RGM®

RGM WorkBench User Guide

Edition: A, February 2019

Part Number 903-800006-06

Original Documentation

For safe and proper use, follow these instructions.
Keep them for future reference.

KOLLMORGEN

Because Motion Matters™

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2 About This Manual

2.1 Related Documentation

- Indexer 2 Program User Guide
- ASCII Interface Programmer's Guide
- Parameter Dictionary

Kollmorgen software and related information can be found at:

www.kollmorgen.com

2.2 Copyrights

2.3 Document Validity

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2.4 Product Warnings

Observe all relevant state, regional and local safety regulations when installing and using Kollmorgen amplifiers. For safety and to assure compliance with documented system data, only Kollmorgen should perform repairs to amplifiers.

DANGER	**Hazardous voltages.** Exercise caution when installing and adjusting Kollmorgen amplifiers.
	Risk of electric shock. On some Kollmorgen amplifiers, high-voltage circuits are connected to mains power. Refer to hardware documentation.
	Risk of unexpected motion with non-latched faults. After the cause of a non-latched fault is corrected, the amplifier re-enables the PWM output stage without operator intervention. In this case, motion may re-start unexpectedly. Configure faults as latched unless a specific situation calls for non-latched behavior. When using non-latched faults, be sure to safeguard against unexpected motion.
	Latching an output does not eliminate the risk of unexpected motion with non-latched faults. Associating a fault with a latched, custom-configured output does not latch the fault itself. After the cause of a non-latched fault is corrected, the amplifier re-enables without operator intervention. In this case, motion may re-start unexpectedly. For more information, See "Faults" (➜ p. 35). When operating the amplifier as a CAN, the use of RGMWorkBench or ASCII serial commands may affect operations in progress. Using such commands to initiate motion may cause network operations to suspend. Operation may restart unexpectedly when the commanded motion is stopped.
	Use equipment as described. Operate amplifiers within the specifications provided in the relevant hardware manual or data sheet. **FAILURE TO HEED THESE WARNINGS CAN CAUSE EQUIPMENT DAMAGE, INJURY, OR DEATH.**

2.5 Revision History

Revision	Date	Applies to	Comments
00	November 2017	RGM WorkBench V8.0 Beta 1	
A	June 2018	RGM WorkBench v8.0 Beta 7	Initial Release

3 Introduction

3.1 Host Computer Requirements

3.1.1 Computer and Operating System

Minimal hardware requirements:

- CPU: 1 GHz
- RAM: 1 GB

Operating Systems Supported: Windows XP, Windows 7 and Windows 8.

3.1.2 Default File Locations

The default location for RGM WorkBench data files (ccx, ccm, etc.) is determined by the Operating System.

Windows XP:

C:\Program Files\Kollmorgen Motion\RGM WorkBench

Windows 7 and Windows 8

C:\Users\Public\Documents\Kollmorgen Motion\RGM WorkBench

3.1.3 Serial Communications

- Standard RS-232 serial port or a USB-to-RS-232 adapter.
- Serial communication cable. See data sheet for part numbers.

3.1.4 CAN Communications

The following CAN card manufacturers are supported:

- Kvaser

3.2 RGM WorkBench Overview

3.2.1 Setup and Tuning

Java based RGM WorkBench configuration software is powerful and intuitive. Comprehensive diagnostics, auto-tuning and advanced oscilloscope tools simplify system commissioning. Auto-phasing eliminates time consuming rewire-and-try for encoder/Halls/motor connections. RGM WorkBench automatically compensates for crossed wires eliminating the most common cause of startup headaches.

3.2.2 Indexing

Point-and-click to define up to 32 indexes or index sequences. Simply select the index/sequence and command GO. Index sequences can include motion, parameter changes, dwell times and I/O control. Any parameter can be assigned to a register for efficient control by a PLC.

Custom functions can be provided for complex applications. Install the Java "bean" and fill in the blanks. Kollmorgen also provides a flexible OEM programming environment. Kollmorgen Virtual Machine assembler/debugger enables the development of fast, compact control program.

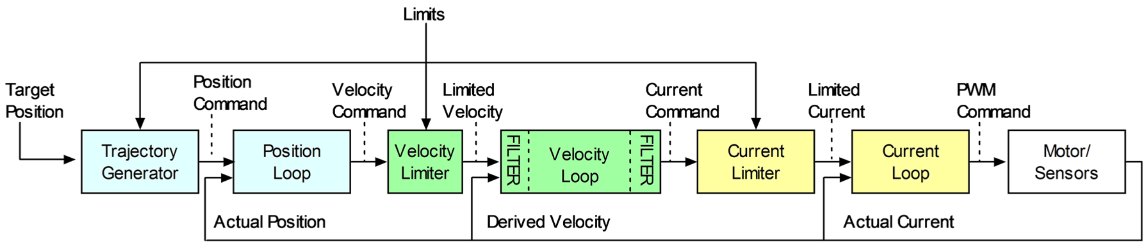
3.3 Servo Operating Modes and Control Loops

3.3.1 Servo Operating Modes and Control Loops

Kollmorgen drives use up to three nested control loops - current, velocity, and position - to control a motor in three associated operating modes.

3.3.2 Control Loops Model

In position mode, the amplifier uses all three loops. As shown in the typical system illustrated below, the position loop drives the nested velocity loop, which drives the nested current loop.



In velocity mode, the velocity loop drives the current loop. In current mode, the current loop is driven directly by external or internal current commands.

3.3.3 Basic Attributes of All Servo Control Loops

Loop Attribute	Description
Command input	Every loop is given a value to which it will attempt to control. For example, the velocity loop receives a velocity command that is the desired motor speed.
Limits	Limits are set on each loop to protect the motor and/or mechanical system.
Feedback	The nature of servo control loops is that they receive feedback from the device they are controlling. For example, the position loop uses the actual motor position as feedback.
Gains	These are constant values that are used in the mathematical equation of the servo loop. The values of these gains can be adjusted during amplifier setup to improve the loop performance. Adjusting these values is often referred to as tuning the loop.
Output	The loop generates a control signal. This signal can be used as the command signal to another control loop or the input to a power amplifier.

For more information on using RGM WorkBench to set up and tune control loops, see "Control Loops" (➜ p. 45).

4 Installation, Startup, and Interface Tour

4.1 Download and Install RGM WorkBench Software

1. Navigate to:
   www.kollmorgen.com
   Select RGM WorkBench to start the download.
2. Navigate to the folder where RGM WorkBench was downloaded to and extract the contents of RGM WorkBench.zip.
3. Run Setup.exe and follow the instructions on the installer screens. We recommend accepting all default installation values.

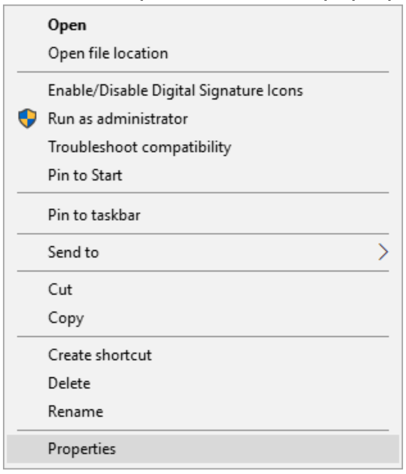
4.1.1 Installer

When the installer starts, Windows will display a dialog asking for permission to make changes to your computer. Click the button to allow the installer to continue, and RGM WorkBench will be installed properly.

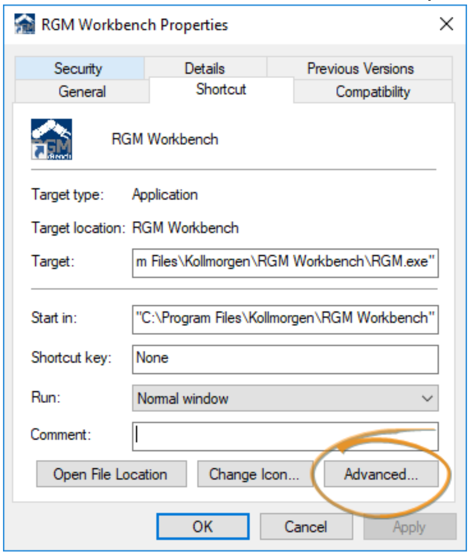
4.1.2 Set up RGM WorkBench to run as administrator

On some versions of Windows 7 and Windows 8, RGM WorkBench will have to be set up to run as administrator to access the communications drivers (serial, CANopen, EtherCAT).

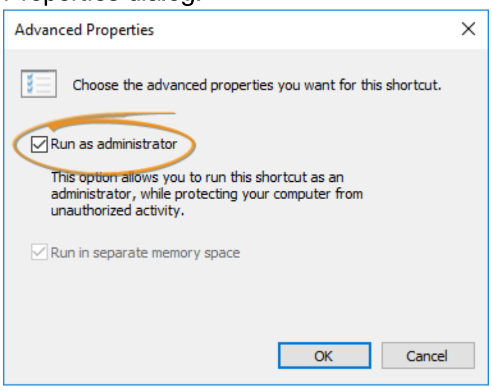
1. Right-click the RGM WorkBench icon on the desktop.
2. Choose Properties from the pop-up menu.



3. Click the Advanced button on the Properties dialog.



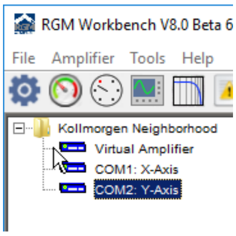
4. Select Run as Administrator. Click OK to close the Advanced Properties dialog, then OK to close the Properties dialog.

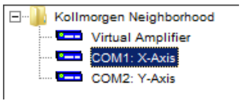
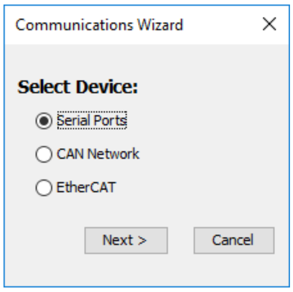


4.2 Start RGM WorkBench

1. Double-click the RGM WorkBench shortcut icon on the Windows desktop to start RGM WorkBench.

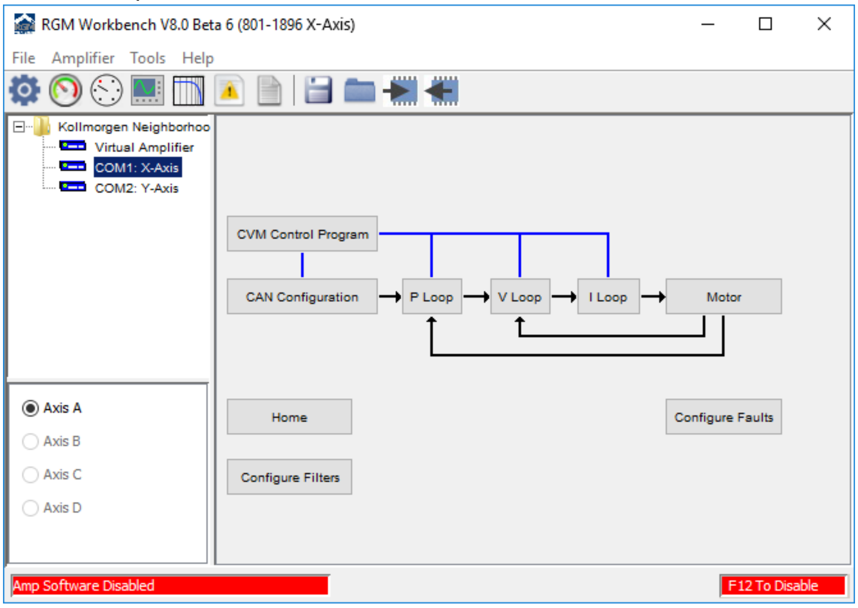
2.

<table>
<tr><th>If communications were set up already…</th><th>If communications were not set up…</th></tr>
<tr><td>…the RGM WorkBench Main Screen opens. If there are multiple ports, Kollmorgen Neighborhood will be selected in the tree as shown below:


Select the desired drive:

</td><td>…the Communications Wizard will be displayed as shown below:


In this case, proceed to "Communications Wizard" (➜ p. 14)</td></tr>
</table>

After an amplifier has been selected, the RGM WorkBench Main Screen looks similar to this:

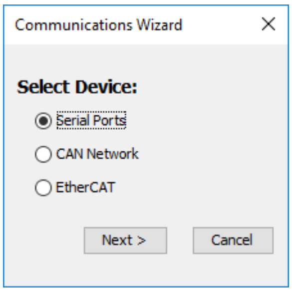


4.3 Communications Wizard

4.3.1 Configure Serial Ports

1. Start the Communications Wizard

   If communications has never been set up, the Communications Wizard will be displayed automatically when RGM WorkBench starts up.

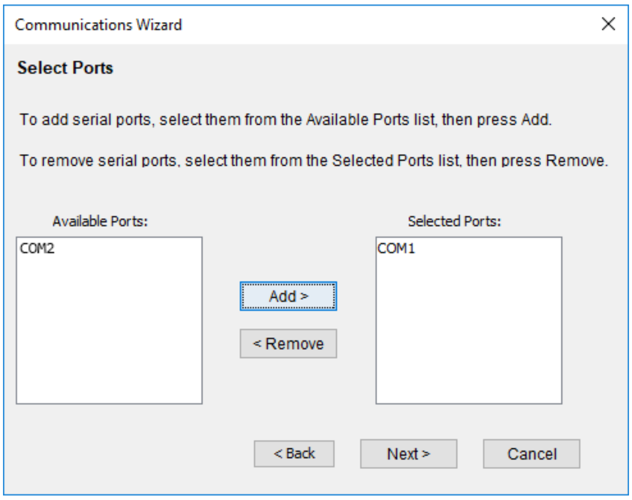


   Otherwise choose Tools→Communications Wizard

   Choose Serial Ports and click Next

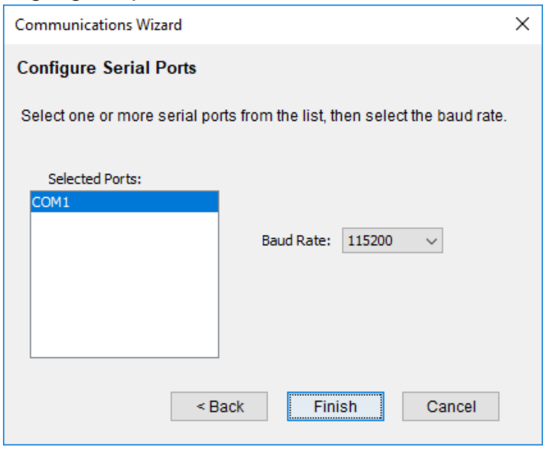
2. Select serial ports

   Select one or more serial ports from the Available Ports list then click Add.



   When finished, click Next.

3. Configure serial ports
   - Highlight a port in the *Selected Ports* list.



   - Choose a *Baud Rate* for that port.
   - Repeat for each selected port.

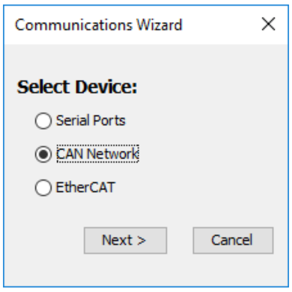
Click **Finish** to save the settings.

4.3.2 Configure CANopen Network

1. Start the Communications Wizard

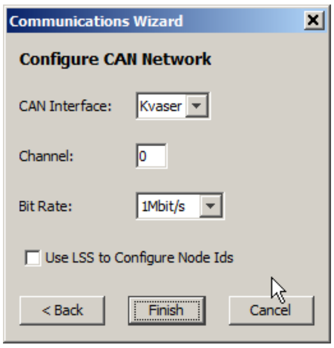
   If communications has never been set up, the Communications Wizard will be displayed automatically when RGM WorkBench starts up.

   Otherwise choose Tools→Communications Wizard

   Choose CAN Network and click Next

2. Configure CAN Network
   - Select the CAN card from the list.
   - Enter the channel number (0 for single channel CAN cards).
   - Select the bit rate.

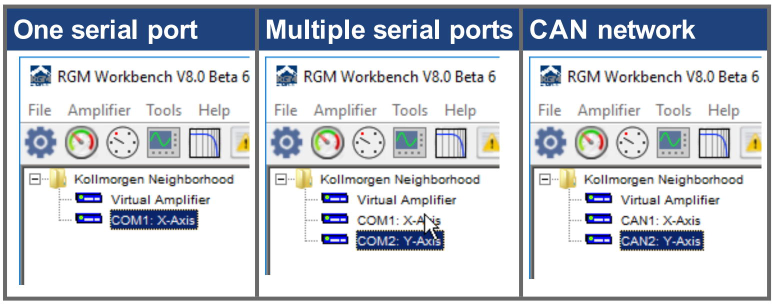
Click Finish to save the settings.

NOTE

1. The CAN Card list only shows the CAN cards that are supported by RGM WorkBench and are properly installed on the PC.
2. All amplifiers must be set to the same bit rate (default is 1 Mbit/s).

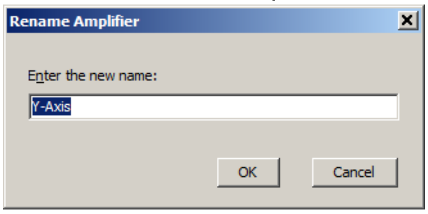
4.4 Connect to an Amplifier

Choose an amplifier by clicking on its name in the Kollmorgen Neighborhood. When there is only one amplifier, RGM WorkBench will automatically connect on startup.



4.5 Rename an Amplifier

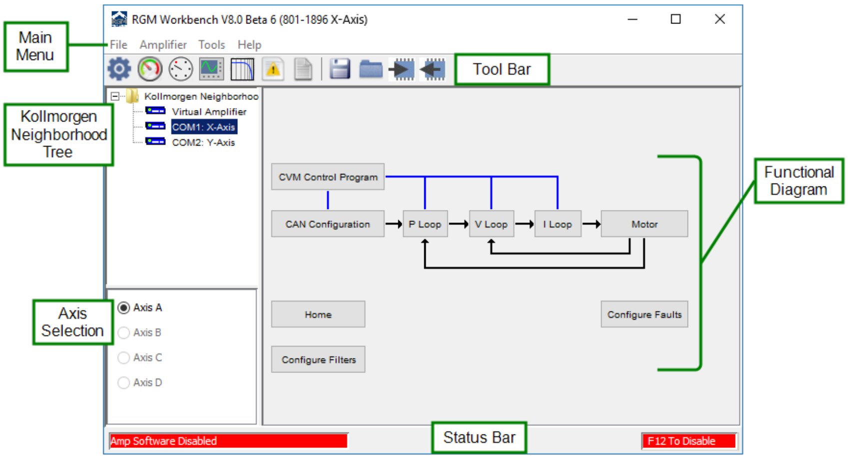
1. Choose Main Menu Amplifier→Rename to open the Rename Amplifier screen.



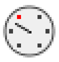
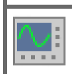
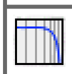
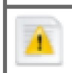
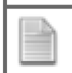
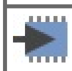
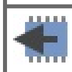
2. Enter the new name and click OK to close the screen.

4.6 RGM WorkBench Interface Tour

RGM WorkBench features are called out in the diagram below. Screen details vary depending on amplifier model and mode selection. Details follow in the chapter.



4.6.1 Tool Bar

Icon	Name	For More Information
	Basic Setup	"Basic Setup" (➔ p. 23)
	Control Panel	"Control Panel" (➔ p. 74)
	Auto Phase	"Motor Phasing" (➔ p. 38)
	Scope	"Oscilloscope" (➔ p. 79)
	Frequency Analysis	"Frequency Analysis" (➔ p. 101)
	Error Log	"Error Log" (➔ p. 112)
	Amplifier Properties	
	Save amplifier data to disk	"Data Management Tools" (➔ p. 108)
	Restore amplifier data from disk	
	Save amplifier data to flash	
	Restore amplifier data from flash	

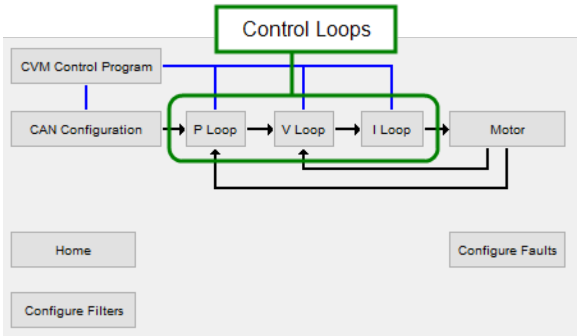
4.6.2 Menu Bar

Menu	Selection	Description	For More Information
File	Save Drive Configuration (.ccd)	Saves contents of amplifier RAM and all CVM flash to a drive configuration file.	"Data, Firmware, and Logs" (➜ p. 107)
	Save Amplifier Data (.ccx)	Saves comtents of amplifier RAM to a file on disk.	
	Save As	Saves amplifier data file in format usable by RGM WorkBench	
	Restore > Drive Configuration (.ccd)	Restores contents of a drive configuration file to amplifier RAM and CVM flash.	
	Restore > Amplifier Data (.ccx)	Restores contents of an amplifier file from disk to amplifier RAM.	
	Restore > CVM Control Program (.ccp)	Restores a CVM program from a file to the CVM Flash.	Kollmorgen Indexer 2 Program User Guide.
	Restore > Gain Scheduling Table(.ccg)	Restores Gain Scheduling Table from a file (.ccg).	"Gains Scheduling" (➜ p. 115)
	Exit	Closes RGM WorkBench	
Amplifier	Setup	Opens Setup screen.	"Basic Setup" (➜ p. 23)
	Control Panel	Opens Control Panel.	"Control Panel" (➜ p. 74)
	Auto Phase	Opens Auto Phase tool.	"Motor Phasing" (➜ p. 38)
	Scope	Opens Scope Tool screen.	"Oscilloscope" (➜ p. 79)
	Frequency Analysis	Opens Frequency Analysis screen	"Frequency Analysis" (➜ p. 101)
	Error Log	Opens Error Log screen.	"Error Log" (➜ p. 112)
	Amplifier Properties	Displays basic amplifier properties	
	Network Configuration	Opens the CAN Configuration screen	"Network Configuration" (➜ p. 34)
	Rename	Prompts for new amplifier name	"Rename an Amplifier" (➜ p. 17)
	Gain Scheduling	Opens Gain Scheduling screen	"Gains Scheduling" (➜ p. 115)

Menu	Selection	Description	For More Information
Tools	Communications Wizard	Starts sequence of prompts to set up communications.	"Communications Wizard" (➜ p. 14)
	Communicaitons Log	Opens Communications Log.	"Communications Log" (➜ p. 113)
	Download Firmware	Starts prompts to download firmware from disk to amplifier.	"Firmware Download" (➜ p. 111)
	Manual Phase	Opens Manual Phase tool.	"Manual Phase" (➜ p. 42)
	View Scope Files	Opens Trace Viewer window.	"Scope Trace Files" (➜ p. 91)
	RGM WorkBench Lock/Unlock	Opens screen for locking and unlocking RGM WorkBench functionality.	Lock/Unlock CME
	ASCII Command Line	Opens screen to accept ASCII format commands.	Kollmorgen ASCII Interface
	Login	Needs Definition	
Help	RGM WorkBench User Guide	Opens this manual	
	All Documents	Opens the Doc folder in the RGM WorkBench installation folder (typically c://Program Files/Kollmorgen/RGM WorkBench/Doc). This folder contains all of the related documents that were installed with RGM WorkBench.	
	Downloads Web Page	Opens default web browser with pages from Kollmorgen website.	
	Software Web Page		
	View Release Notes	Opens latest RGM WorkBench release notes in a text viewer.	
	About	Displays RGM WorkBench version information.	

4.6.3 Functional Diagram

The functional diagram, shown below, provides button-click access to most of the screens used to configure an amplifier. It also indicates the flow of control from input, across all active control loops, to motor/feedback. Only those control loop buttons that are appropriate to the amplifier and operational mode appear on the diagram.

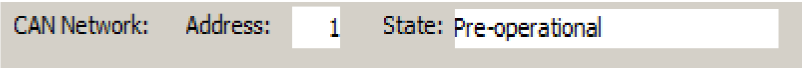


Name	Description	For More Information
CVM Control Program	Opens Kollmorgen Virtual Machine screen.	Kollmorgen Indexer Program User's Guide.
Control Loops	Each opens a control loop configuration screen.	"Control Loops" (➜ p. 45)
Motor	Opens the Motor screen.	"Motor" (➜ p. 29)
Home	Configure and test homing.	"Homing" (➜ p. 69)
Configure Faults	Opens Fault Configuration screen.	"Faults" (➜ p. 35)
Configure Filters	Opens Filter Configuration Screen	"Filters" (➜ p. 93)

4.6.4 CAN Information and Status Bar

4.6.4.1 CAN Information

The Main screen displays the basic CAN information. The example below shows CAN information:



The Address field shows the amplifier’s present CAN address. For more information, see "Network Configuration" (➜ p. 34). When the Position Loop Input is set to CAN, the State field shows the state of the amplifier’s CANopen state machine (for more information, see Kollmorgen’s CANopen Programmer’s Manual).

4.6.4.2 Status Bar

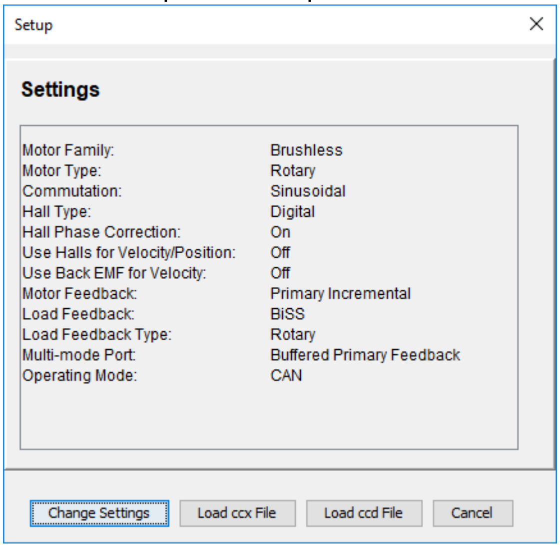
The status bar describes the present commutation mode, motor type, and amplifier control status as shown below. It also includes a reminder that pressing the F12 function key while RGMWorkBench is running disables the amplifier.

5 Basic Setup

5.1 Basic Setup Overview

The Basic Setup Wizard is used to set up the parameters that define the fundamental characteristics of the system. This is where the motor, feedback, and operating mode are setup. The setup can be done three different ways: manually change settings, load settings from a ccx file, or run the ServoTube setup wizard. Each of these methods are explained in this chapter.

1. Click to open the Setup screen.

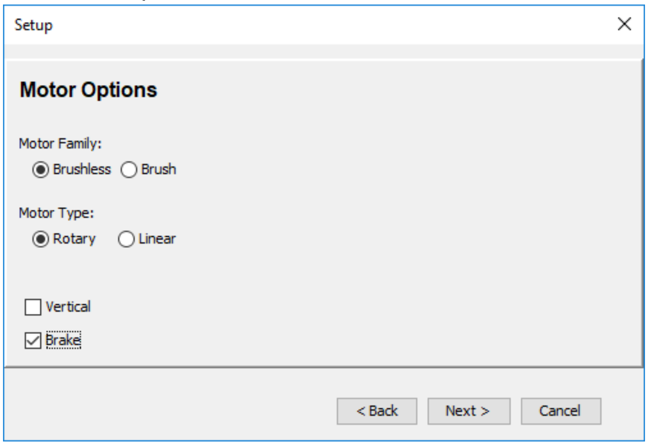


2. Change settings.
3. Choose:
   - Change Settings Click Change Settings to manually "Change Setup Settings" (➜ p. 24).
   OR
   - Load ccx File If you have a .ccx file that was prepared for the amplifier/motor combination, click Load ccx File and see "Data Management Tools" (➜ p. 108).
   OR
   - Cancel To accept the displayed settings, click Cancel.

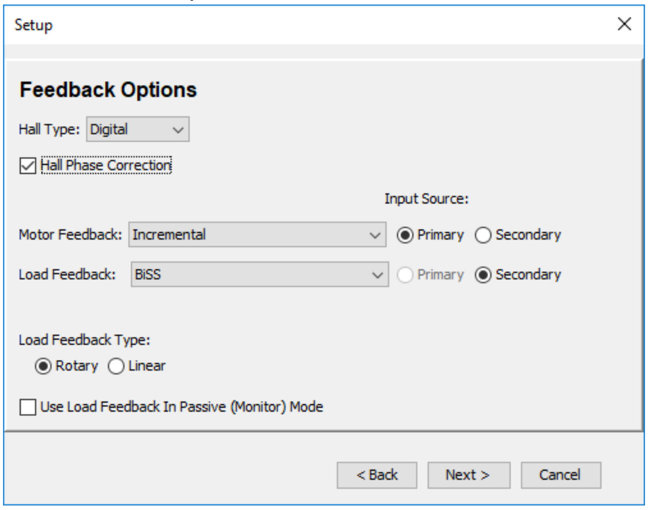
5.2 Change Setup Settings

1. 

On the Basic Setup screen, click Change Settings to manually change all Basic Setup settings. Use the Back and Next buttons to navigate screens.
2. Set Motor Options

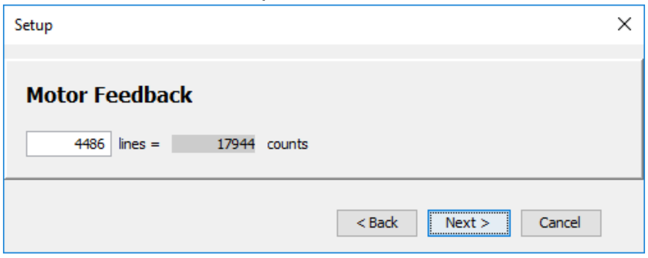


3. Set Feedback Options



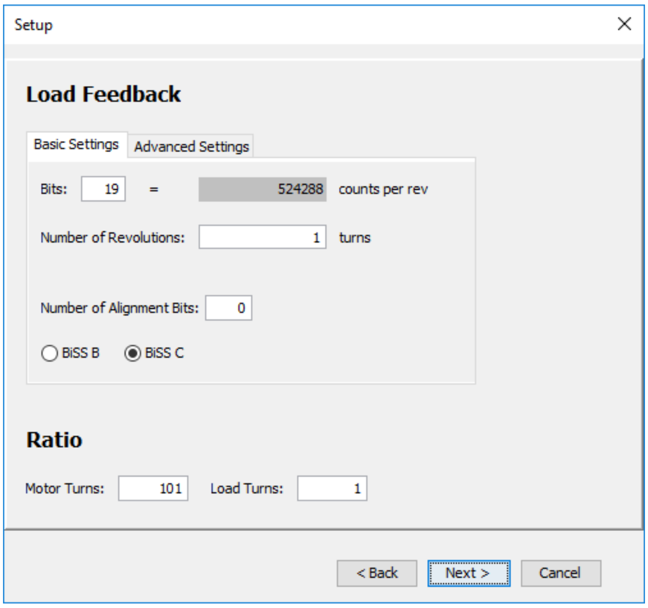
Setting	Description
Hall Type	Select Hall type: None, Digital.
Hall Phase Correction	If selected, will enable error checking between hall sensors and encoder phase angle.
Motor Feedback	Select type and source of motor feedback. • Incremental • Primary Incremental: Incremental encoder on primary feedback connector.
Load Feedback	Select type and source of Position (load) feedback. • none • BiSS
Load Feedback Type	Select the type of Position (load) feedback: • Rotary
Use Position Encoder in Passive (Monitor) Mode	When this is checked, the position of the position encoder will be reported by the passive load position variable but it will not be used to control the position of the axis.

4. Set Motor Feedback Options



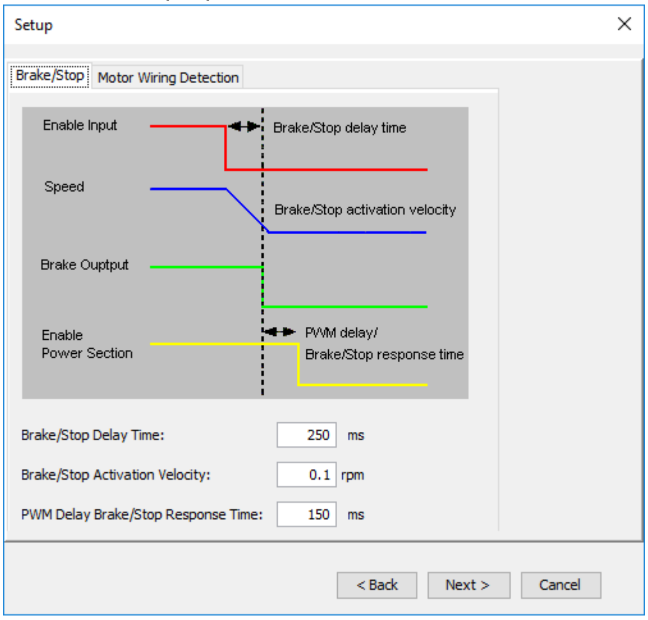
Model	Lines
RGM 14	4130
RGM 17	4274
RGM 20	4486
RGM 25	5342

5. Set Load Feedback Options

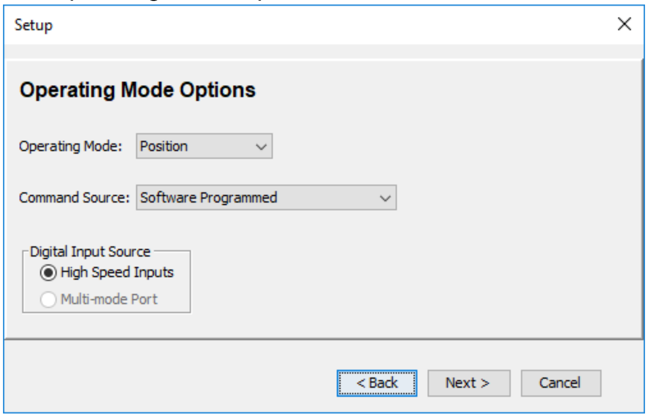


Setting	Description
Bits	19
Number of Revolutions	1 turn
Number of Alignment Bits	0
Biss	Biss C
Ratio	
Motor Turns	101
Load Turns	1

6. Set Brake/Stop Options

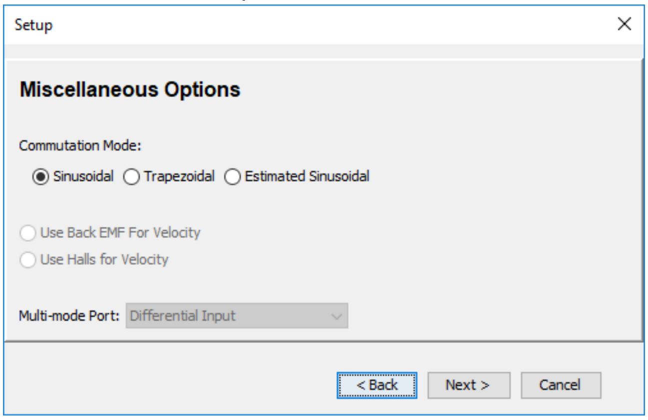


7. Set Operating Mode Options



Setting	Description	
Command Source	CAN	Command input is provided over the CANopen network. See the CANopen Programmer's Guide.
	Function Generator	Internal function generator provides the command input.
	Software Programmed	The amplifier is controlled by software commands from either the Kollmorgen Virtual Machine (CVM) or an external source. See Kollmorgen Indexer Program User’s Guide or the Kollmorgen ASCII Interface Programmer’s Guide.

8. Set Miscellaneous Options



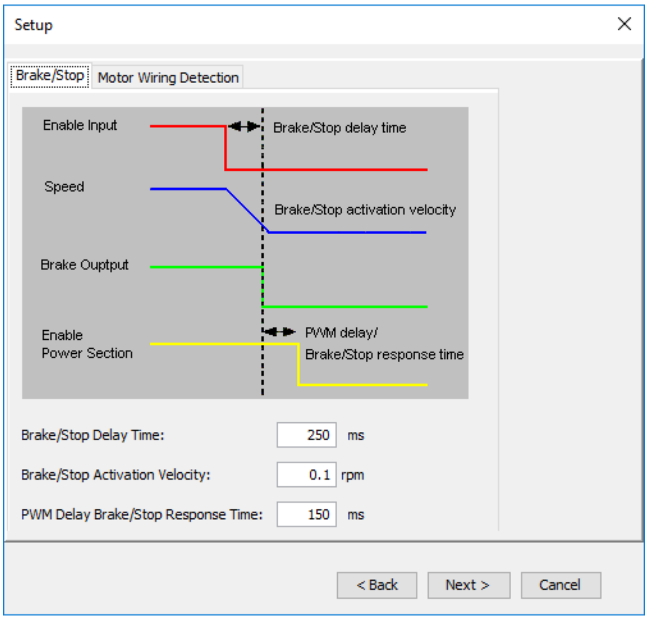
Setting	Description
Commutation	Commutation method: Sinusoidal, Trapezoidal, or Estimated Sinusoidal

9. When changes are complete, click **Finish**.

5.3 Brake/Stop Parameters

Many control systems employ a brake to hold the axis when the amplifier is disabled. On brake-equipped systems, disabling the amplifier by a hardware or software command starts the following sequence of events.

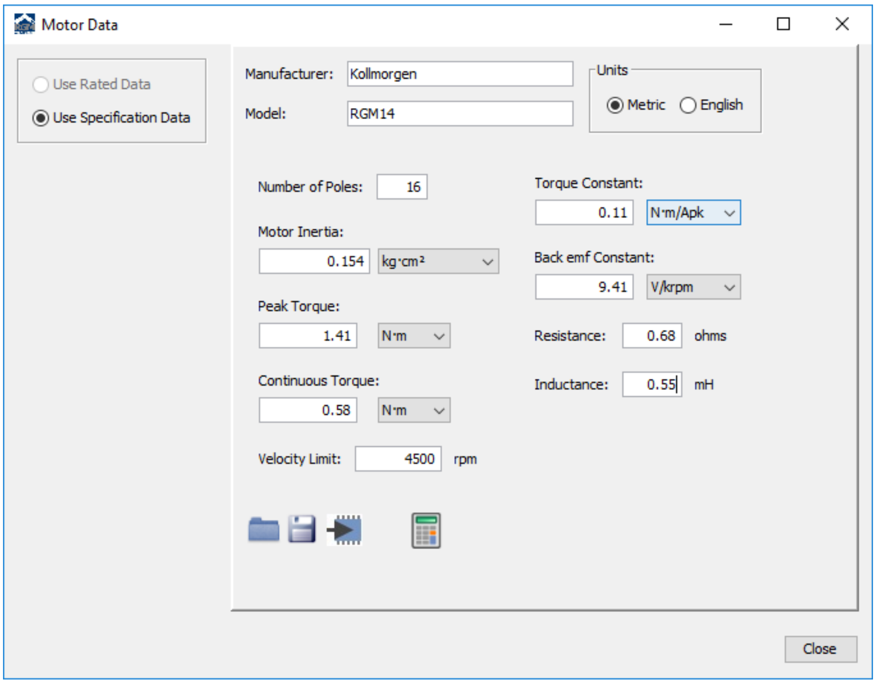
1. The motor begins to decelerate (at Abort Deceleration rate in position mode or Fast Stop Ramp rate in velocity mode). At the same time, the Brake/Stop Delay Time count begins. This allows the amplifier to slow the motor before applying the brake.
2. When response time has passed, the amplifier's output stages are disabled. This delay ensures the brake has time to lock in before disabling the power section.
3. This feature is not available when the amplifier is configured for current mode. In this mode, the amplifier output turns off and the brake output activates immediately when the disable command is received.
4. This feature is available when a fault is activated.



Parameter	Description
Brake/Stop Delay Time	Range of accepted values: 0 to 10,000 mS
Brake Activation Velocity	Range of accepted values: 0 to encoder resolution dependent limit rpm (mm/s for linear motor)
PWM Delay Brake/Stop Response Time	Range of accepted values: 0 to 10,000 mS
Set Defaults	Sets the three brake parameters to defaults values, based on the motor data.

6 Motor

6.1 Motor Data Screen Overview



Action	Name	Description
	Restore motor data from disk	Restores contents of a .ccm file from disk to PC.
	Save motor data to disk	Saves motor/feedback/brake settings from PC to a disk file with .ccm name extension.
	Save motor data to flash	Saves motor/feedback/brake settings from PC to amplifier permanent flash memory.
	Calculate	Calculates initial tuning and limit values.

1. Motor Click Motor to open the Motor screen.
2. "Load Motor Settings from a File" (➜ p. 30) data from disk.

OR

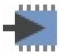
Enter settings manually:

1. Motor Click the Motor tab to view or change Motor Data.
2. Click "Calculate" (➜ p. 31) to calculate initial gains and limits.
3. On the Main screen, click Save to Flash to avoid losing the changes.

6.2 Load Motor Settings from a File

Load the motor data to the amplifier.

1. 

Click Motor to open the Motor screen.
2. On the Motor screen, click Restore Motor Data from Disk.
3. When prompted, navigate to the folder containing the file, then click on the file name, and then click Open.
4.  Calculate initial gains and limits with.
5.  On the Main screen, click Save to Flash to avoid losing the changes.

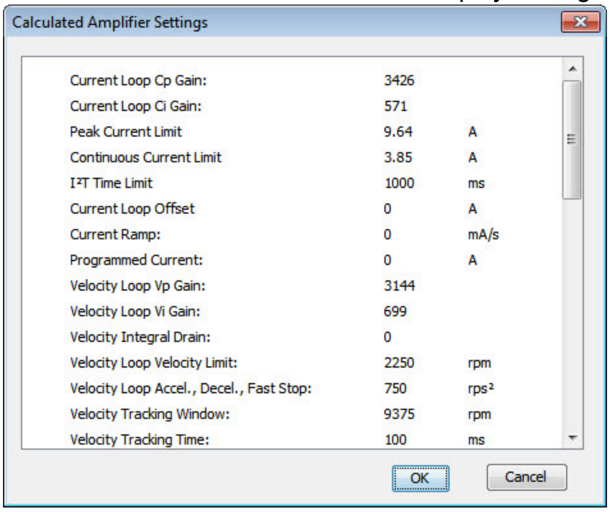
6.3 Motor Parameters

Setting	Description
Manufacturer	Motor manufacturer’s name. Saved for reference in the motor data file.
Model	Motor model number. Saved for reference in the motor data file.
Units	Selects whether the parameters entered in this screen are in Metric or English units.
Motor Inertia	The rotor inertia of the motor. Used for calculating initial velocity loop tuning values. Range: 0.00001 to 4,294 kg cm^2. Default: 0.00001 kg-cm^2.
Number of Poles	The number of magnetic poles in the motor. Required for correct commutation of the motor. If the number of poles is not known, Verify the motor’s pole count using the "Data accuracy test" (➜ p. 44).. Range: 2 to 200. Default: 4.
Peak Torque	The peak torque that the motor can produce. Peak Torque divided by torque constant = motor’s peak current limit. Range: 0.0001 to 2,100 Nm. Default: 0.0001 Nm.
Continuous Torque	The continuous torque that the motor can produce. Used with the torque constant to calculate continuous current. Range: 0.0001 to 1,000 Nm. Default: 0.0001 Nm.
Velocity Limit	Maximum speed of the motor. Used to calculate the velocity and acceleration limits for the velocity loop. Range dependent on encoder resolution.
Torque Constant	Relates the motor's input current to torque produced. Sometimes abbreviated as Kt. Range: 0.001 to 1,000 Nm/Apk. Default: 0.001 Nm/Apk.
Back emf Constant	Relates the motor's input voltage to speed. Sometimes abbreviated as Ke. Used for calculating the maximum velocity for a given amplifier bus voltage. Range: 0.01 to 21,000,000 V/Krpm. Default: 0.01 V/Krpm.
Resistance	Motor resistance line-to-line. Used for calculating the initial current loop tuning values. Range: 0.01 to 327 Ω. Default: 0.01 Ω.
Inductance	Motor inductance line-to-line. Used for calculating the initial current loop tuning values. Range: see the hardware documentation.

6.4 Calculate

The Calculate function uses the motor and feedback data to calculate initial gains and limits. These can be modified to fine-tune the amplifier. Follow the steps below:

1.  Click Calculate to calculate and display settings.



2. Verify the peak current limit, continuous current limit, and velocity loop velocity limit.

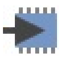
   If one or more of these values seems inappropriate, click Cancel and check: Peak Torque, Continuous Torque , Velocity Limit, and Torque Constant. Correct them if needed. See "Motor Parameters " (➜ p. 30).

   If the Motor/Feedback values were correct but the peak current limit, continuous current limit, or velocity loop velocity limit values are not optimal for the application, change these limits during the tuning process.

3. Save the values into amplifier RAM by clicking OK.

NOTE

When loading motor data from a file, if the motor wiring configuration in the motor file does not match the configuration currently stored in the amplifier, CME prompts for verification on which configuration to use. Select the file configuration by clicking Yes. The configuration will be tested as part of "Motor Phasing" (➜ p. 38).

4.  On the Main screen, click Save to Flash to avoid losing the changes.

7 Command Inputs

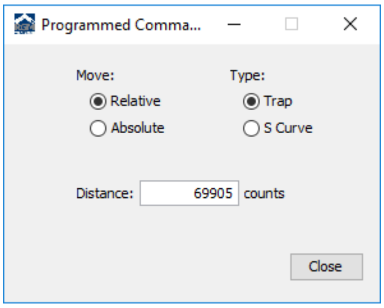
7.1 Software Programmed Input Settings

These settings can be saved to flash to allow default conditions to be set and used when the amplifier is powered up or reset.

7.1.1 Programmed Position

- 

Click the Programmed Position button on the Main screen.

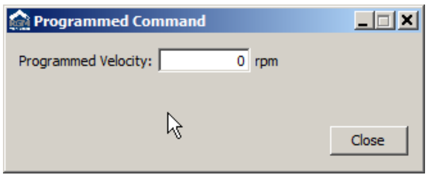


Setting	Description
Move	Relative or Absolute.
Type	Trap or S-Curve.
Distance	Move distance (relative) or location (absolute)

7.1.2 Programmed Velocity

- 

Click the Programmed Velocity button on the Main screen.



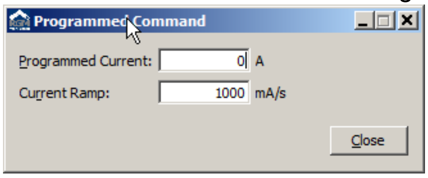
⚠ DANGER	**Potential for unexpected movement.**
	If the Programmed Velocity is set to values other than 0, the motor will move after power-up or reset if the amplifier is hardware enabled. **Failure to heed this warning can cause equipment damage, injury, or death.**

Setting	Description
Programmed Velocity	Move velocity. Units: rpm (rotary) or mm/s (linear).

7.1.3 Programmed Current

- 

Click the Programmed Current button on the Main screen.



⚠ DANGER	**Potential for unexpected movement.**
	If the Programmed Current is set to values other than 0, the motor will move after power-up or reset if the amplifier is hardware enabled. **Failure to heed this warning can cause equipment damage, injury, or death.**

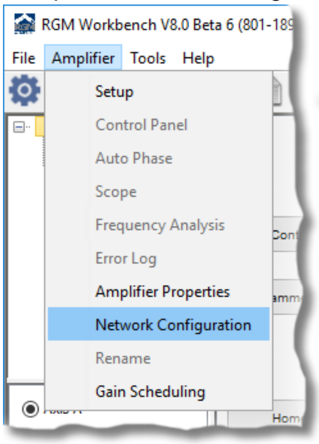
Setting	Description
Programmed Current	Current applied during the constant velocity portion of the move. Units: A.
Current Ramp	Acceleration/deceleration current. Units: mA/s.

8 Network Configuration

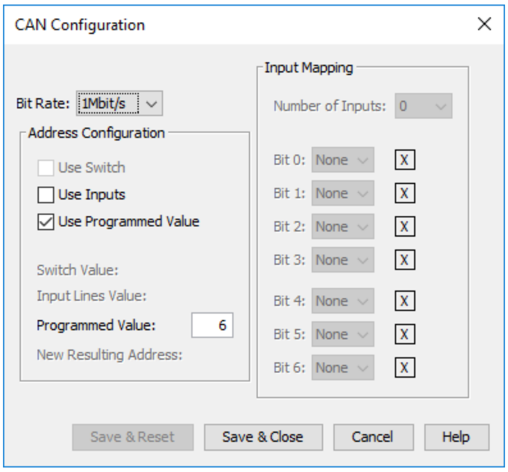
8.1 CANopen Network

A CANopen network can support up to 127 nodes. Each node must have a unique and valid seven-bit address (Node ID) in the range of 1-127. (Address 0 should only be used when the amplifier is serving as a RGM WorkBench serial port multi-drop gateway.)

1. Verify that the CAN network has been cabled and terminated as per amplifier documents.
2. To open the CAN Configuration screen, choose Amplifier→Network Configuration.)



3. Choose a Bit Rate and choose any combination of address sources (Inputs, and Programmed Value). The address is the sum of the values from these sources.



4. For each source selected, perform the additional steps described below.

Source	Additional Steps
Use Inputs	Enter Number of Inputs, then choose inputs to represent each CAN address bit.
Use Programmed Value	Enter the Programmed Value.

5. Click Save & Reset to save changes to amplifier flash, close the screen, and reset the amplifier. Click Save & Close to save changes to amplifier flash without resetting.

NOTE

Address and bit rate changes take effect only after power-up or reset.

9 Faults

9.1 Faults Overview

9.1.1 Latched vs Non-latched Faults

When a fault is configured to be latched, the fault can only be cleared after the fault has been corrected and at least one of the following actions has been taken:

- Power-cycle the amplifier
- Cycle (disable and then enable) an input that is configured as *Enable with Clear Faults or Enable with Reset*
- Open the Control Panel and press Clear Faults or Reset
- Clear the fault over the CANopen network or serial bus

A non-latched fault will be cleared when the fault condition has been removed. This can occur without operator intervention.

⚠ DANGER	**Risk of unexpected motion with non-latched faults.**
	After the cause of a non-latched fault is corrected, the amplifier re-enables the PWM output stage without operator intervention. In this case, motion may re-start unexpectedly. Configure faults as latched unless a specific situation calls for non-latched behavior. When using non-latched faults, be sure to safeguard against unexpected motion. **Failure to heed this warning can cause equipment damage, injury, or death.**

9.1.2 Latched vs Non-latched Faults Example

The drive's temperature reaches the fault level. The drive reports the fault and disables the PWM output. Then, the drive temperature falls below the fault level.

Non-latched fault operation:

The fault is cleared and the amplifier's PWM outputs are enabled without operator intervention.

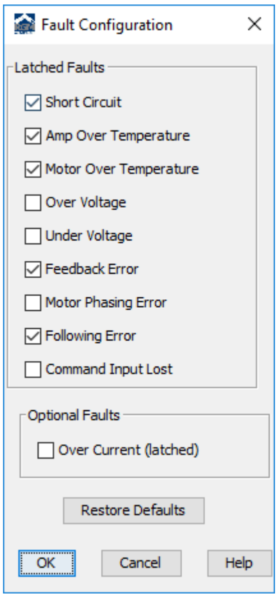
Latched fault operation:

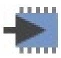
The fault remains active and the drive's PWM outputs remain disabled until the faults are cleared as described above.

9.1.3 Fault Latching Procedure

1. 

Click the Configure Faults button on the Main screen.
2. Select the faults to latch. See "Fault Descriptions " (➜ p. 37)



3. Click OK to close screen and save changes to amplifier RAM.
4.  On the Main screen, click Save to Flash to avoid losing the changes.

9.2 Fault Descriptions

NOTE

The list of faults may vary with amplifier model.

Fault Description	Fault Occurs When ...	Fault is Corrected When ...
*Short Circuit Detected	Output to output, output to ground, internal PWM bridge fault.	Short circuit has been removed.
*Amp Over Temperature	Amplifier's internal temperature exceeds specified temperature.	Amplifier's internal temperature falls below specified temperature.
Over Voltage	Bus voltage exceeds specified voltage limit.	Bus voltage returns to specified voltage range.
Under Voltage	Bus voltage falls below specified voltage limit.	Bus voltage returns to specified voltage range.
*Feedback error	Over current condition detected on output of the internal +5 Vdc supply used to power the feedback. Differential signals from incremental encoder not connected.	Encoder power returns to specified voltage range. Feedback signals stay within specified levels. Differential signals connected.
Motor Phasing Error	Encoder-based phase angle does not agree with Hall switch states. This fault can occur only with brushless motors set up using sinusoidal commutation. It does not occur with Halls correction turned off.	Encoder-based phase angle agrees with Hall switch states. See "Troubleshoot Manual Phase w/ Encoder and Halls" (➔ p. 44)
*Following Error	User set following error threshold exceeded.	See "Following Error Fault Details" (➔ p. 68)
*Motor Over Temp	Motor over-temperature switch changes state to indicate an over-temperature condition.	Temperature switch changes back to normal operating state.
Over Current (Latched)	Output current I2T limit has been exceeded.	Amplifier is reset and re-enabled.

*Latched by default.

10 Motor Phasing

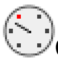
10.1 Auto Phase

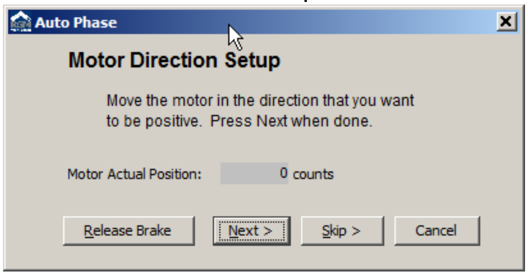
The examples in this chapter show particular amplifier operating modes and motor feedback configurations. Some screens and choices may vary from those described here.

10.1.1 Auto Phase Example: Servo Amplifier

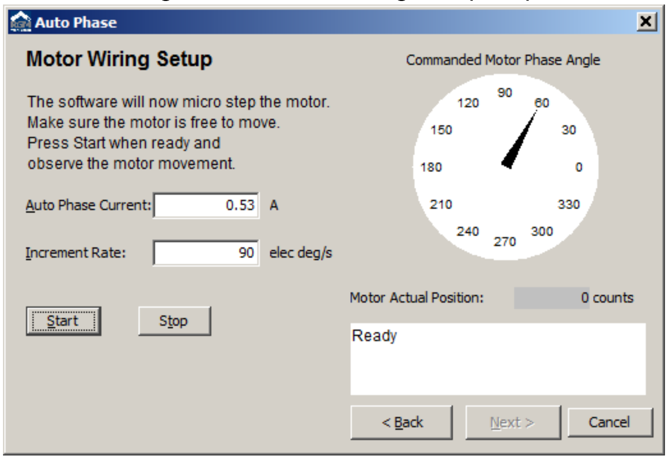
NOTE

The following steps show Auto Phase with a brushless rotary motor, digital Halls, and an incremental quadrature encoder. Screens vary for other configurations.

1. Verify that the Enable Input is not activated and that HV or AC power is applied.
2. Click Auto Phase to open the Auto Phase wizard.



3. Move the motor in the direction to be considered positive.
   OR
   If you cannot move the motor, click Skip (you will confirm motor direction later).
4. Click Next to go to the Motor Wiring Setup step:



5. Activate the Enable Input.
6. Click Start to begin the motor wiring setup.

   The message area displays messages: Configuring Initial Settings, Microstepping, Test Complete, Motor Wiring has been configured.

   During microstepping, a current vector is applied to the motor windings and microstepped through an electrical cycle at a set rate, causing the motor to move.

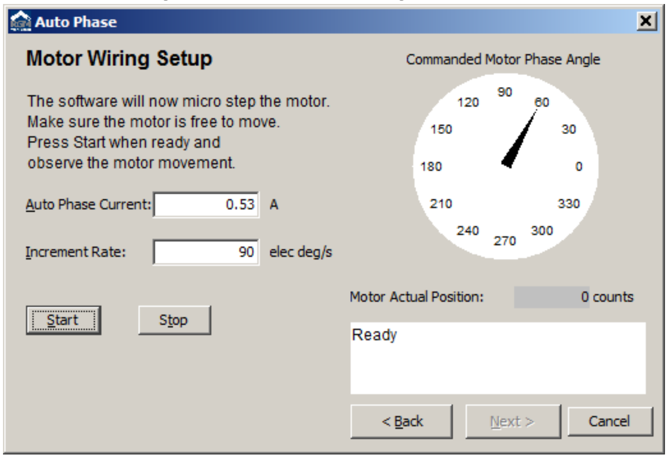
   If you chose to Skip the motor direction setup step, Auto Phase will prompt for confirmation of correct motor direction.

   If the step fails see "Troubleshooting the Auto Phase Problems" (➜ p. 41)

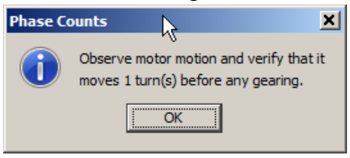
NOTE

If incorrect values were entered for inductance and resistance, the calculated Cp and Ci values may produce current loop oscillation, evidenced by an audible high frequency squeal during auto phasing.

7. Click Next to go to the Motor Wiring Setup step:

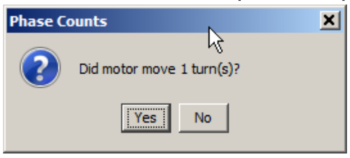


8. Click Start to begin the Phase Count Test. Observe status messages. See the prompt:



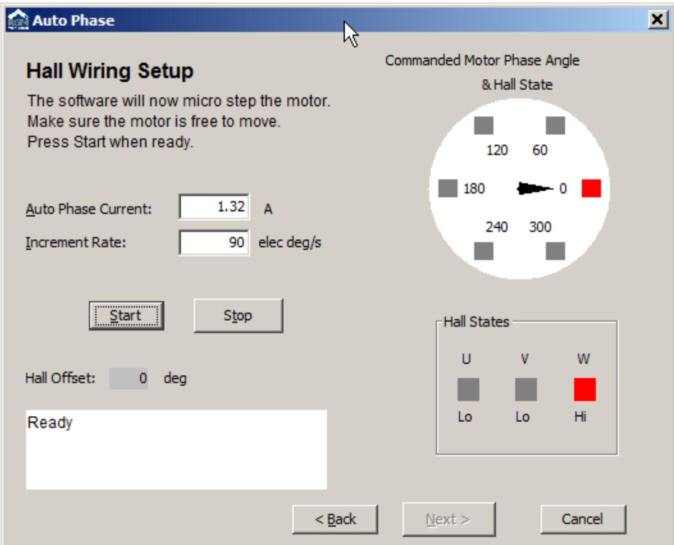
9. When you are ready to observe motion, click OK.

When motion is complete the prompt will be displayed:



- If motor did not turn 1 full turn, click No and see "Phase count test" (➜ p. 41).
- If motor turned 1 full turn, click Yes.

10. Click Next to open the Hall Wiring Setup screen.

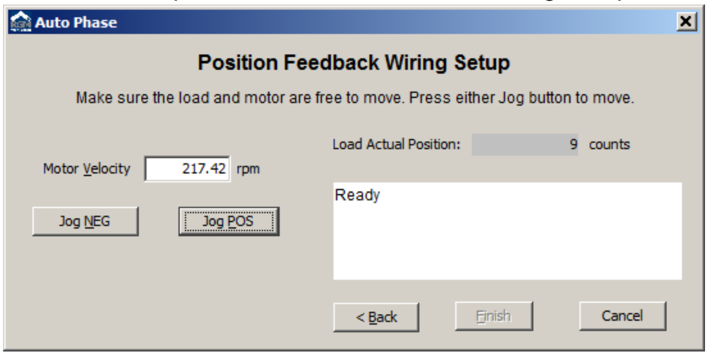


11. Click Start to begin the Halls wiring setup. The message area displays the messages: Microstepping. Test Complete. Motor has been properly phased.

During microstepping, a current vector is applied to the motor windings and microstepped through an electrical cycle at a set rate, causing the motor to move. As the motor moves the Hall lines are decoded for proper commutation.

If the step fails, see "Halls wiring setup" (➜ p. 41).

12. If the Auto Phase algorithm does not produce desired results, try adjusting the Auto Phase Current and Increment Rate values, using the guidelines in "Tips for Auto Phase Current and Increment Rate" (➜ p. 40).
13. If desired results are not obtained, or to confirm results, proceed to "Manual Phase" (➜ p. 42)
14. Click Next to open the Position Feedback Wiring Setup screen.



15. Click Start to begin the Position Feedback Wiring Setup.
16. Select either Jog Neg or Jog POS and ensure the motor rotates in the desired direction.

10.1.2 Tips for Auto Phase Current and Increment Rate

- If friction is high, more current may be required to move the load.
- High static friction may require more current to overcome stiction.
- Transition from static friction to dynamic friction, and back, may produce jerky motion.
- A faster increment rate will operate in the dynamic friction range.
- A slower rate will operate in the static friction range.
- If the friction is low, as in the case of air bearings, low frequency oscillations may occur; thus, less current and slower rates may be required. If oscillations persist, then friction may need to be temporarily added.

10.2 Troubleshooting the Auto Phase Problems

10.2.1 Motor direction setup

If motor direction setup step failed:

- Check Encoder or resolver power and signals.
- Verify that the encoder is differential. (Contact factory if encoder is single-ended.)
- Check shielding for proper grounding.

10.2.2 Motor wiring setup

If motor wiring setup step failed:

- Verify that amplifier is disabled.
- Check for mechanical jamming.
- Check for smooth motion with no mechanical jerking.
- Check for good connections to the motor power wires.
- Disconnect motor power wires and measure for proper motor resistance.

10.2.3 Phase count test

If phase count test failed:

- Verify that in the Motor/Feedback screen the following parameters have been set correctly:
- Number of Poles for rotary motors. Verify the motor’s pole count with the "Data accuracy test" (➜ p. 44).
- Magnetic Pole Pair Length for linear motors.
- Encoder Lines or Fundamental Lines for rotary encoders.
- Encoder Resolution for linear encoders.

10.2.4 Halls wiring setup

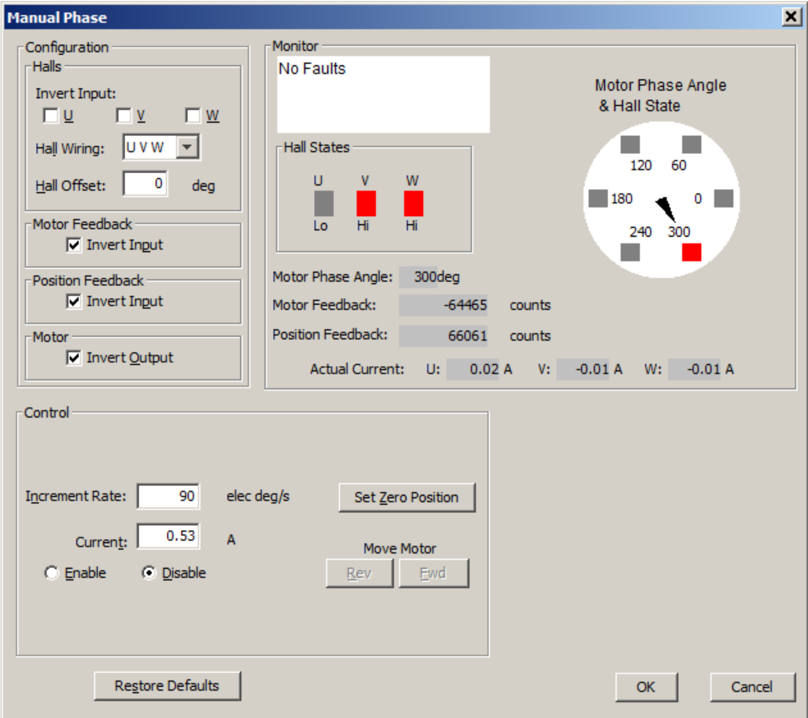
If Halls wiring setup step failed:

- Check Halls power and signals.
- Check for smooth motion with no mechanical jerking.
- Check shielding for proper grounding.

If the auto phase procedure fails despite these corrective measures, see "Manual Phase" (➜ p. 42)

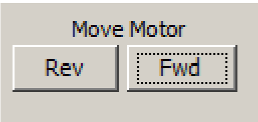
10.3 Manual Phase

1. Remove load from the motor.
2. On the Main screen, choose Tools > Manual Phase to open the window:

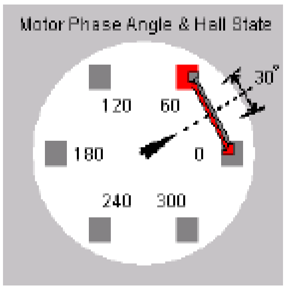


3. Verify the Current setting before enabling the drive.

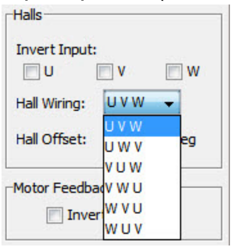
4. To control the current vector rotation, command the motor forward or reverse.



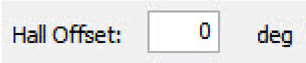
5. If the motor cannot keep up with the rate of vector rotation, then reduce the Increment Rate or increase the Current.
6. Verify that pressing forward button moves motor forward. If the motor moves in the wrong direction, toggle the Motor Invert Output setting.
7. Verify actual position count agrees with direction of rotation: increasing counts in forward direction and decreasing counts in reverse direction. If it does not, toggle the Motor Feedback Invert Input box setting.
8. Monitor the vector rotation through one electrical cycle for proper Hall transitions:
   - Verify that the red indicator rotates in the same direction as the motor phase angle, and that the transition occurs when the needle is between indicators (±30 degrees, as shown below).



- If the needle and Hall states do not track properly, use the Hall Wiring list box and/or Invert Input options (shown below) to swap the amplifier's Hall wire configuration.



- If the red indicator transition leads or lags behind the centered needle by more than 30 degrees, then try adjusting the Hall Offset in +/- 30 degree increments:



9. Phasing of a motor with encoder and Halls is complete. Click OK.

10.4 Troubleshoot Manual Phase w/ Encoder and Halls

To perform trapezoidal commutation after power-up or reset, the amplifier must receive good Hall signals. After the first Hall transition is detected, then sinusoidal commutation can be performed. In sinusoidal commutation, the amplifier uses the encoder for commutation while monitoring the Halls to verify proper phase. If the error between the encoder count and Hall transition is too large, then the Hall phase correction will not be performed and a phase fault will be triggered.

Test for phase fault problems in the order shown below.

10.4.1 Data accuracy test

1. Verify the motor's pole count:
   - Apply a current vector at zero Increment Rate to lock motor in position.
   - Turn the motor shaft and count the number of distinct locking positions.
   - Calculate the number of poles: Poles = number of locking positions * 2
2. Verify the encoder line count OR a linear motor's magnetic pair length and the encoder resolution.

10.4.2 Encoder wiring test

If the Halls produce good trapezoidal commutation but a phase fault is persistent in sinusoidal commutation mode, the encoder is highly suspect:

- Verify the differential encoder signals.
- Verify proper twisted shielded cable with good grounding.
- Disable the amplifier and move the motor manually to test for phase fault.
- If phase fault only occurs under command of current, make sure the motor power cable is not bundled with the encoder cable.

10.4.3 Hall signals test

If the Halls signals are suspected to be faulty:

- Make sure Halls change states as the motor moves through one electrical cycle.
- Some Hall signals are noisy and require filtering. Check with motor manufacturer.
- Some Halls are not properly calibrated to the motor manufacturer's specification.

10.4.4 Hall transition test

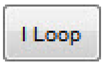
If the location of the Hall transition is not within +/-30 degrees:

- Adjust Hall offset in smaller increments.
- Verify Hall alignment.
- Make sure motion is smooth.

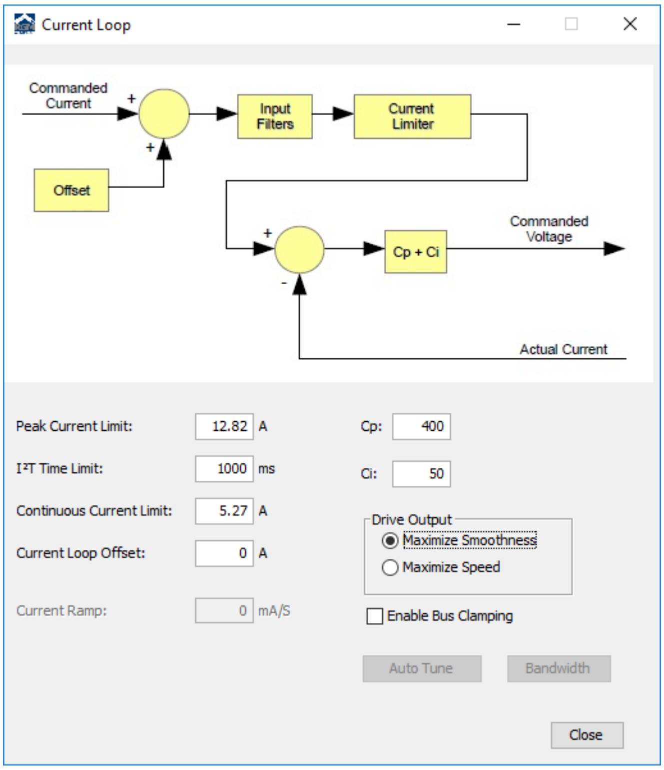
11 Control Loops

11.1 Current Loop Setup and Tuning

Initial current loop proportional gain (Cp) and current loop integral gain (Ci) values can be calculated with "Calculate" (➜ p. 31).



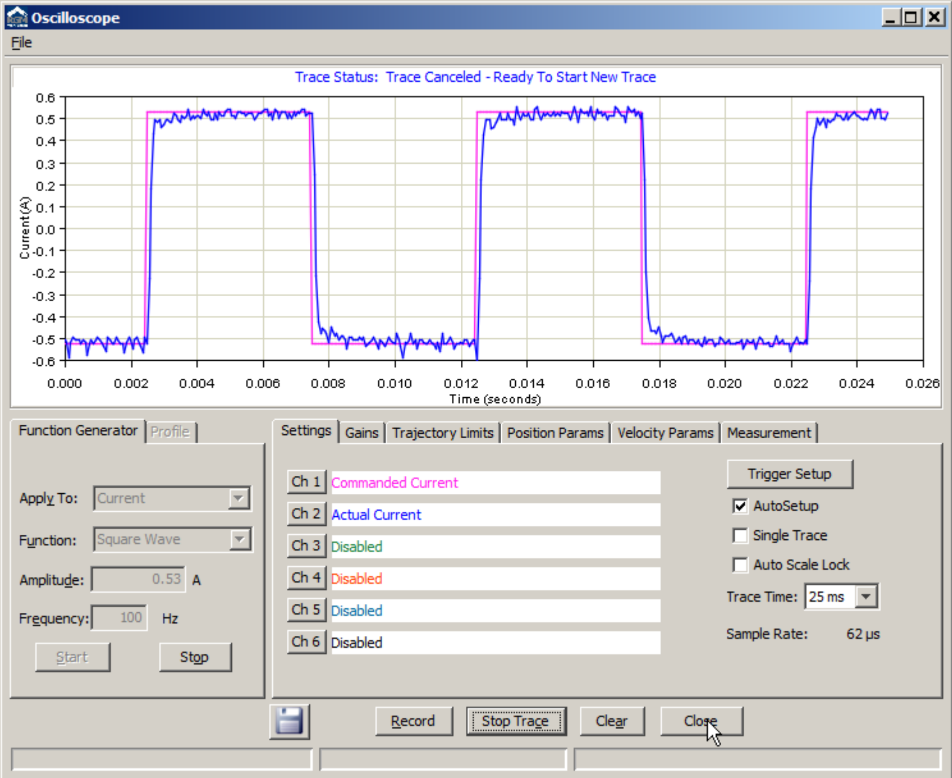
Click I Loop to open the Current Loop screen:



Parameter	Description
Peak Current Limit	Used to limit the peak phase current to the motor. Max value depends upon the amplifier model; Min value > continuous limit.
I^2T Time Limit	Sets I^2T Time Limit in ms. See "Appendix: I2T Time Limit Algorithm" (➜ p. 119).
Continuous Current Limit	Used to limit the Phase Current. Max Value is < Peak Current and depends upon the amplifier model. Min value: 0
Current Loop Offset	Sets current loop offset. Leave it set to zero until after tuning. For more information, see "Offset" (➜ p. 50)
Cp	Current loop proportional gain. Range 0 – 32,767.
Ci	Current loop integral gain. Range 0 – 32,767.
Drive Output	Maximize Smoothness: Amplifier uses circular vector limiting to produce smooth operation even into the voltage limits. Maximize Speed: Allows for slightly more of the bus voltage to be used when in the voltage limit. This may produce a small disturbance at top speed.
Enable Bus Clamping	
Auto Tune	See "Current Loop Auto Tune" (➜ p. 48)
Bandwidth	Measure bandwidth using the Cp and Ci values now in the amplifier.

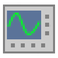
11.1.1 Manually tune the Current Loop

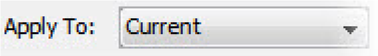
Apply square-wave excitation to the current loop and adjust current loop proportional gain (Cp) and current loop integral gain (Ci) to obtain a desired waveform.



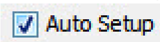
NOTE

- During tuning, observe any warnings or faults that appear in the status bar of the scope.
- Some users prefer the Auto Tune feature. See Current Loop Auto Tune (p. 121)

1. Click the Scope Tool. 
2. Choose Current from the Function Generator Apply To: list



3. On the Settings tab, make sure Auto Setup is selected.



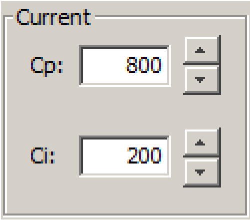
Auto Setup automatically sets the following parameters:

Parameter	Description
Function Generator Tab	
Function	Square Wave
Amplitude	10% of continuous current value
Frequency	100 Hz
Settings Tab	
Channel 1	Commanded current (violet)
Channel 2	Actual current (blue)

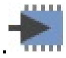
4. Verify that the Amplitude value is not excessive for the motor.

5. Click Start.

6. On the Gains tab, adjust current loop proportional gain (Cp):



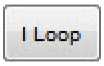
   - Set current loop integral gain (Ci) to zero.
   - Raise or lower Cp to obtain desired step response. (Typically, little or no overshoot with a 100 Hz, low-current square wave.) If the Cp value is too large, ringing may occur. If the Cp value is too low, bandwidth decreases.
7. Adjust current loop integral gain (Ci) until desired settling time is obtained.
8. Press Stop to stop the function generator.

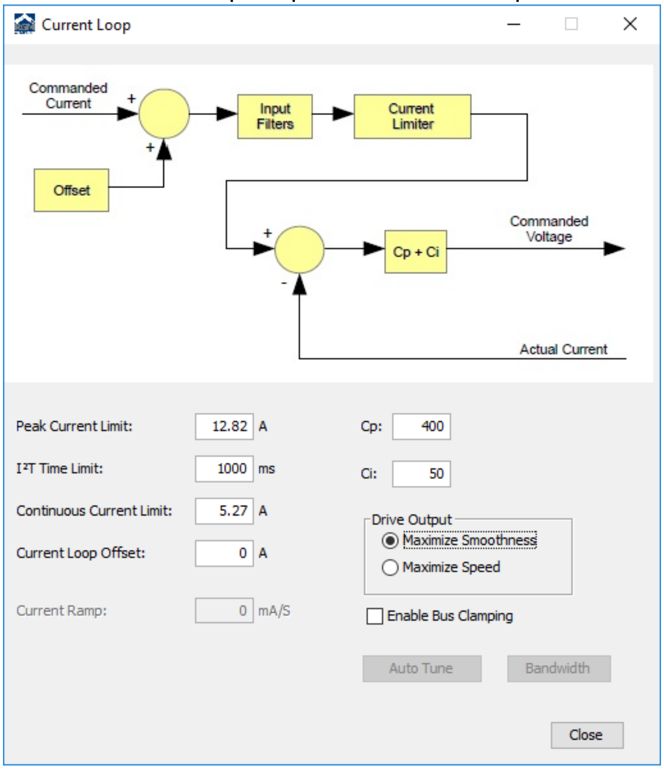
9. On the Main screen, click Save to Flash to avoid losing the changes. 

11.2 Current Loop Auto Tune

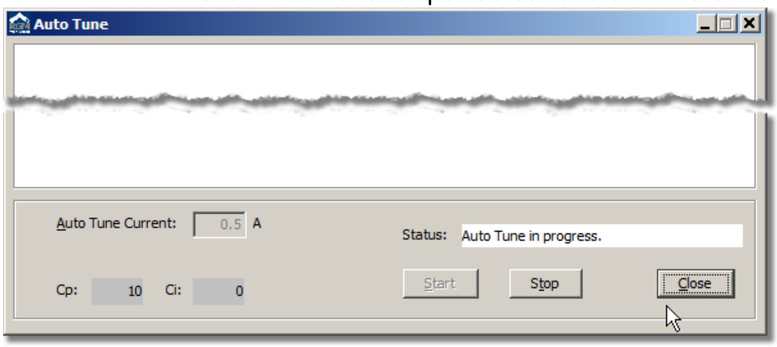
The current loop Auto Tune algorithm applies a square-wave command to the current loop and adjusts current loop proportional gain (Cp) and current loop integral gain (Ci) until a desirable waveform is obtained.

Initial current loop proportional gain (Cp) and current loop integral gain (Ci) values can be calculated with "Calculate" (➔ p. 31).

1. 

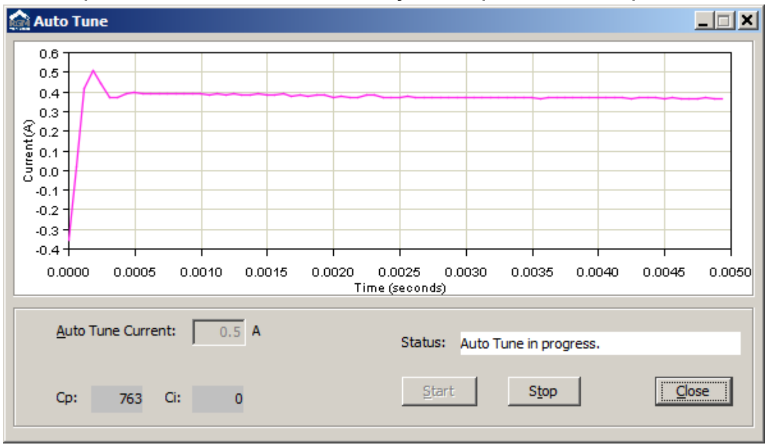
Click I Loop to open the Current Loop screen:


2. Verify that the amplifier is hardware enabled.
3. 

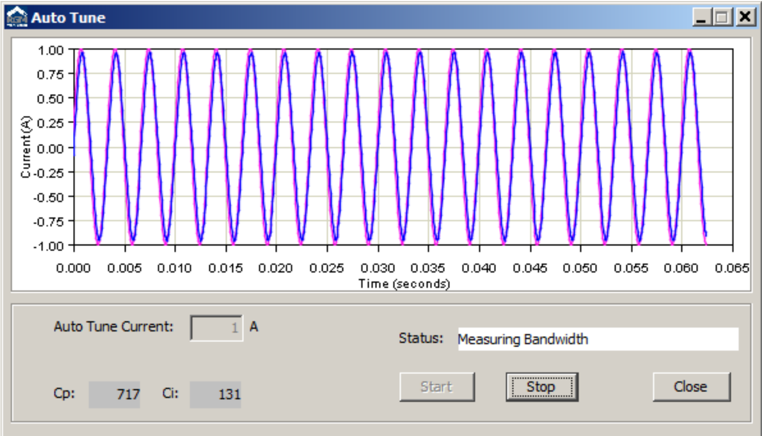
Click Auto Tune to open screen and start the Current Loop Auto Tune.


4. To Change the Auto Tune Current, Press Stop, enter the new current in the Auto Tune Current field, and then press Start.

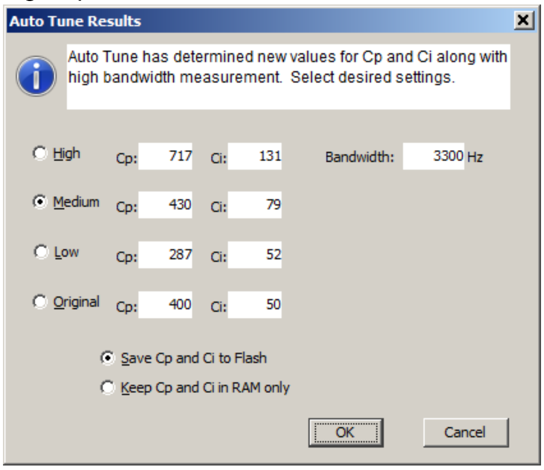
5. Observe the Auto Tune process and results. A typical example:
    - Sets Cp and Ci to zero and then adjusts Cp and Ci for optimal values.



    - Uses a frequency sweep to determine the small signal, current loop bandwidth.



    - Displays the results: a set of Cp and Ci alternatives, and the bandwidth measured using the high Cp and Ci values.

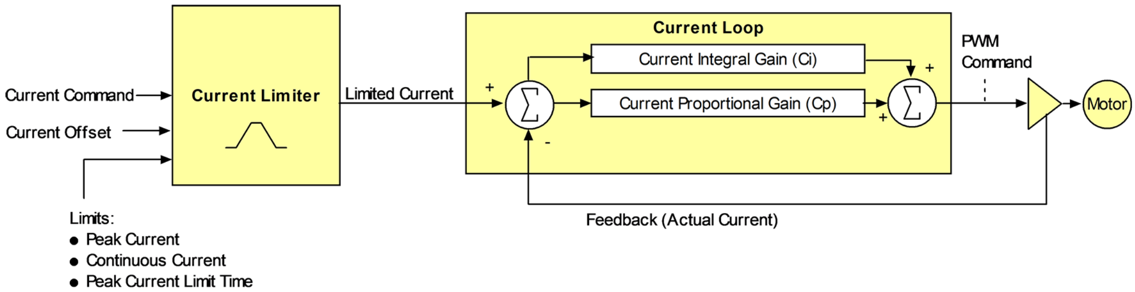


6. Choose an action based on Auto Tune results.
    - Choose which set of values to save: High, Medium, Low, or Original. The Medium values, selected by default, are appropriate for most applications.
    - Optionally choose how to save: Save Cp and Ci to Flash or Keep Cp and Ci in amplifier RAM only.
7. Click OK to save the values as chosen, and close the Auto Tune Results window.

11.3 Notes on the Current Mode and Current Loop

11.3.1 Current Loop Diagram

As shown below, the “front end” of the current loop is a limiting stage. The limiting stage accepts a current command, applies limits, and passes a limited current command to the summing junction. The summing junction takes the commanded current, subtracts the actual current (represented by the feedback signal), and produces an error signal. This error signal is then processed using the integral and proportional gains to produce a command. This command is then applied to the amplifier’s power stage.



11.3.2 Current Loop Inputs

- The amplifier’s analog or PWM inputs.
- A CANopen network via the amplifier’s CAN interface.
- A Kollmorgen Virtual Motion (CVM) control program.
- The amplifier’s internal function generator.

In velocity or position modes, the current command is generated by the velocity loop.

11.3.3 Offset

The current loop offset is intended for use in applications where there is a constant force applied to, or required of, the servomotor and the system must control this force. Typical applications would be a vertical axis holding against gravity, or web tensioning. This offset value is summed with the current command before the limiting stage.

11.3.4 Limits

The current command is limited based on the following parameters:

Limiter	Description
Peak Current Limit	Maximum current that can be generated by the amplifier for a short duration of time. This value cannot exceed the peak current rating of the amplifier.
Continuous Current Limit	Maximum current that can be constantly generated by the amplifier.
I2T Time Limit	Maximum amount of time that the peak current can be applied to the motor before it must be reduced to the continuous limit or generate a fault. For more details, see "Appendix: I2T Time Limit Algorithm" (➜ p. 119). **NOTE** Although the current limits set by the user may exceed the amplifier's internal limits, the amplifier operates using both sets of limits in parallel, and therefore will not exceed its own internal limits regardless of the values programmed.
Ramp	Rate of change in current command. Used to limit jog moves initiated from the Control Panel Jog function in current mode, and in advanced Indexer Program functions.

11.3.5 Current Loop Gains

Gain	Description
Cp - Current loop proportional	The current error (the difference between the actual and the limited commanded current) is multiplied by this value. The primary effect of this gain is to increase bandwidth (or decrease the step-response time) as the gain is increased.
Ci - Current loop integral	The integral of the current error is multiplied by this value. Integral gain reduces the current error to zero over time. It controls the DC accuracy of the loop, or the flatness of the top of a square wave signal. The error integral is the accumulated sum of the current error value over time.

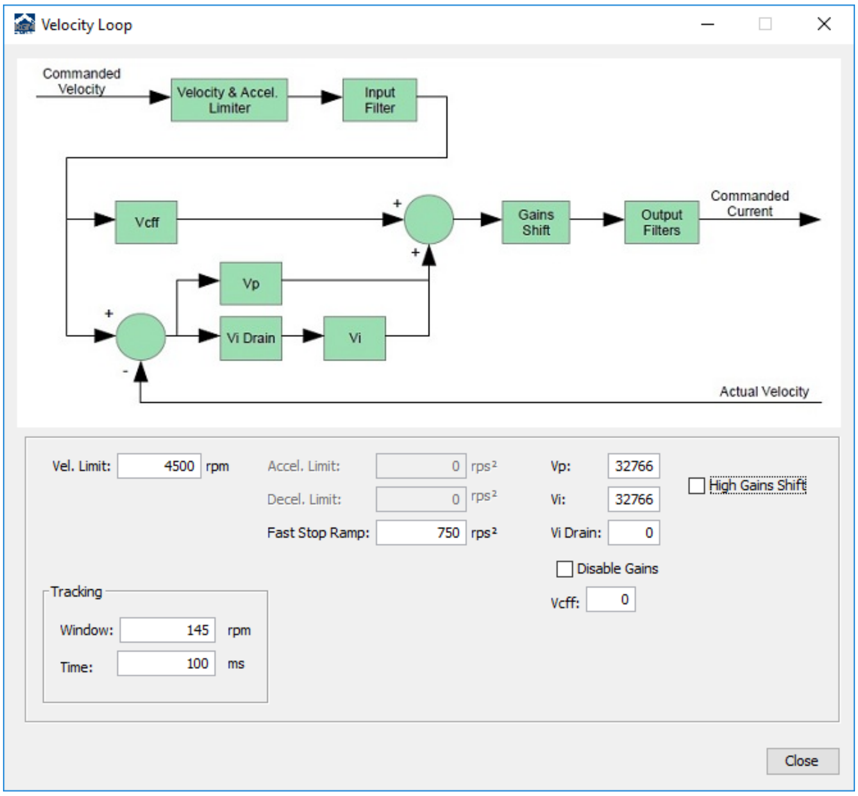
11.3.6 Current Loop Output

The output of the current loop is a command that sets the duty cycle of the PWM output stage of the amplifier.

11.4 Velocity Loop Setup and Tuning

Initial velocity loop proportional gain (Vp) and velocity loop integral gain (Vi) values can be calculated with "Calculate" (➜ p. 31)

Click the V Loop button on the Main screen.:

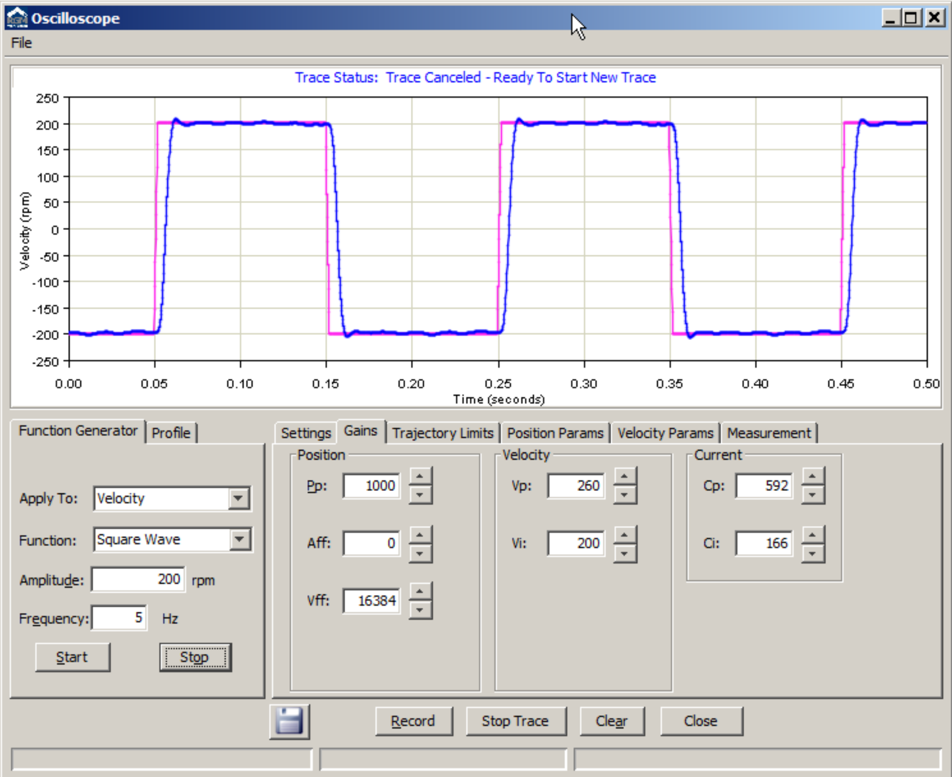


Parameter	Description
Velocity Limit	Top speed limit. Max value may depend upon the back EMF & the Encoder value. Min value: 0.
Acceleration Limit	Maximum acceleration rate. Max value may depend upon load, inertia, & peak current. Min value: 1. (Does not apply in position mode.)
Deceleration Limit	Maximum deceleration rate. Max value may depend upon load, inertia, & peak current. Min value: 1. (Does not apply in position mode.)
Tracking Window	See "Position and Velocity Tracking Windows" (➜ p. 68)
Tracking Time	
Vp	Velocity loop proportional gain. Range: 0 to 32,767.
Vi	Velocity loop integral gain. Range: 0 to 32,767.
Fast Stop Ramp	Deceleration rate used by the velocity loop when the amplifier is hardware disabled. Range: 0 to 100,000,000. Default: velocity loop Decel. Limit value.
Low Gains Shift	Increases the resolution of the units used to express Vp and Vi, providing more precise tuning. For more information, see "Velocity Gains Shift " (➜ p. 57)
Hi Gains Shift	Decreases the resolution of the units used to express Vp and Vi, providing more precise tuning. For more information, see "Velocity Gains Shift " (➜ p. 57)

Parameter	Description
Vi Drain (integral bleed)	Vi drain modifies the effect of velocity loop integral gain. The higher the Vi Drain value, the faster the integral sum is lowered. Range: 0 to 32,000. Default: 0.
Vcff	Velocity loop command feed forward. The input command to the velocity loop (after limiting) is scaled by this value and added to the output of the velocity loop.

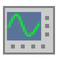
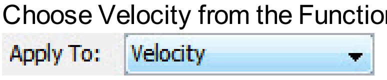
11.4.1 Manually Tune the Velocity Loop

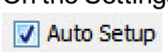
Apply square-wave excitation to velocity loop and adjust proportional gain (Vp) and integral gain (Vi) to obtain desired waveform. For instance:



NOTE

During tuning, observe any warnings that appear to the left of the trace.

1. Click the Scope Tool. 
2. Choose Velocity from the Function Generator Apply To: list.
   

3. On the Settings tab, make sure Auto Setup is selected.
   

   Auto Setup automatically sets the following parameters:

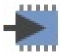
Parameter	Description
Function Generator Tab	
Function	Square Wave
Amplitude	10% of maximum velocity value

Parameter	Description
Frequency	5 Hz
Settings Tab	
Channel 1	Limited velocity (green).
Channel 2	Actual Motor Velocity (white).

4. Verify that Amplitude value is not excessive for the motor.

5. Click Start.

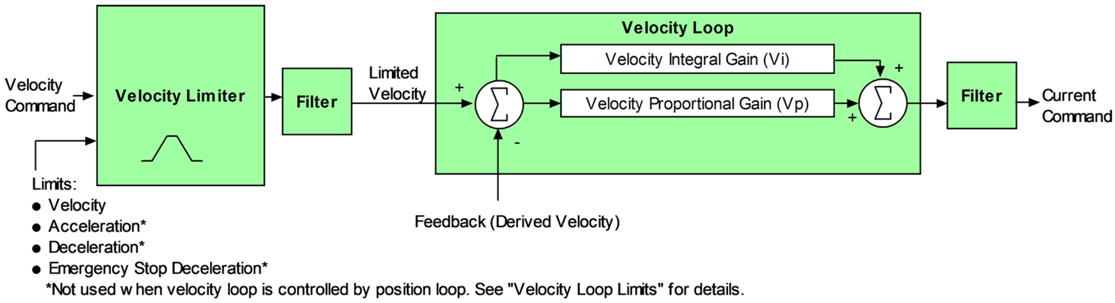
6. On the Gains tab, adjust velocity loop proportional gain (Vp):
   - Set velocity loop integral gain (Vi) to zero.
   - Raise or lower proportional gain (Vp) to obtain desired step response. (Typically, little or no overshoot on a 5 Hz small, slow-speed square wave.)
7. Adjust velocity loop integral gain (Vi) until desired settling time is obtained.
8. Press Stop to stop the function generator.

9. On the Main screen, click Save to Flash to avoid losing the changes. 

11.5 Notes on the Velocity Mode and Velocity Loop

11.5.1 Velocity Loop Diagram

As shown below, the velocity loop limiting stage accepts a velocity command, applies limits, and passes a limited velocity command to the input filter. The filter then passes a velocity command to the summing junction. The summing junction subtracts the actual velocity, represented by the feedback signal, and produces an error signal. (The velocity loop feedback signal is always from the motor feedback device even when an additional encoder is attached to the load.) The error signal is then processed using the integral and proportional gains to produce a current command. Programmable digital filters are provided on both the input and output command signals.



11.5.2 Inputs

In velocity mode, the velocity command comes from one of the following:

- The amplifier's analog or PWM inputs.
- A CANopen network via the amplifier's CAN interface.
- A Kollmorgen Virtual Motion (CVM) control program.
- The amplifier's internal function generator.

In position mode, the velocity command is generated by the position loop.

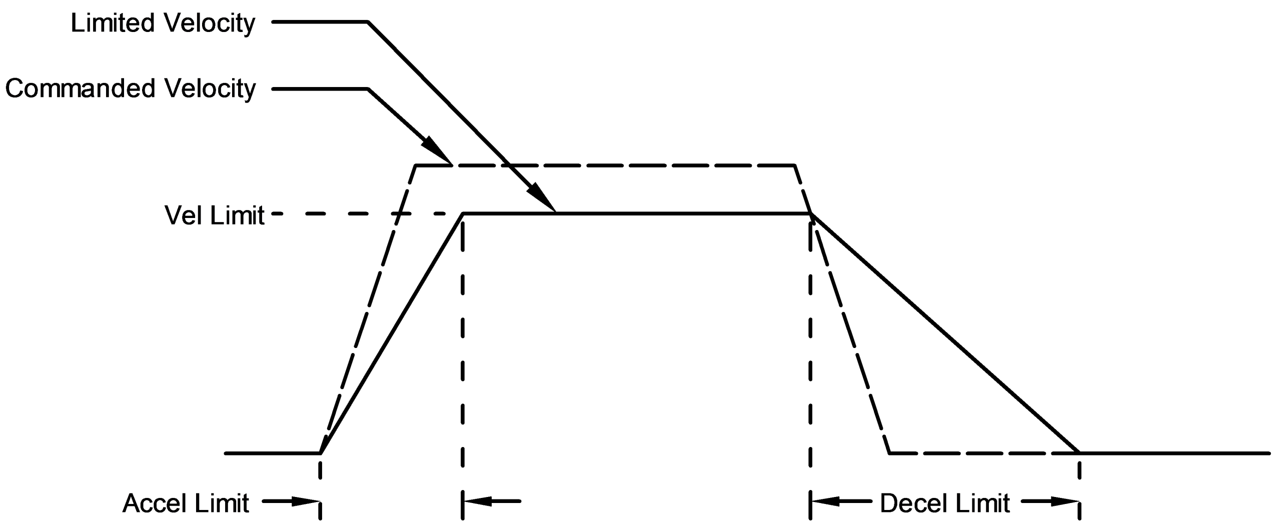
11.5.3 Velocity Loop Limits

The velocity command is limited based on the following set of parameters designed to protect the motor and/or the mechanical system.

Limiter	Description
Velocity Limit	Sets the maximum velocity command input to the velocity loop.
Acceleration Limit	Limits the maximum acceleration rate of the commanded velocity input to the velocity loop. This limit is used in velocity mode only. In position mode, the trajectory generator handles acceleration limiting.
Deceleration Limit	Limits the maximum deceleration rate of the commanded velocity input to the velocity loop. This limit is used in velocity mode only. In position mode, the trajectory generator handles deceleration limiting.
Fast Stop Ramp	Specifies the deceleration rate used by the velocity loop when the amplifier is hardware disabled. (Fast stop ramp is not used when amplifier is software disabled.) If the brake output is active, the fast stop ramp is used to decelerate the motor before applying the brake. **NOTE** Fast Stop Ramp is used only in velocity mode. In position mode, the trajectory generator handles controlled stopping of the motor. There is one exception: if a non-latched following error occurs in position mode, then the amplifier drops into velocity mode and the Fast Stop Ramp is used.

11.5.4 Diagram: Effects of Limits on Velocity Command

The following diagram illustrates the effects of the velocity loop limits.



11.5.5 Velocity Loop Gains

The velocity loop uses these gains:

Gain	Description
Vp - Velocity loop proportional	The velocity error (the difference between the actual and the limited commanded velocity) is multiplied by this gain. The primary effect of this gain is to increase bandwidth (or decrease the step-response time) as the gain is increased.
Vi - Velocity loop integral	The integral of the velocity error is multiplied by this value. Integral gain reduces the velocity error to zero over time. It controls the DC accuracy of the loop, or the flatness of the top of a square wave signal. The error integral is the accumulated sum of the velocity error value over time.

11.5.6 Velocity Gains Shift

The Velocity Gains Shift feature adjusts the resolution of the units used to express Vp and Vi, providing more precise tuning. If the non-scaled value of Vp or Vi is 64 or less, the Low Gains Shift option is available to increase the gains adjustment resolution. (Such low values are likely to be called for when tuning a linear motor with an encoder resolution finer than a micrometer.) If the non-scaled value of Vp or Vi is 24001 or higher, the High Gains Shift option is available to decrease the gains adjustment resolution.

11.5.7 Velocity Loop Filters

"Standard Filter Types" (➜ p. 97)

11.5.8 Velocity Loop Outputs

The output of the velocity loop is a current command used as the input to the current loop.

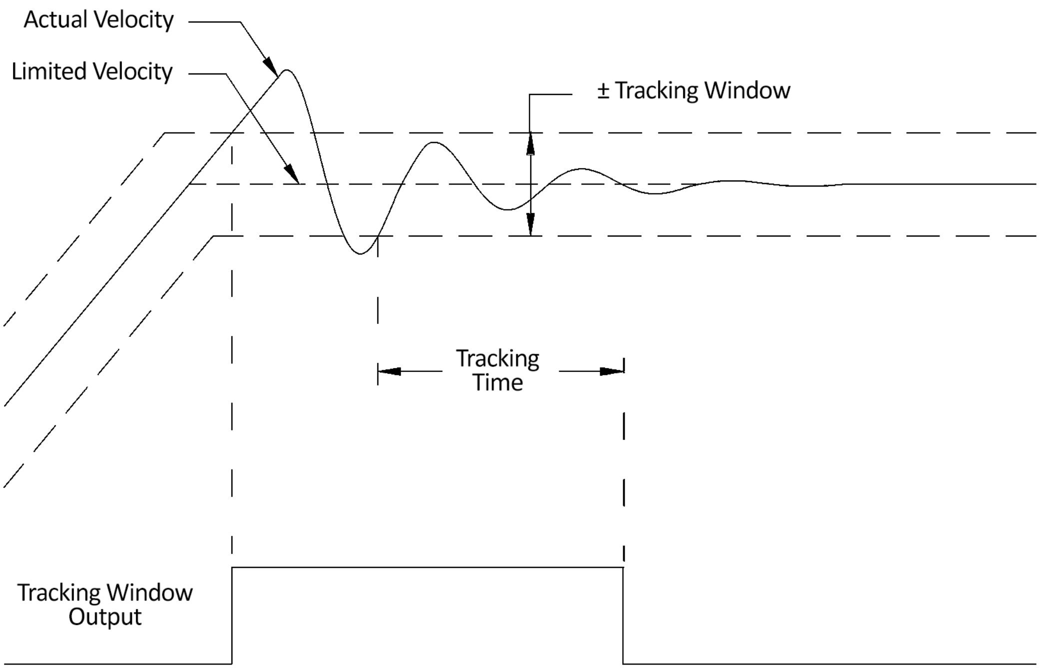
11.5.9 Proper Tracking Over Time

As described earlier, position error is the difference between the limited position output of the trajectory generator and the actual position. Velocity error is the difference between commanded and actual velocity.

When the position or velocity error exceeds the programmed tracking window value, a status word bit is set. The bit is not reset until the error remains within the tracking window for the programmed tracking time.

11.5.10 Velocity Tracking Illustration

The following diagram illustrates the use of tracking window and time settings in velocity mode.

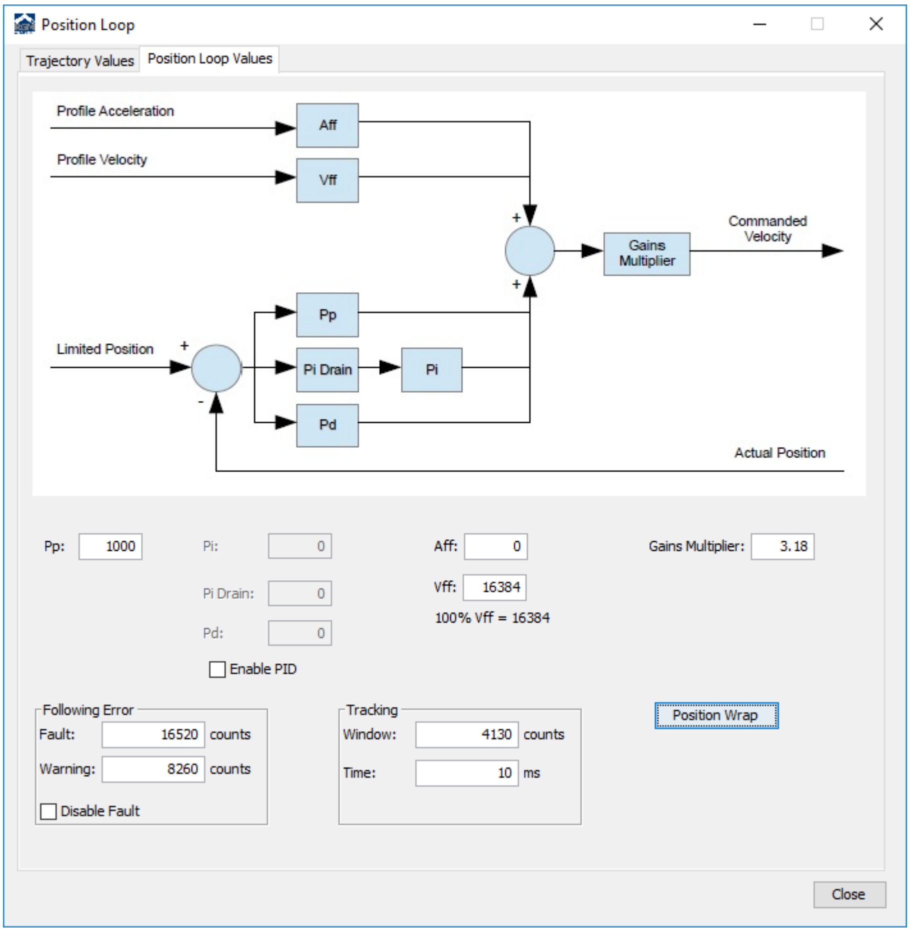

Actual Velocity
Limited Velocity
± Tracking Window
Tracking
Time
Tracking Window
Output

11.6 Position Loop Setup and Tuning

Initial position loop proportional gain (Pp), velocity feed forward (Vff), and acceleration feed forward (Aff) values can be calculated with "Calculate" (➜ p. 31)

1. 

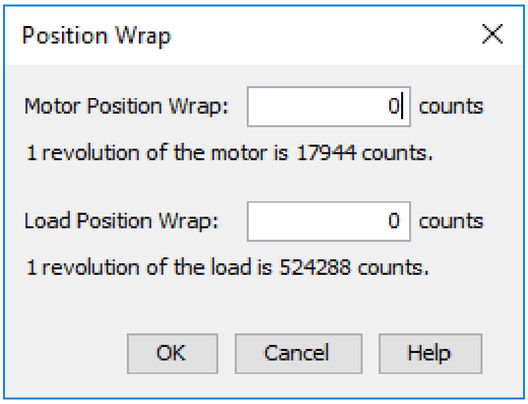
Click the P Loop button on the Main screen.



Parameter	Description
Aff	Acceleration feed forward. Range: 0 to 32,767. See "Trajectory Limits " (➜ p. 66)
Vff	Velocity feed forward. Range: 0 to 32,767. 100% Vff: 16,384. "Trajectory Limits " (➜ p. 66)
Pp	Position loop proportional gain. Range: 0 to 32,767. See "Trajectory Limits " (➜ p. 66)
Gains Multiplier	Position loop output is multiplied by this value before going to the velocity loop. In dual encoder systems, the multiplier's initial value is calculated based on the ratio of motor encoder turns to position encoder turns.
Following Error Fault	The level (in encoder counts) at which the following error produces a fault, which stops the servo loop. We recommend raising the fault level before tuning the loop. See "Following Error Faults " (➜ p. 67)
Following Error Warning	The level (in counts) at which the following error produces a warning (without stopping the loop). See "Following Error Warnings" (➜ p. 67)

Parameter	Description
Disable Fault	Stops following error from faulting. See "Following Error Faults " (➜ p. 67)
Tracking Window	Width of tracking window in counts. See "Position and Velocity Tracking Windows" (➜ p. 68)
Tracking Time	Position must remain in the tracking window for this amount of time to be considered tracking. See "Position and Velocity Tracking Windows" (➜ p. 68)
Pi	Position loop integral gain
Pd	Position loop derivative gain
Pi Drain	Position loop integral drain
Enable PID	Enables the PID parameters

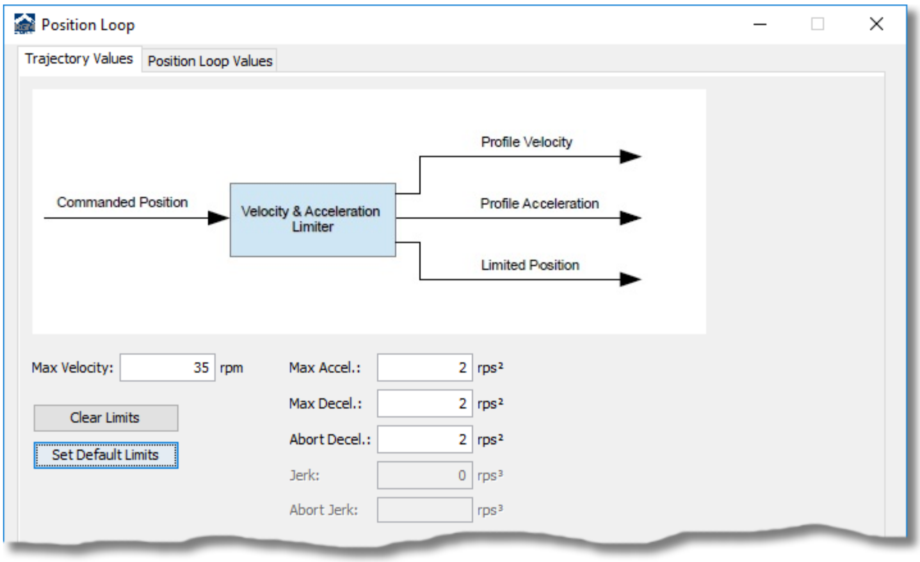
2. Click the Position Wrap button. 



3. Change/verify the position wrap parameters as needed. Set both values to zero to disable position wrapping. Note that the changes do not take effect until OK is pressed.
For more information about this feature, see "Position Wrap" (➜ p. 67)

Parameter	Description
Motor Position Wrap	Position at which the actual motor position count returns to zero. In a single feedback system, it also applies to the actual load position.
Load Position Wrap	Position at which the actual load position count returns to zero in dual feedback systems. If the position encoder is set to passive mode, this value applies to the passive encoder position.

4. Click on the Trajectory Values tab:



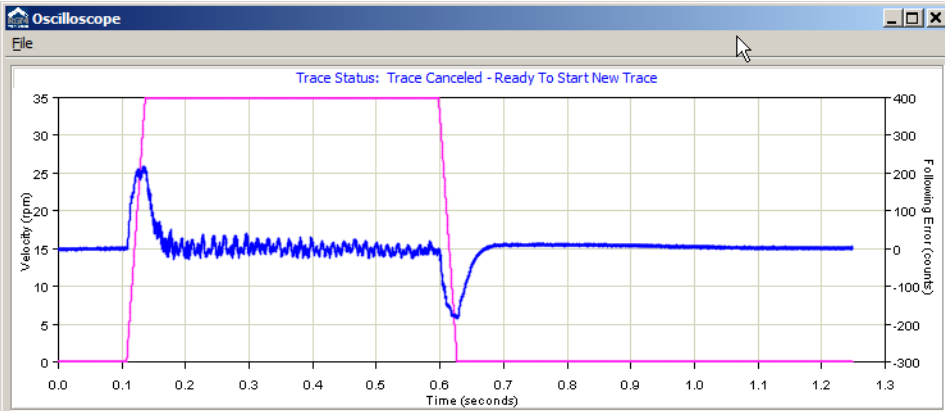
Parameter	Description
Max Velocity	Maximum trajectory velocity. Max value may depend upon the back EMF and the Max feedback count. Min:0. Default: 0.25 x motor velocity limit.
Max Accel	Maximum trajectory acceleration. Max value may depend upon the load inertia and peak current. Min:0. Default: 0.5 x velocity loop Accel. Limit value.
Max Decel	Maximum trajectory deceleration. Max value may depend upon the load inertia and peak current. Min:0 (disables limit). Default: 0.5 x velocity loop Accel. Limit value.
Abort Decel	Deceleration rate used by the trajectory generator when motion is aborted. Min:0. Default: 0.5 x velocity loop Accel. Limit value.
Jerk	Rate of change of acceleration. The value of jerk set during the calculate procedure produces an S-Curve whose maximum slope is equal to the trajectory profile slope. This value will produce a maximum acceleration that is not more than the initial default value of acceleration. Small values will produce less jerking but will take longer to complete move. Large values will produce more jerking and a more trapezoidal profile but will complete the move faster.

NOTE

Setting limits to zero disables the trajectory generator so that the command input is not limited by the generator. Velocity is only limited by the Velocity Limit set in the Velocity Loop.

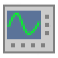
11.6.1 Manually Tune the Position Loop

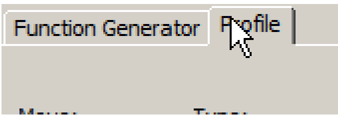
Minimize following error and oscillation by running profiles and adjusting position proportional gain (Pp), velocity feed forward (Vff), acceleration feed forward (Aff) and other settings. For instance:

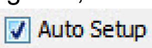


NOTE

During tuning, observe any warnings that appear to the left of the trace.

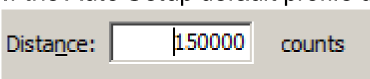
1. Click the Scope Tool. 
2. Select the Profile tab.

3. On the Settings tab, make sure Auto Setup is selected. Auto Setup automatically sets the following parameters 

Parameter	Description
Profile Tab	
Move	Relative
Type	Trap
Distance	150000 counts
Reverse and repeat	Not selected
Settings Tab	
Channel 1	Profile velocity (Violet)
Channel 2	Following error (Blue)

4. If the Auto Setup default profile distance is not appropriate, enter an appropriate short distance.

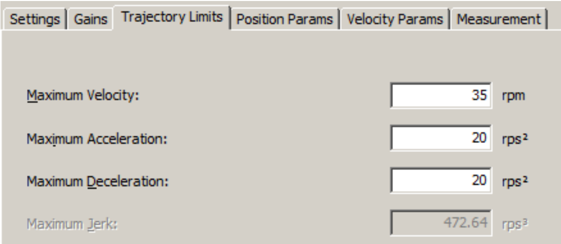
   

5. Click Start. The Profile Generator executes a short move. 

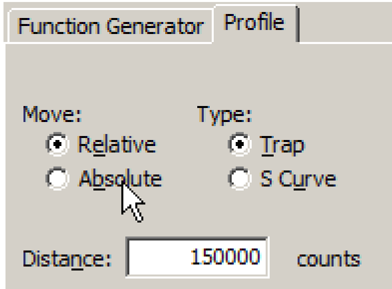
NOTE

- The profile may not reach constant velocity during a short move.
- If a following error occurs, open the Control Panel and click Clear Faults.

6. Set up a trapezoidal profile by setting the trajectory limits and distance. See table below.

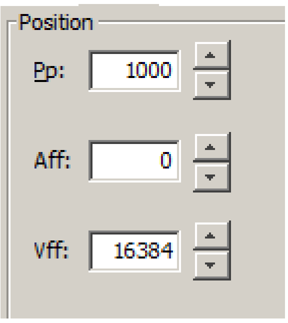


and



Parameter	Description
Trajectory Limits Tab	
Maximum Velocity	Set values typical of those expected to be used in the application.
Maximum Acceleration	
Maximum Deceleration	
Profile Tab	
Distance	Set the move distance to produce a complete trajectory profile. Be sure that this distance does not exceed mechanical limits of the system.
Move	Relative
Type	Trap

7. Adjust position proportional gain (Pp) to minimize following error:
   - On the Gains tab, set velocity feed forward (Vff) and acceleration feed forward (Aff) to zero.
   - On the Profile tab, click Start. On the Gains tab, adjust position loop proportional gain (Pp) until best result is obtained.
   - Click Start after each adjustment to test on a new profile move.



NOTE

- Too much position loop proportional gain (Pp) might cause oscillation.
- If a following error occurs, open the Control Panel and click Clear Faults.

8. Adjust velocity feed forward (Vff):
   - Velocity feed forward (Vff) reduces following error in the constant velocity portion of the profile. Often, a velocity feed forward (Vff) value of 16384 (100%) provides best results.
   - Click in the Vff field and adjust the value.
   - Click Start after each adjustment to test on a new profile move.
9. Adjust acceleration feed forward (Aff):
   - Acceleration feed forward (Aff) reduces following error during profile acceleration and deceleration.

- Click in the Aff field and adjust the value.
- Click Start after each adjustment to test on a new profile move.

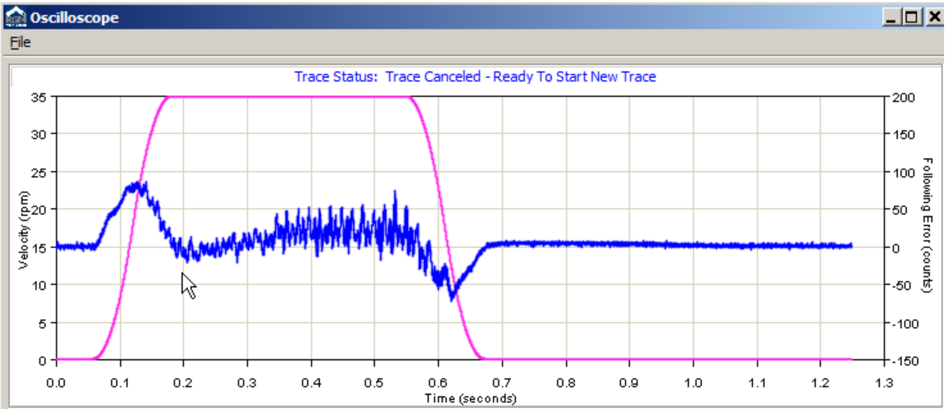
NOTE

- If, after tuning the position loop, the motor makes a low frequency audible noise while enabled but not moving, the velocity loop gains (Vp and Vi) may be lowered to reduce the noise. If the gain values are set too low, the response to instantaneous rates of change might be reduced (i.e., slow correction to disturbances or transients).
- If the amplifier is set up to run in position mode under analog input command, and the analog command signal produces too much noise at the motor after tuning, the Analog Command Filter or the Velocity Loop Command Filter may be used to reduce the noise further.

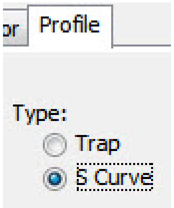
10. Tune to multiple sets of profiles representing typical moves that might be executed in the application. Starting with Step 6, repeat the process as needed.

11.6.2 Test S-Curve Profile

If the amplifier will perform S-Curve profile moves, use this procedure to tune the level of jerk. (Jerk is the rate of change of acceleration. S-Curve moves reduce jerk to provide a smooth profile.) Run an S-Curve profile and adjust velocity, acceleration, deceleration, and jerk levels until the desired profile is obtained. For instance:



1. On the Profile tab, click the S-Curve button.



2. Set up an S Curve profile by adjusting the following parameters to represent a typical move under normal operation.

Parameter	Description
Trajectory Limits Tab	
Maximum Velocity	Maximum speed of the profile.
Maximum Acceleration/ Deceleration	Maximum acceleration/deceleration of the profile. The deceleration is set to be the same as acceleration.
Maximum Jerk	The value of jerk set during the calculate procedure produces an S-Curve whose maximum slope is equal to the trajectory profile slope. This value will produce a maximum acceleration that is not more than the initial default value of acceleration. Small values will produce less jerking but will take longer to complete move. Large values will produce more jerking and a more trapezoidal profile but will complete the move faster.
Profile Tab	
Distance	Increase the move distance to produce a complete trajectory profile. Use an acceptable value the does not exceed mechanical limits of the system.
Move	Relative
Type	S-Curve

3. Click Start
4. Try multiple sets of profiles representing typical moves that might be executed in the application. Starting with Step 2, repeat the process as needed.

11.7 Notes on the Position Mode and Position Loop

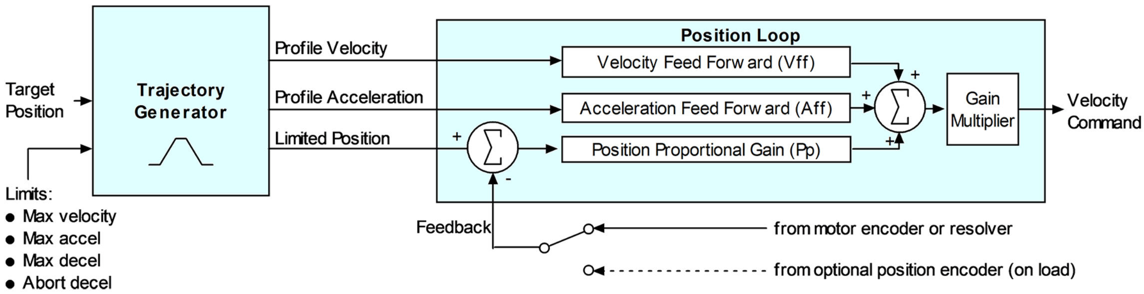
11.7.1 Position Loop Diagram

The amplifier receives position commands from the digital or analog command inputs, over the CAN interface or serial bus, or from the CVM Control Program. When using digital or analog inputs, the amplifier's internal trajectory generator calculates a trapezoidal motion profile based on trajectory limit parameters. When using the CAN bus, serial bus, or CVM Control Program, a trapezoidal or S-curve profile can be programmed. The trajectory generator updates the calculated profile in real time as position commands are received.

The output of the generator is an instantaneous position command (limited position). In addition, values for the instantaneous profile velocity and acceleration are generated. These signals, along with the actual position feedback, are processed by the position loop to generate a velocity command.

To bypass the trajectory generator while in digital or analog position modes, set the maximum acceleration to zero. The only limits in effect will now be the velocity loop velocity limit and the current limits. (Note that leaving the maximum acceleration set to zero will prevent other position modes from operating correctly.)

The following diagram summarizes the position loop.



11.7.2 Trajectory Limits

In position mode, the trajectory generator applies these limits to generate the profile.

Limiter	Description
Maximum Velocity	Limits the maximum speed of the profile.
Maximum Acceleration	Limits the maximum acceleration rate of the profile.
Maximum Deceleration	Limits the maximum deceleration rate of the profile.
Abort Deceleration	Specifies the deceleration rate used by the trajectory generator when motion is aborted.

11.7.3 Position Loop Inputs From the Trajectory Generator

The position loop receives the following inputs from the trajectory generator.

Input	Description
Profile Velocity	The instantaneous velocity value of the profile. Used to calculate the velocity feed forward value.
Profile Acceleration	The instantaneous acceleration/deceleration value of the profile. Used to calculate the acceleration feed forward value.
Limited Position	The instantaneous commanded position of the profile. Used with the actual position feedback to generate a position error.

11.7.4 Position Loop Gains

The following gains are used by the position loop to calculate the velocity command:

Gain	Description
Pp - Position loop proportional	The loop calculates the position error as the difference between the actual and limited position values. This error in turn is multiplied by the proportional gain value. The primary effect of this gain is to reduce the following error.
Vff - Velocity feed forward	The value of the profile velocity is multiplied by this value. The primary effect of this gain is to decrease following error during constant velocity.
Aff - Acceleration feed forward	The value of the profile acceleration is multiplied by this value. The primary effect of this gain is to decrease following error during acceleration and deceleration.
Gain Multiplier	The output of the position loop is multiplied by this value before being passed to the velocity loop.

11.7.5 Position Loop Feedback

Some Kollmorgen amplifiers feature dual-sensor position loop feedback, configured as follows:

- Single sensor. Position loop feedback comes from the encoder or resolver on the motor.
- Dual sensor. Position loop feedback comes from the encoder attached to the load.

NOTE

In either case, velocity loop feedback comes from the motor encoder or resolver.

11.7.6 Position Loop Output

The output of the position loop is a velocity command used as the input to the velocity loop.

11.7.7 Position Wrap

The position wrap feature causes the position reported by the amplifier to “wrap” back to zero at a user-defined value instead of continually increasing. Once set, the reported position will be between 0 and n-1 where n is the user entered wrap value. This feature is most useful for rotary loads that continually turn in one direction and only the position within a revolution is of interest to the user.

Relative moves with the wrap value set will move the relative distance called for. Example; if the wrap value is set to 1000 and a relative move of 2500 is commanded, the axis will turn 2 ½ revolutions.

Absolute moves will move the shortest distance to arrive at the programmed position. This could be in the positive or negative direction. Moves programmed to a point greater then the wrap value will cause an error.

11.7.8 Following Error Faults

When the position error reaches the programmed fault threshold, the amplifier immediately faults. (The following error fault can be disabled.)

11.7.9 Following Error Warnings

When the position error reaches the programmed warning threshold, the amplifier immediately sets the following error warning bit in the status word. This bit can be read over the CAN network. It can also be used to activate a digital output.

11.7.10 Position and Velocity Tracking Windows

When the position error exceeds the programmed tracking window value, a status word bit is set. The bit is not reset until the position error remains within the tracking window for the programmed tracking time.

A similar method is used to handle velocity errors.

11.7.11 Following Error Fault Details

11.7.11.1 Position Error Reaches Fault Level

As described earlier, position error is the difference between the limited position output of the trajectory generator and the actual position. When position error reaches the programmed Following Error Fault level, the amplifier faults (unless the following error fault is disabled.) As with a warning, a status bit is set. In addition, the fault is recorded in the error log. See "Error Log" (➜ p. 112).

Additional responses and considerations depend on whether the fault is non-latched or latched, as described below.

11.7.11.2 Amplifier Response to Non-Latched Following Error Fault

When a non-latched following error fault occurs, the amplifier drops into velocity mode and applies the Fast Stop Ramp deceleration rate to bring the motor to a halt. The amplifier PWM output stage remains enabled, and the amplifier holds the velocity at zero, using the velocity loop.

11.7.11.3 Resuming Operations After a Non-Latched Following Error Fault

The clearing of a non-latched following error depends on the amplifier’s mode of operation. Issuing a new trajectory command over the CAN bus or the ASCII interface will clear the fault and return the amplifier to normal operating condition.

If the amplifier is receiving position commands from the digital or differential inputs, then the amplifier must be disabled and then re-enabled using the amplifier’s enable input or though software commands. After re-enabling, the amplifier will operate normally.

11.7.11.4 Amplifier Response to a Latched Following Error Fault

When a latched following error fault occurs, the amplifier disables the output PWM stage without first attempting to apply a deceleration rate.

11.7.11.5 Resuming Operations After a Latched Following Error Fault

A latched following error fault can be cleared using the steps used to clear other latched faults:

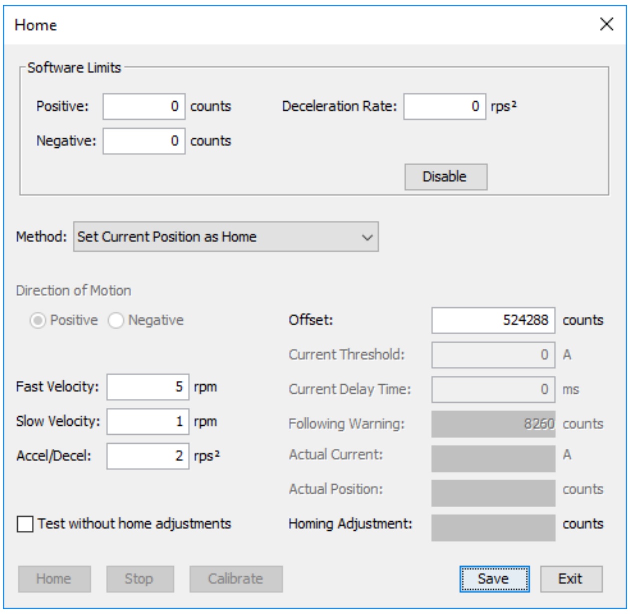
- Power-cycle the amplifier
- Cycle (disable and then enable) an enable input that is configured as Enable with Clear Faults or Enable with Reset
- Access the RGM WorkBench Control Panel and press Clear Faults or Reset
- Clear the fault over the CANopen network or serial bus

12 Homing

12.1 Homing Overview

The Homing screen allows homing to be configured and tested. Changes made to this screen get saved to amplifier RAM. On amplifiers configured for Absolute encoders, calibration can be performed.

Click the Home button on the Main screen to open the Home screen



Parameter	Description
Software limits: Positive	Position of user-defined travel limits that take effect after homing operation.
Software limits: Negative	
Software limits: Deceleration Rate	Deceleration rate used to stop a motor when approaching a software limit.
Software limits: Disable	Disables the use of software limits by setting both limits to zero.
Method	Homing method. See "Homing Method Descriptions" (➜ p. 122)
Direction of Motion	Initial direction of motion for the homing method (Pos or Neg).
Fast Velocity	The velocity used to find a limit or home switch. Also used when moving to an offset position, or a resolver or Servo Tube index position.
Slow Velocity	The velocity used to find a switch edge, incremental or analog encoder index pulse, or hard stop.
Accel/Decel	The acceleration and deceleration rate used during homing.
Offset	Execute a move of this distance after the reference is found. Set actual position to 0 and call the new position home.
Current Limit	Hard stop home is reached when the amplifier outputs the homing Current Limit continuously for the time specified in the Delay Time.
Current Delay Time	
Following Warning	Shows the programmed following warning level.
Actual Current	Shows actual current being applied to windings during homing.
Actual Position	Shows the actual position of the axis.

Parameter	Description
Homing Adjustment	Shows the Home offset measured after homing is performed.
Test without home adjustments	Selecting this option and pressing the Home Button tests the adjusted home position without making any changes to the saved home position. The resulting homing offset is reported in the Homing Adjustment text field.
Home	Starts the homing sequence using the settings shown on the screen.
Stop	Stops the homing sequence.
Save	Saves the homing parameters to amplifier flash.
Exit	Discards unsaved homing parameters, then closes the screen. The rules for discarding unsaved values are as follows: • If the Save button was never clicked, all of the homing parameters will be reverted to the values at the time that the screen was opened.. • If the Save button was clicked, then the homing parameters will be reverted back to the values at the time of the last Save event. Upon closing, any home sequence in progress will be aborted.

12.2 Mechanical Homing

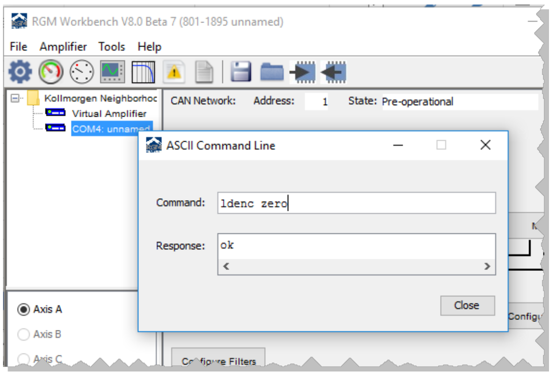
Mechanical homing is the process of moving the motor to the position that is machine-zero. This is the location from which all dimensions are absolute in the machine's position reference frame.

1. Enter the values of the appropriate homing parameters.
2. Click the Home button to run the home sequence.
   Home
3. Repeat if necessary until the motor is positioned at machine zero.
4. Click the Save button.
   Save

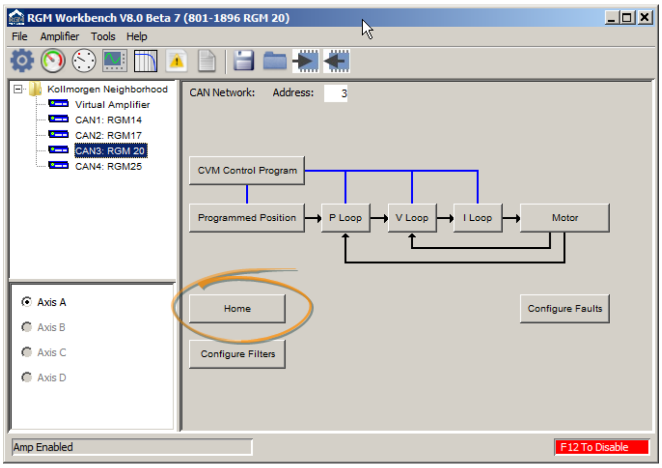
12.3 Zeroing the Home Position Example

Following is a recommended procedure for setting the Home position to zero (0).

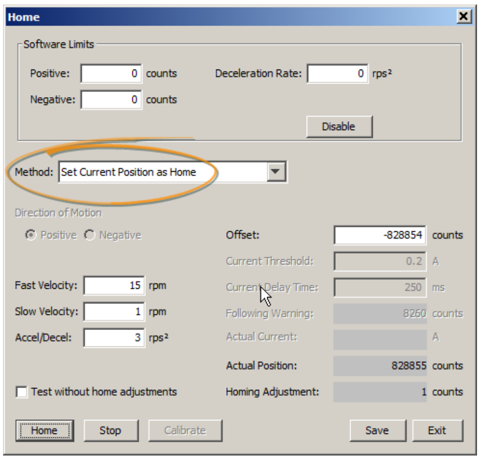
1. Clear the Mutli-turn Encoder information.



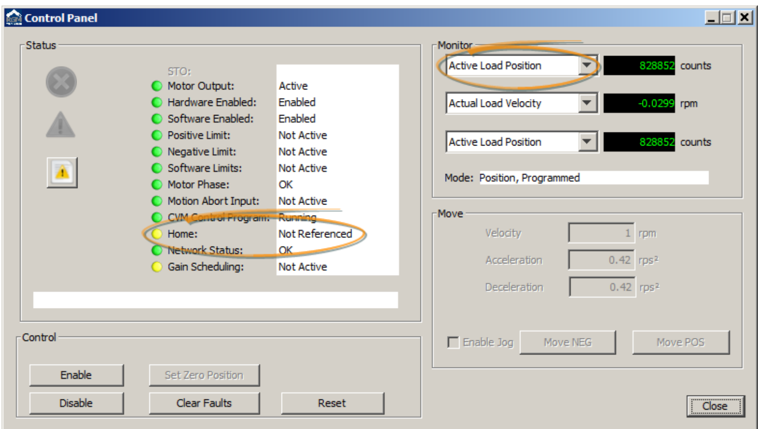
2. From the main RGM WorkBench screen, select the **Home** button.



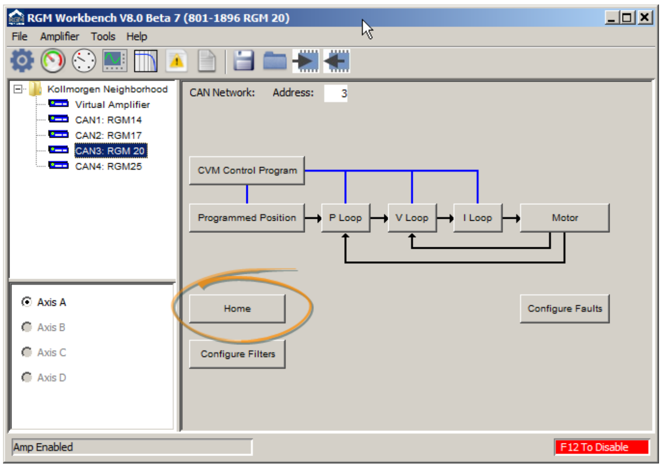
3. Select **Set Current Position as Home** from the **Method** drop-down menu. Then save and exit the window.



4. Open the Control Panel  and confirm that the *Home* LED icon is yellow and that the status is **Not Referenced** (shown below).
5. From the **Monitor** section, choose the **Active Load Position** setting, then close the window.

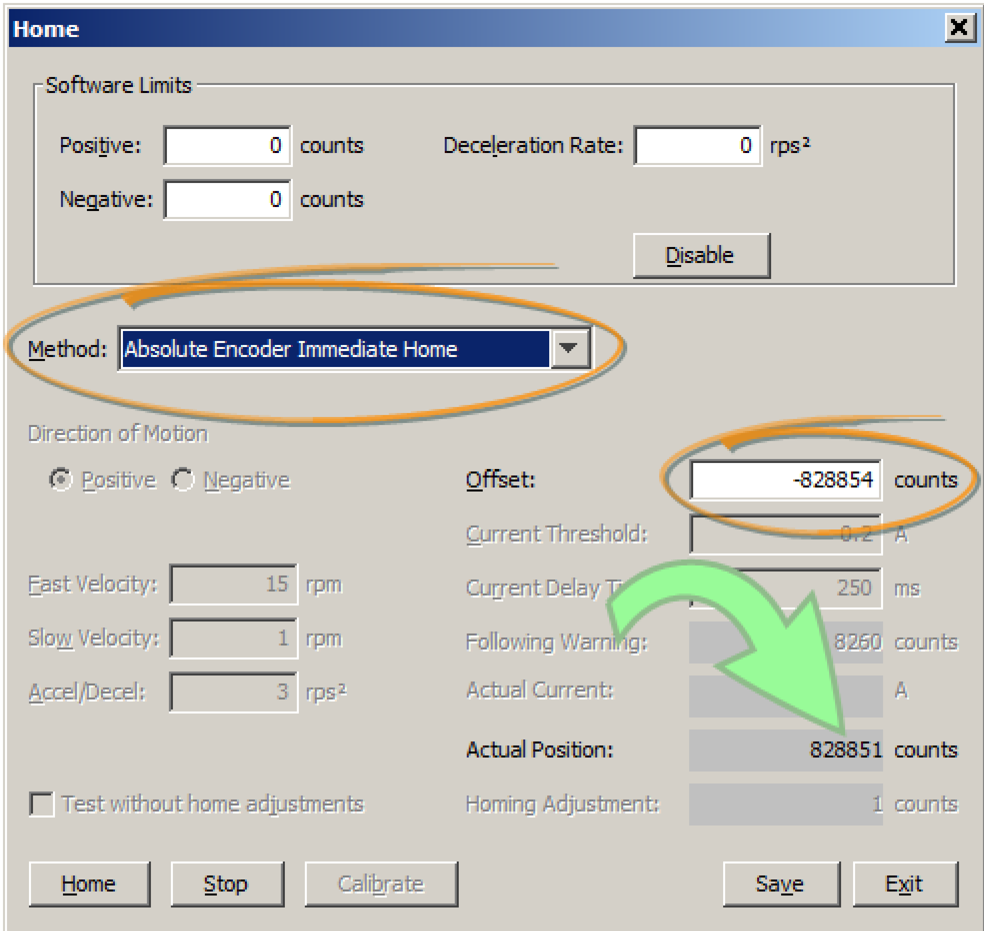


6. Click the **Home** button.



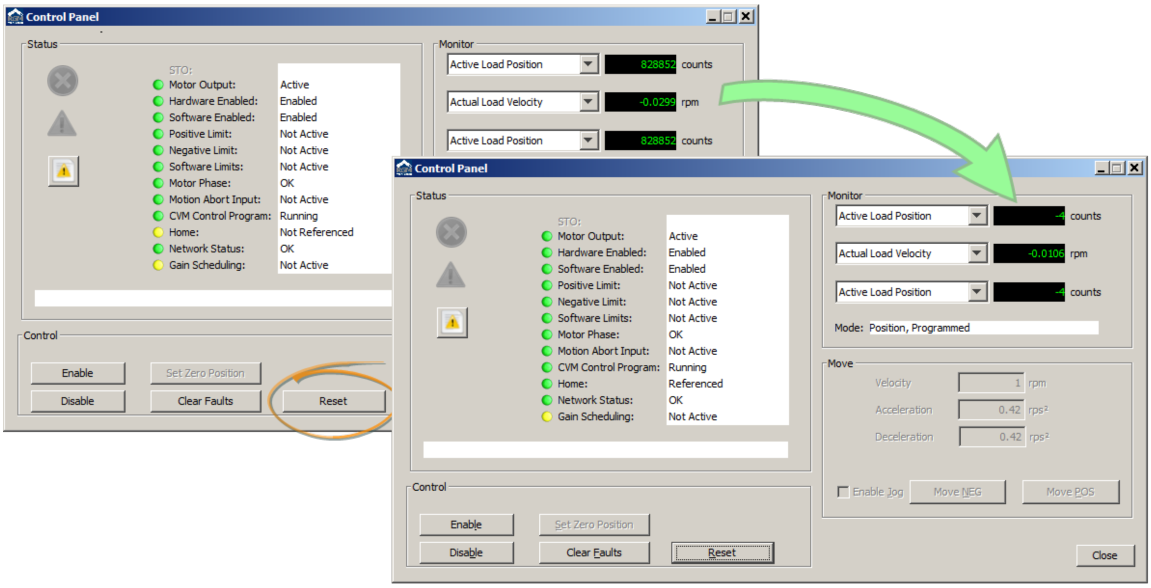
7. From the **Method** drop-down menu select **Absolute Encoder Immediate Home**.

   Note the **Actual Position** counts. If the desired home position count is "0", then enter the *negative* value of the Actual position in to the **Offset** field.



   Save and Exit the window.

8. Open the Control Panel and select Reset. Note that the Active Load Position is set to 0.

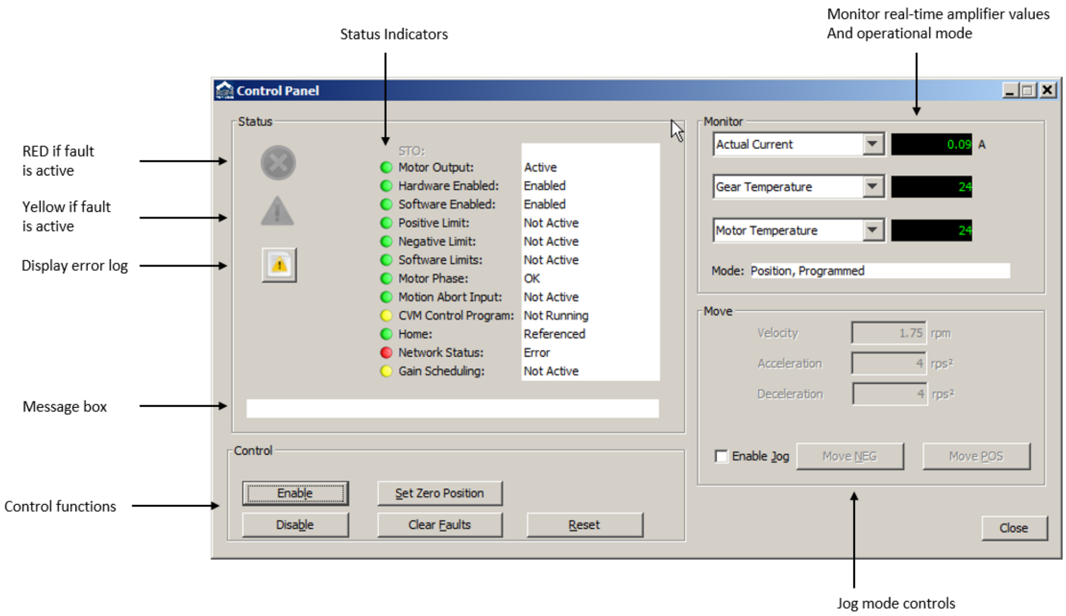


13 Control Panel

13.1 Control Panel Overview

-  Click to open the Control Panel.

Status Indicators



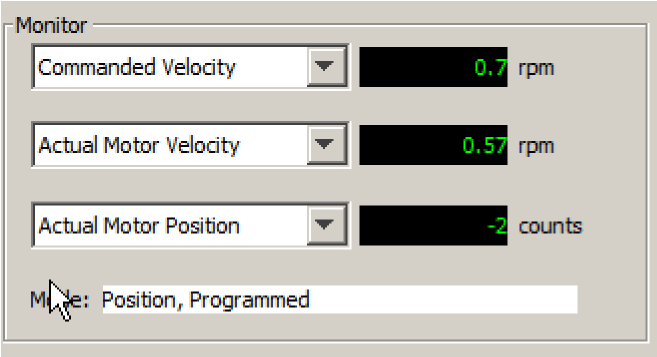
13.2 Status Indicators and Messages

The Status area includes status indicator lights (described below) and a message box. Any red lights indicate that motion will be inhibited.

Indicator	States / Description
Safety	State of the safety circuit. Enabled or HI/LO disabled. On amplifiers with safety circuit.
Motor Output	State of the PWM output stage. Red if the output stage is inactive (disabled)
Hardware Enabled	State of the hardware enable input(s). Red if one or more enable inputs are inactive.
Software Enabled	State of the software enable. Red if the amplifier is disabled by software.
Positive Limit	State of the positive limit switch input. Red indicates an activated positive limit switch.
Negative Limit	State of the negative limit switch input. Red indicates an activated negative limit switch.
Software Limits	State of the software limits. Red indicates an activated software limit.
Motor Phase	Indicates a motor phasing error. Red indicates a motor phasing error exists.
Motion Abort Input	State of the programmed Motion Abort Input. Red indicates the input is active.
CVM Control Program	Status of the CVM Control Program.
Home	Indicates whether the axis has successfully been referenced (homed).
CAN Status	Status of the CAN Bus. Yellow indicates CAN warning limit reached. Red indicates bus error detected.
Gain Scheduling	Indicates whether "Gains Scheduling" (➜ p. 115) is active.
	Indicates that a fault is active. Check the status message box for a description of the most recent fault: Fault: Under Voltage. Check the Error Log for a full history of faults and warnings.
	Indicates that a warning is active. Check the status message box for a description of the most recent: Warning: Pos Outside of Tracking Window. Check the Error Log for a full history of faults and warnings.
Message Box	Displays status descriptions.

13.3 Control Panel Monitor

The Control Panel Monitor displays real-time values of selected variables.



Monitor Variables

Actual Current	Following Error	Passive Load Position
Actual Motor Velocity	Commanded Current	Limited Position
Actual Motor Position	Commanded Velocity	Analog Command
Actual Load Velocity	Commanded Position	Bus Voltage
Actual Load Position	Profile Velocity	Amplifier Temperature
Velocity Error	Profile Acceleration	Motor Phase Angle

Mode: Displays the amplifier's operating mode in RAM. In camming mode it also displays the active cam table number

13.4 Control Functions

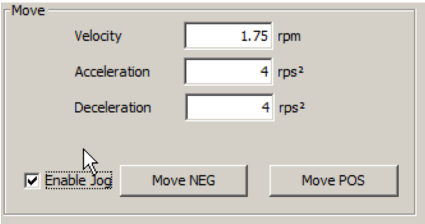
The Control area of the screen provides functions related to overall amplifier control. The screen options vary with model and configuration.

Control	Description
Enable	Click to software enable the amplifier.
Disable	Click to software disable the amplifier. This will also stop any CVM programs that are running.
Set Zero Position	Click to set the amplifier's actual position counter to zero.
Clear Faults	Click to clear all amplifier faults.
Reset	Click to reset the amplifier.

⚠ WARNING	**Risk of unexpected or uncontrolled motion.**
	Using the RGM WorkBench Set Zero Position function while the amplifier is operating under external control could cause unexpected or uncontrolled motion. **Failure to heed this warning can cause equipment damage.**

13.5 Jog Mode

Jog mode provides a simple means for moving/jogging the motor.



1. To put the amplifier in jog mode, select Enable Jog.
2. Set up a jog move by setting the following mode-specific parameters:

Mode	Parameter	Description
Current	Current	Current applied to the motor. Limited by current loop Continuous Current. Warning: Unloaded motors may, depending on torque setting, ramp up in speed very quickly.
Velocity	Jog Speed	Velocity of the jog move. Limited by velocity loop Vel. Limit.
Position	Velocity	Velocity of the jog move. Limited by velocity loop Vel. Limit.
	Acceleration	Acceleration limit of the jog move.
	Deceleration	Deceleration limit of the jog move.

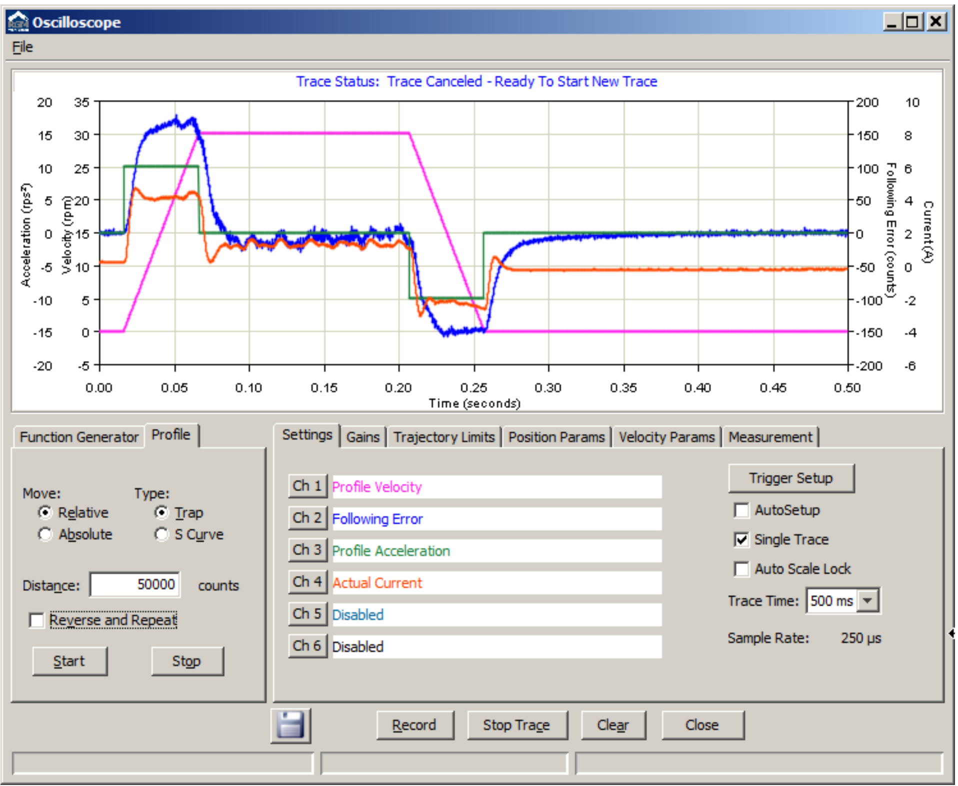
3. Command the move:

Mode	Steps
Current	• Hold Pos to apply positive current to the motor or hold down Neg to apply negative current to the motor. • Release the button to command zero current.
Velocity	• Hold Jog Pos to command a forward velocity or hold down Jog Neg to command a negative velocity. • Release the button to command zero velocity.
Position	• Hold Move Pos to generate a forward move profile or hold Move Neg to generate a negative move profile. • Release the button to stop movement. **NOTE** Position mode jog is accomplished by continuously updating the commanded position. If a following error develops with Following Error Fault disabled, motion will not stop on button release. Instead, it stops when actual position = commanded position.

14 Oscilloscope

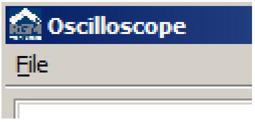
14.1 Oscilloscope Overview

The Oscilloscope can be used to tune the amplifier, monitor performance, and perform diagnostics. Function Generator and Profile Generator can drive the motor without external control. Auto Set Up feature sets typical initial values for scope parameters.



14.2 Menu, Display and Controls

14.2.1 File Menu

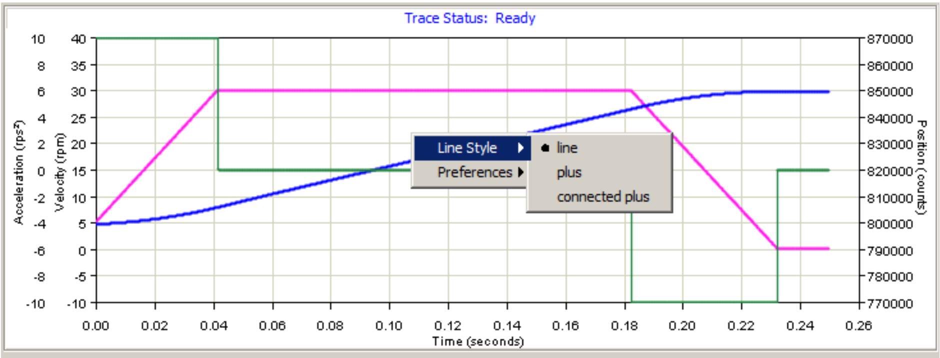


The File menu contains the options to save/restore scope settings. This feature is useful for saving custom settings used for tests that are run frequently.

Menu Item	Action
Save Settings	Saves current scope settings to a file
Restore Settings	Restores settings from a file

14.2.2 Display

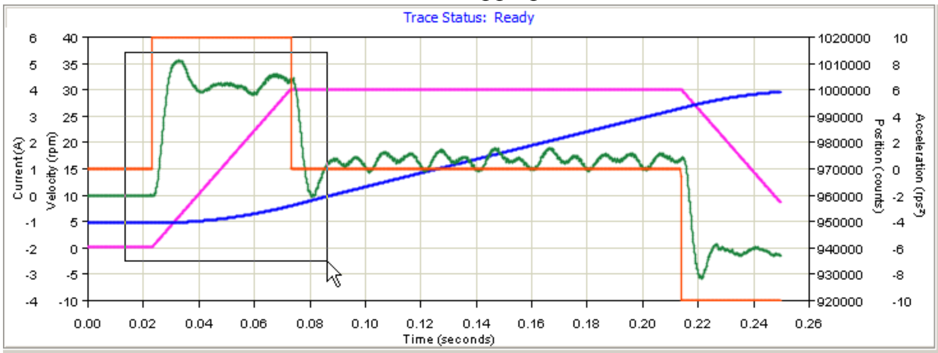
To access the Trace Display menu, Right-click in the trace display area



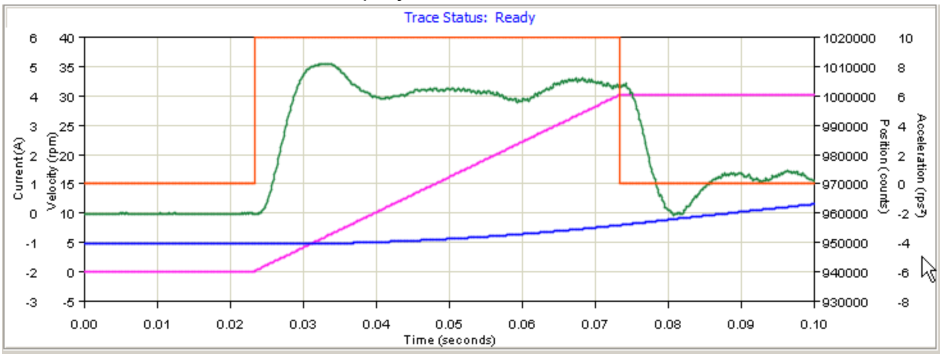
Menu	Parameter	Description
Line Style	line	A line connects the plotted data points.
	plus	The Scope plots data points as plus signs, with no connecting line.
	connected plus	Data points are plotted as plus signs and are connected with a line.
Preferences	anti-aliasing	When anti-aliasing is selected, the Scope removes screen-related jaggedness in the displayed trace. Use of this feature may slow down the refreshing of traces on slow computers.
	grid	When selected a grid is displayed on the scope screen.

14.2.3 Trace Display Zoom

1. Hold the left mouse button down while dragging a box around the area of interest.

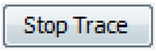
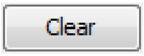


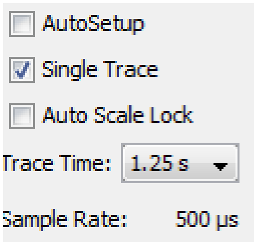
2. Release the button to let the display zoom in on the selected area.



3. To restore the normal zoom level immediately, left-click anywhere on the trace. (Normal zoom level is also restored when the next trigger event occurs.)

14.2.4 Controls

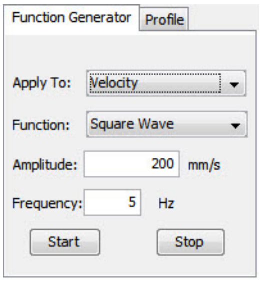
Action	Description
	Save a trace. See Scope Trace Files
	Begins recording a trace
	Stops recording a trace
	Clears the trace from the screen and trace data from buffer



Function	Description
Auto Setup	When selected, the scope will be set up based on the setting for either the Function or Profile Generator (whichever is active).
Single Trace	When selected only one trace will be collected and displayed, otherwise a new trace will be started as soon as the current trace is displayed.
Auto Scale Lock	When displaying the trace data, the scope will automatically scale the vertical axis for optimal viewing. When Auto Scale Lock is selected, the y-axis scale will be locked at is current setting.
Trace Time	This is the total amount of time the trace is recorded.
Sample Rate	The rate at which each sample is collected. When tracing multiple channels, all channels are collected at approximately the same time.

14.3 Function Generator

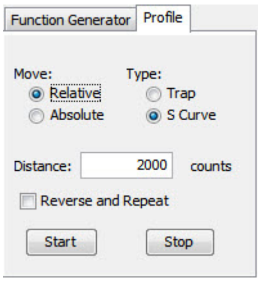
The Function generators can provide inputs to the different control loops for tuning and diagnostics purposes without using an external control source.



The Start button starts the function or profile generator. The Stop button stops the generator and aborts any profiles in progress.

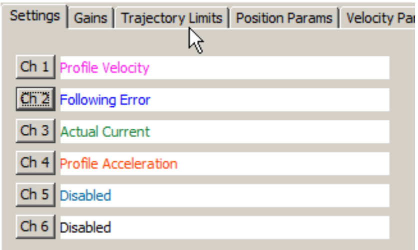
<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Apply To</td><td>Control loop to which the Excitation will be applied: Current (available in all modes), Velocity (available in velocity or position mode), or Position (available in position mode only).</td></tr>
<tr><td>Function</td><td>Function that will be applied to the control loop selected in the Apply To list box. The choices vary with the control loop selected:
<table>
<tr><th>Selected Control Loop</th><th>Function Available</th></tr>
<tr><td>Current</td><td>Sine Wave, Square Wave, Step Forward, Step Forward and Reverse, and Impulse</td></tr>
<tr><td>Velocity</td><td>Sine Wave, Square Wave, Step Forward, Step Forward and Reverse</td></tr>
<tr><td>Position</td><td>Sine Wave, Square Wave</td></tr>
</table></td></tr>
<tr><td>Amplitude</td><td>Amplitude of the command. Units vary depending on the value chosen in the Apply To field.</td></tr>
<tr><td>Frequency</td><td>(Sine Wave and Square Wave only.) Frequency of input command cycle.</td></tr>
<tr><td>Period</td><td>(Step Forward, Step Forward and Reverse, and Impulse only.) Duration of each input pulse.</td></tr>
</table>

14.4 Profile Generator

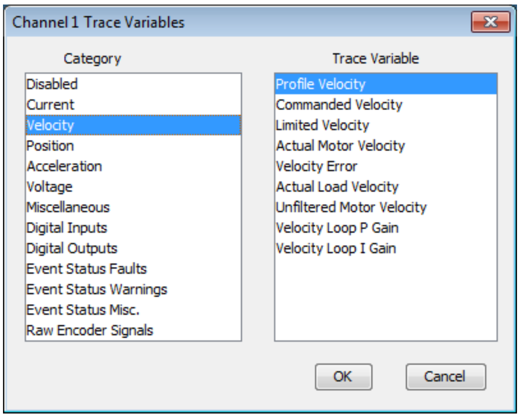


Parameter	Description
Move	Relative: Moves axis a specified distance from the starting position. Absolute: Moves axis to a specific position.
Type	Trap or S-Curve.
Distance	Distance for Relative move.
Position	Target position for Absolute move.
Reverse and Repeat	(Relative move only.) When selected, will continuously generate forward and reverse moves of the distance specified until Stop is pressed.

14.5 Trace Channel Variables



Click the Channel button to open the Trace Variable selection screen

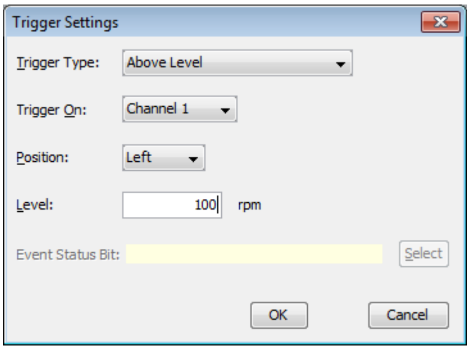


Category	Trace Variable
Disabled	<Channel disabled, no associated variable>
Current	Commanded Current, Actual Current, Limited Current, I^2T Amplifier Accumulator, I^2T Motor Accumulator.
Velocity	Profile Velocity, Commanded Velocity, Limited Velocity, Actual Motor Velocity, Actual Load Velocity, Unfiltered Motor Velocity, Velocity Error
Position	Commanded Position, Limited Position, Actual Load Position, Actual Motor Position, Following Error, Passive Load Position
Acceleration	Profile Acceleration
Voltage	Analog Command, Bus Voltage, Analog sin Input, Analog cos Input, Terminal Voltage Stepper, Terminal Voltage Servo
Miscellaneous	Motor Phase Angle, Amplifier Temperature, Hall States
Digital Inputs	Digital input line states
Digital Outputs	Digital output line states
Event Status Faults	Short Circuit, Amp Over Temperature, Over Voltage, Under Voltage, Motor Over Temperature, Feedback Error, Motor Phasing Error, Following Error, Command Input Fault, Amplifier Fault (a latched fault is active).
Event Status Warnings	Current Limited, Voltage Limited, Positive Limit Switch, Negative Limit Switch, Following Warning, Velocity Limited, Acceleration Limited, Positive Software Limit, Negative Software Limit, Pos Outside of Tracking Window, Vel Outside of Tracking Window.

Category	Trace Variable
Event Status Misc.	Amp Disabled by Hardware, Amp Disabled by Software, Attempting to Stop Motor, Motor Brake Active, PWM Outputs Disabled, Position Has Wrapped, Home Switch Active, In Motion, Phase Not Initialized.
Raw Encoder Signals	Primary Encoder A, Primary Encoder B, Primary Encoder X, Primary Encoder S, Secondary Encoder A, Secondary Encoder B, Secondary Encoder X, Secondary Encoder S

14.6 Trigger Setup

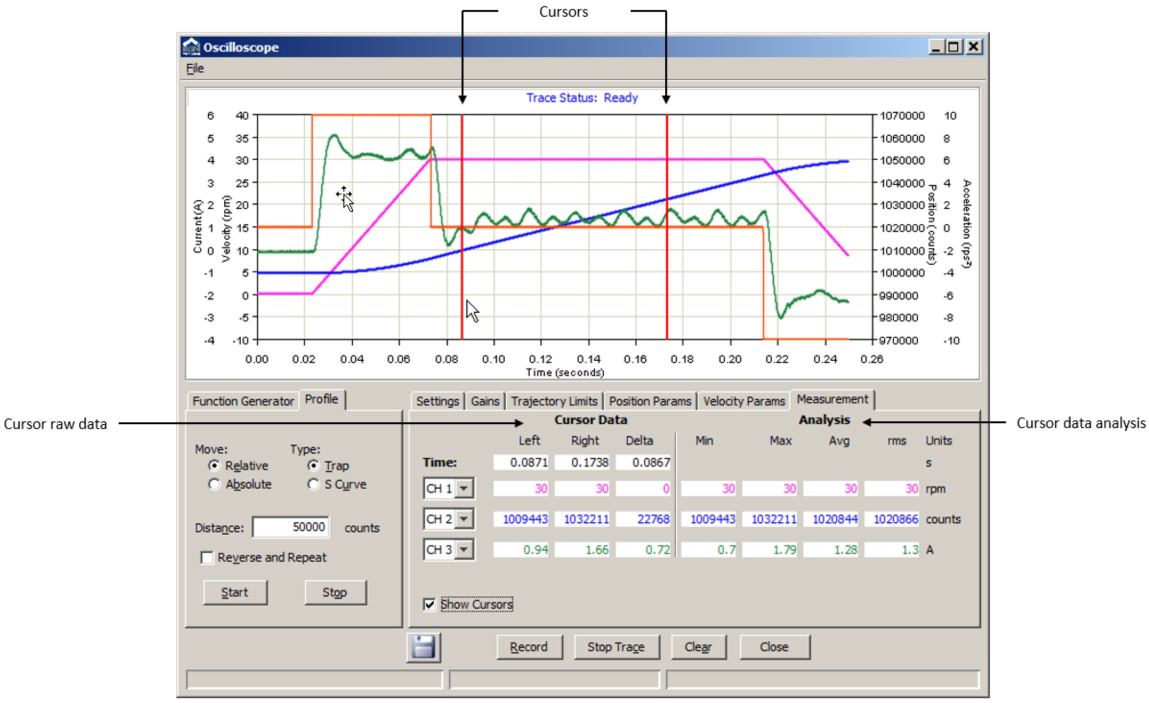
Click the Trigger Setup button to open the Trigger Settings screen.



Setting	Description	
Trigger Type	**Type**	**Condition**
	Immediate Trigger	Trigger as soon as a trace is started (when the Record button is pressed).
	Rising Edge	Trigger when the selected channel's input changes from below to above the trigger level.
	Falling Edge	Trigger when the selected channel's input changes from above to below the trigger level
	Above Level	Trigger as soon as the selected channel's input is greater than or equal to the trigger level.
	Below Level	Trigger as soon as the selected channel's input is less than or equal to the trigger level.
	Function Generator	Trigger on the start of the next function generator cycle.
	Input Level High/Lo	Trigger when specified input is high or low
	Output Active/Inactive	Trigger when specified output is active/inactive
	Event Status Rising Edge/Falling Edge	Trigger on the rising or falling edge of an event status bit.
	Raw Encoder Signal Level H/Lo	Triggers when the raw encoder signal is Hi/Lo
Trigger On	Selects which channel will be used as the trigger source.	
Position	Selects placement of the trigger event on the screen. (Value is not configurable for Immediate or Function Generator trigger types.). • Left for optimal viewing of events following the trigger. • Middle for optimal viewing of events preceding and following the trigger. • Right for optimal viewing of events preceding the trigger.	
Level	Sets the trigger level, in units appropriate to the channel selected.	
Event Status Bit	With an event status trigger type selected, choose the status bit that will trigger the trace. For descriptions of the event status word.	

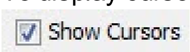
14.7 Measurement Tab

The Measurement tab allows you to measure and analyze data from up to three parameters during an interval defined by adjustable cursors. The Cursor Data area displays a parameter's values at the left and right cursor locations, and the difference between the two values. The Analysis area displays the minimum, maximum, average, and root mean square of the parameters during the cursor period.

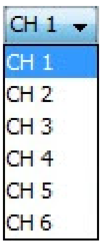


When Show Cursors is not set, the Cursor Data fields are inactive and the Analysis fields show calculations based on data from the entire trace cycle.

1. To display cursors and activate the Cursor Data fields, set Show Cursors.

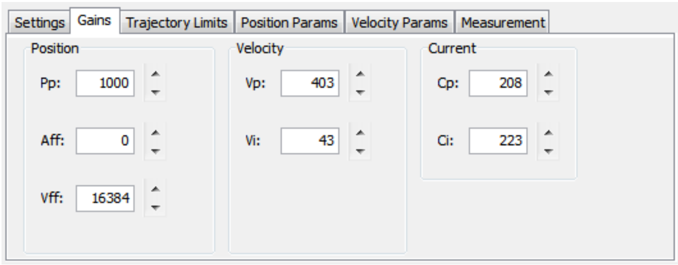
   

2. To move a cursor, click on the cursor and hold the left button while dragging the cursor to the desired location. Release the left button to place the cursor in the new location.
3. To select a parameter to measure and analyze within the cursors, choose a channel in one of the three channel lists on the Measurement tab:

14.8 Control Loop Parameters

The Oscilloscope provides convenient access to all of the control loop parameters that might be used in tuning and diagnosing an amplifier. The user can adjust these parameters and see the results immediately on the scope. Control loop parameters are accessed through a set of tabs, shown below.



Note that the parameters represented on these tabs can also be accessed through the screens used to configure the control loops and the digital position input. Changing a value in the Scope tool automatically updates the value on the other screens where it appears, and vice versa.

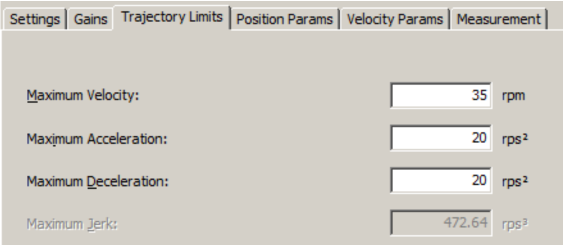
Control loop parameter tab descriptions follow.

14.8.1 Gains Tab

Modes	Gains	Description	For More Information
Position mode only	Pp	Position loop proportional gain.	"Position Loop Gains" (➜ p. 67)
	Aff	Acceleration feed forward.	
	Vff	Velocity feed forward.	
Position or velocity mode only	Vp	Velocity loop proportional gain.	"Velocity Loop Gains" (➜ p. 57)
	Vi	Velocity loop integral gain.	
All modes	Cp	Current loop proportional gain.	"Current Loop Gains" (➜ p. 51)
	Ci	Current loop integral gain.	

14.8.2 Trajectory Limits Tab

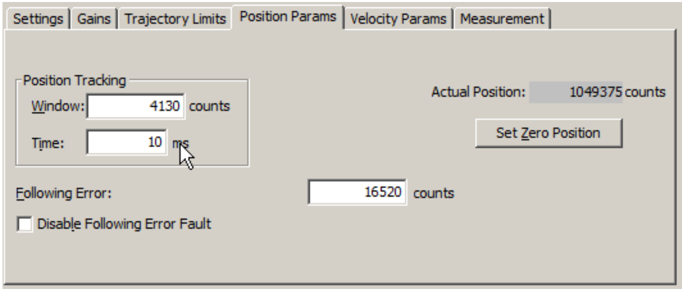
Available in position mode.



For more information see "Position Loop Setup and Tuning" (➜ p. 59)

14.8.3 Position Loop Parameters

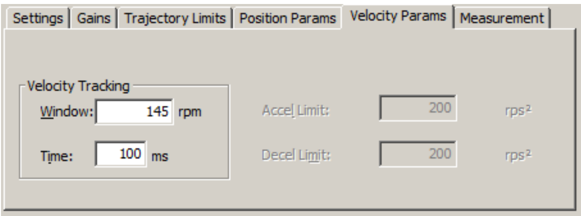
Available in position mode.



Set Zero Position sets the amplifier's actual position count to zero. For more information, see "Position Loop Setup and Tuning" (➜ p. 59)

14.8.4 Velocity Loop Parameters

Available in position and velocity modes.



For information see "Velocity Loop Setup and Tuning" (➜ p. 52)

14.9 Scope Trace Files

The Oscilloscope can save trace data to disk that can be opened later with the Trace Viewer. When the save trace data to disk operation is performed, RGM WorkBench saves the data in three different files:

- **.sco**: This is a RGM WorkBench format which contains scope settings and trace data
- **.csv**: This is a standard comma-separated value file format that can be imported into spreadsheet software like Microsoft Excel.
- **.txt**: This is a tab-separated value file similar to the .csv file. This is intended to be imported by software that can only read tab-separated values.

The format of the .csv and the .txt files are identical except for the separator:

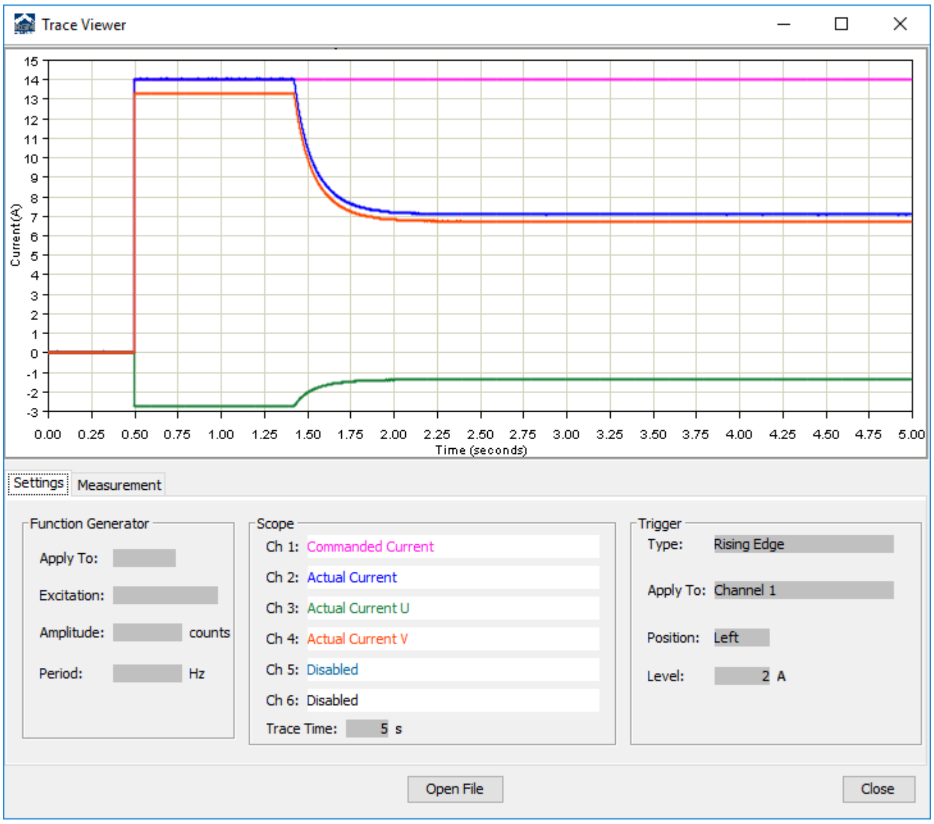
- Column 1: time
- Column 2: Trace Channel 1 data
- Column 3: Trace Channel 2 data (if used)
- Column n: Trace Channel n data (if used)

The trace data is in amplifier units, not user units (see Parameter Dictionary for units).

14.10 Trace Viewer

The Trace Viewer screen displays the contents of .sco files. All of the trace display features (zooming, line style, etc.) as well as the measurement functions are available in this screen.

1. On the Main screen, choose Tools→View Scope Files to open the window.
2. Click Open File. When prompted, select the name of the file you wish to open. Then, click Open to display the file in the Trace Viewer window.

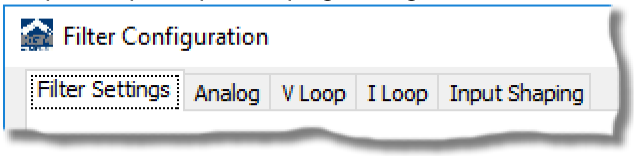


15 Filters

15.1 Setting Parameters

To change or view filter configurations follow these steps:

1. Choose the Configure Filters button from the main screen to open the Filter Configuration screen.


2. To view present filter settings choose the Filter Settings tab. Choose other tabs to configure Analog, V Loop, I Loop or Input Shaping settings.


15.2 Filter Configuration Windows

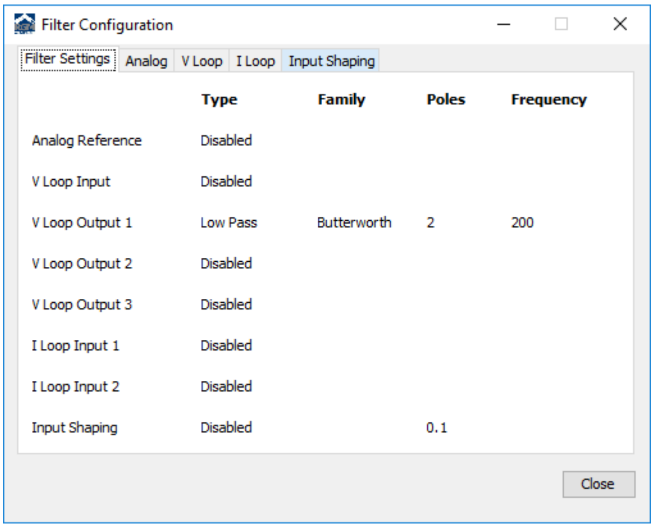
Along with the location of a cut-off frequency on the filter curve, there are several filter configuration parameters available depending on the initial choice of: Standard Filter Types and Standard Filter Families.

Filter configuration choices may include:

- Number of Poles (the location of a cut-off frequency on the filter curve)
- Cut Off Frequency
- Frequency 2 (If two poles are chosen)
- Pass Band Ripple
- Stop Band Ripple

15.3 Filter Settings

The Filter Settings tab opens a window that shows what filters have been selected.



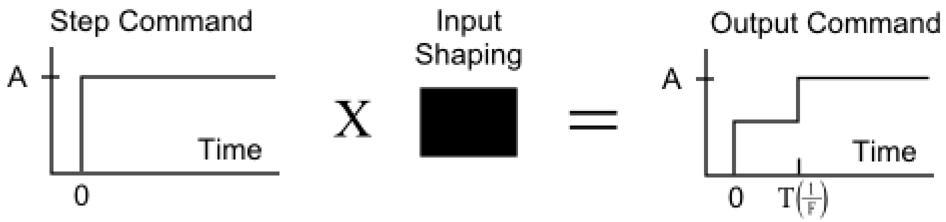
	Type	Family	Poles	Frequency
Analog Reference	Disabled			
V Loop Input	Disabled			
V Loop Output 1	Low Pass	Butterworth	2	200
V Loop Output 2	Disabled			
V Loop Output 3	Disabled			
I Loop Input 1	Disabled			
I Loop Input 2	Disabled			
Input Shaping	Disabled		0.1	

15.4 Input Shaping

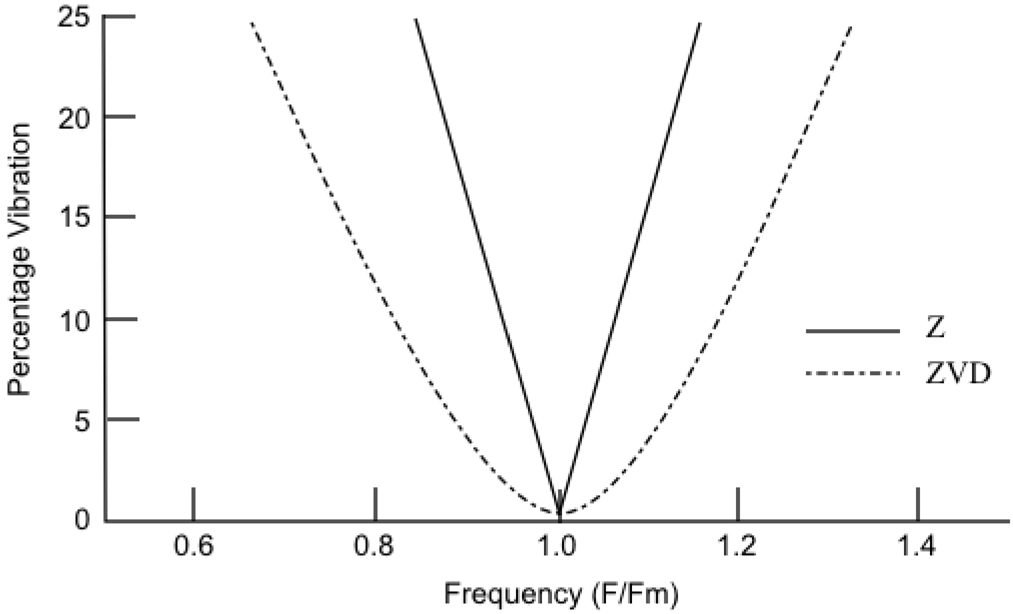
Input shaping is a method by which unwanted command induced vibrations are kept to a minimum by damping them with superimposed impulses. This produces a command that will drive the system with limited residual vibration.

In order to set the input shaping parameters, first measure the mechanical frequency; see .

Below is a diagram of the input shaping process.

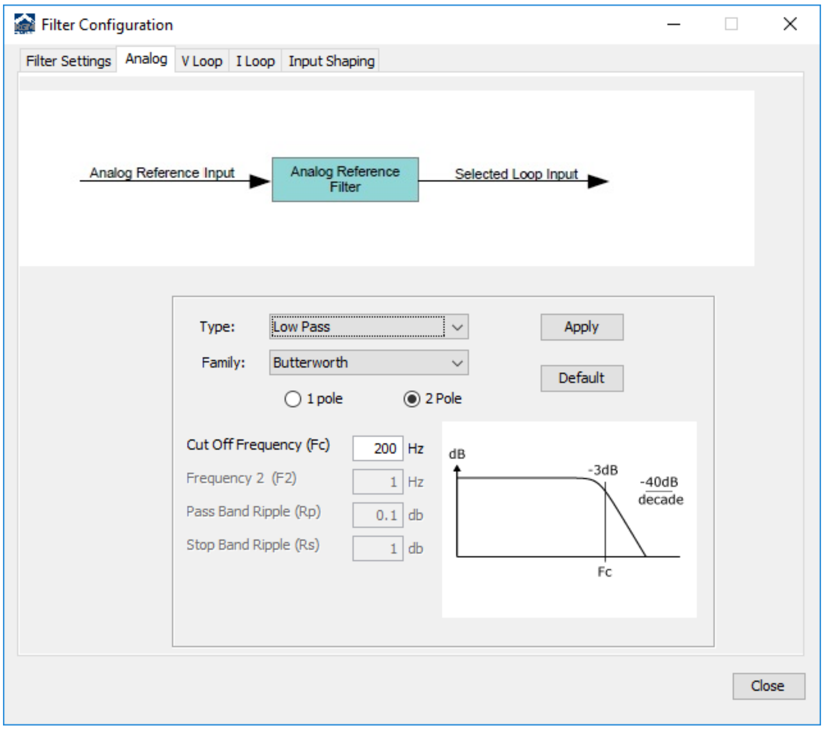


Below is a sensitivity curve. When F = Fm, there is zero vibration.



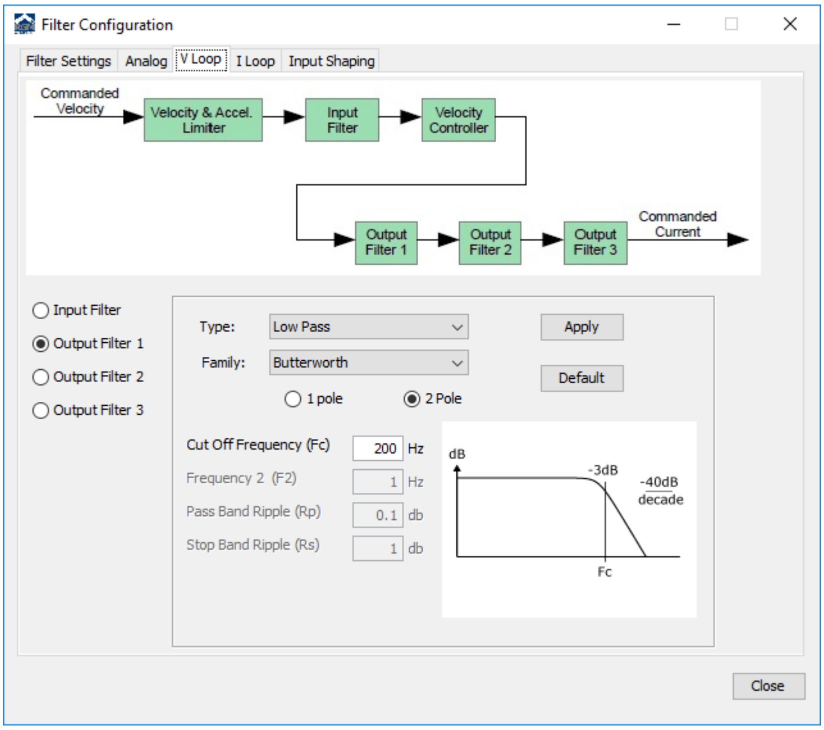
15.4.1 Analog

The Analog tab opens a window that shows analog filter choices and a representative curve. Modify the settings as needed and press **Apply**.



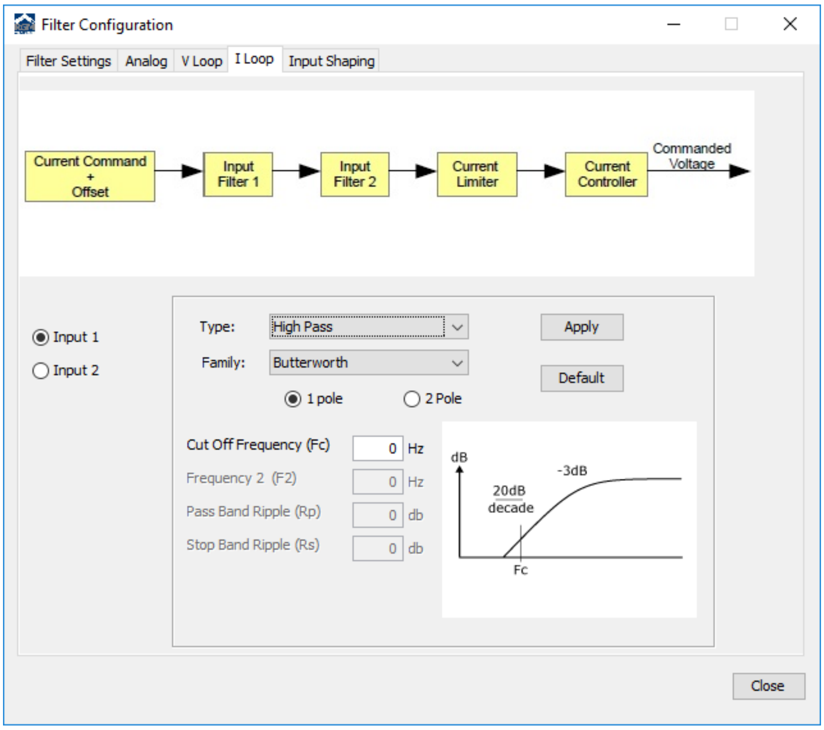
15.4.2 Velocity Loop

The V Loop tab opens a window that shows Velocity Loop filter choices and a representative curve. Modify the settings as needed and press **Apply**. Selecting **Default** will supply a 200 Hz Low Pass filter to the first velocity loop output filter.



15.4.3 Current Loop

The I Loop tab opens a window that shows Current Loop filter choices and a representative curve. Modify the settings as needed and press **Apply**.

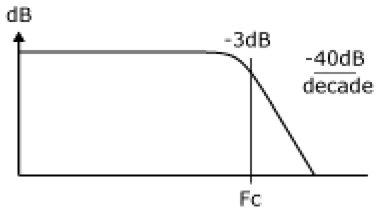


15.5 Standard Filter Types

15.5.1 Low Pass Filter

Frequencies below the selectable cut-off are allowed to pass.

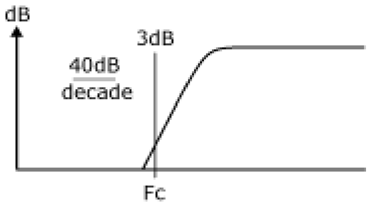
Example:



15.5.2 High Pass Filter

Frequencies above the selectable cut-off are allowed to pass.

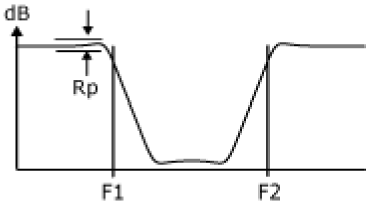
Example:



15.5.3 Notch Filter

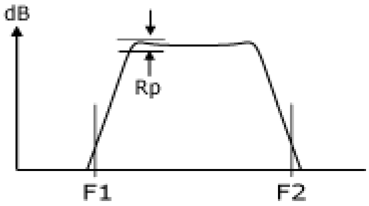
Notch filters allow a bandstop in a range between two selectable frequencies. It may be Butterworth (no ripple), Chebyshev (selectable passband ripple), or elliptical (ripple on both passband and bandstop).

Example:



15.5.4 Band Pass Filter

Band pass filters allow a range of frequencies, between two selectable cut-offs, to pass. It may be Butterworth, Chebyshev, or Elliptical.



15.5.5 Custom Biquad Filter

The Bi-Quadratic filter has two quadratic terms: one in the numerator, and one in the denominator. The numerator affects the filter's two zeros and the denominator affects the filter's two poles. Many filter classes and types can be expressed in the Bi-Quad form by entering the coefficients. The coefficients can be calculated using any commercially available math software package and entered as floating point numbers. However, due to the fixed-point representation, the numbers may be rounded.

Example:

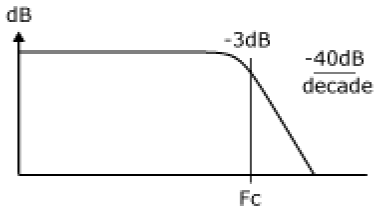
$$H_{(z)} = \frac{b_0 + b_1 z^{-1} + b_2 z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}}$$

15.6 Standard Filter Families

15.6.1 Butterworth Filter

A Butterworth filter has two poles for faster roll-off at the cut-off frequency.

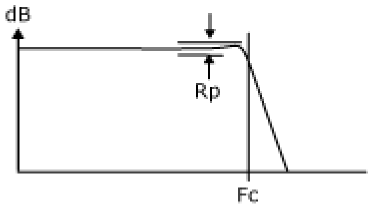
Example:



15.6.2 Chebychev Filter

A Chebyshev filter has a faster roll-off than a Butterworth filter, but, as a result of the fast roll-off, ripple is introduced into the passband frequency.

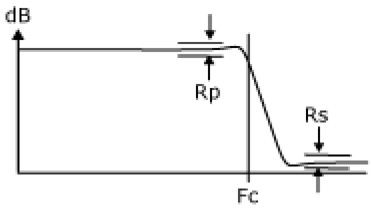
Example:



15.6.3 Elliptic Filter

Similar to a Chebyshev filter but ripple is introduced into both the passband and the stopband. It has a faster roll-off than a Chebyshev filter.

Example:



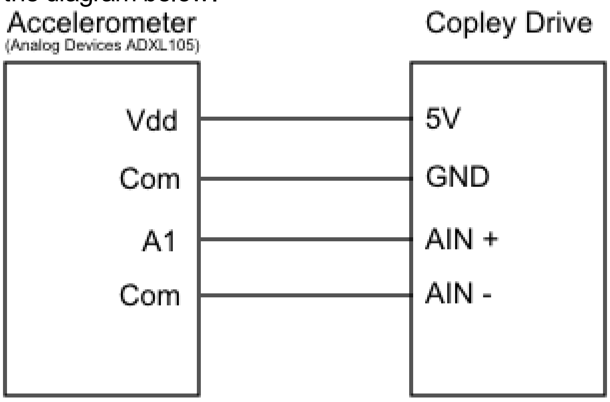
15.7 Measuring Mechanical Vibration

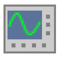
There are several ways to measure mechanical vibration. Two choices are offered below.

15.7.1 Using an Accelerometer with RGM WorkBench

Begin with a Kollmorgen drive operational and controlled by RGM WorkBench.

1. Connect the accelerometer analog output to Kollmorgen drive's Analog + and - on the signal input as in the diagram below.

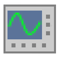


2. On RGM WorkBench, click the Scope Tool. 
3. Select the Measurement tab, choose a channel, select Voltage, then Analog Command.
4. Perform a move.
5. After the move is complete, measure Tm (1/Fm), which is the period of mechanical oscillation.

15.7.2 Using RGM WorkBench to Monitor Following Error

Monitor the following error using RGM WorkBench's scope option.

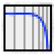
Begin with a Kollmorgen drive operational and controlled by RGM WorkBench.

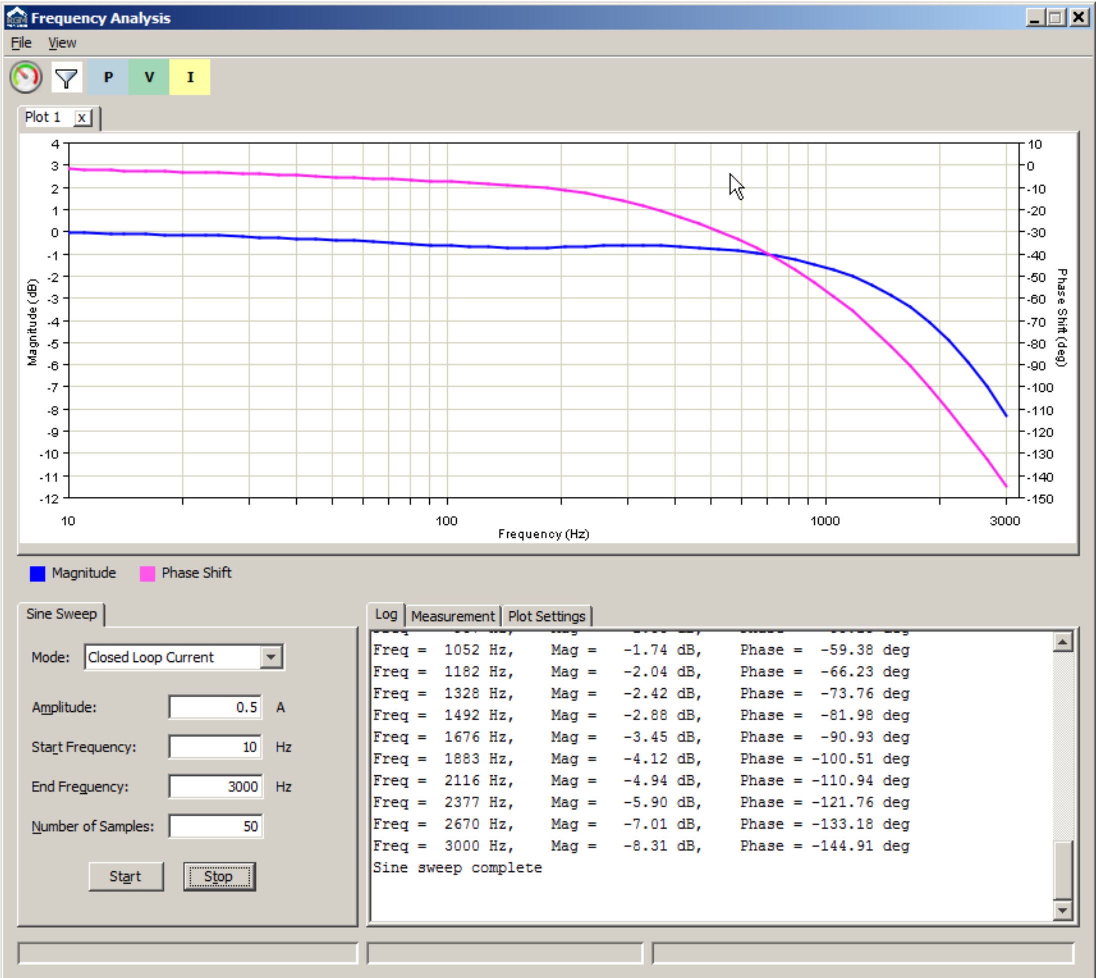
1. On RGM WorkBench, click the Scope Tool 
2. Select the Measurement tab, choose a channel, select Position, then Following Error.
3. Perform a move.
4. After the move is complete, measure Tm (1/Fm), which is the period of mechanical oscillation.

16 Frequency Analysis

16.1 Frequency Analysis Overview

The Frequency Analysis screen expands on the functionality of RGM WorkBench by providing a tool to measure the frequency response of a system while running a sine sweep. This further enhances the ability to tune and troubleshoot systems, particularly when there is a mechanical resonance present. The frequency analysis tool will measure and plot the current/velocity loop frequency response on a semi-log graph.

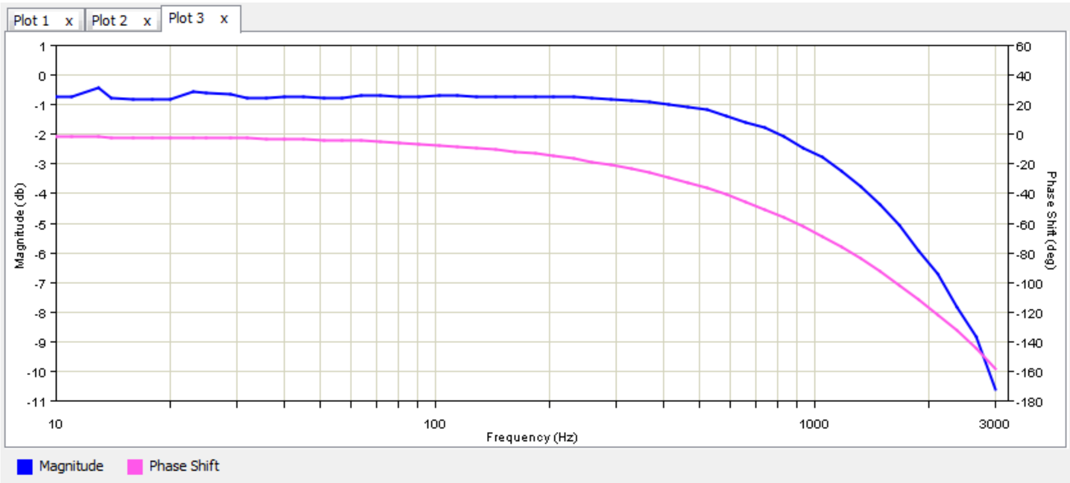
- Click  to open the Frequency Analysis screen.



16.2 User Interface

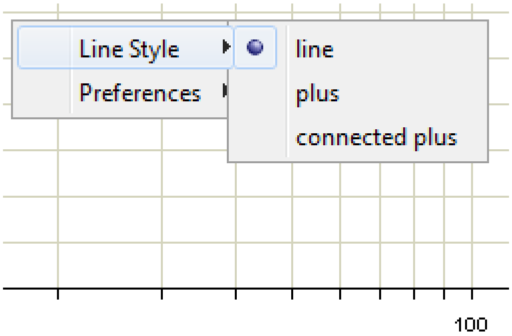
16.2.1 Graph

The frequency response data is plotted on a semi-log graph when the sign sweep completes. Each time a sine sweep is run, the data is plotted on a graph in a new tab. The tabs are named with the plot number (Plot 1, Plot 2, etc.). For multi-axis drives, the axis letter is appended to the tab name (e.g. Plot 1A, Plot 2B, etc.). The magnitude scale is displayed on the left Y axis and the phase shift scale is displayed on the right Y axis.



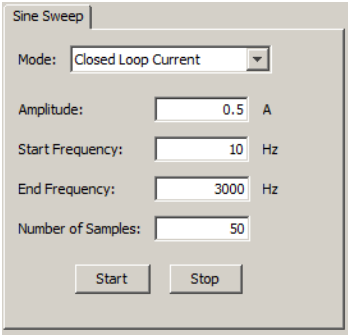
16.2.2 Graph Options Menu

To display the plot options menu, right-click anywhere on the graph.



Menu	Menu Items	Description
Line Style	line	A line connects the plotted data points.
	plus	The Scope plots data points as plus signs, with no connecting line.
	connected plus	Data points are plotted as plus signs and are connected with a line.
Preferences	anti-aliasing	When anti-aliasing is selected, the Scope removes screen-related jaggedness in the displayed trace. Use of this feature may slow down the refreshing of traces on slow computers.
	grid	When selected a grid is displayed on the scope screen.

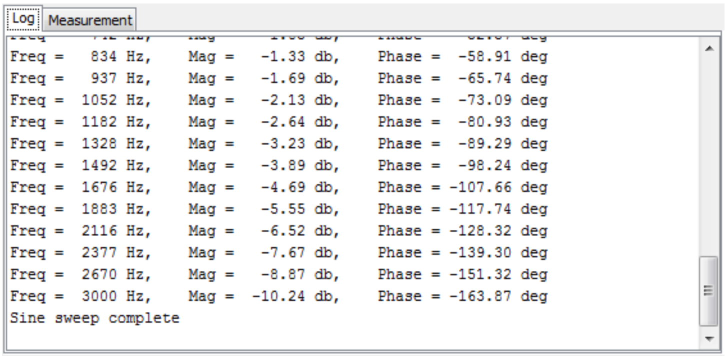
16.2.3 Sine Sweep Controls



Control	Parameters	Description
Apply To / Mode	Description	The control loop to which the sine wave will be applied. The options are current and velocity.
	Units	None
	Default	Closed Loop Current
Amplitude	Description	The amplitude of the sine wave.
	Units	A (current), rpm (velocity, rotary motor), mm/s (velocity, linear motor).
	Default	Current: 10% of the current loop continuous current.
	Velocity	5% of the velocity loop velocity limit.
Start Frequency	Description	The first frequency of the sine sweep.
	Range	1 to 9999 Hz (whole numbers only)
	Units	Hz
	Default	Current: 10 Hz
	Velocity	5 Hz
End Frequency	Description	The last frequency of the sine sweep.
	Range	2 to 10000 Hz (whole numbers only)
	Units	Hz
	Default	Current: 3000 Hz
	Velocity	250 Hz
Number of Samples	Description	The number of sine wave frequencies to run during the sine sweep. The frequencies are calculated so that there are an equal number of frequencies per decade.
	Range	2 to 100
	Units	None
	Default	50
Start	Description	Starts the sine sweep.
	Units	N/A
	Default	N/A
Stop	Description	Cancels the sine sweep in progress.
	Units	N/A
	Default	N/A

16.2.4 Log Text Window

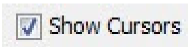
The log text window shows the progress of the sine sweep. For each frequency, the measured frequency response (magnitude and phase shift) is displayed. These are the values that get plotted in the graph.

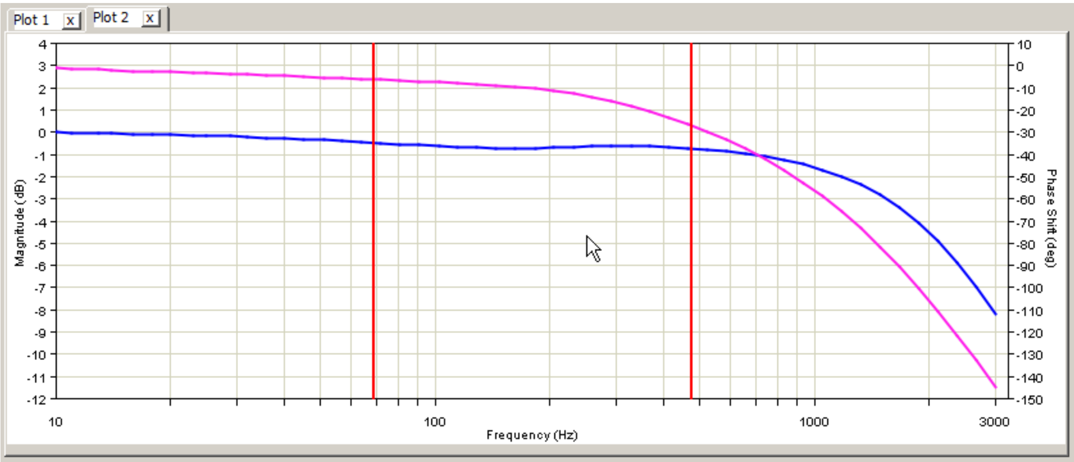


16.2.5 Measurement

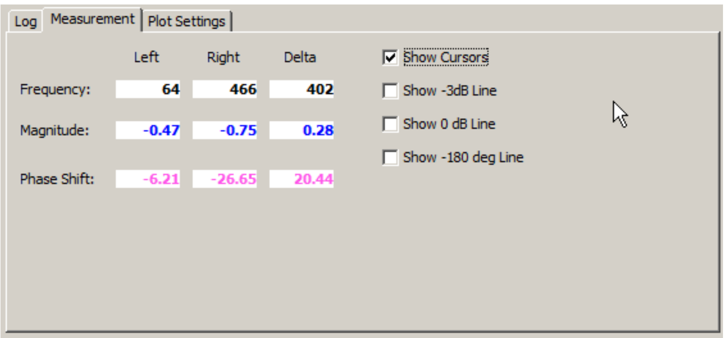
The Measurement tab contains tools to analyze the data displayed on the graph.

16.2.5.1 Cursors

Select  to display the cursors on the graph.

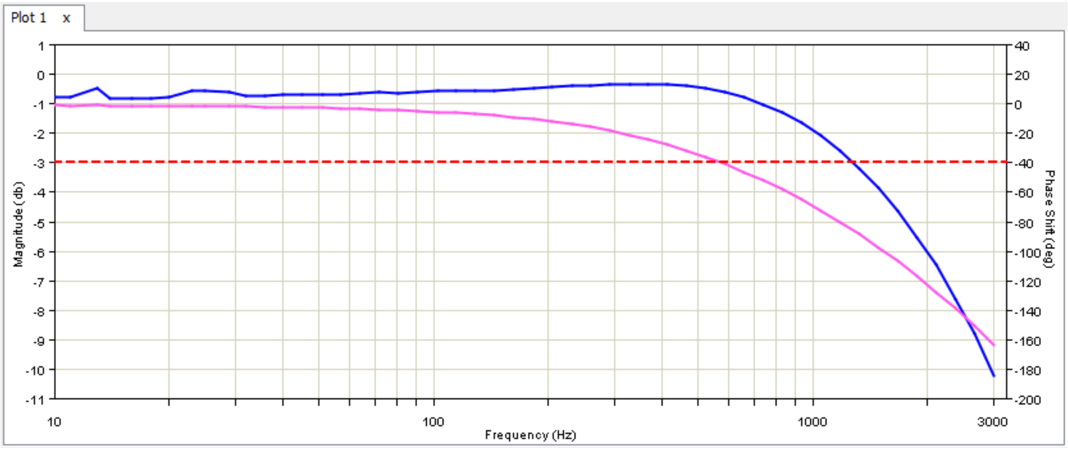


To move the cursors, left-click a cursor and drag it to the left or right. As the cursor is moved along the plot, the values for Frequency, Magnitude, and Phase Shift are updated in the Measurement tab.



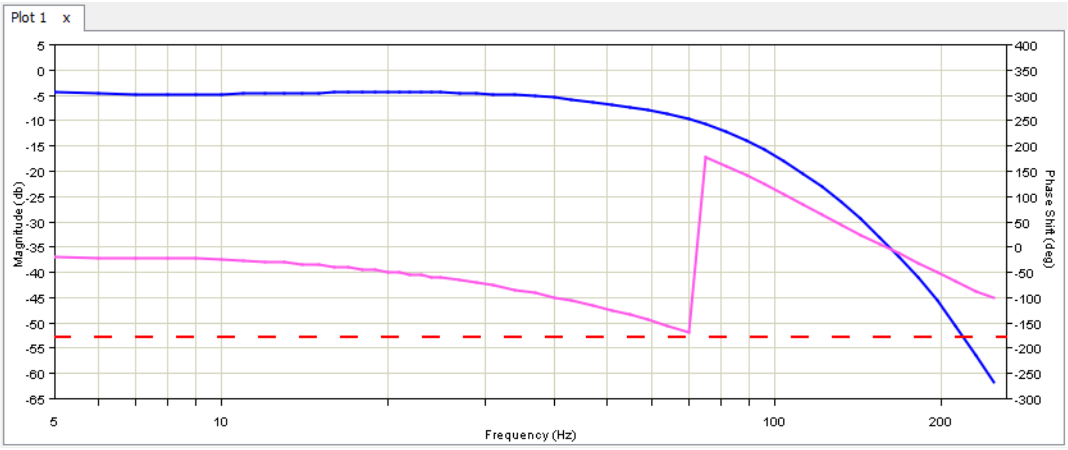
16.2.5.2 Show -3db Line

Select ☑ Show -3db Line to display a horizontal dashed line where the magnitude is -3db. The -3db point on the magnitude plot is used to determine the bandwidth of the system.

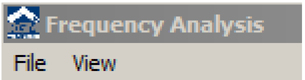


16.2.5.3 Show -180 degree Line

Select ☑ Show -180 Line to display a horizontal dashed line where the phase shift is -180 degrees. This line is useful for determining the phase and gain margins of your system.



16.2.6 File Menu



File Menu Items	Description
Save Current Plot	Saves the data from the sine sweep of the plot currently displayed in a csv format that can be imported to other software such as spreadsheets or mathematical analysis programs.

17 Data, Firmware, and Logs

17.1 Amplifier RAM and Flash Memory

17.1.1 Amplifier RAM

- Volatile. Contents erased when amplifier is reset or powered off.
- Initial contents read from flash on power-up. Contents then updated in real time to reflect certain operational conditions and changes entered with RGM WorkBench software. At any time, the user can use RGM WorkBench to restore data from flash into amplifier RAM.

17.1.2 Flash

- Non-volatile. Contents retained when the amplifier is reset or powered off.
- Modified only by using a Save to Flash tool or by closing certain screens (Motor/Feedback, Basic Setup, Homing, or CAN Configuration), whose contents are automatically saved to flash upon closing of the screen.

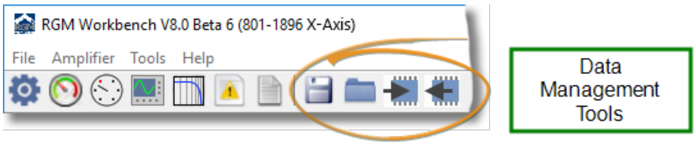
Parameters reside in RAM only, Flash only, or both RAM and Flash. The table below illustrates the typical parameter locations. Refer to the Parameter Dictionary for information about specific parameters.

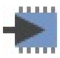
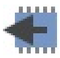
Data Resides In	Data
Flash only	This category includes all Motor/Feedback screen data and Basic Setup screen (motor/feedback data only), This data is saved to flash when the user confirms the values and closes the screens without canceling.
Amplifier RAM only	Includes operating status data such as actual position, actual current, and amplifier temperature. Such data is never stored in flash. It is destroyed from amplifier RAM with each power-down or amplifier reset.
Flash and amplifier RAM	Includes all other data not represented in the two categories above. When changing these parameters in RGM WorkBench, the value is saved to amplifier RAM only. To save these values to flash, the Save To Flash operation must be performed or data will be lost on power down or reset.

17.2 Data Management Tools

17.2.1 Amplifier

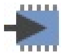
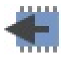
Operations performed using the amplifier data management tools at the top of the Main screen (shown below) affect amplifier settings, including motor/feedback data. (CVM Control Program data is not saved by these operations).



Action	Name	Description
	Save amplifier data to disk	Saves both amplifier and motor/feedback data to a disk with a .ccx filename extension.
	Restore amplifier data from disk	Restores amplifier and motor/feedback data from a .ccx file to the amplifier's RAM, or flash for the flash only variables. See Parameter Dictionary for parameter descriptions. A To Flash operation should be performed to insure that all data is saved to flash
	Save amplifier data to flash	Saves contents of amplifier RAM to amplifier flash memory.
	Restore amplifier data from flash	Restores contents of amplifier flash memory to amplifier RAM.

17.2.2 Motor Screen

Operations performed using the Motor screen data management tools only apply to the motor/feedback parameters.

Action	Name	Description
	Save motor data to disk	Saves only motor/feedback data to disk with a .ccm filename extension. Amplifier data that is not represented on the Motor/Feedback screen is not saved in this file.
	Restore motor data from disk	Restores only motor data from a disk file with a .ccm filename extension amplifier flash (the motor/feedback parameters are flash only).
	Save motor data to flash	Saves the contents of the Motor/Feedback screen from to amplifier flash memory. Amplifier data that is not represented on the Motor/Feedback screen is not saved. Can be used to assure that all changes are saved to flash without closing the Motor/Feedback screen.
	Restore motor data from flash	Restores only motor data from amplifier flash memory to the PC. Amplifier data that is not represented on the Motor/Feedback screen is not affected. Can be used before closing the Motor/Data screen to restore settings to the previously saved values.

17.3 Drive Configuration

The Plus Family of drives (Feature set E), have the capability of saving/restoring the entire drive configuration to a file. The drive configuration consists of all parameters (RAM/Flash and Flash Only) and the entire contents of the CVM flash, which includes any CVM programs, cam tables, and gain scheduling tables. The file is saved with a .ccd file extension.

This feature is useful to clone drives in one step rather than separately loading each file (.ccx, .ccp, .cct, .ccg). Additionally, the file is in XML format which can be read by some EtherCAT masters.

17.3.1 Save Drive Configuration

From the menu on the Main screen, select File→Save Amplifier Data, then choose a filename.

17.4 Firmware Download

The amplifier's flash memory holds the amplifier's firmware. As needed, perform the following steps to obtain new firmware and download it to amplifier flash memory.

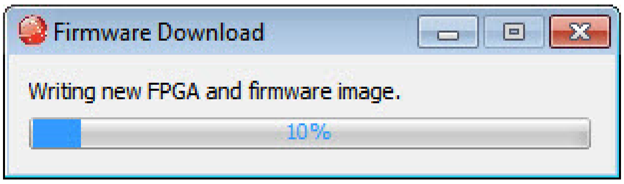
NOTE

- RGM WorkBench does not support downloading firmware to a node amplifier via a multi-drop gateway amplifier; a direct connection (serial, CAN) must be used.
- To check the firmware version currently loaded, click the Amplifier Properties button or choose Help→About.

⚠WARNING

Do not power down or disconnect the amplifier during firmware download.

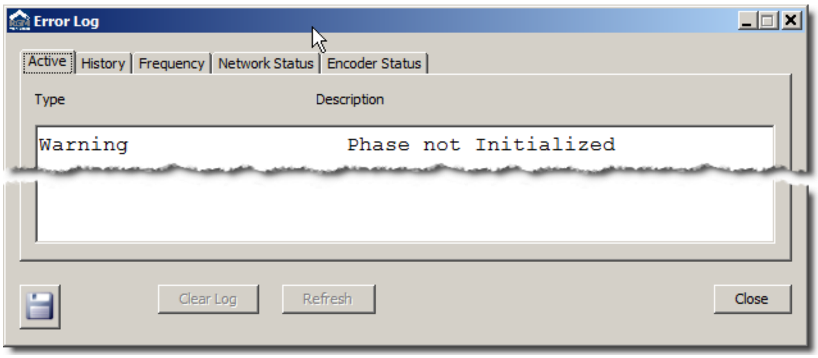
1. On the Main screen choose Tools→Download Firmware to open the Download Firmware window. Browse to where the firmware file is located and click Open to start the download. The progress will be displayed while downloading.



When the progress dialog closes, the firmware download is complete.

17.5 Error Log

 Click the Error Log tool on the Main screen

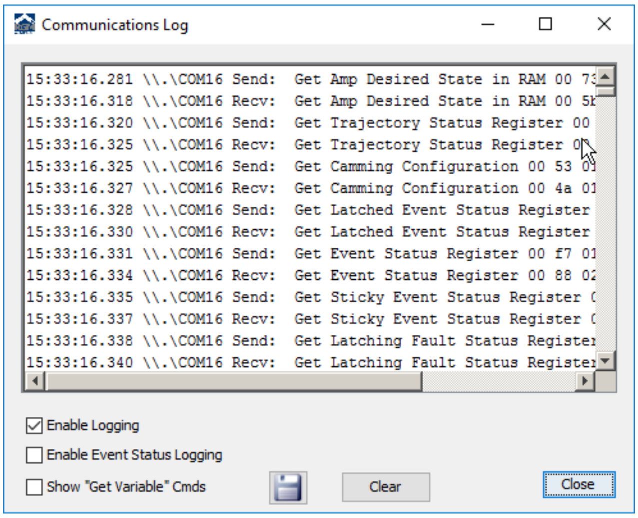


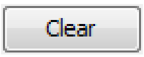
Tab / Button	Contents / Description
Active	Type and description of each active fault and warning. The contents of this tab are automatically refreshed as new events occur.
History	Type, description, and time of occurrence of each fault and most warnings since the log was last cleared. The contents of this tab are not refreshed automatically as new events occur. The contents are refreshed only when the tab is displayed or when Refresh is clicked.
Frequency	Type, description, and frequency of each fault and warning that has occurred since the log was last cleared. The contents are refreshed only when the tab is displayed or when Refresh is clicked.
Network Status	(Under CAN control only.) Status of CANopen network. Lists warnings and errors.
	Saves the contents of the History and Frequency tabs to a text file.
Clear Log	Clears all History and Frequency entries in the drive.
Refresh	Updates the contents of the History or Frequency tabs.

17.6 Communications Log

The communications log displays all communications between RGM WorkBench and the amplifier. The data is only stored in the PC's RAM by RGM WorkBench; it is not part of the amplifier's data.

On the Main screen, choose Tools→Communications Log



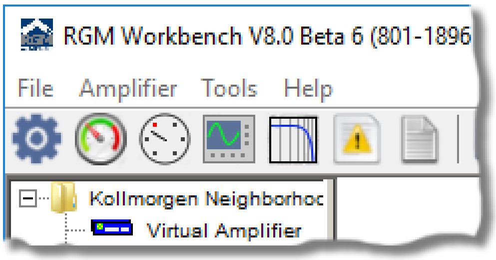
Option	Description
Enable Logging	When selected, logging is enabled and all communications, with the exception of status messages, are recorded in the log
Enable Event Status Logging	When selected, status messages are included in the log. Note that Show "Get Variable" Cmnds must also be checked to log Event Status commands.
Show "Get Variable" Cmds	When selected, "Get Variable" commands are added to the log.
	Saves the contents of the Communications Log to a text file.
	Clears the log contents from the PC's RAM

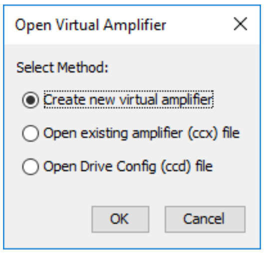
18 Virtual Amplifier

18.1 Overview

Virtual amplifiers can be used for creating amplifier and motor data files off line. A new virtual amplifier can be created based on a virtual amplifier template file (.ccv) or from an existing .ccx file. RGM WorkBench includes a set of .ccv files for each model that is supported.

1. Select the Virtual Amplifier node from the Kollmorgen Neighborhood. This will display the Open Virtual Amplifier screen.





2. Create a new amplifier file
   - Select Create new amplifier and click OK.
   - When prompted, select the .ccv that represents the appropriate drive model.
   - Click Open. The Basic Setup screen will be displayed.
   - Motor and amplifier values may now be viewed, entered, and adjusted.

   OR

   Open existing amplifier file

   - Select Open existing amplifier file and click OK.
   - When prompted, select the appropriate .ccx file.
   - Click Open.
   - Motor and amplifier values may now be viewed, entered, and adjusted.

19 Gains Scheduling

19.1 Gain Scheduling Overview

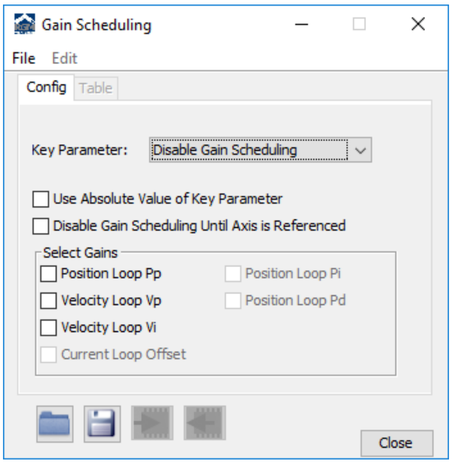
The Gain Scheduling feature allows you to schedule gain adjustments based on changes to a key parameter. For instance, Pp, Vp, Vi, and Current Offset (A) could be adjusted based on changes to commanded velocity.

Gain adjustments are specified in a Gain Scheduling Table. Each table row contains a key parameter value and the corresponding gain settings. The amplifier uses linear interpolation to make smooth gain adjustments between the programmed settings.

Gain scheduling involves the basic steps outlined below. Details follow in the chapter.

19.2 Configure Gain Scheduling

1. From the menu on Main screen, choose Amplifier→Gain Scheduling.



2. Choose the Key Parameter:

Key Parameter	Description
Disable Gain Scheduling.	Disable gain scheduling.
Use Written Parameter.	An external controller can write to this parameter using any of several protocols and corresponding parameter IDs: Kollmorgen ASCII Interface or the Kollmorgen Indexer 2 Program (ID 0x128), CANopen and EtherCAT(Index 0x2371), and MACRO I-variable (0x528). See the Kollmorgen ASCII Interface Programmer's Guide, the Kollmorgen Indexer 2 Program User Guide, or the Kollmorgen CANopen Programmer's Guide.
Use Commanded Velocity.	Schedule gain adjustments based on changes to commanded velocity.
Use Actual Velocity.	Schedule gain adjustments based on changes to actual velocity.
Use Commanded Position.	Schedule gain adjustments based on changes to commanded position.
Use Actual Position.	Schedule gain adjustments based on changes to actual position.

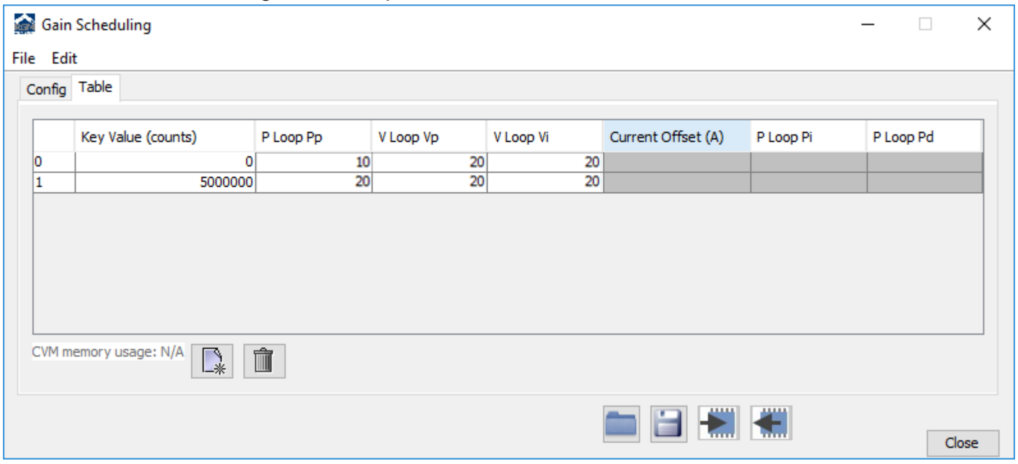
3. Optionally set controls:

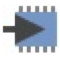
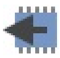
Control	Description
Use Absolute Value of Key Parameter	If a velocity or position value is chosen for the Key Parameter and this option is set, the Key Parameter is interpreted as an absolute value.
Disable Gain Scheduling Until Axis is Referenced	When this option is set, the scheduled gain adjustments do not take place until the axis is referenced (homed).

4. Select the gains that you wish to adjust by schedule. The choices are Pp, Vp, Vi and Current Offset (A). For each gain you select, a column will be enabled in the Gain Scheduling Table.
5. Continue with "Set Up Gain Scheduling Tables" (➔ p. 116)

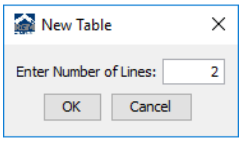
19.3 Set Up Gain Scheduling Tables

On the Gain Scheduling screen, open the Table tab:



Action	Description
	Creates a new table
	Deletes the table from the amplifier flash and PC's RAM
	Saves configurations and table to disk
	Restores configuration and table to PC only
	Saves configuration and table to amplifier flash
	Restores configuration and table from amplifier flash to PC. This operation overwrites all data on the Gains Scheduling screen.

1. On the *Gain Scheduling* screen, open the *Table* tab:
2. Click the Create New Table button  and enter the number of lines for the table.



3. Enter the Key Parameter and gain adjustment values.

NOTE

- All values must be whole numbers (no fractional values)
- All Key Values must be increasing

4. After all values have been entered, click the Save Table button.  This action saves both configuration and table data.

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20 Appendix: I^2T Time Limit Algorithm

20.1 I^2T Time Limit Algorithm Overview

The I^2T current limit algorithm continuously monitors the energy being delivered to the motor using the I^2T Accumulator Variable. The value stored in the I^2T Accumulator Variable is compared with the I^2T setpoint that is calculated from the user-entered Peak Current Limit, I^2T Time Limit, and Continuous Current Limit. Whenever the energy delivered to the motor exceeds the I^2T setpoint, the algorithm protects the motor by limiting the output current or generates a fault.

20.1.1 Formulas and Algorithm Operation

20.1.1.1 Calculating the I^2T Setpoint Value

The I^2T setpoint value has units of Amperes^2-seconds (A^2S) and is calculated from programmed motor data. The setpoint is calculated from the Peak Current Limit, the I^2T Time Limit, and the Continuous Current Limit as follows:

I^2T setpoint =
(Peak Current Limit^2 – Continuous Current Limit^2) * I^2T Time Limit

20.1.1.2 Algorithm Operation

During amplifier operation, the I^2T algorithm periodically updates the I^2T Accumulator Variable at a rate related to the output current Sampling Frequency. The value of the I^2T Accumulator Variable is incrementally increased for output currents greater than the Continuous Current Limit and is incrementally decreased for output currents less than the Continuous Current Limit. The I^2T Accumulator Variable is not allowed to have a value less than zero and is initialized to zero upon reset or +24 Vdc logic supply power-cycle.

20.1.1.3 Accumulator Increment Formula

At each update, a new value for the I^2T Accumulator Variable is calculated as follows:

I^2T Accumulator Variable$_{n+1}$ =

I^2T Accumulator Variable$_{n}$

+(Actual Output Current$_{n+1}{}^2$ – Continuous Current Limit^2) * Update period

After each sample, the updated value of the I^2T Accumulator Variable is compared with the I^2T setpoint. If the I^2T Accumulator Variable value is greater than the I^2T Setpoint value, then the amplifier limits the output current to the Continuous Current Limit. When current limiting is active, the output current will be equal to the Continuous Current Limit if the commanded current is greater than the Continuous Current Limit. If instead the commanded current is less than or equal to the Continuous Current Limit, the output current will be equal to the commanded current.

20.1.2 Application Example

Operation of the I^2T current limit algorithm is best understood through an example. For this example, a motor with the following characteristics is used:

- Peak Current Limit – 12 A
- I^2T Time Limit – 1 S
- Continuous Current Limit – 6 A

From this information, the I^2T setpoint is:

setpoint = (12 A^2–6 A^2) * 1 S = 108 A^2S

20.1.2.1 Plot Diagrams

The plots that follow show the response of an amplifier (configured w/ I^2T setpoint = 108 A^2S) to a given current command. For this example, DC output currents are shown in order to simplify the waveforms. The algorithm essentially calculates the RMS value of the output current, and thus operates the same way regardless of the output current frequency and wave shape.

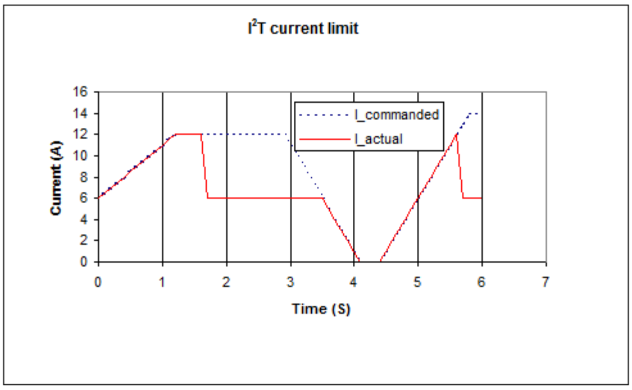


Figure 1: Diagram A

At time 0, plot diagram A shows that the actual output current follows the commanded current. Note that the current is higher than the continuous current limit setting of 6 A. Under this condition, the I^2T Accumulator Variable begins increasing from its initial value of zero. Initially, the output current linearly increases from 6 A up to 12 A over the course of 1.2 seconds. During this same period, the I^2T Accumulator Variable increases in a non-linear fashion because of its dependence on the square of the current.

At about 1.6 seconds, the I^2T Accumulator Variable reaches a values equal to the I^2T setpoint. At this time, the amplifier limits the output current to the continuous current limit even though the commanded current remains at 12 A. The I^2T Accumulator Variable value remains constant during the next 2 seconds since the difference between the actual output current and the continuous current limit is zero.

At approximately 3.5 seconds, the commanded current falls below the continuous current limit and once again the output current follows the commanded current. Because the actual current is less than the continuous current, the I^2T Accumulator Variable value begins to fall incrementally.

The I^2T Accumulator Variable value continues to fall until at approximately 5.0 seconds when the commanded current goes above the continuous current limit again. The actual output current follows the current command until the I^2T Accumulator Variable value reaches the I^2T setpoint and current limiting is invoked.

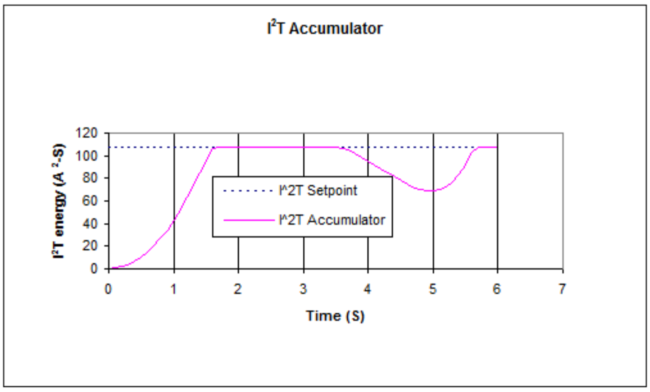


Figure 2: Diagram B

20.1.2.2 I^2T Scope Trace Variables

Two Scope Tool trace variables are available for monitoring whether the I^2T accumulator is accumulating or discharging.

- The I^2T Amplifier Accumulator variable evaluates the accumulator against the factory set current limits of the amplifier.
- The I^2T Motor Accumulator variable evaluates the accumulator against the user-programmed current loop values.

The value shown Diagram B has been normalized so that 100% equals the I^2T setpoint.

When either trace variable line reaches 100%, current limiting will be invoked.

21 Appendix: Homing Methods

21.1 Overview

There are several homing methods. Each method establishes the:

- Home reference
- Direction of motion.

21.2 Homing Method Descriptions

21.2.1 Absolute Encoder Immediate Home

Absolute encoder actual position is set to Home

Active Load position is set to zero.

21.2.2 Set current position as home

The current position is the home position.

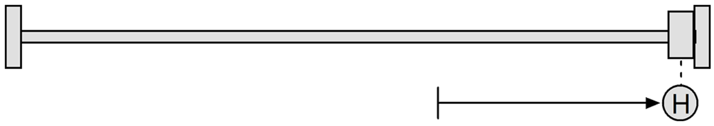
Actual position is set to zero or to a value that is entered into the "Offset:" position box after "Home" button is pressed..

21.2.3 Hardstop

Direction of Motion: Positive

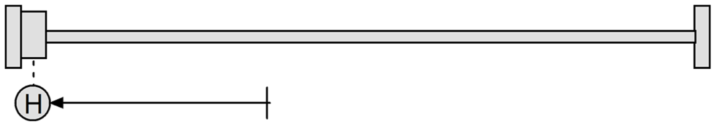
Home is the positive hard stop. Direction of motion is positive. In servo modes, the hard stop is reached when the amplifier outputs the homing Current Limit continuously for the amount of time specified in the Delay Time.

If a positive limit switch is activated before the hard stop, an error is generated.



Direction of Motion: Negative

Home is the negative hard stop. Direction of motion is negative. The hard stop is reached when the amplifier outputs the homing Current Limit continuously for the amount of time specified in the Delay Time. If a negative limit switch is activated before the hard stop, an error is generated.



22 Appendix: ASCII Commands/Serial Control

22.1 Kollmorgen ASCII Interface

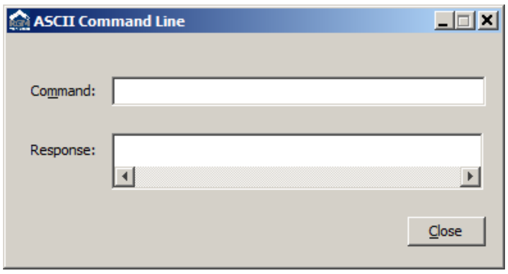
An amplifier's RS-232 serial bus can be used by an external control application (HMI, PLC, PC, etc.) for setup and direct serial control of the amplifier. The control application can issue amplifier commands from the set of ASCII format commands that make up the Kollmorgen ASCII Interface.

22.2 RGM WorkBench ASCII Command Line Interface Tool

As described below, the RGM WorkBench ASCII Command Line Interface tool provides a simple way to enter Kollmorgen ASCII commands.

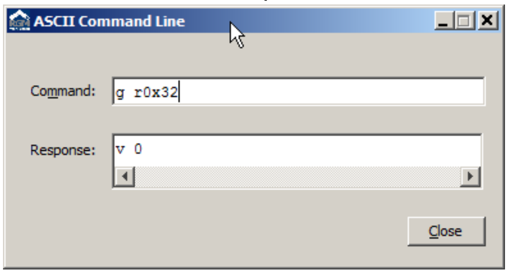
Use the ASCII Command Line Interface to Enter Commands

1. From the Main screen, choose Tools→ASCII Command Line to open the tool.



2. Enter an ASCII Command in the Command field.
3. Press the Enter key to send the command to the amplifier. Observe the Response field.

   If a value is returned, it is preceded by the letter "v." In the following example, the get command was used to retrieve the amplifier RAM value of variable 0x32 (actual position).



   An error code would be preceded by the letter "e."

   TIP

   To view an error definition, hold the mouse pointer over the error number.

For more information, see the Kollmorgen ASCII Interface Programmer's Guide and the Kollmorgen Amplifier Parameter Dictionary.

22.3 Single-Axis Serial Connection

For RS-232 serial bus control of a single axis, set the CAN node address of that axis to zero (0). Note that if the CAN node address is switched to zero after power-up, the amplifier must be reset or power cycled to make the new address setting take effect.

23 Appendix: USB to Serial Adapter

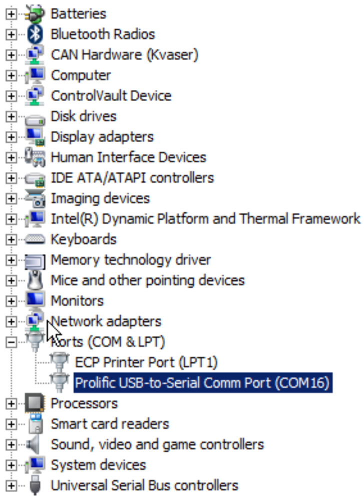
23.1 Recommended Device

Kollmorgen recommends using the USB to Serial adapter, part number XX-XXXXX-XXX

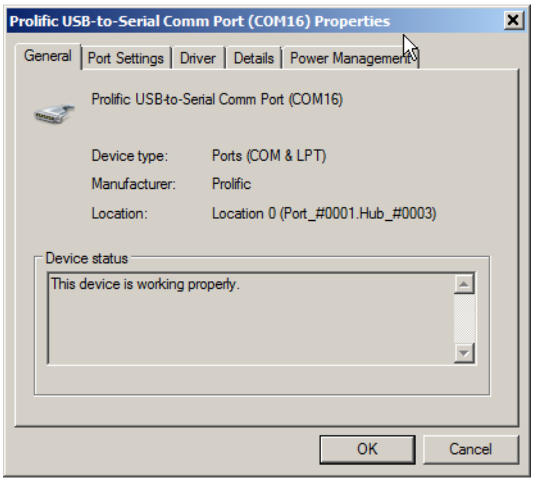
23.2 Factory Settings

The factory settings for this device works well, but Kollmorgen recommends changing the Latency time for faster performance with RGM WorkBench software. This value is changed through the Windows Device Manager

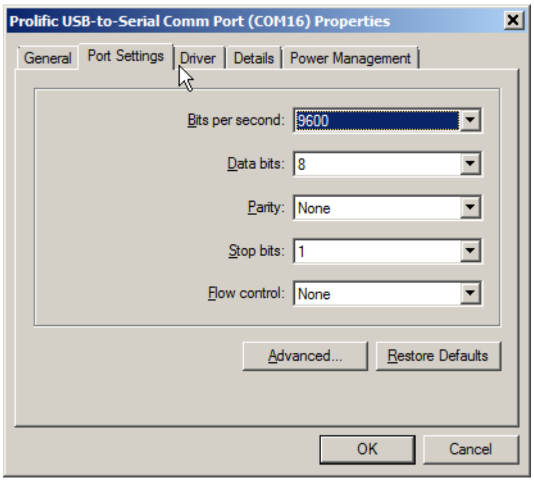
1. Open the Device Manager dialog from the Windows Control Panel and expand the Ports (COM &LPT) node:

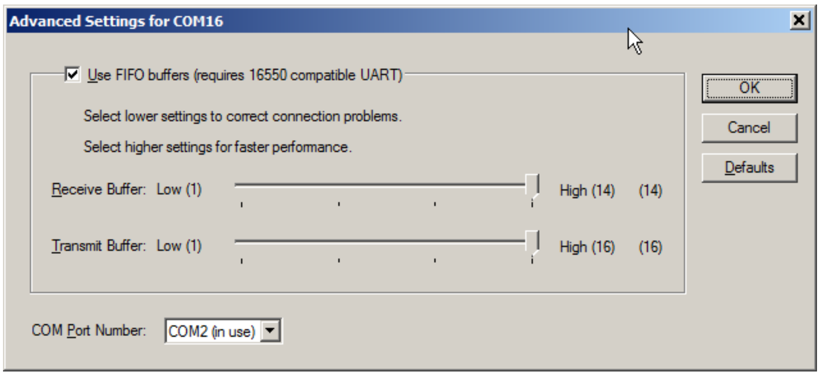


2. Select the COM port that is used by the USB to Serial Adapter (refer to manufacturer's documentation for details).
3. Right-click that port and select Properties from the pop-up menu. This will open the device properties.



4. Select the Port Settings tab, then click the Advanced button.





5. The factory default setting for Latency Timer is 16 ms as shown above. Change the Latency Timer to 1 ms, No other settings should be changed. Click OK to set the new value and close the dialog.
6. Click OK to close the device properties dialog.

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About Kollmorgen

Kollmorgen is a leading provider of motion systems and components for machine builders. Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions that are unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

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