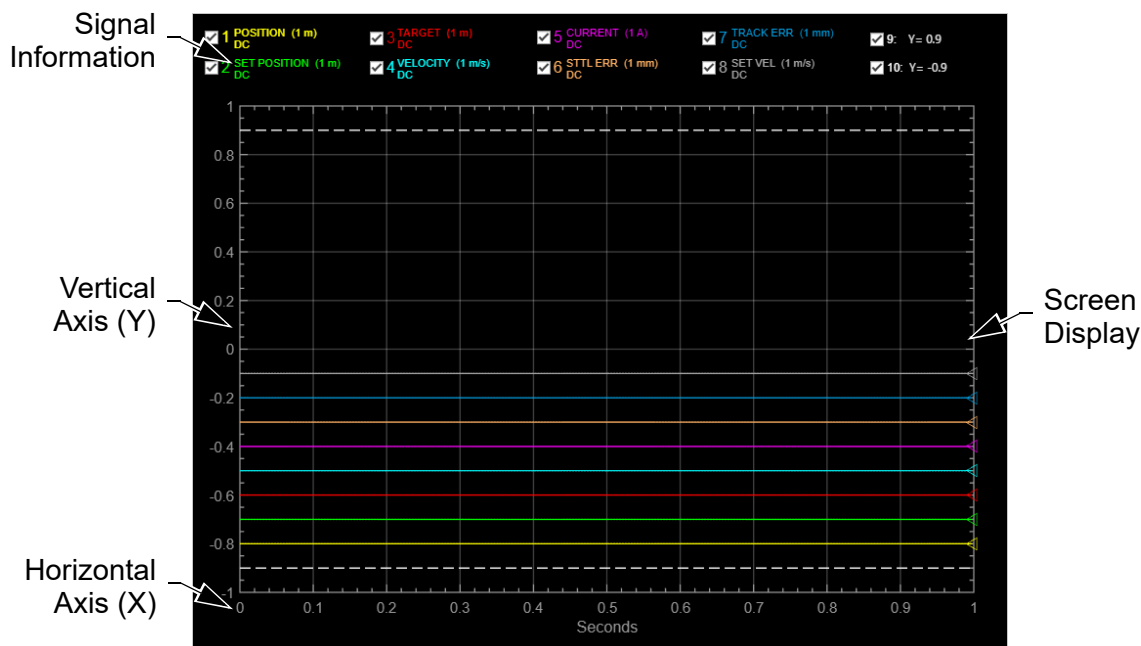


Figure 4-15: Scope Display

**Signal Information** – Displays the names of all signals and their vertical scale per division, coupling, filtering, and any offset. The settings are not displayed if the signal is not being displayed (checkbox is cleared). The checkbox before each signal determines the display status for the signal (select (check) to display).

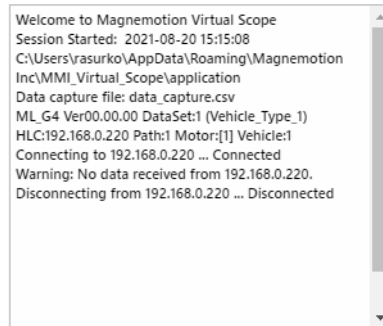
**Vertical Axis** – Displays the current vertical axis (Y). When **Fixed Limit** is being used, the axis extends to the limits set in the **Set Y Axis Limits** dialog box. When **Auto Limit** is being used, the axis automatically centers around the signals on the display and extends to include all signals on the display.

**Horizontal Axis** – Identifies the amount of time displayed (in seconds). This axis can be adjusted using the **Low** limit and **High** limit controls.

**Screen Display** – Displays the waveforms for the selected signals.

## Information

The Information Panel (see [Figure 4-16](#)), at the top of the Scope Controls pane, as shown in [Figure 4-7](#), provides scope status.



*Figure 4-16: Information Panel*

- **Information Panel** – Display field that shows a log of Virtual Scope operation information. The text that is displayed can be copied and pasted into another application (for example, a text editor).

## Run Controls

The Run Controls section (see [Figure 4-17](#)), in the middle of the Scope Controls pane, as shown in [Figure 4-7](#), provides access to the scope setup and control functions.

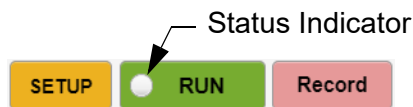
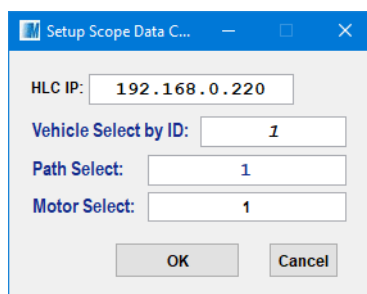
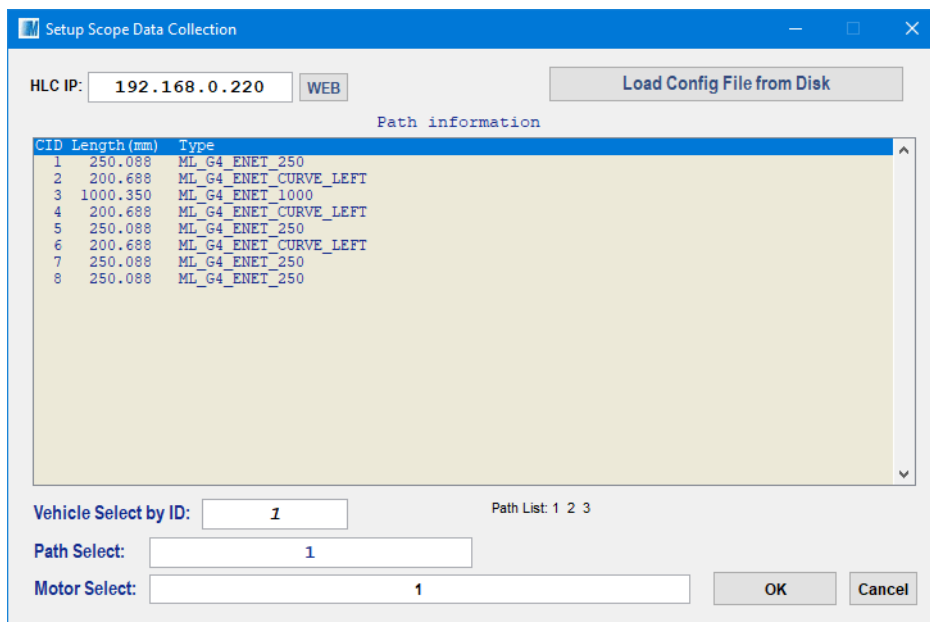


Figure 4-17: Run Controls

- **SETUP** – Opens the **Setup Scope Data Collection** dialog box (see [Figure 4-18](#)) to configure the Virtual Scope. The **Single Motor Mode** setting on the **Advanced** menu determines the functions that are available through the dialog box. This function is not available while the scope is collecting data.



Single Motor Mode Selected



Single Motor Mode Not Selected  
(Multiple Motor Mode)

Figure 4-18: Setup Scope Data Collection Dialog Box

- **HLC IP** – Text field for the entry of the IP address of the high-level controller.



- **Web** – Opens the node controller Web Interface for the HLC specified in **HLC IP** in the default web browser for the computer. Only available in Multiple Motor Mode.
- **Load Config File from Disk** – Opens a dialog box to locate and load the Node Controller Configuration File for the transport system being monitored. Only available in Multiple Motor Mode.
- **Path Information** – Displays a list of all motors on the path that is specified in **Path Select** in their order on the path as defined in the Node Controller Configuration File loaded through **Load Config File from Disk**. The type and length of each motor is displayed, including any Downstream Gap. Only available in Multiple Motor Mode.
- **Vehicle Select by ID** – Specifies the vehicle (as assigned by the HLC) to monitor.
- **Path Select** – Text field for entry of the path where the motor and vehicle to monitor are located.
- **Motor Select** – Text field for entry of the motor on the selected path to monitor. Multiple motors can be monitored by listing them with a space between the ID for each motor. Entering “0” selects all motors on the path that is specified in **Path Select**.
- **OK** – Accepts the configuration changes and closes the dialog box.
- **Cancel** – Cancels the configuration changes and closes the dialog box.
- **RUN/STOP** – Starts/stops data collection on the specified vehicle from the specified motor. Any data collected while running continues to be displayed once data collection is stopped.
- **Status Indicator** – An indicator in the RUN button that turns green to indicate a good connection to the motors defined in the **Setup Scope Data Collection** dialog box.
- **Record/Stop REC** – Starts/stops recording to the log that contains the data points for each of the eight channels, even if they are not being displayed. The new data is appended to the end of the existing file unless a new file is specified. Each time the log is started the **Screen Export** dialog box opens to allow entry of descriptive information that is related to the data capture.

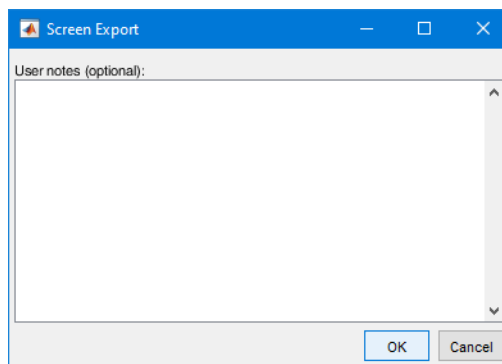
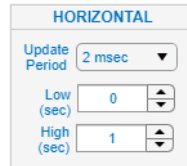


Figure 4-19: Screen Export Dialog Box

- **User Notes** – Free form text field for entry of any descriptive information related to the data being captured.
- **OK** – Adds any entered notes into the *data\_capture.csv* file before the next set of captured data, closes the dialog box, and starts the data capture.
- **Cancel** – Does not add any additional information into the *data\_capture.csv* file, closes the dialog box, and starts the data capture.

## Horizontal Control

The Horizontal Control section (see [Figure 4-20](#)), at the bottom of the Scope Controls pane, as shown in [Figure 4-7](#), provides tools for configuring the horizontal axis (X) of the scope display.



*Figure 4-20: Horizontal Control Pane*

- **Update Period** – Provides a menu to select the rate that data is being collected from the motor (1 ms ... 60 s). Can only be changed when data collection is stopped.

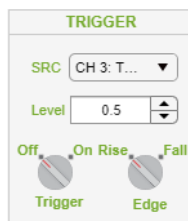
**NOTE:** The maximum amount of data that can be collected for display is 10,000 points per channel at the specified update rate.

A smaller **Update Period** collects more data for a shorter amount of time and provide finer resolution on the display.

- **Low (sec)** – Text field for entry of the lower limit for the horizontal axis (data collection start point). If a value outside of the valid range (>10,000 points) is entered, the High value is changed to make it valid. This text field turns red to indicate that the value does not apply while in zoom mode.
- **High (sec)** – Text field for entry of the total time for data being collected and displayed (horizontal axis maximum). If a value outside of the valid range (determined by the Update Period to a maximum of 10,000 data points) is entered, the value is changed to a value as close to the entered value as possible. This text field turns red to indicate that the value does not apply while in zoom mode.

## Trigger Control

The Trigger Control section (see [Figure 4-21](#)) at the bottom of the Scope Controls pane, as shown in [Figure 4-7](#), provides tools for configuring the scope trigger.



*Figure 4-21: Trigger Control Pane*

- **SRC** – Provides a menu to select the signal to be used to trigger the display based on the trigger settings.
- **Level** – Text field for entry of the trigger point for the signal. Used when **Trigger** is set to On.

---

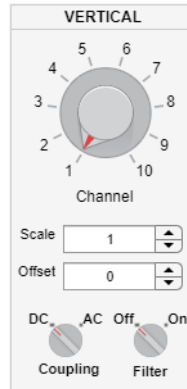
**IMPORTANT** Make sure the trigger level that is specified is within the limits of the signal.

---

- **Trigger** – Provides a control to turn on the edge trigger.
  - **Off** – No trigger is used.
  - **On** – The specified edge trigger is used.
- **Edge** – Provides a control to select the type of edge trigger that is used to start the display when the specified signal crosses the trigger level in the specified direction.
  - **Rise** – Trigger on a rising edge.
  - **Fall** – Trigger on a falling edge.

## Vertical Control

The Vertical Control section (see [Figure 4-22](#)) at the bottom of the Scope Controls pane, as shown in [Figure 4-7](#), provides tools for configuring the vertical axis (Y) for each signal being displayed.

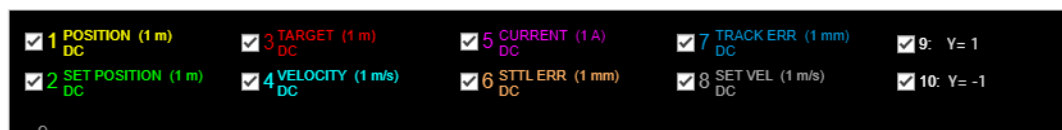


*Figure 4-22: Vertical Control Pane*

- **Channel** – Provides a control to select any of the eight channels or two reference lines for vertical adjustment.
- **Scale** – Text field for entry of the vertical scale of the selected signal. The scale varies the vertical size of the waveform for the signal on the screen. Not all signals are using the same units (that is, Position is in meters, Velocity is in meters/second).
- **Offset** – Text field for entry of the vertical offset of the selected signal. The offset varies the vertical position of the waveform for the signal on the screen. Not all signals are using the same units (that is, Position is in meters, Velocity is in meters/second).
- **Coupling** – Determines which part of the selected signal is displayed.
  - **DC** – Shows the input signal with any DC offset.
  - **AC** – Blocks the DC component of the signal, centering the waveform at 0.
- **Filter** – Provides a Median Filter for the data from the selected signal. This filter only affects the display of the data, it does not affect the actual data being collected. This filter uses the raw data from the points ahead of and behind each point by the amount that is specified in the Set Filter Level dialog box.
  - **Off** – Disables signal filtering.
  - **On** – Enables signal filtering.

## Channel Control

The Channel Control section (see [Figure 4-23](#)) at the top of the Scope Display, as shown in [Figure 4-7](#), provides the tool for selecting the parameters to be displayed. This section also shows the display status, vertical scale per division, coupling, filtering, and any offset for each signal. The parameters available, and the channel they are displayed on is defined in the Data Stream Configuration File.



*Figure 4-23: Channel Controls*

The checkbox before each signal determines the display status for the signal (checked to display).

- **POSITION** – The actual position of the vehicle on the motor in meters.
- **SET POSITION** – The expected position (profile position) of the vehicle on the motor in meters.
- **TARGET** – The position on the motor where the vehicle has been granted move permission in meters (target position). This position is ahead of the vehicle for a vehicle that is moving forwards.
- **VELOCITY** – The actual velocity of the vehicle in meters/second. This is the velocity value that is used by the PID control loop. Standard when using DataSet\_1 Data Streams.
- **VEL (LN)** – The filtered velocity of the vehicle in meters/second with a Low Noise filter applied by the motor. This is the velocity value that is returned to the host controller when using vehicle status commands. Standard when using DataSet\_2 Data Streams.
- **CURRENT** – The commanded motor current for the vehicle in Amps. This is the amount of current required to move the vehicle as commanded.
- **STTL ERR** – The **Target** position - actual **Position** (settling error), this signal shows how well the vehicle position settles relative to the destination position in millimeters.
- **TRACK ERR** – The **Set Position** - actual **Position** (tracking error), this signal shows how well the vehicle position follows the profiled position command during its motion, in millimeters.
- **SET VEL** – The commanded velocity (profile velocity) for the vehicle in meters/second.
- **Y** – Reference line for display. The position of the reference line is specified using the **Offset** control in the **Vertical** functions panel.

## Overview

This chapter describes the common difficulties that may be encountered when using the Virtual Scope utility. Included in this chapter are:

- Virtual Scope utility troubleshooting.
- Signal troubleshooting.

## Virtual Scope Utility Troubleshooting

This section describes the common difficulties that may be encountered with the MagneMotion® Virtual Scope utility, and general solutions.

*Table 5-1: Virtual Scope Utility Troubleshooting*

Symptom	Problem	Solution
The Virtual Scope utility does not connect to the HLC even though it did previously.	The IP address of the HLC has been changed.	Use the host controller or the NCHost TCP Interface Utility to connect to the HLC to verify the address.
	The network is not connected or there are network problems.	Verify all network connections (use the Windows Command Prompt to ping the IP address). Contact the IT department at the facility for additional network support.
The Virtual Scope utility disconnects from the HLC.	Another device is accessing the HLC on TCP port 8000. The HLC supports only one Virtual Scope TCP connection at a time. If a new TCP connection is made when there is already an established connection, the established connection is dropped and the new TCP connection is used.	Determine the location of the other device and disconnect it.
The Virtual Scope utility becomes unresponsive.	The person running the utility must have administrator permission on the computer where the utility is running.	Configure the computer so the person has administrator permission.
		Copy the Virtual Scope folder to a location elsewhere on the computer with the appropriate permissions and run it from there.
The Virtual Scope utility does not exit when selecting <b>Exit</b> in the <b>File</b> menu or the <b>X</b> in the upper-right corner and an error message is displayed.	The Virtual Scope does not have write permission to update the Scope_Config.xml file.	Make sure that the Virtual Scope is being run from a folder where it has write permission.
		Select <b>Quit</b> in the <b>File</b> menu to force Virtual Scope to close.
The error message “Dot indexing is not supported for variables of this type.” is displayed when selecting <b>SETUP</b> .	There is an error in the scope configuration.	Delete the Scope_Config.xml and node_configuration.mat files from the install folder then restart the scope.



*Table 5-2: Signal Troubleshooting*

Symptom	Problem	Solution
The message “Warning: No data received from <i>IP_address</i> .” is displayed in the <b>Information Panel</b> .	Another device is accessing the HLC on TCP port 8000.	Determine the location of the other device and disconnect it.
	Cannot connect to the specified IP address.	Verify all network connections (use the Windows Command Prompt to ping the IP address). Contact the IT department at the facility for additional network support.
		Verify that the correct IP address is entered in the <b>Setup Scope Data Collection</b> dialog box.
		Verify that the correct IP address is specified in the Node Controller Configuration File.
	The HLC is not responding.	Verify that the correct IP address is specified for the HLC.
		Verify that the HLC is running by connecting to it through the web interface.
	The motor is not responding.	Verify that the correct motor is specified in the <b>Setup Scope Data Collection</b> dialog box.
		Verify that the correct path is specified in the <b>Setup Scope Data Collection</b> dialog box.
		Use the host controller or the NCHost TCP Interface Utility to verify that the motor is running.
	The information that is requested is not available.	Verify that the correct Vehicle ID is specified in the <b>Setup Scope Data Collection</b> dialog box.
		Verify that the vehicle is moving over the specified motor.
	The motor is not actively controlling a vehicle.	Use the host controller or the NCHost TCP Interface Utility to move a vehicle onto the motor.

Table 5-2: Signal Troubleshooting (Continued)

Symptom	Problem	Solution
The waveform is not being displayed.	Another device is accessing the HLC on TCP port 8000.	Determine the location of the other device and disconnect it.
	There is no data to display.	Command a vehicle onto the motor.
	The signals are not selected in the <b>Channel Controls</b> .	Verify that the desired channels are On (selected).
	The wrong motor, path, or vehicle is specified in the <b>Setup Scope Data Collection</b> dialog box.	Verify that the correct motor, path, and vehicle are specified.
	The waveform is off the screen.	Adjust the vertical <b>Offset</b> and <b>Scale</b> .
		Set signal <b>Coupling</b> to AC if the signal has a large DC component.
		Set the <b>Y Axis Limits</b> to Fixed and specify an appropriate range.
The waveform is indistinguishable.	The waveform scale is either too large or too small.	Adjust the vertical <b>Scale</b> .
	The waveform is not centered on the display.	Adjust the vertical <b>Offset</b> .
	The beginning or end of the waveform is not being displayed.	Adjust the horizontal <b>High</b> or <b>Low</b> limits.
The waveforms do not make sense.	The Data Stream Configuration File specifies the wrong motor type.	Make sure that the correct Motor Type and Runtime Version are specified.
The waveforms are not updating.	The <b>Trigger Level</b> is not set correctly or the wrong parameter is being used for the trigger.	Make sure that the <b>Trigger</b> is correctly defined for the parameter being monitored and the correct parameter is being used for the trigger.
	Data may be dropped if the motor is using RS-422 communication and is located far from the start of the path (ex. Motor ID #10).	Reference a motor that is closer to the beginning of the path.
	Data may be dropped if the vehicle status update rate is too fast.	Reduce the vehicle status update rate.
“Value must be numeric” error message is displayed when entering values using EU formatting.	Virtual Scope uses US decimal formatting.	Format numbers using 1000.0 format (omit any commas).

## Contact Rockwell Automation Technical Support

Before contacting Technical Support, have the following information ready.

1. The name, email address, and telephone number of the person to contact.
2. The facility address where the system is located and the project name.
3. The date, time, and a detailed description of the anomaly, including:
  - The command the equipment was executing when the anomaly occurred.
  - The effect on system performance (for example, stalled vehicles, overheating).
  - How the system was operating before the anomaly occurred and for how long.
  - Any recent changes to the system (physical reconfiguration, speed/acceleration changes, configuration file changes).
  - Any corrective actions performed (for example, system reset, replaced parts, loaded software, power cycle). Describe the results of those actions.
  - Any special system environmental conditions (for example, vacuum, high heat, high humidity).
  - Any potential non-MagneMotion causes of the issue (for example, power outage, mechanical interference, host failure).
  - Reproducibility of the anomaly.
4. The equipment type, part number, serial number, and location in the system (path, motor id).
5. Include the following files from the time of the anomaly.
  - Node controller and high-level controller log files.
  - Node Controller Configuration Files.
  - Host controller command logs (if available).
  - Any product-related faults and error messages observed through the system host, NCHost, the web interface, and so on.
6. Include any other information that can assist our specialist.

Contact your Motion Solution Consultant or Rockwell Automation TechConnect<sup>SM</sup> ([rockwellautomation.custhelp.com](https://rockwellautomation.custhelp.com)).

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# Appendix

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## Overview

The following appendices are included to provide the user with one location for additional information that is related to the Virtual Scope utility.

Included in this appendix are:

- Communications protocol.
- Data Stream file types.
- File maintenance.
- Additional documentation.
- Transport system configuration limits.

# Communications Protocol

## Communications Format

The high-level controller (HLC) supports communication with the host application that runs on a general-purpose computer via TCP/IP over Ethernet as defined in the OSI model. Each layer of network communication within the standard OSI (Open Systems Interconnect, ISO/IEC 7498-1) model is described here. Ethernet TCP/IP runs directly over the TCP and UDP layer 4 transport layers in the OSI model. The MagneMotion<sup>®</sup> implementation of TCP/IP only uses the TCP transport layer.

## Ethernet TCP/IP

The standard OSI model for layers 1...4 are outlined here. The HLC application runs on top of the TCP transport layer. The standard 10/100/1000 Base-TX, half-duplex, or full-duplex twisted-pair Ethernet is used for all network communications.

### Physical Layer

The electrical interface that is supported for communication between the HLC software that runs on the node controller hardware and the host controller is twisted-pair Ethernet. This interface is based on the IEEE 802.3 and IEEE 802.3u Ethernet and Fast Ethernet communication standards.

The interface uses IEEE 802.3 and IEEE 802.3u standard signal levels for 10/100/1000 Base-TX. A standard Category 5 or better cable is used to connect the HLC directly to the host controller when a hub, switch, or router is not used for the connection.

### Data Link Layer

The data link layer is standard 802.3/802.3u Ethernet packet framing. This framing uses 6 byte destination and source MAC addresses, 2 byte protocol type, 1500 byte MTU (maximum transmission unit) of payload data, and 2 byte FCS (frame check sequence). 10 Mbps and 100 Mbps signaling rates in full-duplex and half-duplex modes are supported. It is expected that any standard Ethernet device that uses a twisted-pair physical layer will have no problems interoperating with the HLC computer at the physical and data link layers.

### Network Layer

The network layer communications for the HLC is Internet Protocol Version 4 (IPv4). For diagnostic purposes during initial setup and optional network layer health status checks, the HLC supports accepting Internet Control Message Protocol (ICMP) echo requests and supports responding to echo requests with ICMP echo responses. The HLC supports the additional ICMP messages that are required to support IPv4 fragmentation and redirection of network layer packets to the next hop IP router if customer provided networking equipment

requires the HLC to honor such IP fragmentation or packet routing redirection. It is expected that any standard modern IPv4 implementation will have no problems interoperating with the HLC computer.

The HLC does not support dynamic routing protocols and does not act as a router in the customer network. The HLC drops any packets that it receives via some other peer on the network that uses the HLC computer as its next hop IPv4 router.

The HLC supports configuration with a static IPv4 address, network mask, and gateway address of the next hop IP router.

The HLC supports IPv4 Address Resolution Protocol (ARP) to support the discovery of peer Ethernet data link layer MAC addresses.

## Transport Layer

The HLC uses a Transmission Control Protocol (TCP) stream over the IPv4 network layer to support an end to end connection.

The HLC is the server and the host controller is the client for TCP endpoint communication roles. The HLC listens for incoming TCP connections from the host controller (general-purpose computer) on the following ports:

- 799 for the Host Control connection.
- 800 for the Host Status connections.
- 801 for the System Monitoring connection.
- 8000 for the MagneMotion Virtual Scope connection.

When the HLC receives an invalid message on an established TCP connection (due to a framing error), the HLC software drops the connection.

The HLC throttles incoming TCP connections to ports 799 and 800 if a problem occurs in the host controller software that causes an excessive number of connections to be established. In extreme cases, the HLC is forced to drop the connection. In the event a connection is dropped, the HLC waits one second before allowing a new connection.

## Host Control Connection

The HLC supports one Host Control TCP connection from the host controller at a time. If a new TCP connection is made to TCP port 799 when the HLC already has an established connection, the established connection is dropped and the new connection is used. Even though TCP/IP supports a more or less arbitrary number of peers at the transport layer, for safety reasons, the HLC supports only one Host Control TCP connection at a time.

### Host Status Connection

The HLC supports up to four Host Status TCP connections at a time. If a new TCP connection is made to port 800 when the HLC already has four established connections, the oldest connection is dropped and the new connection is used.

**NOTE:** The Host Status connections can be used to monitor the status of the transport system using the various status request commands. Any other commands are dropped.

### System Monitoring Connection

The HLC supports one System Monitoring connection at a time. If a new TCP connection is made to port 801 when the HLC already has an established connection, the established connection is dropped and the new connection is used.

**NOTE:** The System Monitoring connection can be used to monitor the status of transport system components using the various monitoring request commands. Any other commands are dropped.

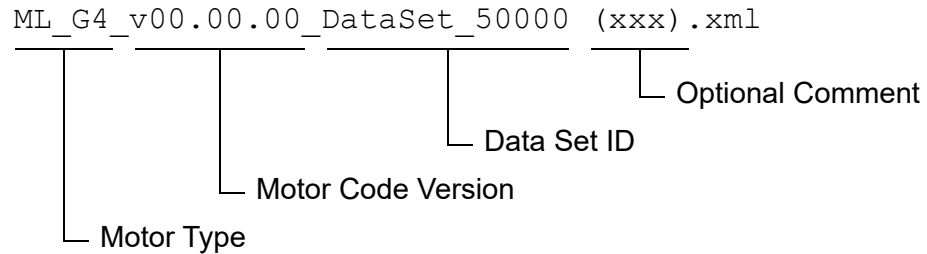
### Virtual Scope Connection

The HLC supports one Virtual Scope TCP connection at a time. If a new TCP connection is made to port 8000 when the HLC already has an established connection, the established connection is dropped and the new connection is used.



## Data Stream Configuration Files

The name of the data\_stream\_config.xml file identifies its use as shown in [Figure A-1](#) and [Table A-1](#). Additional Data Stream Configuration files can be created for monitoring of custom data sets. Contact your Motion Solution Consultant or TechConnect<sup>SM</sup> ([rockwellautomation.custhelp.com](http://rockwellautomation.custhelp.com)) for more information.



*Figure A-1: Data Stream Configuration File Naming Convention*

*Table A-1: Data Stream Configuration File Data Set Identification*

Data Set ID	Description
1	Standard Velocity
2	Filtered Velocity*

\* Uses a Low Noise filter that the motor applies. This filtered value is the velocity value that is returned to the host controller when using vehicle status commands.

## **File Maintenance**

### **Backup Files**

Making regular backups of all files that have been changed is recommended. Keep copies of all original and backup files at a remote location for safety.

### **Creating Backup Files**

Backup files are not created automatically. It is the responsibility of the user to create backups of all files by copying them to a secure location.

### **Restoring from Backup Files**

Damaged files can be restored by copying the backup files into the appropriate locations.

## **Additional Documentation**

### **Release Notes**

The release notes that are supplied with MagneMotion software include special instructions, identification of software versions, identification of new features and enhancements, and a list of known issues. Reading this file is recommended before using the software.

### **Upgrade Procedure**

The upgrade procedures that are supplied with MagneMotion software provide instructions for upgrading from one version of MagneMotion software to another. They also include the procedures for file and driver upgrades that are associated with the software.

## Transport System Limits

Table A-2: MagneMotion Transport System Limits

	Path	Node Controller	System (HLC)
<b>Motors</b>	20/RS-422 30/Ethernet	— <sup>†</sup>	3,840
<b>Node Controllers</b>	—	—	96
<b>Nodes</b>	2	— <sup>†</sup>	320
<b>Paths</b>	—	— <sup>†</sup>	160
<b>Stations</b>	—	—	2048
<b>Vehicles</b>	50/RS-422* 300/Ethernet	384	5,120 <sup>‡</sup>

\* When using RS-422 communication with the motors, 50 vehicles maximum per path when all vehicles on the path are commanded forward (downstream).  
45 vehicles maximum per path when all vehicles on the path are commanded backwards (upstream).

† When using RS-422 communication with the motors, limited by the number of RS-422 connections on the node controller (NC LITE up to 4 connections, NC-12 up to 12 connections, NC-S up to 8 connections).  
When using Ethernet communication with the motors, limited by the node controller configuration and processor loading (NC LITE up to 5 nodes, NC-12 up to 16 nodes, NC-E up to 36 nodes, NC-S up to 16 nodes), see the *Node Controller Hardware User Manual*, [MMI-UM013](#).

‡ 6,000 vehicles maximum when using HLC Control Groups.

Table A-3: MagneMotion Transport System Motion Limits\*

	Acceleration	Velocity	Thrust
<b>MagneMover® LITE<sup>†</sup></b>	2.0 m/s <sup>2</sup> [0.2 g]	2.0 m/s [4.5 mph]	10.0 N/cycle <sup>‡</sup>
<b>QuickStick® 100</b>	9.8 m/s <sup>2</sup> [1.0 g]	2.5 m/s [5.6 mph]	16.3 N/cycle <sup>§</sup>
<b>QuickStick® HT with QSMC</b>	60.0 m/s <sup>2</sup> [6.1 g]	3.5 m/s [7.8 mph]	182.0 N/cycle**
<b>QuickStick® HT with QSHT 5700 Inverter</b>	60.0 m/s <sup>2</sup> [6.1 g]	5.0 m/s [11.2 mph]	182.0 N/cycle**

\* The limits that are shown are at the typical payloads (contact your Motion Solution Consultant or TechConnect<sup>SM</sup> ([rockwellautomation.custhelp.com](#)) for payload guidance). Use of a smaller payload may permit higher limits. Use of a larger payload may lower the limits.

† The limits that are shown are for standard MagneMover LITE glide pucks. Using other pucks, or custom vehicles, may permit different limits.

‡ Thrust at 25% duty cycle, nominal Vehicle Gap is 1 mm for G3 and 1.5 mm for G4.2 magnet arrays.

§ Thrust at 4.0 A stator current with a nominal Vehicle Gap of 3 mm with a standard magnet array.

\*\* Thrust at 10.9 A stator current with a nominal Vehicle Gap of 12 mm with a high flux magnet array.

# Glossary

---

<b>Block:</b>	See <i>Motor Block</i> .
<b>Bogie:</b>	A structure underneath a vehicle to which a magnet array is attached. The structure is then attached to the vehicle. For vehicles that travel over curves, the attachment is through a bearing that allows independent rotation.
<b>Brick-wall Headway:</b>	The space that is maintained between vehicles to make sure that a trailing vehicle is able to stop safely if the lead vehicle stops suddenly (“hits a brick wall”).
<b>Byte:</b>	An octet of data (8 bits).
<b>Clearance Distance:</b>	The distance from a node where the trailing edge of a vehicle is considered cleared from a node. See <i>Entry Gate</i> .
<b>Component:</b>	The main parts that form a MagneMotion® <i>Transport System</i> . Also called system components, these include the <i>High-Level Controller</i> , <i>Motors</i> , <i>Nodes</i> , <i>Node Controllers</i> , <i>Paths</i> , and <i>Vehicles</i> .
<b>Configuration File:</b>	See <i>Node Controller Configuration File</i> .
<b>Configurator:</b>	The application that is used to define and edit the basic operating parameters of the transport system that are stored in the <i>Node Controller Configuration File</i> .
<b>Control Path:</b>	The path that is linked to a <i>Peer Path</i> to create a junction. Once linked, this path remains the Control Path for the life of the junction until the junction transitions to the unlinked state.
<b>Controller:</b>	A device that monitors and controls the operating conditions of the equipment being monitored. In a MagneMotion transport system, the types of controllers include the <i>High-Level Controller</i> , <i>Node Controller</i> , and <i>Host Controller</i> .
<b>Couple:</b>	The joining of a vehicle into a platoon, where one vehicle follows another vehicle at a defined distance.
<b>Cycle Length:</b>	The distance between the centerlines of two like poles on the magnet array.
<b>Demo Script:</b>	A text file that is used with the NCHost TCP Interface Utility for test or demonstration purposes to move vehicles on the transport system.
<b>Design Specifications:</b>	The unique parameters for a specific MagneMotion transport system.
<b>Downstream:</b>	The end of a motor or path as defined by the logical forward direction. Vehicles typically enter the motor or path on the <i>Upstream</i> end.

<b>Downstream Gap:</b>	The physical distance from the end of the stator in one motor to the beginning of the stator in the next motor downstream on the same path. This distance includes the <a href="#">Motor Gap</a> .
<b>Drive:</b>	The remote QSMC motor controller or the QSHT 5700 inverter for a QSHT motor.
<b>Emergency Off:</b>	A user-supplied device that disconnects AC power to the transport system.
<b>Emergency Stop:</b>	A user-supplied circuit with a locking button that anyone can press to stop motion in the transport system. It can be wired through the digital I/O on some <a href="#">Node Controllers</a> .
<b>EMO:</b>	See <a href="#">Emergency Off</a> .
<b>Entry Gate:</b>	The position on a path associated with a node where the leading edge of a vehicle is considered cleared from the node. See <a href="#">Clearance Distance</a> .
<b>Entry Path:</b>	A path whose downstream end is a member of a node. A vehicle that is moving downstream enters a node on an entry path.
<b>Equivalent-Route Path:</b>	A path in a set of Moving Path node member paths that offers a route to a destination that is reachable via any other path in the set.
<b>E-stop:</b>	See <a href="#">Emergency Stop</a> .
<b>Ethernet Chain:</b>	Ethernet chains allow devices to be connected in series with standard Ethernet cable, without the need for additional network switches. A daisy chain device has two embedded Ethernet ports that function as an Ethernet switch and an interface to the local device. This embedded switch allows information to flow to the device, or flow through the ports to other devices in the chain.
<b>Exit Path:</b>	A path whose upstream end is a member of a node. A vehicle that is moving downstream exits a node on an exit path.
<b>Fixed Path:</b>	A path whose position is fixed in the track layout. See <a href="#">Moving Path</a> .
<b>Following Vehicle:</b>	A vehicle following another vehicle in a platoon. This vehicle can be following either the lead vehicle or another following vehicle.
<b>Forward Direction:</b>	The default direction of motion, from <a href="#">Upstream</a> to <a href="#">Downstream</a> , on a MagneMotion transport system.
<b>Glide Puck:</b>	A preconfigured vehicle for use on MagneMover <sup>®</sup> LITE transport systems that uses low friction skids to slide on the integral rails.
<b>Global Directives:</b>	The <a href="#">Demo Script</a> commands that define the general operating characteristics for all vehicles specified. See also <a href="#">Vehicle Directives</a> .
<b>Ground:</b>	The reference point in an electrical circuit from which voltages are measured. This point is typically a common return path for electric current. See also <a href="#">PE</a> .
<b>Guideway:</b>	A component of the <a href="#">Track System</a> that consists of rails or other devices in contact with the <a href="#">Vehicle</a> , either through wheels or low friction runners on the vehicle. The guideway maintains the proper relationship between the vehicles and

the motors. In the MagneMover LITE transport system, the guideway is the integral rails that are mounted on the motors.

**Hall Effect Sensor:** A transducer that varies its output in response to changes in a magnetic field. Hall Effect Sensors (HES) are used by MagneMotion LSMs for vehicle positioning and speed detection.

**Headway:** The space that is maintained before a vehicle to make sure that the vehicle is able to stop safely. See *Brick-wall Headway*.

**High-Level Controller:** The application in a node controller that communicates with the host controller. Only one node controller per HLC Control Group runs the high-level controller application. In a transport system with only one node controller, it runs both the node controller and high-level controller applications.

**HLC:** See *High-Level Controller*.

**HLC Control Group:** The portion of a multi-HLC LSM transport system under control of a specific HLC.

**Host Application:** The software on the host controller that provides monitoring and control of the transport system.

**Host Control Session:** A session between a host controller application (such as the NCHost TCP Interface Utility) and an HLC that allows control of all aspects of transport system operation. The Host Control Session also allows active monitoring of transport system status.

**Host Controller:** The user-supplied controller that provides control and sequencing for the operation of the transport system.

**Host Status Session:** A session between a host controller application (such as the NCHost TCP Interface Utility) and an HLC that only provides active monitoring of transport system status.

**ICT:** See *Independent Cart Technology*.

**ID:** The software labels used to identify various components of the transport system to make sure proper execution of commands involving vehicle position, vehicle destination, and transport system configuration. ID types include vehicle and path.

**Independent Cart Technology:** A programmable intelligent conveyor system that uses linear synchronous motors for moving multiple independently controlled vehicles.

**Interlock:** A user-supplied circuit that is used to stop motion in the transport system. It is wired through the digital I/O on the *Node Controller*.

**Inverter:** The hardware that converts DC from the propulsion power bus to pulse-width modulated AC to energize the coils in a *Motor Block* and contains the *Master* and the *Inverter* for QSHT motors. See *Drive*.

**Keep-out Area:** A unidirectional area of a *Path*. A vehicle that is moving in the specified direction of the area is not allowed to enter the area unless it has permission from the motors to either move past or stop within the area. Once a vehicle enters the

keep-out area in the specified direction, all other vehicles that are moving in the same direction must wait to enter the area until that vehicle exits.

**Lead Vehicle:** The vehicle at the front of a platoon. This vehicle determines the destination, acceleration, and velocity of the platoon.

**Linked Path Junction:** The junction in a Moving Path node between two member paths where motor-to-motor communication is being forwarded.

**Logic Power:** The power that is used for the controllers and signals. See also, [Propulsion Power](#).

**LSB:** Least Significant Byte.

**LSM:** Linear Synchronous Motor. See [MagneMover LITE](#) and [QuickStick](#).

**MagneMover LITE:** A MagneMotion linear synchronous motor with integrated guideways and vehicles that enable quick, efficient conveyance of small loads.

**MagneMover LITE System:** A group of specific components that contribute to a [Transport System](#). These components include [MagneMover LITE](#) motors, [Node Controllers](#), [Pucks](#), and other parts available from MagneMotion.

**Magnet Array:** The magnets that are attached to the [Vehicle](#). It is the motor secondary, moved by the primary in the motor.

**Master (also Master Controller):** The supervisory controller for each motor, it communicates with the [Slaves](#) to direct [Motor Block](#) operation and read motor sensors. It communicates vehicle positions and other information to the [Node Controller](#) and upstream and downstream motors. It is internal to the motor assembly on MagneMover LITE and QuickStick<sup>®</sup> motors. For QuickStick HT motors the master is in the [Drive](#).

**MM LITE<sup>™</sup>:** See [MagneMover LITE](#).

**MML<sup>™</sup>:** See [MagneMover LITE](#).

**Motion Controller:** The user-supplied controller for direct control of vehicles through the LSM Synchronization option. It can reside on the host controller.

**Motor:** See [LSM](#).

**Motor Block:** A discrete motor primary section (coil or set of coils) in a motor that can be energized independently. This section can contain only one vehicle during transport system operation.

**Motor Controller:** The hardware that converts DC from the propulsion power bus to AC to energize the coils in a [Motor Block](#) and contains the [Master](#) and the [Inverter](#) for QuickStick HT motors. See [Drive](#).

**Motor Gap:** The physical distance between two motors that are mounted end to end. This gap excludes the distance from the end of the stator to the end of the motor housing.

**Moving Path:** A path that is moved to align with the end of another path. See [Fixed Path](#).



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<b>MSB:</b>	Most Significant Byte.
<b>NC:</b>	See <a href="#">Node Controller</a> .
<b>Node:</b>	A junction that is defined as the beginning, end, or intersection of <a href="#">Paths</a> . The different node types define their use: Simple, Relay, Terminus, Merge, Diverge, and so on.
<b>Node Controller:</b>	<p>The hardware and the application running on that hardware that coordinates vehicle motions along a path or paths of motors. The node controller is responsible for the motors on all paths that begin at nodes that the node controller is responsible for.</p> <p>There can be multiple node controllers in a transport system, each responsible for a subset of the nodes within the transport system.</p>
<b>Node Controller Configuration File:</b>	The XML file unique to the transport system that defines the basic operating parameters of the transport system. A copy of the Node Controller Configuration File is uploaded to each node controller in the transport system.
<b>NRTL/ATL:</b>	<p>Nationally Recognized Test Lab/Accredited Test Lab.</p> <p>OSHA recognizes NRTL organizations in accordance with 29 CFR 1910.7 to test and certify equipment or materials (products).</p> <p>Accreditation bodies evaluate ATL organizations to ISO/IEC 17025 for testing and calibration laboratories.</p>
<b>OSSD:</b>	Output Signal Switching Device. The interface of a sensor (such as a light curtain) designed for reliably signaling a safety-related event. OSSD signals are outputs from the protective device to a safety relay.
<b>Path:</b>	A designation for one or more motors placed end to end, which defines a linear route for vehicle travel. A path begins at the <a href="#">Upstream</a> end of the first motor in the series and ends at the <a href="#">Downstream</a> end of the last motor in the series. All paths must begin at a <a href="#">Node</a> and the beginning of a path is always the zero position for determining positions along that path.
<b>PE:</b>	Protective Earth. A conductor that is provided for safety purposes (for example, against the risk of electric shock) and which also provides a conductive path to earth. See also, <a href="#">Ground</a> .
<b>Peer Path:</b>	The path that is linked to a <a href="#">Control Path</a> to create a junction. Once linked, this path remains the Peer Path for the life of the junction until the junction transitions to the unlinked state.
<b>Pitch:</b>	The distance between a point on one coil and the corresponding point on an adjacent coil in the same motor or an adjacent motor. Or, the distance between a point on one magnet and the corresponding point on an adjacent equivalent magnet in the same array.

<b>Platooning:</b>	A group of vehicles that are moving together and following a lead vehicle. This group of vehicles is allowed to maintain a distance between each other while in motion that is less than the <a href="#">Brick-wall Headway</a> .
<b>Position:</b>	<p>A specific location on a <a href="#">Path</a>, which is measured from the beginning of that path, which is used as a vehicle destination. Position zero on any path is defined as the leading edge of the first LSM in the path.</p> <p>A vehicle at a specific position has its midpoint over that location on the path.</p>
<b>Power Supply:</b>	The equipment that is used to convert facility AC power to the correct voltages for the transport system.
<b>Propulsion Power:</b>	The power that is used for vehicle motion. See also, <a href="#">Logic Power</a> .
<b>Protected Area:</b>	The area around a node that is defined by the <a href="#">Entry Gates</a> and <a href="#">Clearance Distances</a> . 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.
<b>Puck:</b>	A preconfigured vehicle for use on MagneMover LITE transport systems. The magnet array is mounted to the puck and interacts with the motors, which move each vehicle independently. See <a href="#">Glide Puck</a> and <a href="#">Wheeled Puck</a> . See also, <a href="#">Vehicle</a> .
<b>QS:</b>	See <a href="#">QuickStick</a> .
<b>QuickStick:</b>	A MagneMotion linear synchronous motor that enables quick, efficient conveyance of large loads on user-designed guideways and vehicles. QuickStick (QS) motors move loads up to 100 kg [220 lb] per vehicle. QuickStick High Thrust (QSHT) motors move loads up to 4,500 kg [9,900 lb] per vehicle.
<b>QuickStick System:</b>	A group of specific components that contribute to a <a href="#">Transport System</a> . These components include <a href="#">QuickStick</a> motors, <a href="#">Node Controllers</a> , <a href="#">Motor Controllers</a> (QSHT only), <a href="#">Magnet Arrays</a> , and other parts available from MagneMotion.
<b>Sensor Map:</b>	A snapshot of the signal state of vehicle magnet array sensors that are collected from all blocks of a motor.
<b>Signal:</b>	Each motor contains sensors that detect the magnetic field from the magnet array. When the signal from the sensors is higher than a threshold, the signal bit for the associated sensor is set high, otherwise it is set low.
<b>Single Vehicle Area:</b>	A unidirectional area of a <a href="#">Path</a> . Only one vehicle that is moving in the specified direction of the area is allowed to enter the area at a time. Other vehicles on the path that are moving in the same direction as the initial vehicle in the SVA must wait to enter this area until the previous vehicle exits. This queueing allows one vehicle to move backward and forward along a portion of a path without interfering with any other vehicles.
<b>Slave (also Slave Controller):</b>	The subordinate controllers for the motor, they communicate with the <a href="#">Master</a> and operate the <a href="#">Inverters</a> and position-sense hardware. They are internal to the motor assembly on MagneMover LITE and QuickStick motors. For QuickStick HT motors the slaves are in the <a href="#">Drive</a> .

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<b>Station:</b>	A specific location on a <a href="#">Path</a> , which is measured from the beginning of that path, and identified with a unique ID, used as a vehicle destination.
<b>Stator:</b>	The stationary part of the motor over which the magnet array moves.
<b>Switch:</b>	The mechanical guide for positioning a vehicle through guideway sections that merge or diverge.
<b>SYNC IT™:</b>	Provides direct control by a motion controller of up to three sync-zones (requires sync-enabled motors) where the host controller generates the vehicle motion profile.
<b>Sync Zone:</b>	An area where vehicle motion can be synchronized with other systems through direct control of the motor by the host controller.
<b>System Component:</b>	See <a href="#">Component</a> .
<b>Tandem Vehicle:</b>	A vehicle that uses dual <a href="#">Bogies</a> to provide enough thrust to carry larger loads.
<b>Track System:</b>	The components that physically support and move vehicles. For a QuickStick transport system, the track includes a <a href="#">Guideway</a> , one or more <a href="#">QuickStick</a> motors, mounting hardware, and a stand system. For a MagneMover LITE transport system, the track includes the <a href="#">MagneMover LITE</a> motors and stands.
<b>Transport System:</b>	The components that collectively move user material. These components include the <a href="#">Motors</a> , external <a href="#">Motor Controllers</a> (QSHT only), <a href="#">Track System</a> , <a href="#">Node Controllers</a> , <a href="#">Vehicles</a> , cables, and hardware.
<b>Uncouple:</b>	Remove a vehicle from a platoon.
<b>Upstream:</b>	The beginning of a motor or path as defined by the logical forward direction. The upstream ends of all paths are connected to node controllers. Vehicles typically exit the motor or path on the <a href="#">Downstream</a> end.
<b>V-Brace:</b>	The mechanical fixture that is used to align and secure MagneMover LITE guide rail and motor sections.
<b>Vehicle:</b>	<p>The independently controlled moving element in a MagneMotion transport system. The vehicle consists of a platform that carries the payload and a passive magnet array to provide the necessary propulsion and position sensing. All vehicles on paths in the transport system that are connected through nodes must be the same length.</p> <p>The transport system constantly monitors and controls vehicle position and velocity for the entire time the vehicle is on the transport system. All vehicles are assigned a unique ID at startup and retain that ID until the transport system is restarted or the vehicle is removed or deleted.</p>
<b>Vehicle Directives:</b>	The <a href="#">Demo Script</a> commands that define the individual motion characteristics for a specific vehicle. See also <a href="#">Global Directives</a> .
<b>Vehicle Gap:</b>	The distance between the bottom of the magnet array that is attached to a vehicle and the top surface of a motor.

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**Vehicle ID Master Database:** The HLC database for the assignment and tracking of Vehicle IDs in the transport system. When using *HLC Control Groups*, the Master HLC maintains this database.

**Vehicle ID Slave Database:** The Slave HLC database for tracking of Vehicle IDs in the HLC Control Group managed by that Slave HLC and assigned by the Master HLC. This database is only used when using *HLC Control Groups* to subdivide a transport system.

**Vehicle Master:** The motor controlling the vehicle.

**Vehicle Signal:** A motor software flag for each vehicle that is used to indicate if the vehicle is detected on the transport system.

**Vehicle Spacing:** The distance between two vehicles on the same path.

**Wheeled Puck:** A preconfigured vehicle for use on MagneMover LITE transport systems that uses low friction wheels to ride on the integral rails.

**Zero Point:** The position on the *Upstream* end of a *Path* that denotes the first part on which a *Vehicle* travels.

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**Notes:**

## Rockwell Automation Support

Use the following resources to access support information.

<b>Technical Support Center</b>	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, Product Notification Updates, and the Direct Dial Code for your product.	<a href="http://rok.auto/support">rok.auto/support</a>
<b>Literature Library</b>	Installation Instructions, Manuals, Brochures, and Technical Data.	<a href="http://rok.auto/literature">rok.auto/literature</a>
<b>Product Compatibility and Download Center (PCDC)</b>	Get help determining how products interact, check features and capabilities, and find associated firmware.	<a href="http://rok.auto/pcdc">rok.auto/pcdc</a>
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