http://www.rocklogic.com

Printed in the USA.

RockLogic SmartDriver™

Spindle Motor Driver
3XXX Series

User Guide

RockLogic®
Precision Test Equipment

LIMITED WARRANTY
RockLogic warrants that the product, per the specifications of the purchase order, will be free form defects in materials and workmanship under normal use for one (1) year from the date of purchase. This warranty is expressly made in lieu of any and all other warranties, merchantability or as to fitness of the material for any particular purpose.

LIABILITY
Any liability for any loss or damage, either direct, indirect, incidental or consequential is expressly disclaimed. The liability of RockLogic in all cases is limited to replacing the material found to be defective or noncompliant. RockLogic reserves the right to revise or update its products, software, or documentation without obligation to notify any individual or entity. Any lawsuits arising from liability will be filed in Santa Cruz County.

CLAIMS
Any claim for defective, noncompliant or damaged material or for shortages in the material ordered shall be deemed waived by the customer unless made, in writing, within 90 days of the shipping date. Material which the customer deems defective, noncompliant, or damaged, may be returned to RockLogic within said 90-day period and if, after examination, RockLogic finds said material to be defective, noncompliant, or damaged, RockLogic will replace the returned material at no cost to the customer and within a time interval before or equal to the shipping time quoted for the original material. If, after examination, RockLogic finds that the returned material is not defective, noncompliant, or damaged, it shall return said material to the customer at the customer's expense.

Please direct all inquiries to:
RockLogic, Inc. P.O. Box 386, Ben Lomond, CA 95005

OWNERSHIP AND LICENSE
Purchase of the SmartDriver Software is a License Agreement and NOT an agreement for sale. We continue to own the copy of the software contained in the Driver and all other copies that you are authorized by this agreement to make. Your rights to use the software are specified in this Agreement, and we retain all rights not expressly granted to you in this Agreement. Nothing in this Agreement constitutes a waiver of our rights under U.S. Copyright law or any other federal, state or international law.

COPYRIGHT/PROPRIETARY PROTECTION
The SmartDriver software, manual(s) and any other documentation is owned by RockLogic, Inc. or its suppliers and is protected by United States and international copyright laws and international trade provisions. You must treat the SmartDriver Software like any other copyrighted material. This License and your right to use the product terminate automatically if you violate any part of this Agreement. In the event of termination, you must immediately destroy all copies of the Product or return them to RockLogic, Inc.

REVISIONS: P/N 1738-801, Ver 1.1, April 26, 2006
Ver 1.2 Sept 30, 2008
Ver 1.3 July 23, 2009
Ver 1.4 Feb 1, 2010

Table of Contents

INTRODUCTION

Congratulations on your purchase of a RockLogic SmartDriver 3XXX Series Spindle Motor Driver. The 3XXX Series, based on RockLogic's SmartDriver technology, provides you with a turnkey off-the-shelf spindle motor driver that works with all 3-12VDC spindle motors with speeds up to 30K RPM.

The SmartDriver Spindle Motor Driver's unique features, unavailable in any other spindle motor driver, provide you with the accurate, reliable results you need to develop, test and manufacture your best possible product.

FEATURES

- ► Easy to use
- ► Precise speed control with or without load .02% - .08%
- ► Low Jitter typically <1uS
- ► Motor Speed: Up to 30K RPM
- ► Wide Motor Voltage: 1-24V (depending on model)
- ► High-current motor bridge: For motors up to 3A (72W)
- ► Programmable in seconds through RS232 port
- ► Built-in instrumentation through RS232 port
- ► Commands: Run. Coast. Brake. Stop. Clear errors. Reset
- ► Information query: Run-current, Speed, Status, PWM, Motor position, errors
- ► All-digital design. No pots to adjust
- ► Unidirectional motor quick start: No reverse motor rotation
- ► Constant current ramp for short start time and motor protection
- ► Measures acceleration constant on ramp-up to compensate fuzzy speed control loop
- ► Over-current protection: virtually eliminates motor or driver damage
- ► Easy integration into your test environment
- ► Instrumentation data acquisition port

KIT CONTENTS

Please check to make sure that the following items are in your Driver kit:

- ► Spindle Motor Driver Chassis
- ► Power supply (-LCD only)
- ► Motor cable
- ► RS232 cable
- ► Configuration utility installation CD
- ► Power terminal block for 3.3V and 5.0V (3100X, 3200X only)
- ► Spare terminal blocks

CHAPTER 1: Hardware Setup & Utility Install

In this chapter you will learn about
- ► connecting the Driver to the power supply and motor
- ► the Driver communication port
- ► installing the Driver Configuration Utility

HARDWARE SETUP

The rear panel of the Driver is where all of the hardware connections are made. The connectors and ports are:

► Power connector (31XX, 32XX only)	Connects system power supply to Driver
► VMM connector (31XX, 32XX only)	Connects motor power supply or power terminal blocks to Driver
► VMM connector (3300X)	Connects system power supply to Driver
► Motor connector	Connects motor to Driver
► RS232 Port	Connects computer to Driver
► Data Acquisition Port	Connects to various Driver signals

For detailed information on these hardware connections, please refer to Appendix A: Hardware Connection Information.

Power Connector (3100X, 3200X only)

To connect the power supply:

1. Plug the Power Supply cable into the Power connector on the rear panel of the Driver.
2. Plug the Power Cord into the power supply, then
3. Plug the Power Cord into a wall power socket.

The Driver will power up and display on the front panel:

Motor Stopped
No Configuration

If a Motor Configuration Name is ever displayed that you don't recognize, DO NOT plug in your motor until you have programmed the Driver with the correct configuration for your motor, otherwise motor damage may occur.

VMM Connector (3100X, 3200X only)

To supply power to the motor, use one of the following methods:

NOTE: For steps 1 and 2, the *Mating Terminal Blocks* are supplied linked together and can remain linked during use.

1. For a **12V Motor**, where motor power is supplied by the Power Connector:
   Plug the *Mating Terminal Block* with the yellow jumper connected between pins 1 and 3 into the *VMM*

Connector on the rear panel of the Driver.

2. For a **5V or 3.3 V Motor**, where motor power is supplied by the Power Connector:
   Plug the *Mating Terminal Block* with the 5V or 3.3V regulator installed into the *VMM Connector* on the rear panel of the Driver.

3. To connect an external power supply to the VMM connector:
   Plug a mating terminal block with the VMM and GND pins connected to a separate power supply into the *VMM Connector* on the rear panel of the Driver.

   NOTE: Any motor voltage between 1-24VDC (depending on the model) can be used, but **typically you should use the voltage specified for your motor.**

VMM Connector (3300X)

1. Plug a mating terminal block with the VMM and GND pins connected to a 24V 50W power supply into the *VMM Connector* on the rear panel of the Driver.

Motor Connector

To connect the motor to the Driver:

1. Connect the motor phase wires to the terminal block phase pins PH1, PH2, and PH3. (PH4 is not used).
   NOTE: If your motor has a center-tap, leave it disconnected.
   If the motor runs opposite from the desired direction, reverse any two phase wires.
2. Plug the mating terminal block into the *Motor Connector* on the rear panel of the Driver.

RS232 Port Connector

The RS232 communication port connects the Driver to the PC. It is used for configuration of the driver and software control of the motor through the Driver configuration utility or through your application using the RockLogic library. (See Chapter 2: Driver Configuration Utility and Chapter Three: Driver Operation).

To make this connection:

1. Connect an RS232 cable between the Driver and your PC.

Data Acquisition Port

The Data Acquisition Port provides signals necessary for motor analysis.
For pin functions of this port, see Appendix A.

INSTALLING THE CONFIGURATION UTILITY

To install the configuration utility:

1. Insert the RockLogic Configuration Utility program CD into your PC CDROM drive.
2. Run CDROM:setup.exe to start the SmartDriver Configuration Utility Installation Wizard.
3. Click **Next**.
4. Accept the default or click **Browse** to select a Destination Folder.
5. Click **Next**.

6. Click **Next** again to start the installation process.

7. When the installation process is done, click **Finish**.

8. Copy the files from the \Sample Configuration Files on the CD to a convenient location on your hard drive.

9. Remove the program CD.

CHAPTER 2: Getting Started: Using Existing Motor Configuration Files

NOTE: Before continuing, if you haven't already done so, follow the instructions in Chapter One: Hardware Setup & Utility Install.

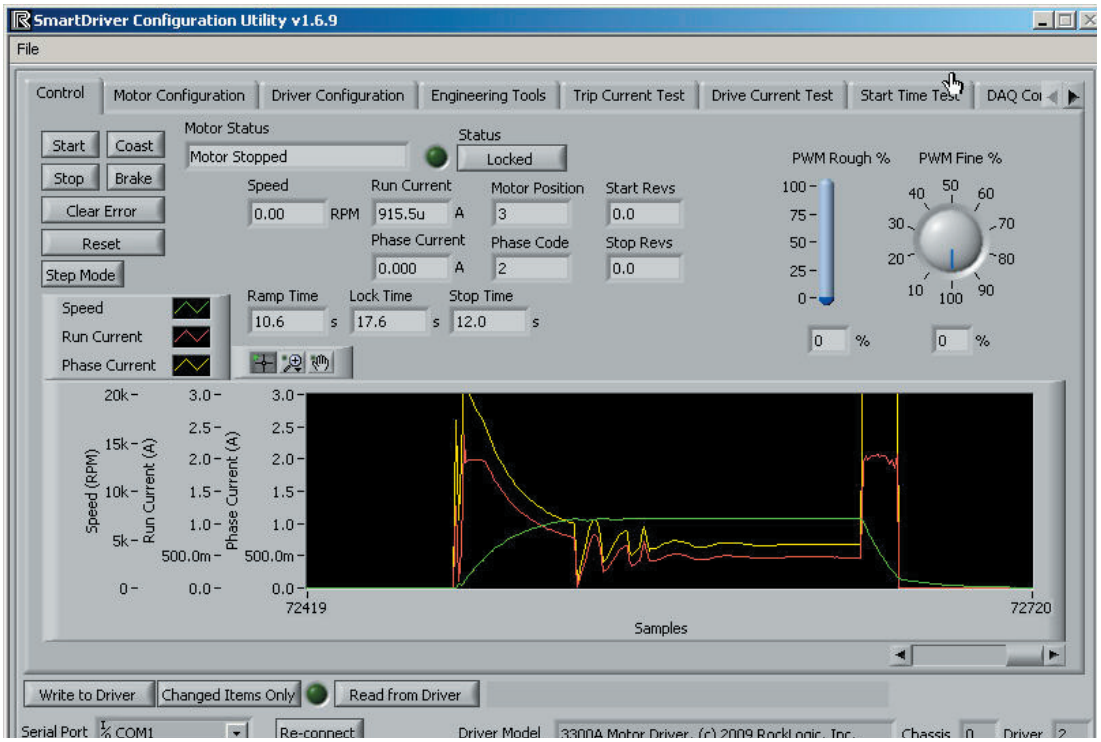
In this chapter, you will learn to operate the Driver using an existing motor configuration file.

The Driver can be operated in two modes: **Serial-command** and **Stand-alone.**

- **Serial-command** mode requires an RS232 cable connection between the Driver and the PC, and the installation of the Configuration Utility (see Chapter One), or your custom application.
- **Stand-alone** mode *does not* require the use of the PC except for configuration. The motor is controlled with the Start/Stop button (-LCD only), the Control button (-CC only), or the Data Acquisition Port control line.

OPERATING THE DRIVER IN SERIAL-COMMAND MODE

Using the **Serial-command** mode allows you to start and stop the motor by commands received from a PC.



Starting the Configuration Utility

To start the configuration utility on your PC:

1. Click on the Windows **Start Menu** button and select Programs/RockLogic/SmartDriver Configuration Utility.

Once the Configuration Utility is open,

2. Click on the *Serial Port* drop-down list at the bottom left of the screen, and select the correct serial port.
   NOTE: In this utility, COM1 may be represented by ASRL1::INSTR; COM2 by ASRL2::INSTR, etc.
   When the correct serial port is selected
   ► the *Status* field will read "SmartDriver Ready" and
   ► the Driver Model, Firmware Version, and Serial Number will be displayed.

Loading an Existing Configuration File

To operate the Driver using an existing motor configuration file:

1. Click on the **File** menu and selct **Open.**
2. Select the desired file.
3. Click on the **Write to Driver** button.

-LCD only: The Motor Configuration Name should now be displayed on the front panel LCD of the Driver.

Starting and Stopping the Motor

To run the motor using the motor configuration file you have just downloaded:
1. Click on the **Control tab**.
2. Click on the **Start** button.

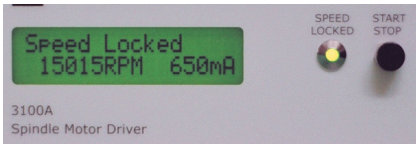
   The *Motor Status* field and the LCD on the front panel of the Driver will read: Motor Starting, Motor Ramping, Speed Locking, and then Speed Locked.
   The *Speed Locked* light and the LED on the front panel will light up when the speed is locked.

   NOTE: Also displayed will be the *Speed, Run Current and Phase Current* values and graphs, *Start Time, Motor Position, Phase Code, Start Revs, Stop Revs, PWM Rough %* and *PWM Fine % motor position (during start)*
   For definitions of this measurement information, see Chapter Three: Utility Screen Definitions.

To stop the motor:
1. Click on the **Stop** button..

   The *Motor Status* field will read: Auto-braking, and then Motor Stopped.
   The *Speed Locked* light will no longer be lit.

OPERATING THE DRIVER IN STAND-ALONE MODE



To start the motor in **Stand-alone** mode:

1. -LCD: Press the **Start-Stop** button on the front panel of the Driver.
   The LCD on the front panel displays the motor's status, speed, and run-current. The Speed Locked LED on the front panel lights up when the motor speed is locked to the target speed.

   -CC: Press the **Control** button
   The Locked LED lights up when the motor speed is locked to the target speed. The Error LED lights up if the Driver is in an error state.

To stop the motor:

1. -LCD: Press the **Start-Stop** button on the front panel of the Driver.

   The LCD on the front panel of the Driver will read: Auto-braking, and then Motor Stopped.
   The Speed Locked LED on the front panel will no longer be lit.

   -CC: Press the **Control** button on the Driver. The Locked LED will no longer be lit.

CHAPTER 3: Utility Screen Definitions

UNDERSTANDING THE CONFIGURATION UTILITY SCREEN

To start the configuration utility click on the Windows **Start Menu** button and select Programs/RockLogic/ SmartDriver Configuration Utility.

Once the utility is open, you will see three tabs at the top of the screen:

- The **Control tab** opens a screen that is used to issue commands to the driver. It also displays motor status and measurements.
- The **Motor Configuration tab** opens a screen that is used to read the configuration from the Driver and write a configuration file to disc.
- The **Driver Configuration tab** opens a screen that is used to specifiy Driver functionality.
- The **Engineering Tools tab** contains tools.

At the bottom of the screen, there are:

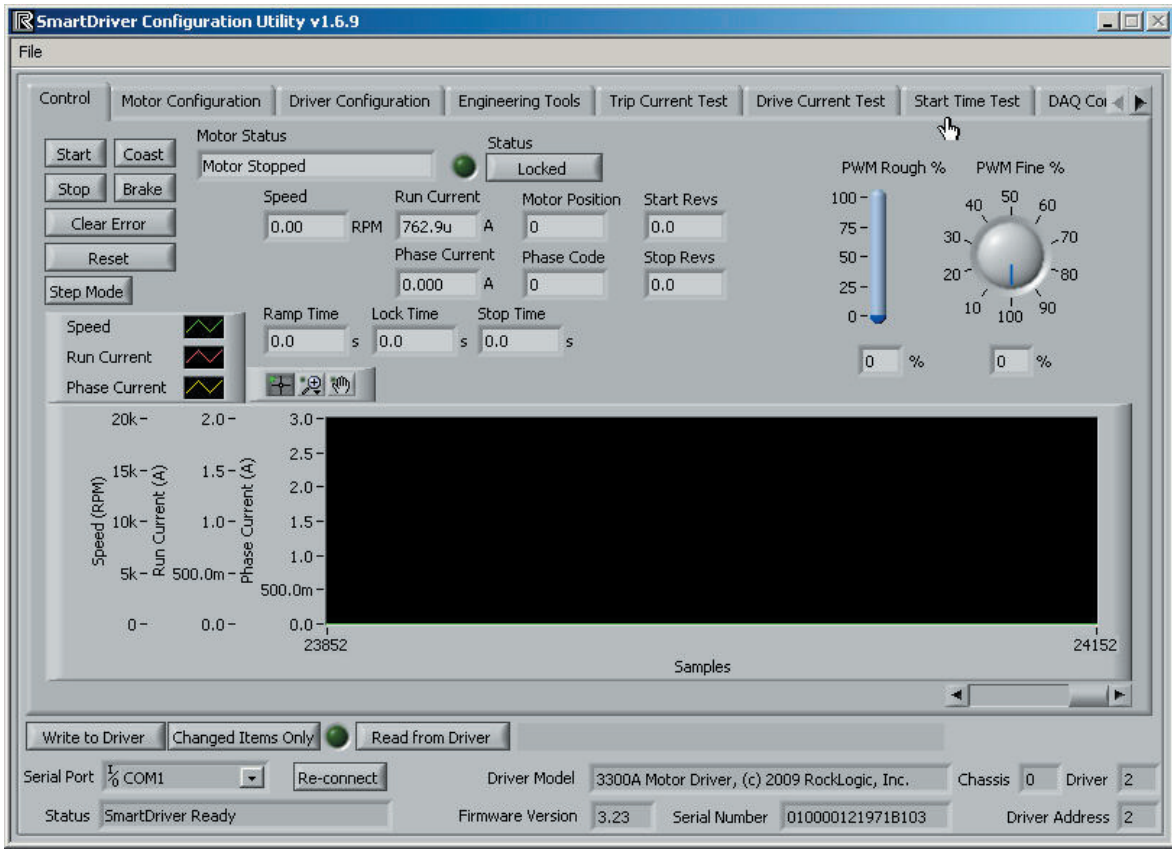
- a **Write to Driver** Button writes the configuration parameters to the Driver.
- a **Changed Items Only** Button sets if all items or just changed items are written to the driver.
- a **Read from Driver** Button uploads from the Driver the configuration parameters and displays them on the screen.

NOTE: A Read from Driver is done automatically when the utility is started.

- a **Serial Port** drop-down list to select the correct serial port
- a **Status** display indicating if the program is communicating with the Driver.
- the **Driver Firmware Version** number
- the Driver **Serial Number**.
- Reconnect: reconnects the SmartDriver Configuration Utility to the Driver

Control Screen

To open the Control screen, click on the **Control tab.**



The Control screen includes commands for operating the Driver and fields that display status and measurement information. NOTE: Graph scales may be changed by double-clicking on the maximum or minimum scale value.

The sections below explain the function of each part of the Control screen. For operation, see Chapter Two.

Start Button

Clicking on this button places the Driver in Run Mode, which will Start and Run the motor.

Clicking on this button is equivalent to pressing the **Start- Stop** button on the front panel of the Driver when the motor is off.

Stop Button

Clicking on this button turns off the power to the motor and turns on the dynamic brake. This mode will stop the motor very quickly. The Driver atuomatically transitions to OFF after the motor stops.

Clicking on this button is equivalent to pressing the **Start- Stop** button on the front panel of the Driver when the motor is running.

Coast Button

Clicking on this button turns off the power to the motor, but without turning on the dynamic brake. The Driver will remain in this state until the you click on the **Run, Brake, or Stop** button.

This mode may be useful for detecting the motor's BEMF.

Brake Button

Clicking on this button turns off the power to the motor and turns on the dynamic brake. This mode will stop the motor very quickly. The Driver will remain in this state until you click the **Stop** button.

Clear Error Button

Clicking on this button clears an Over-current Limit error, a Time Limit error, or a Stall error.

NOTE: If any errors occur, the motor cannot be restarted unless the error is cleared.

Reset Button

Clicking on this button resets the Driver.

Step Mode Button

Clicking on this button puts the Driver in Step Mode.

Motor Status Field

This field shows the status of the motor including Stopped, Ramping, Locking, Locked, and Autobrake. It also shows Over-Current Limit, Time Limit error, or Stall error.

Speed Locked Light

The Speed Locked light turns green when the Driver is in the Speed Locked state.

The remaining fields on the Control screen display motor measurement information.

Speed

This field displays the motor speed in Revolutions Per Minute (RPM).

Start Time

The amount of time it takes for the motor to reach the target speed.

This measurement is in Seconds (S).

Run Current

This field displays the run current in Amps (A) measured across the sense resistor.

Phase Current

This field displays the motor phase current in Amps (A).

Motor Position

This field displays the motor's electrical position in start mode (1,2,3,4,5,6).

Phase Code

This field displays the motor's electrical phase sequence position in start mode (1,3,2,6,4,5).

Start Revs

This field displays the motor revolutions during start, up to the speed specified on the Driver Configura-

tion tab/Start Revs—Stop Count speed.

Stop Revs

This field displays the motor revolutions during stop, when below the speed specified on the Driver configurations tab/Stop Revs—Start Count speed.

PWM Rough % and PWM Fine % Fields and Indicators

These two fields and indicators display the output setting of the two PWM values that control the motor current.

Graph

Speed Trace

This trace displays the motor speed in RPM (Revolutions Per Minute) over Time.

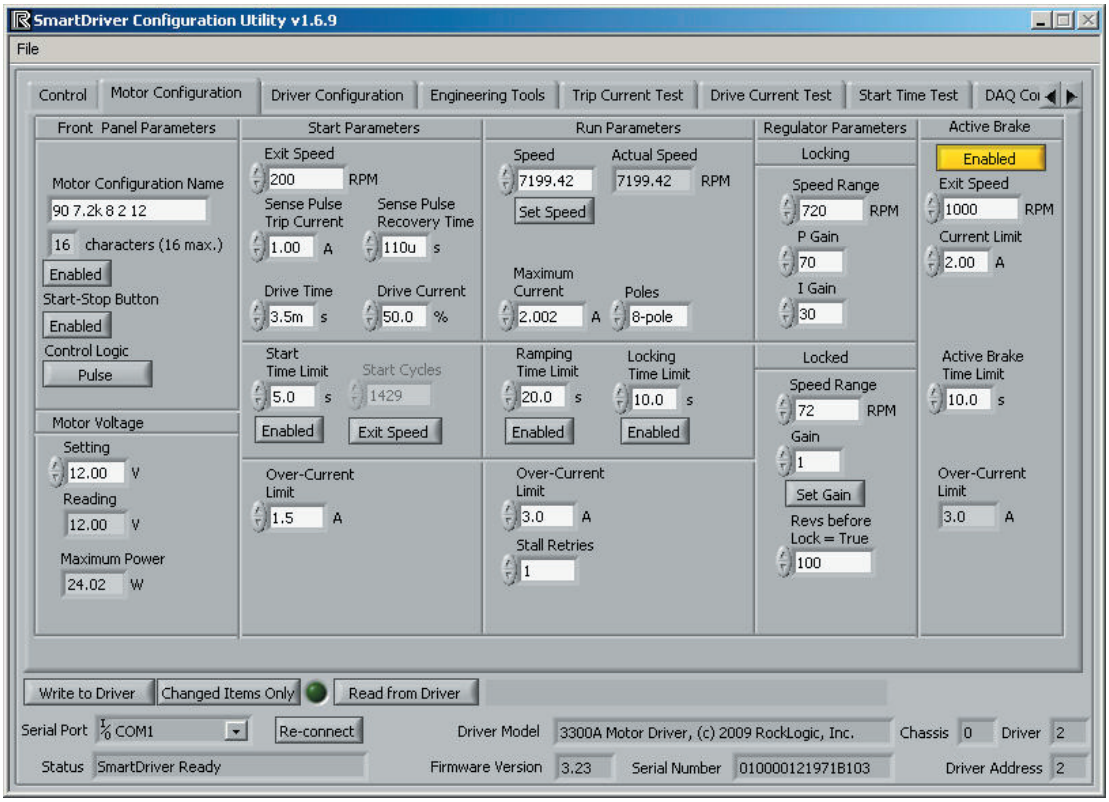
Run Current Trace

This trace displays the run current in Amps (A) over Time.

Phase Current Trace

This trace displays the phase current in Amps (A) over Time.

Motor Configuration Screen

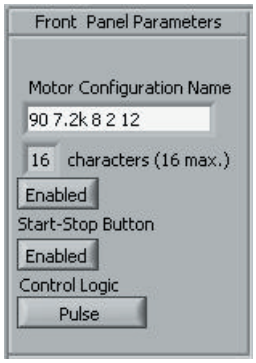


To open the Motor Configuration screen, click on the Motor **Configuration tab.**

File Menu: Clicking on this will open a saved .cfg configuration file and display the configuration parameters on the screen.

Save: This saves the configuration parameters to a disk file with a .cfg default extension.

Exit: Exit SmartDriver Configuration Utility.



Front Panel Parameters

Motor Configuration Name

This field defines what is displayed on the bottom line of the Driver front panel LCD when the motor is stopped. Any alphanumeric string up to 16 characters can be used (i.e., MotorName v1.00). Spaces at the beginning, in the middle, or at the end of the string count as characters.

TIP Displaying the Driver configuration can avoid running, and possibly damaging, an incompatible motor.

Characters (16 max.)

This field displays the number of characters in the current *Motor Configuration Name* field.

Motor Configuration Name **Enabled/Disabled** Toggle

Clicking on this button toggles between Enabled and Disabled to display or not display the *Motor Configuration Name* on the Driver front panel LCD when the motor is stopped.

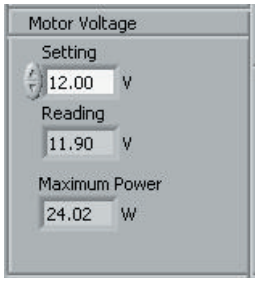
Start-Stop Button **Enabled/Disabled** Toggle

This button is a toggle to Enabled or Disabled the Start-Stop button on the front panel of the Driver.

Control Logic Button

When set to pulse, pushing and releasing the Start-Stop button starts and stops the motor.
When set to level, pushing the button starts the motor and releasing stops the motor.

NOTE: If the Start-Stop button is disabled, the motor can only be started or stopped using the Serial-command mode through the Control screen (discussed above and in Chapters Two and Four).



Motor Voltage

Setting

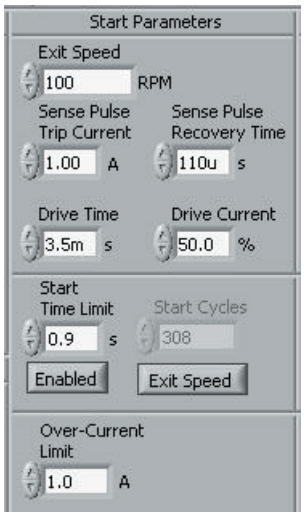
Set for desired motor voltage

Reading

Driver reading of the set voltage

Maximum Power

The maximum power required for maximum current at the set voltage



Start Parameters

Exit Speed

The speed at which the motor exits Start state. Units are Revolutions Per Minute (RPM).

Sense Pulse Trip Current

The peak current of the Sense Pulses. Units are in Amps (A).

Sense Pulse Recovery Time

The time between the end of one sense pulse and the beginning of the next sense pulse. Units are in microseconds (uS).

Sense and Drive Time

The time for each sequence of position sense pulses and motor driving. Units are in milliseconds (mS).

Drive Current

The PWM duty-cycle during the motor drive after each sense pulse sequence. This duty-cycle sets the drive current. The drive current is dependent on this duty-cycle and the motor inductance, and is determined empirically. Units are in percentage (%) of maximum current.

StartTime Limit **Enabled/Disabled** Toggle

The start time limit, if Enabled, sets the maximum time allowed for the motor to reach the start-state Exit Speed. Units are in seconds (S).

Exit Speed/Start Cycles Toggle

Start Cycles, if enabled, sets the fixed number of start cycles executed before exiting start state into run state.

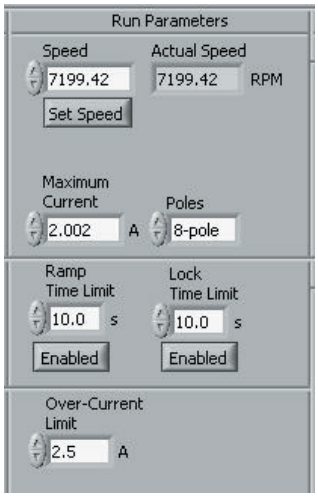
NOTE: If the motor does not reach the recorded speed within the Time Limit, the current to the motor is turned off and the message “Start Error: Time Expired” is displayed in the *Motor Status* field at the top of the Control screen, and on the front panel LCD of the Driver.

The error can be cleared either by clicking on the **Clear Error** button on the Control screen, or by pressing the **Start-Stop** button on the front panel of the Driver.

Over-current Limit

The over-current limit sets the maximum allowed current during start state. Units are in Amps (A).

NOTE: If the current exceeds the speified limit, the current to the motor is turned off and the message “Start Error: Over-Current” is displayed in the *Motor Status* field at the top of the Control screen, and on the front panel LCD of the Driver.



Run Parameters

Speed

The requested speed at which the motor runs. Units are Revolutions Per Minute (RPM).

Actual Speed

The closest available speed to the requested run speed. Units are Revolutions Per Minute (RPM).

Set Speed Button

Writes the speed specified in the *Actual Speed* field to the driver.

NOTE: This speed is stored in SRAM and therefore is not maintained if the driver is reset or the power is cycled. If permanent storage of the speed setting is desired, push **Stop** on the Control tab, then push the **Write to Driver** button on the configuration tab to store the value in EEPROM. (See Chapter Three: Driver Operation).

Maximum Current

Specifies the Maximum Current driven through the motor during Ramping, Locking, or Locked state. Units are in Amps (A).

NOTE: This is a closed-loop constant-current control used to protect the motor from damage while providing sufficient current to quickly ramp the motor up to the Run Speed.

TIP If insufficient current is specified, the motor will never reach the desired Run Speed.

Poles

The number of motor poles: 4, 6, 8, or 12.

Ramp Time Limit **Enabled/Disabled** Toggle

The time limit, if enabled, sets the maximum time allowed for the Ramp sequence. Units are in seconds (S).

NOTE: If the motor does not reach the recorded speed within the Time Limit, the current to the motor is turned off and the message “Run Error: Ramp Time Expired” is displayed in the *Motor Status* field at the top of the Control screen, and on the front panel LCD of the Driver.

Lock Time Limit **Enabled/Disabled** Toggle

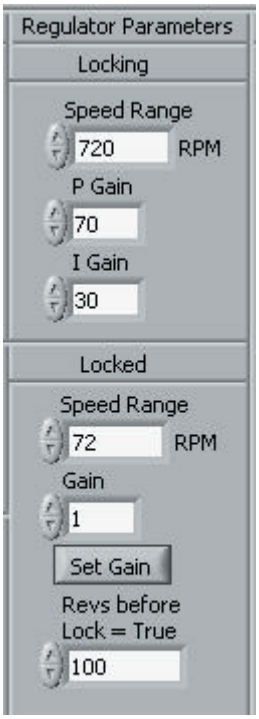
The time limit, if enabled, sets the maximum time between the end of the Ramp state (when the motor reaches the Run Speed) and Speed Lock. This state is called “Locking.” Units are in seconds (S).

NOTE: If the motor does not reach the specified speed within the Time Limit, the current to the motor is turned off and the message “Run Error: Lock Time Expired” is displayed in the *Motor Status* field at the top of the Control screen, and on the front panel LCD of the Driver.

Over-current Limit

The over-current limit sets the maximum allowed current during Ramping, Locking, and Locked states. Units are in Amps (A).

NOTE: If the current exceeds the specified limit, the current to the motor is turned off and the message "Run Error: Over-Current" is displayed in the *Motor Status* field at the top of the Control screen, and on the front panel LCD of the Driver.



Regulator Parameters--Locking

Speed Range

Locking Speed Range is the distance from the target speed at which the speed regulator switches into Locking state. Units are in Revolutions Per Minute (RPM).

P Gain

The Proportional gain value of the speed regulator during locking state. No units.

I Gain

The Integral gain value of the speed regulator during locking state. No units.

Regulator Parameters--Locked

Speed Range

Locked Speed Range is the distance from the target speed at which the speed regulator switches into Locked state. Units are in Revolutions Per Minute (RPM).

Gain

Locked-Gain is the increment of PWM Fine (see Control screen) used when the regulator adjusts the motor current during Locked state. Units are in Percent (%).

Set Gain Button

Clicking on this button temporarily sets the Locked Gain specified in the Gain field. Locked Gain is used to minimize speed jitter. It can be adjusted while the motor is running. **NOTE:** To make the setting permanent, press the **Write to Driver** button.

Revs before Lock=True

This field specifies the number of revolutions the motor must make within the Locked Speed Range before Lock state is entered.

Active Brake Parameters

Exit Speed

The speed active brake is exited and auto brake is entered

Current Limint

Current applied to motor during active braking

Active Brake Time Limit

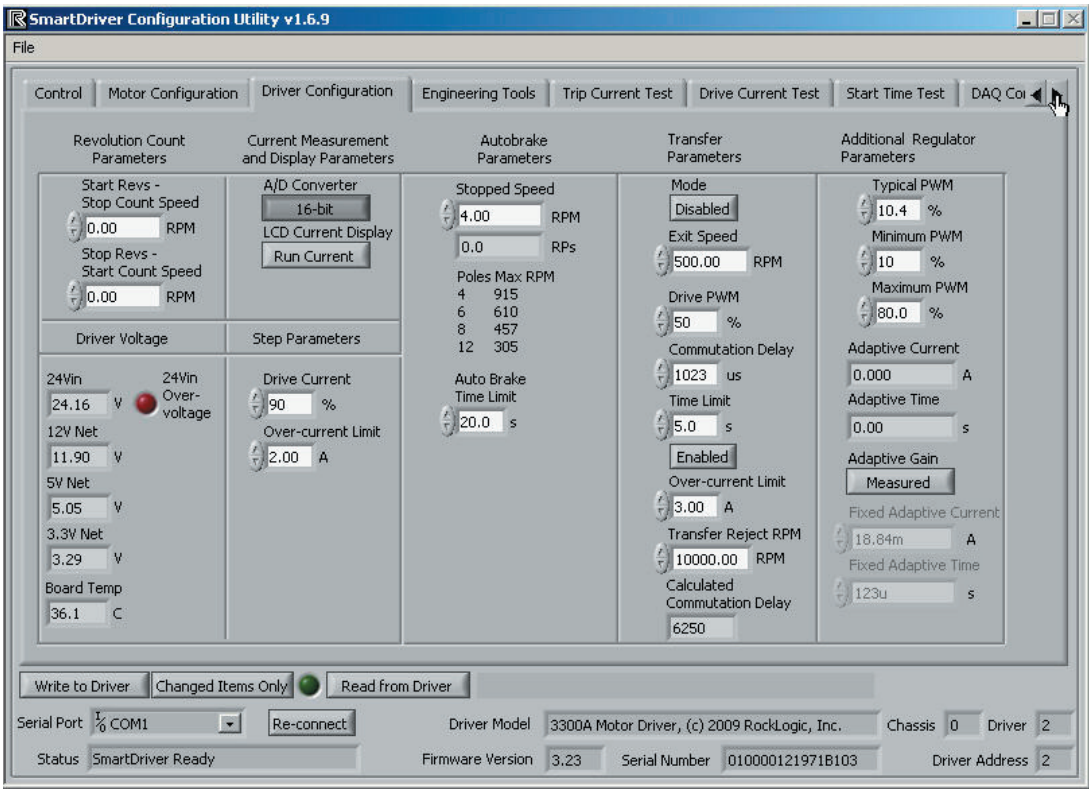
Maximum active brake time. If exceeded, autobrake will be entered.

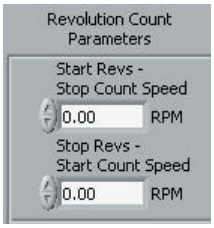
Over-current Limit

Set to the same value as Run Parameters over-current limit.

Driver Configuration Screen

To open the Driver configuration screen, hit F9 and click on the **Driver configuration** tab.





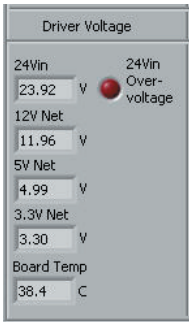
Revolution Count Parameters

Start Revs--Stop Count Speed

This field shows the speed at which revolution count is stopped when the motor is started.

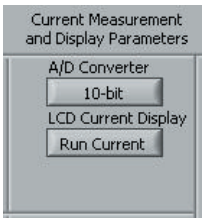
Stop Revs--Start Count Speed

This field shows the speed at which revolution count is started when the motor is stopped.



Driver Voltage

Shows measured voltage for 24VIN, 12V Net, 5V Net, 3.3V Net, the board temperature, and an over-voltage indicator for VIN (trips at 26V).



Current Measurement and Display Parameters

A/D Converter **10-bit/16-bit** Toggle

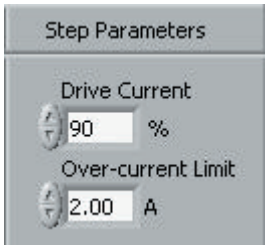
10-bit: Selects the 10-bit ADC.

16-bit: Selects the 16-bit ADC.

LCD Current Display **Run Current/Phase Current** Toggle

Run Current: Displays the run current measured across the sense resistor.

Phase Current: Displays the phase current.



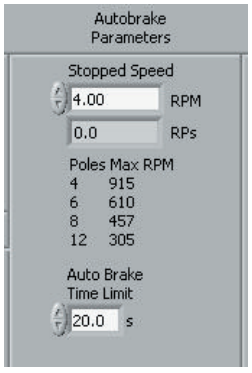
Step Parameters

Drive Current

PWM value used during step mode.

Over-current Limit

The over-curent limit sets the maximum allowable current during step mode.



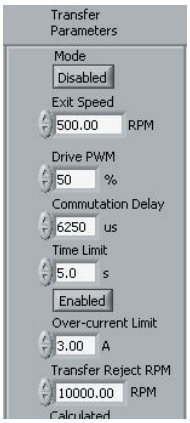
Autobrake Parameters

Stopped Speed

The speed at which the motor is considered stopped. Also acts as a time delay to extend the auto-brake time before motor is considered stopped.

Autobrake Time Limit

Maximum Autobrake time. If exceeded, stopped state will be entered.



Transfer Parameters

Transfer mode is a manual drive mode that is used to set the drive PWM used when the motor transfers from start to run modes.

Mode **Enable/Disable** Toggle

Enables/disables transfer mode

Exit Speed

The speed at which the motor exits transfer state into run state.

Drive PWM

PWM value used in transfer mode and on the transition from start to run mode.

Commutation Delay

Commutation delay used in transfer mode.

Time Limit **Enabled/Disabled** Toggle

The time limit, if enabled, sets the maximum time allowed for the motor to reach the transfer exit speed.

Over-Current Limit

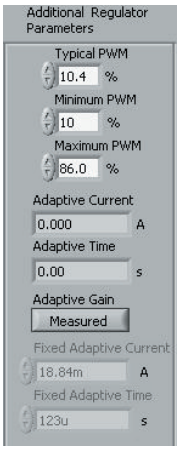
The over-current limit sets the maximum allowable current during transfer state.

Transfer Rejet RPM

The limit of acceptable RPM. Values exceeding this parameter are rejected.

Calculated Commutation Delay

The commutation delay should be set to the calculated commutation delay.



Additional Regulator Parameters

Typical PWM

Initial PWM value used when run state is first entered.

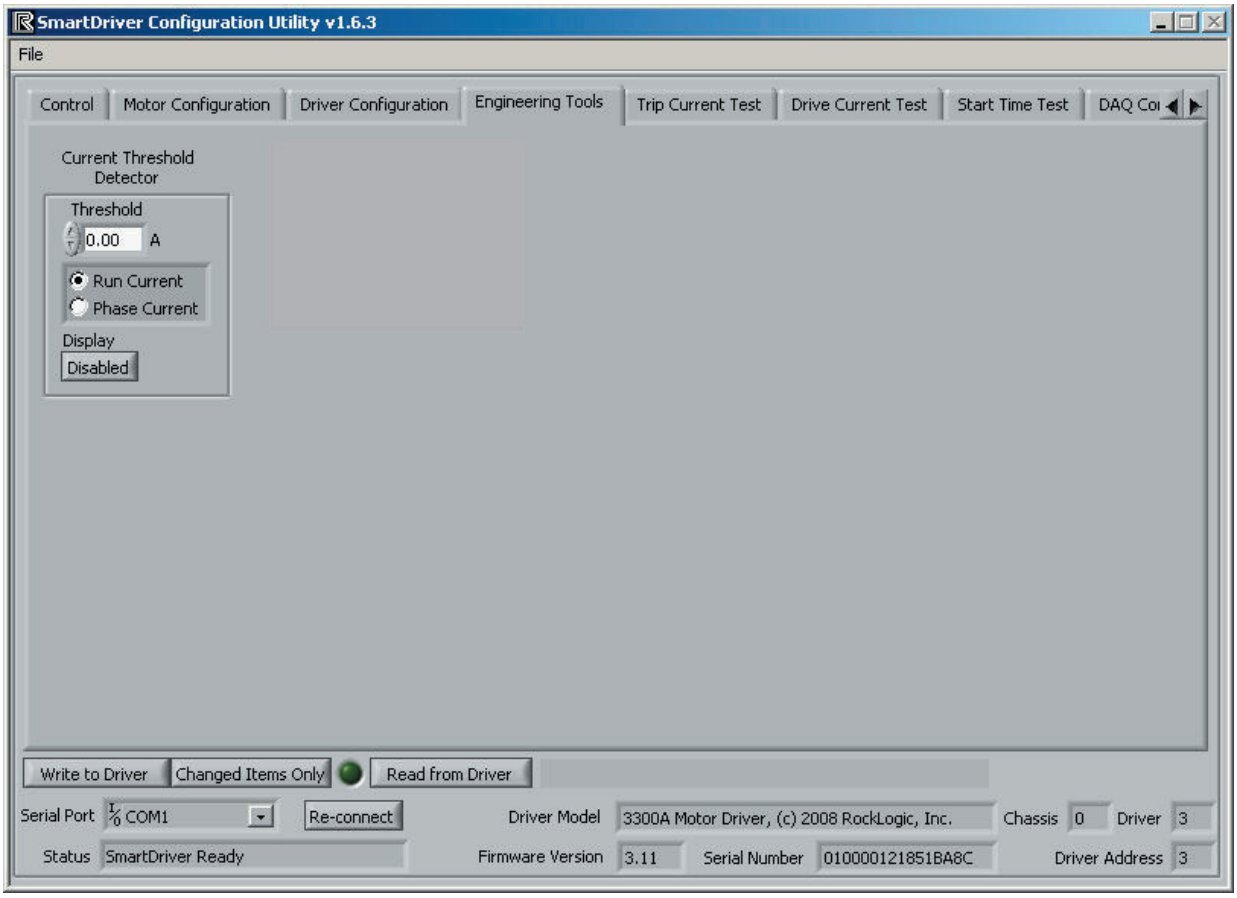
Minimum PWM

Minimum PWM value used in run state.

Maximum PWM
Maximum PWM value used in run state.
*Adaptive Curr*ent
Current value measured on motor start to adapt regulation to motor load.
Adaptive Time
Time value measured on motor start to adapt regulation to motor load.
Adaptive Gain: Measured/Fixed
Set if the adaptive gain is measured with each motor start or if the fixed adaptive current and fixed adatpive time are used.

Engineering Tools Screen

To open the Engineering Tools screen, click on the Engineering Tools tab.



Current Threshold Dectector
Threshold Field
This field specifies the current at which the indicator will turn on.
Run Current Radio Button
Clicking on this button will set the motor Run Current for comparison to the Threshold.
Phase Current Radio Button
Clicking on this button will set the motor Phase Current for comparison to the Threshold.
Display **Enabled/Disabled** Button
Clicking on this button sets whether the threshold indicator will be displayed. If Enabled, the Threshold indicator will appear on the Control tab.

CHAPTER 4: Motor Configuration Procedure

Motor type used in this example: 15KRPM, 4-disk, 3.5inch, 6-pole

Note on data entry: the fields of the Configuration Utility are SI notation. This means that for 15mS, it is entered and displayed and 15m. If 0.015 is entered, it will still be displayed as 15m.

Front Panel Parameters

Enter whatever string desired for the **Motor Configuration Name**. This string will be displayed on the driver LCD.
If the **Motor Configuration Name** is disabled, it will not show on the LCD, but will still be stored in the Driver.
The **Start-Stop** button can be disabled.

Start Parameters--Position Sense Configuration

NOTE: the signals are found on the Data Acquisition Port. See Appendix A.
Oscilloscope setup:

- Channel 1 to signal **RSH3K** with the scope ground connected to **DGND**. Set to 50mV/div.
- Channel 2 to signal **TRIGGER** with the scope ground connected to **DGND**. Set to 5V/div
- Set the time-base to 100uS/div
- Trigger the scope off Channel 2.

On the **Configuration** tab, set the Start Parameters to initial values:

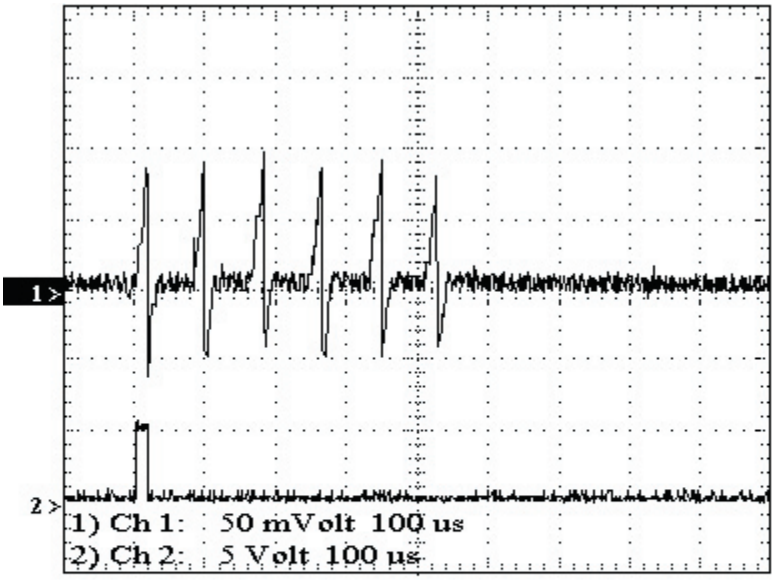
Exit Speed: 10,000 RPM
This will stop exit from Start Mode during configuration.
Sense Pulse Trip Current: 1A
This is a good initial value. **NOTE:** this is not the average current driven through the motor. It is a very short peak current; the average motor current should be quite low.
Sense Pulse Recovery Time: 64uS
This is a good initial value.
Sense and Drive Time: 2.0mS
This is a good initial value.
Drive Current: 0.0%
Keeps the motor from moving during configuration.
Start Time Limit: Disabled
This will stop a “Start Error: Time Expired” error during configuration.
Over-Current Limit: 1.0A
This will be adjusted after it is determined what the current draw is in Start Mode.

Press the **Write to Driver** button to write the changes to the Driver EEPROM. **NOTE:** whenever a configuration value is changed, the **Write to Driver** button must be pressed to write into the Driver’s EEPROM.

On the **Control** tab, press the **Start** button.

- The oscilloscope display should now look something like this:
  Position Sense Pulses on channel 1.
  Trigger on channel 2.

Start Parameters – Position Sense Configuration, cont.

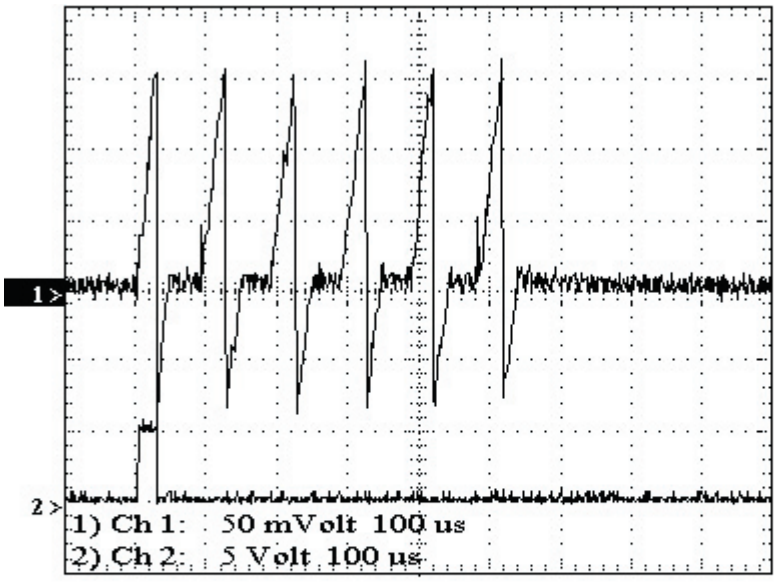


Now rotate the motor by hand in the forward direction (CCW or CW depending on motor design). If the pulses are high enough, you should see:

- The first pulse getting longer when the second pulse is getting shorter, and vise-versa.
- The third pulse getting longer when the fourth pulse is getting shorter, and vise-versa.
- The fifth pulse getting longer when the sixth pulse is getting shorter, and vise-versa.
- **Position** on the **Control** tab changing consistently through the sequence 1, 2, 3, 4, 5, 6, 1, 2, 3….
  NOTE: if the sequence is 6, 5, 4, 3, 2, 1, reverse any two phase wires.

If the **Motor Position** is not stable, increase the **Sense Pulse Trip Current**. Make sure the run current does not exceed the motor rating.

Sense Pulse Trip Current increased to 2A:



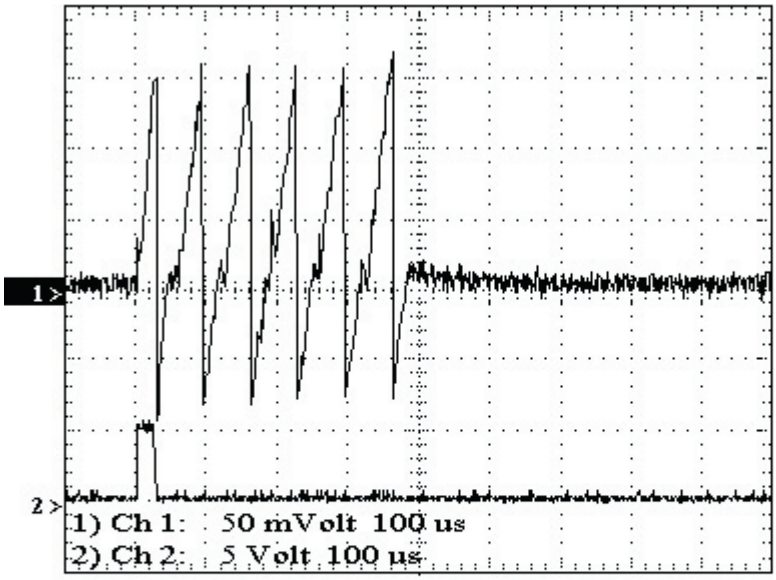
Start Parameters – Position Sense Configuration, cont.

Position on the **Control** tab now changes consistently through the sequence 1, 2, 3, 4, 5, 6, 1, 2, 3….
Continue adjusting **Sense Pulse Trip Current** on your driver until the Position sequence is stable.

- If the current is set too low, the position cannot be detected.
- If the current is set too high, the motor will saturate the position sequence will become unstable, and the run current will increase dramatically.

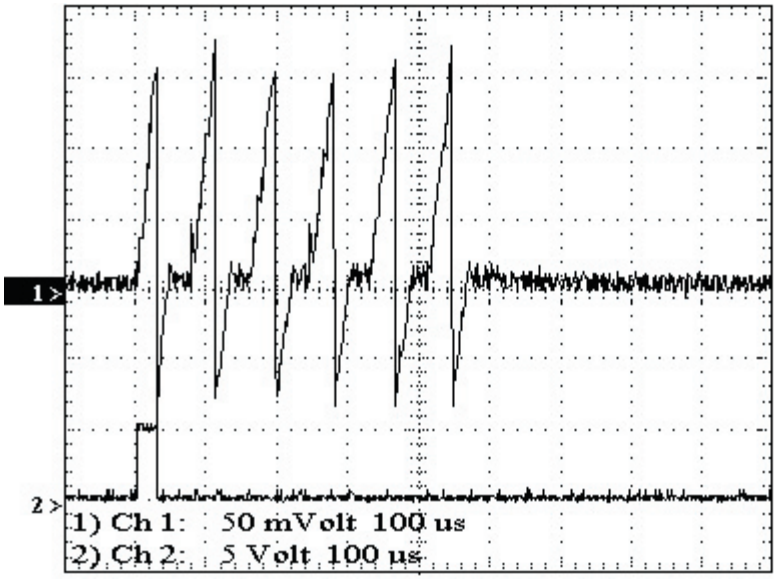
The **Sense Pulse Recovery Time** can now be optimized. This is the time between the end of a sense pulse and the start of the next one. It is now set to 64uS, and as can be seen on the above waveform, can be reduced.

The time was reduced to 32uS:



This time is too short because there is not always time between pulses.

Increase time to 50uS

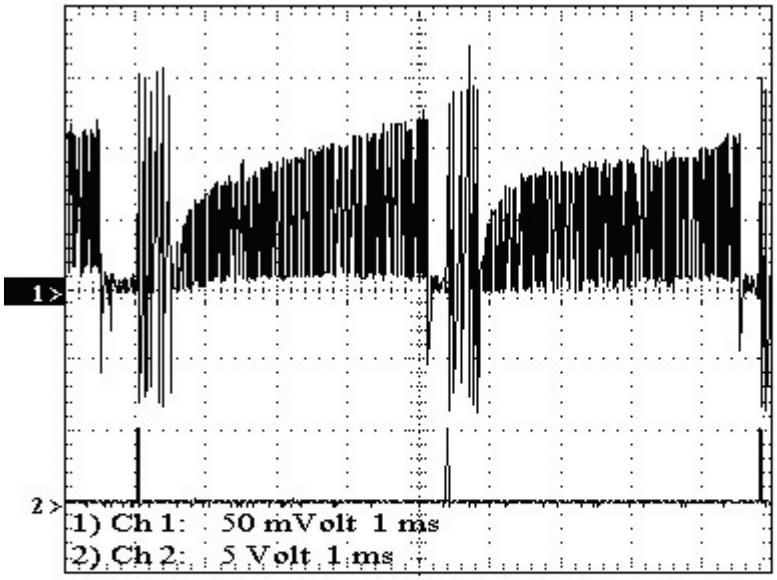


50uS gives enough time between each pulse.

Start Parameters--Drive Current Configuration

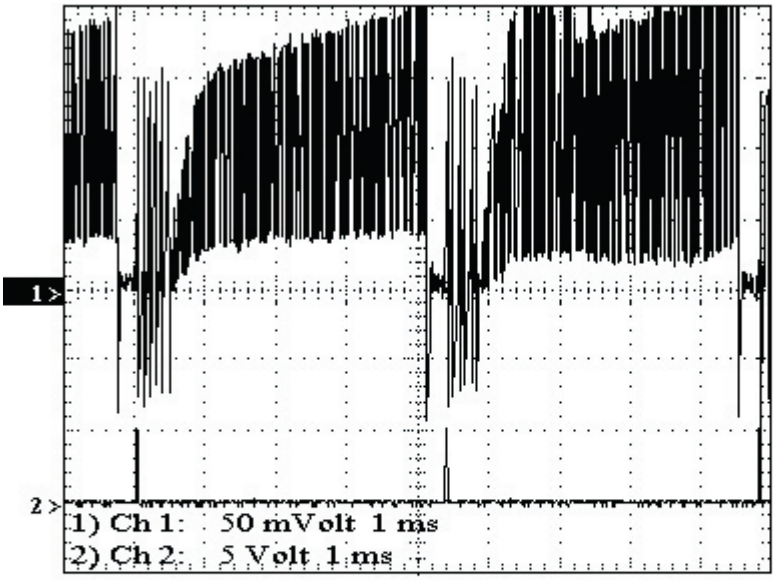
Now that the position sensing is working, we can apply some **Drive Current** to get the motor spinning.

- The **Drive Current** is specified in % of maximum current. The maximum current is dependant on the motor type and voltage.
- Set the **Drive Current** to 10%.
- Press **Start** on the Control screen.
- The motor should start spinning.
- Note the drive current after the sense pulses.



If the motor does not spin, or has low torque or speed, incrementally increase the **Driver Current** until there is good torque but maximum run current is not exceeded.

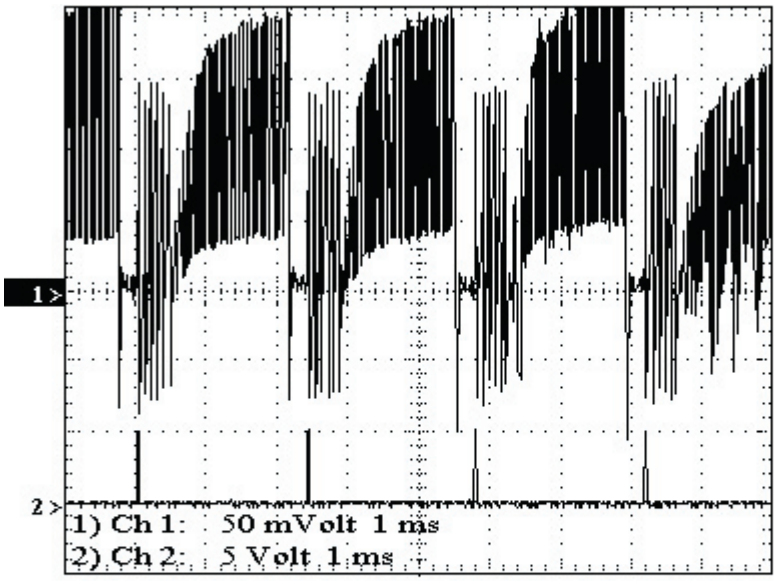
The drive current was set to 20% to increase torque and speed:



Start Parameters--Sense and Drive Time Configuration

The **Sense and Drive Time** controls the total length of each cycle including the six position sense pulses and driving the motor.

- If set too short, the motor will not be driven long enough and will have low torque and speed. (Remember, the amount of torque is also dependant on the **Drive Current**)
- If set too long, the motor rotates passed the energized position which causes reverse torque. This causes instability, limits speed, and causes an erratic **Tach** and **Index** signals affect proper transition into Run mode.
- Set the **Sense and Drive Time** to 2mS. This looks good because there is sufficient drive time to apply enough current to the motor for good torque, yet the drive time is relatively short, which keeps the **Tach** and **Index** signals stable.



Start Parameters--Over-Current Limit

With the motor running, note the Run Current on the Control tab.
Stop the motor and enter 2X the Run Current for the Over-Current Limit.

Start Parameters--Exit Speed Configuration

When the motor reaches **Exit Speed**, it will exit Start Mode and transition into Run mode.

- Typically, this speed should be set as low as possible. At higher speeds, the position sense pulses may become unstable. This can cause errors transferring to Run mode.
- If set too low, the motor may not transition properly into Run mode because it is not going fast enough.
- An **Exit Speed** of 100RPM should work in most cases.

Start Parameters--Start Time Configuration

Enable Start Time Limit.

- It should be set to a value that exceeds the time it takes the motor to exit from Start Mode.
- A **Start Time Limit** of 5 seconds should work in most cases.

Run Parameters--Speed

Enter the motor Speed. The Actual Speed will display the closest possible speed to your entry.
The **Set Speed** button allows the speed to be changed while the motor is running. **NOTE:** this value is only written to temporary memory (SRAM). In order to write the value permanently to the driver, press the **Write to Driver** button.

Run Parameters--Maximum Current

Enter the **Maximum Current** that will be driven through the motor during Run Mode. If possible, this value should come from the motor specification.

If this value is set too low, the motor:

- May never reach the target speed.
- Will not lock quickly, if at all, to the target speed.
- May reach the target speed without the Run Current dropping below Maximum Current before speed lock. This sequence is required for proper speed regulation.

If this value is set too high, the motor:

- May saturate, causing unstable speed regulation.
- May cause damage to motor windings.

Run Parameters--Poles

Set to the number of motor poles, 4, 6, 8, or 12.

Run Parameters--Ramp Time Limit

Set to a value larger than the longest Ramp Time. 10 Seconds will work for most cases.

Run Parameters--Lock Time Limit

Set to a value larger than the longest Lock Time (Locking state). 10 Seconds will work for most cases.

Run Parameters--Over-Current Limit

Set 50% higher than the **Maximum Current**

Regulator Locking Parameters--Speed Range

Set to 10% of the Run **Speed**.

Regulator Locking Parameters--P Gain

Start at 70.

Regulator Locking Parameters--I Gain

Start at 30.

Regulator Locked Parameters--Speed Range

Set to 1% of the Run **Speed**. Then increase if necessary up to 3% if the motor will not lock.

Regulator Locked Parameters--Gain

Typically left at 1. With some motors, adjusting this value may improve speed jitter.
The **Set Gain** button allows the gain to be changed while the motor is running. Note that this value is only written to temporary memory (SRAM). In order to write the value permanently to the driver, press the **Write to Driver** button.

Regulator Locked Parameters--Revs before Lock=True

Typically this can be left at 100. For very small motors, the minimum value of 18 may be required.

Active Brake Parameters -- Enable/Disable

Set to Enable to enable the Active Brake feature.

Active Brake Parameters – Exit Speed

Set to the speed that Active Brake will exit into Autobrake. 1000RPM is a good starting point.
If this speed is set too low, the motor may stop and then run backward until the Active Brake Time Limit.

Active Brake Parameters – Current Limit

Set to the amount of motor current during the Active Brake mode. 1Amp is a good starting point.

Active Brake Parameters – Active Brake Time Limit

Set to the maximum time Active Brake mode should be continued if the exit into Autobrake does not occur properly. 10sec is a good starting point.

Active Brake Parameters – Over-Current Limit

This is automatically set to Run Parameters – Over-Current Limit.

Select the Driver Configuration tab for the next set of parameters

Revolution Count Parameters – Start Revs – Stop Count Speed

Set this to the speed where starting revolutions should stop being counted.

Revolution Count Parameters – Stop Revs – Start Count Speed

Set this to the speed where stopping revolutions should start being counted.

Current Measurement and Display Parameters – A/D Converter

Set the desired A/D converter resolution, 10-bit or 16-bit. 16-bit provides more accurate run current measurement and should always be used, especially for smaller, low current motors.

Current Measurement and Display Parameters – LCD Current Display

Set to Run Current to display the motor run-current on the LCD.
Set to Phase Current to display the motor phase-current on the LCD.

Autobrake Parameters – Stopped Speed

Set this to the motor speed where the driver should exit from Autobrake into Stopped. Lower this value if the motor is still spinning when the driver indicates that the motor is stopped.

Autobrake Parameters – Autobrake Time Limit

Set to the maximum time Autobrake mode should be continued if the exit into stopped does not occur properly. 10sec is a good starting point.

Transfer Parameters – Mode

Enable Transfer mode.

Transfer Parameters – Exit Speed

Set to the speed to 100000RPM so Transfer mode will not be exited.

Transfer Parameters -- Drive PWM

Set this to 20% as a good starting point.

Transfer Parameters – Commutation Delay

Set this to the calculated commutation delay. If the motor slows down between start and ramping states, lower this value for a smooth transition.

Transfer Parameters – Time Limit

Disable the Time Limit.

Transfer Parameters – Over-current Limit

Set this to the same value as Run Parameters – Maximum Current.

Transfer Parameters – Transfer Reject RPM

Set this to a default of 50000RPM

- Start the motor and insure it enters Transfer Mode without stalling.
- Adjust Drive PWM to set the Run Current to the desired value.
- Disable Transfer Mode.

Additional Regulator Parameters – Typical PWM

Set this to a default of 10%

Additional Regulator Parameters – Minimum PWM

Set this to a default of 10%. This value may need to be lowered for very low speed running.

Additional Regulator Parameters – Maximum PWM

Set this to a default of 86%. Lower this value if the motor speed gets erratic when trying to enter Locking state.

Additional Regulator Parameters – Adaptive Current and Adaptive Time

If Adaptive Gain is set to Measured, these values are measured each time the motor is started and used to regulate the motor speed.

Additional Regulator Parameters – Fixed Adaptive Current and Fixed Adaptive Time

If Adaptive Gain is set to Fixed, these values are used to regulate motor speed.

These values should be set to the measured values after the motor is started and run at full speed. This feature is typically used if the motor speed is much lower than the standard motor speed (5400RPM, 7200RPM, etc.)

CHAPTER 5: Motor Configuration Procedure with the NI USB-6251
(3100X, 3200X, 3300X)

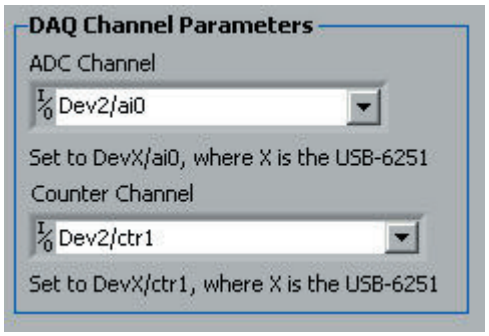
In this chapter you will learn about using the DAQ Interface.

SETUP

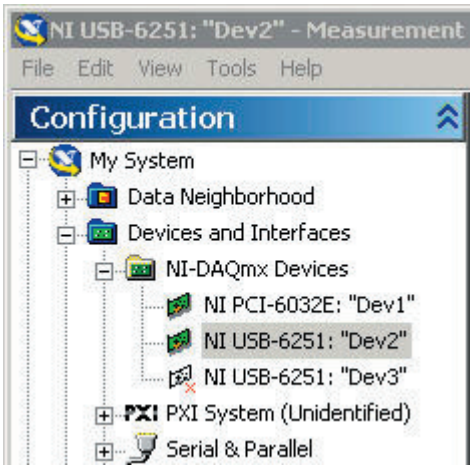
1. In the SmartDriver Configuration Utility, insure the correct Serial Port is selected and that Status is SmartDriver Ready.

2. Insure that the READY light is lit on the front of the USB-6251.

3. Insure that the device for the USB-6251 is correctly selected on the DAQ Configuration tab.



4. If there is more than one device in your system, the device number of the USB-6251 can be determined using NI's Measurement and Automation (MAX) application. Look under My System/Devices and Interfaces/NI-DAQmx Devices. The NI USB-6251 will be listed along with its device number.



PROCEDURE starts next page...

MOTOR CONFIGURATION PROCEDURE

1. Determine Motor Parameters

NOTE: We will use a 7200RPM, 400mA, 8-pole, 3.5inch motor for demonstration purposes.

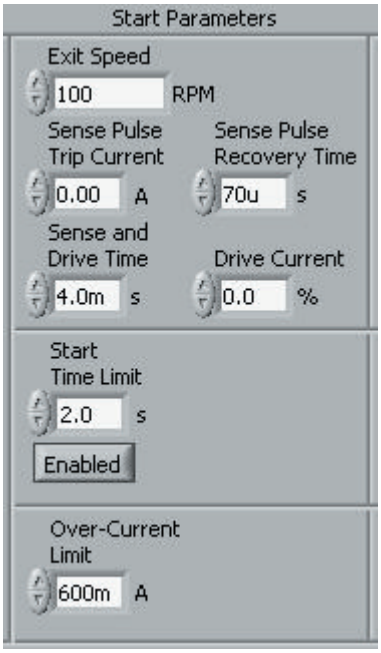
Determine the following motor parameters from the motor specifications data sheet:

- Speed = 7200RPM
- Run Current = 400mA
- Poles = 8

2. Set Start Parameters

Set Start Parameters to initial values:

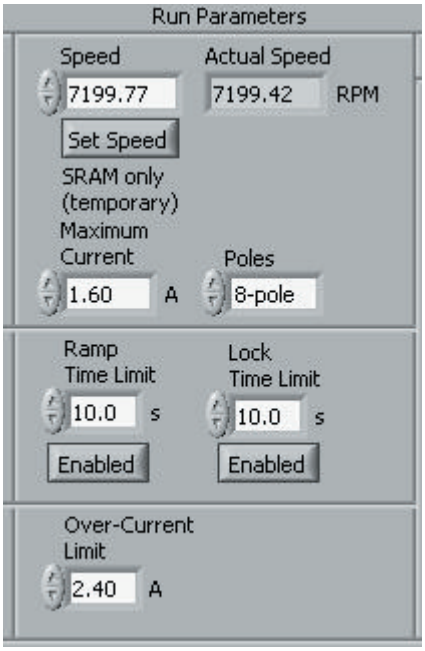
- Exit Speed = 100RPM
- Sense Pulse Trip Current = 0.00A
- Sense Pulse Recovery Time = 100us
- Sense and Drive Time = 4.0ms
- Drive Current = 0%
- Start Time Limit = 2.0s
- Over-Current Limit = 400mA * 1.5



3. Set Run Parameters

- Speed = 7200RPM
- Maximum Current = 400maA * 4
- Poles = 8
- Ramp Time Limit = 10s
- Lock Time Limit = 10s
- Over-Current Limit = 400mA * 6

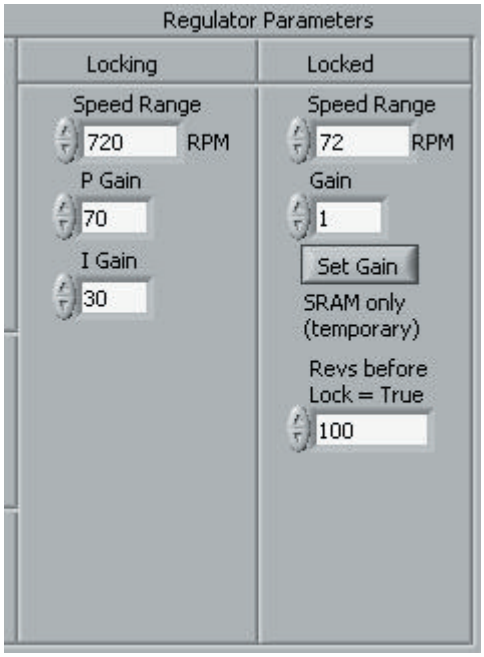
See example next page...



4. Set Regulator Parameters

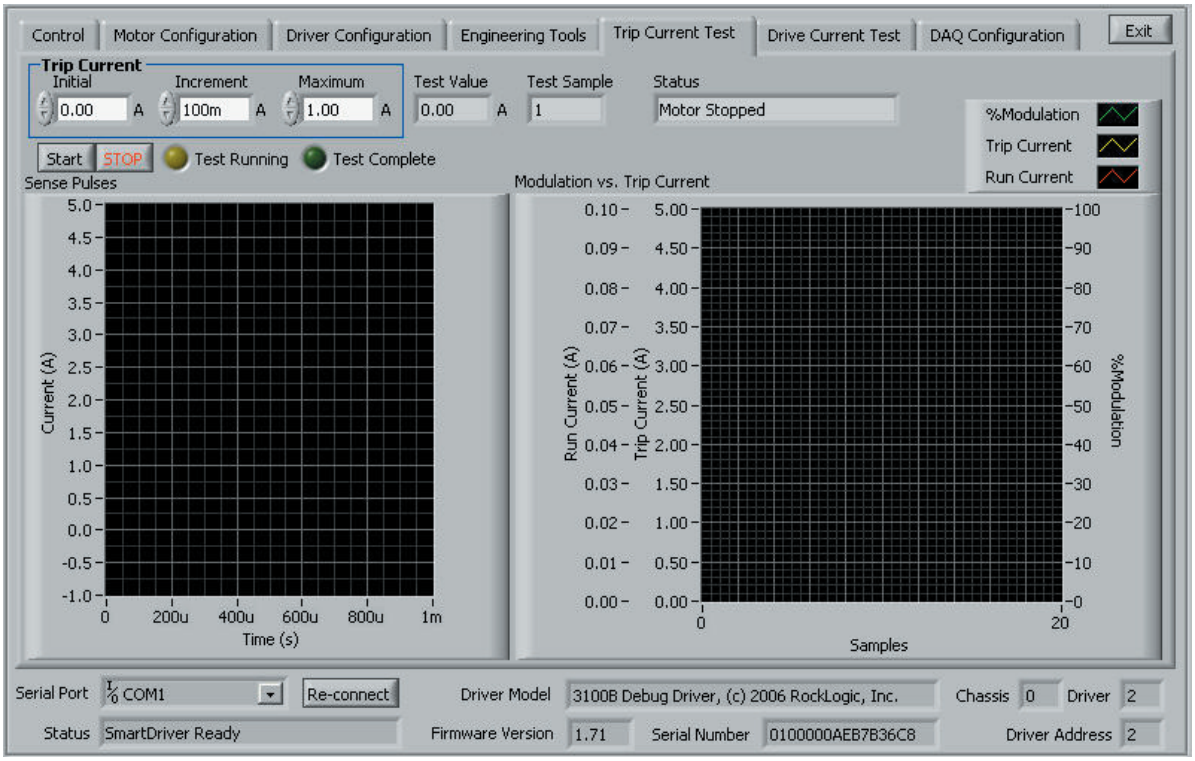
Locking
- Speed Range = 7200RPM * 10%
- P Gain = 70
- I Gain = 30

Locked
- Speed Range = 7200RPM * 1%
- Gain = 1
- Revs before Lock = True 100



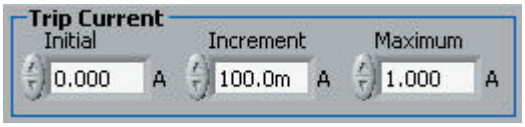
5. Trip Current Test

Using the Trip Current test to determine the Start Parameters - Sense Pulse Trip Current



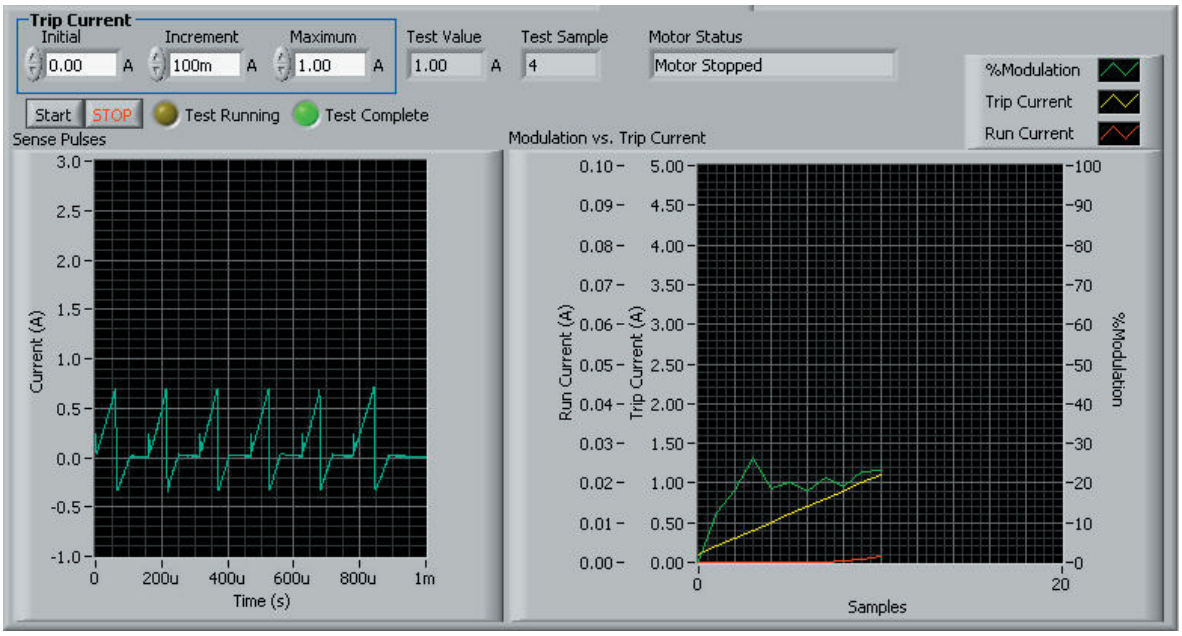
- Set the DAQ box front panel switch to “Trig.”

- Set Trip Current Parameters. The default Trip Current - Initial, Increment, and Maximum are good initial test values. After the first test, these values can be adjusted as necessary
  - Trip Current - Initial = 0A
  - Trip Current - Increment = 100mA
  - Trip Current - Maximum = 1A

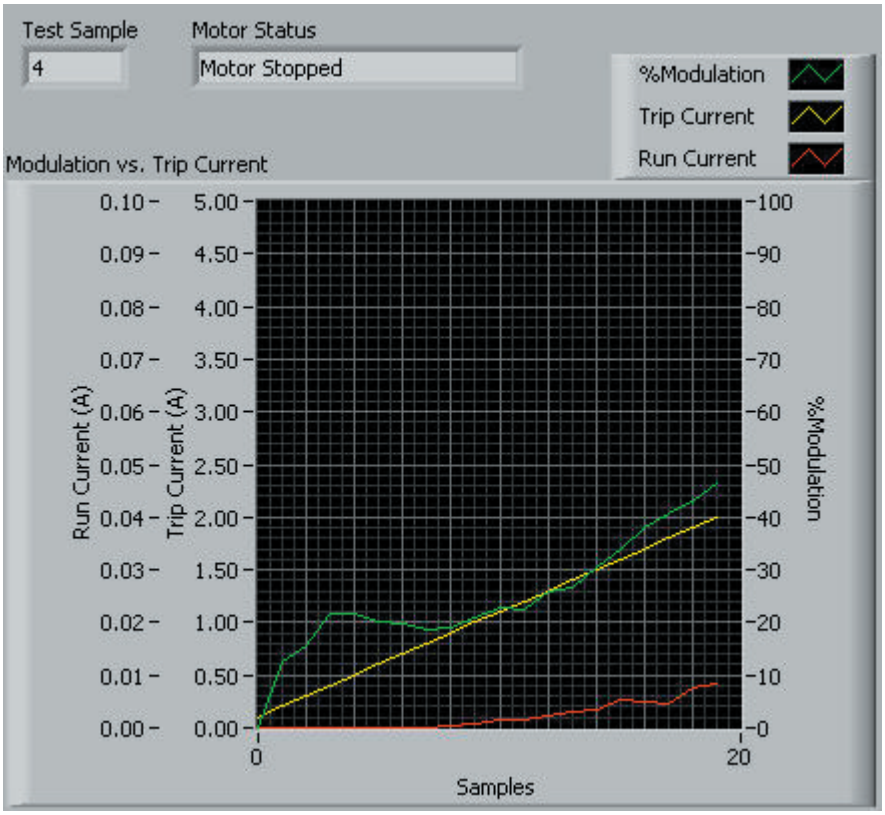


- Start the test and observe the Modulation vs. Trip Current graph

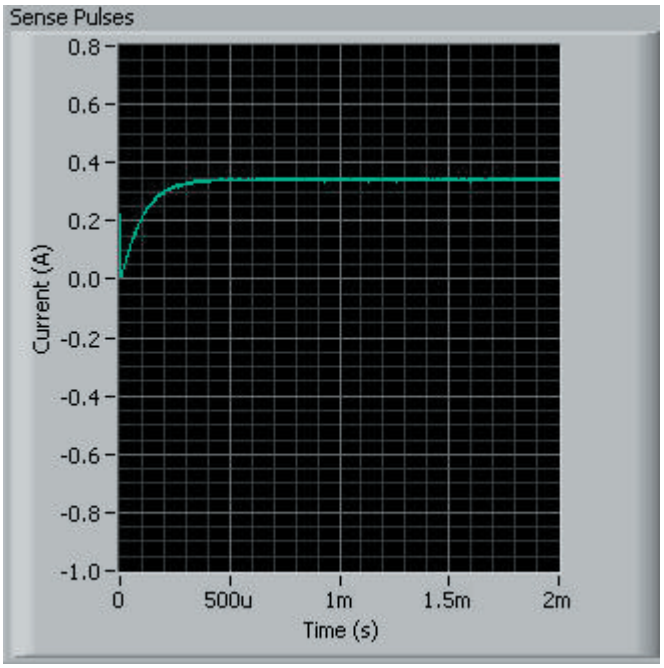
  See next page for graph...



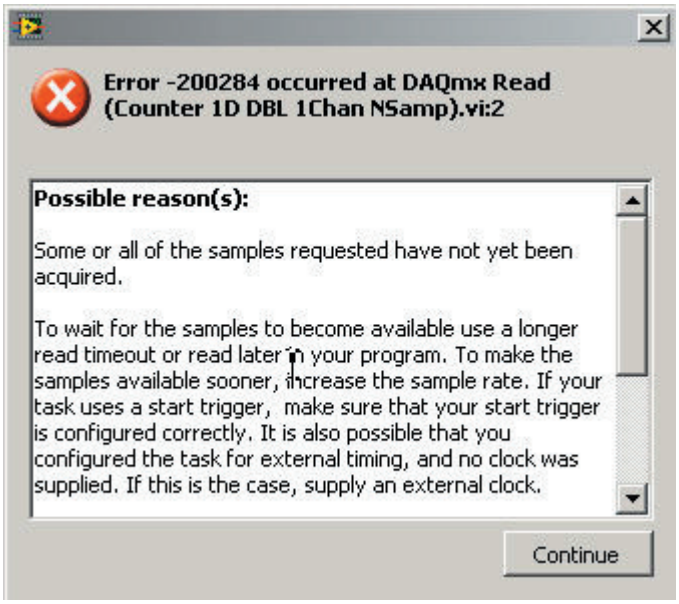
- Note that the %Modulation is typically unstable at low current and becomes more stable as the current increases.
- As current increases, %Modulation stabilizes and then begins to rise.
- If the %Modulation does not stabilize you may need to increase the Trip Current - Maximum.



- If you enter a Trip Current - Maximum that is greater than what the motor is capable of, the trip does not occur and you will not see the typical 6 Sense Pulses.



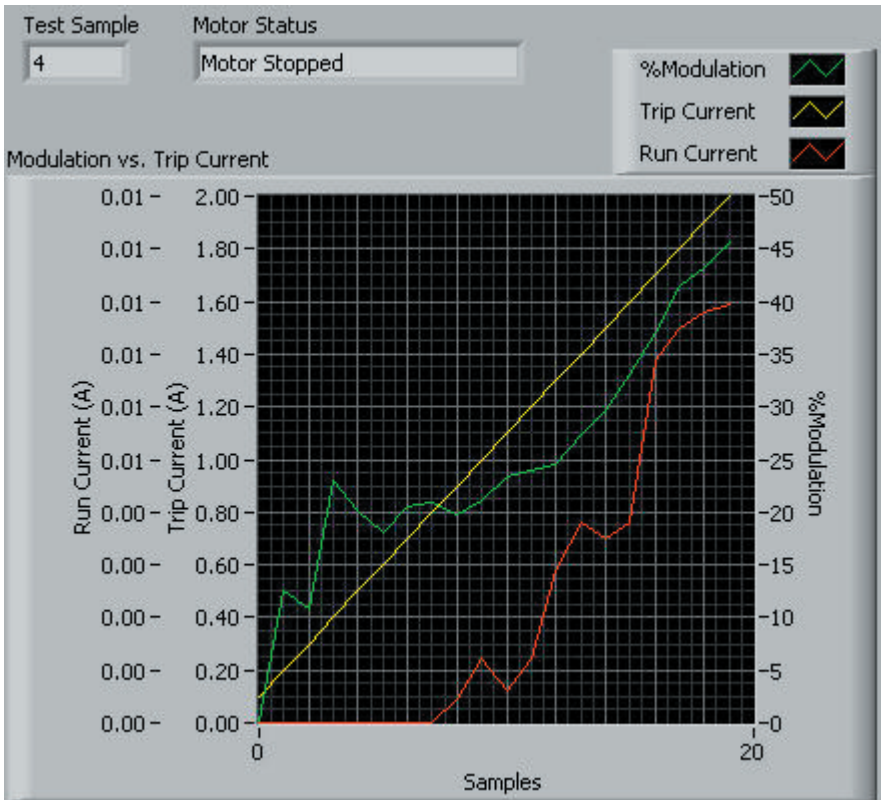
- A high Trip Current - Maximum may also cause the motor to go into the “Start Error: Over-Current” error state.
  - If this occurs, a DAQ error message will appear.



  - When you hit Continue, the Motor Status will change to “Start Error: Over-Current.”

- To clear this error, go to the Control tab and press the Clear Error button.
- To correct this problem, you will need to either decrease the Trip Current - Maximum or increase Start Parameters – Over-Current Limit. Be cautious when increasing the Over-Current Limit; if current is allowed to go too high, your motor could be damaged.

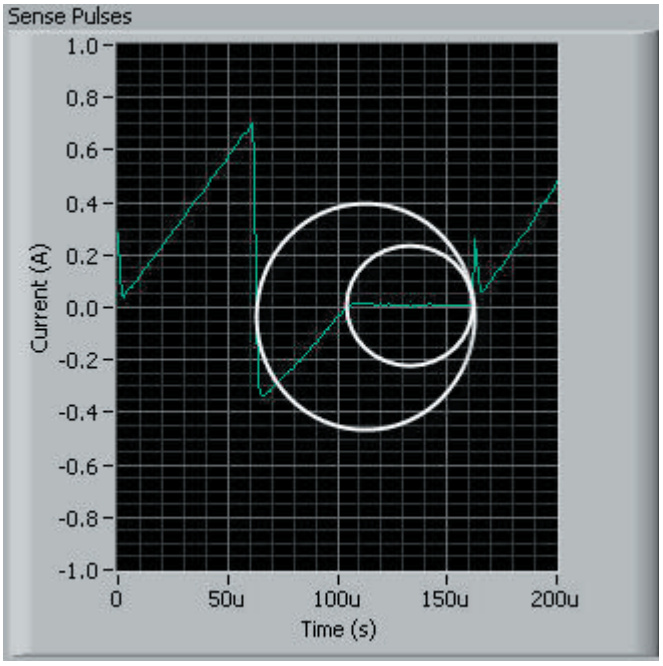
o You can zoom in on a graph by double-clicking on the maximum scale value and entering a new value.



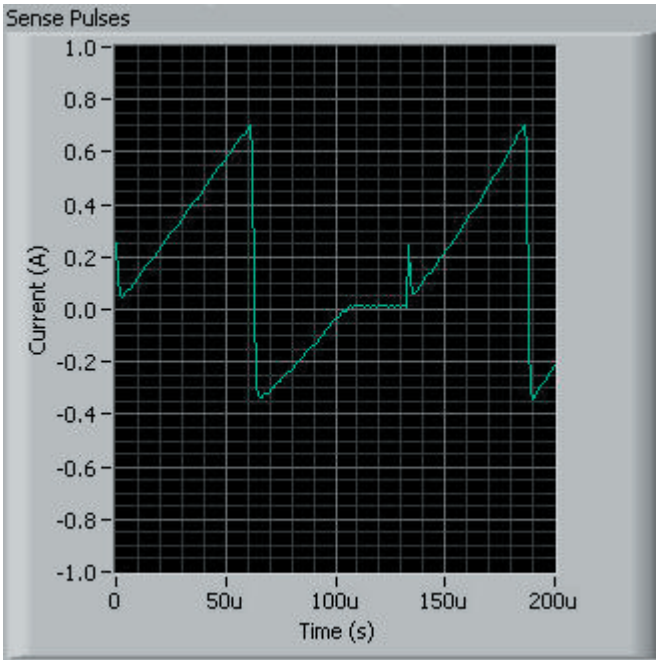
o Once you are satisfied with your Trip Current range, pick a Trip Current that corresponds to where the %Modulation stabilizes and starts to rise. For our example motor, this appears to be about 1.00A.

o Once you have decided on an optimum Trip Current, you can test it by entering it as the Initial and Trip Current - Maximum.
- If you enter an Increment of 0, the test will repeat until you press the Stop button.
- If you enter an Increment of anything greater than 0, the test will run for the 4 Test Samples and stop automatically.

- Adjust the Sense Pulse Recovery Time:
  - Zoom in on the first Sense Pulse by setting the Time scale maximum to a smaller value, like 200us and the Current scale as appropriate.
  - The region in the large circle is the time specified as the Start Parameters - Sense Pulse Recovery Time. This time can be shortened if the current reaches zero before the beginning of the next Sense Pulse, as shown in the smaller-circled region. This region is about 50us long. 20uS is the minimum time so the time can be shortened from 100uS to 100us – 30us = 70us.
  - Enter this time as the Start Parameters – Sense Pulse Recovery Time and press Write to Driver.



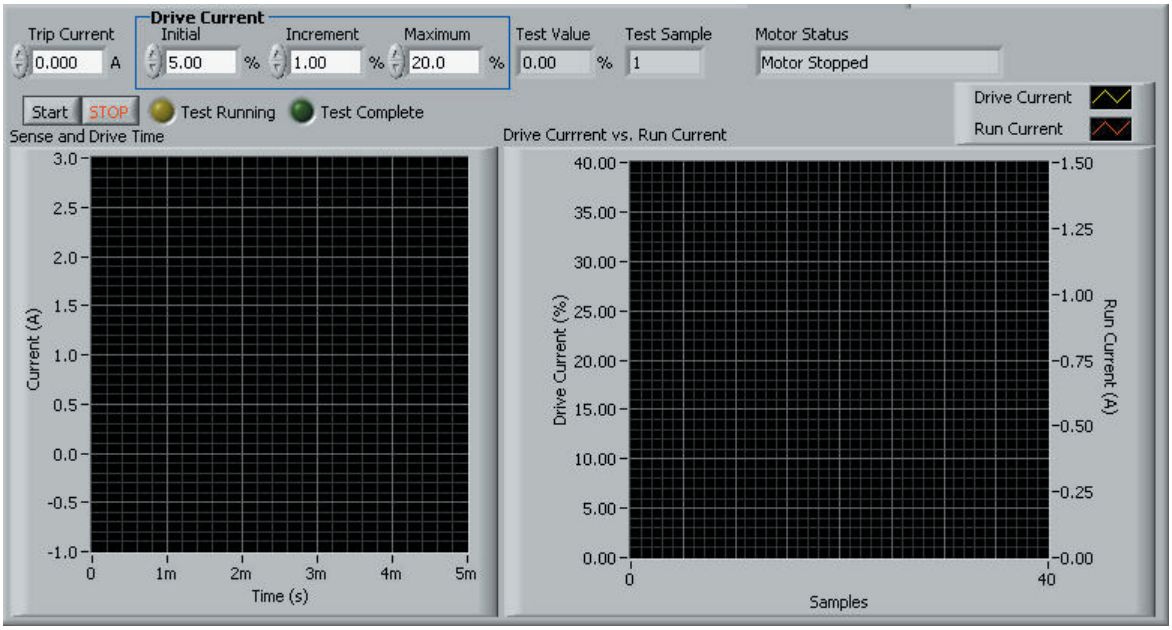
  - Re-run the Trip Current Test to view the Sense Pulses with your optimized Sense Pulse Recovery Delay.



- o If you are satisfied with the waveform, set the Start Parameters – Sense Pulse Trip Current to the optimum determined, and press the Write to Driver button.

6. Drive Current Test

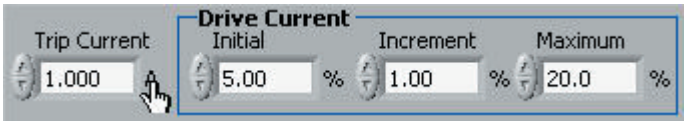
Using the Drive Current test to determine the Start Parameters - Drive Current



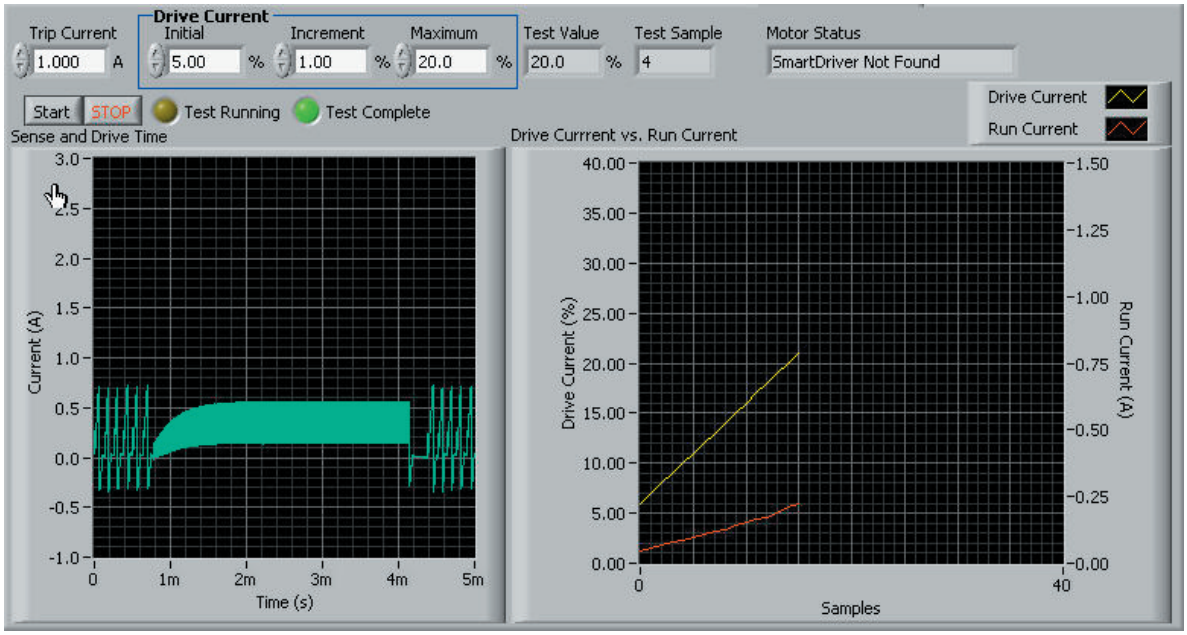
- Set the DAQ box front panel switch to “Trig.”

- Use a piece of tape between the disk and the drive base to stop the disk from turning during this test.
- Enter the optimum Trip Current you determined using the Trip Current Test. In our case it is 1.00A.

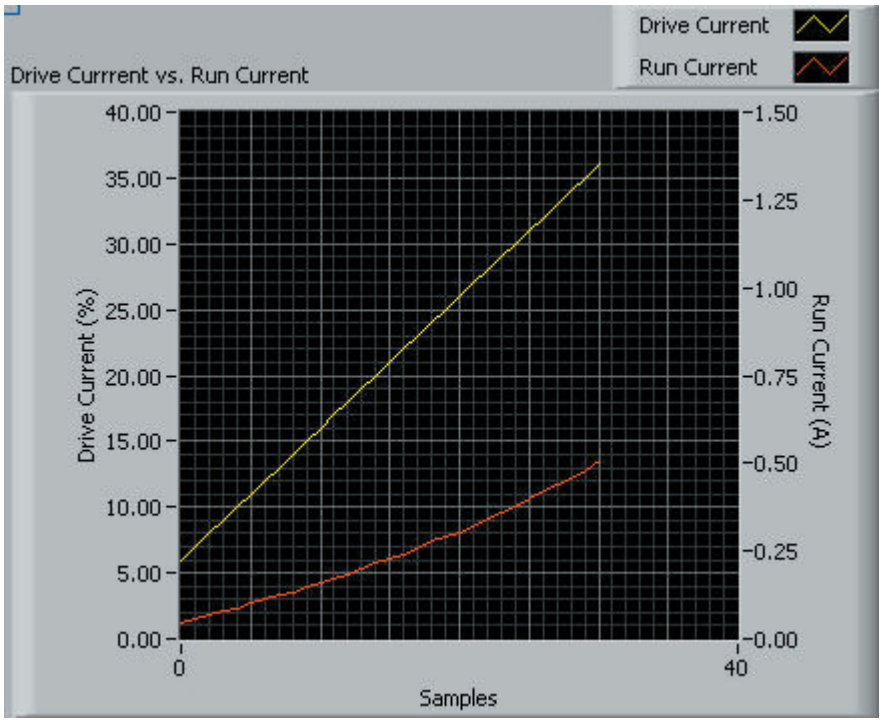
- Set Drive Current Parameters. The default Drive Current - Initial, Increment, and Maximum good initial test values. After the first test, these values can be adjusted as necessary.
  - Drive Current - Initial = 5%
  - Drive Current - Increment = 1%
  - Drive Current - Maximum = 20%



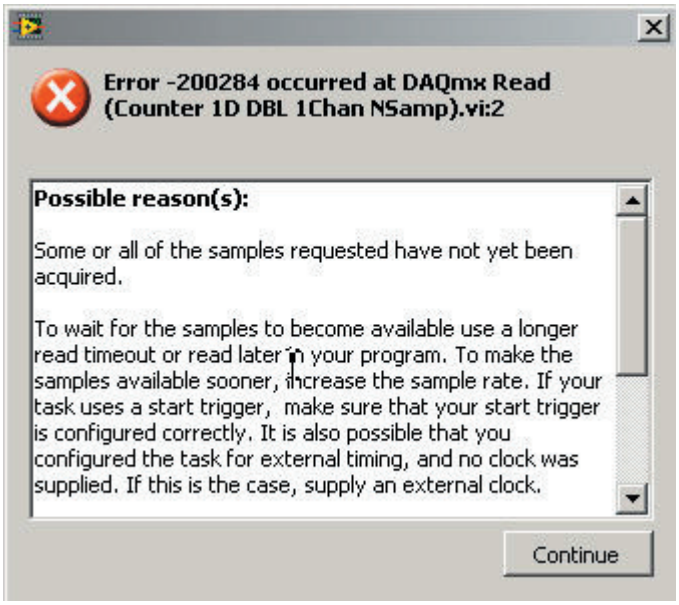
- Start the test and observe the Sense and Drive Time and Drive Current vs. Run Current graphs.
- The time that Drive Current is applied during the start cycle is shown in the white circle on the Sense and Drive Time graph.



- You are looking for a value of Drive Current that gives a Run Current equal to the motor Run Current from the motor specification.
- You may need to increase the Drive Current – Maximum to achieve the correct current.



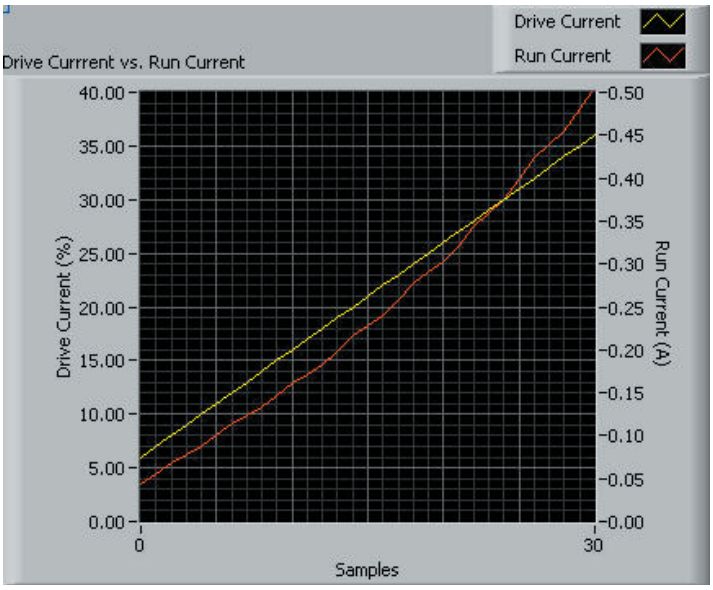
o A high Drive Current - Maximum may cause the driver to go into the “Start Error: Over-Current” error state.
  • If this occurs, a DAQ error message will appear.



  • When you hit Continue, the Motor Status will change to “Start Error: Over-Current.”

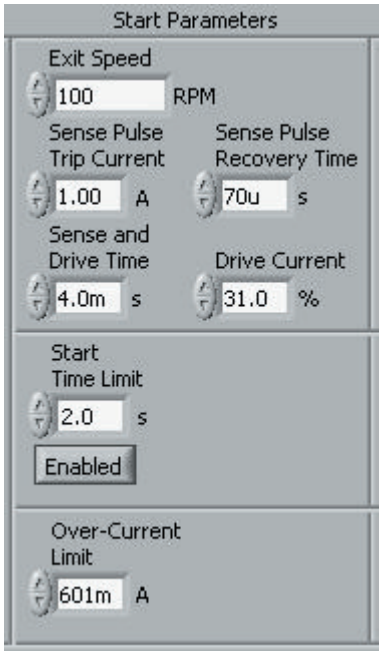
  • To clear this error, go to the Control tab and press the Clear Error button.
  • To correct this problem, you will need to either decrease the Trip Current - Maximum or increase Start Parameters – Over-Current Limit. Be cautious when increasing the Over-Current Limit; if current is allowed to go too high, your motor could be damaged.

- You can zoom in on a graph by double-clicking on the maximum scale value and entering a new value.



- Once you are satisfied with your Drive Current range, pick a Drive Current that corresponds to a Run Current equal to the run-current from the motor data sheet. In our case, a drive current of 31% appears correct.

- Set the Start Parameters – Drive Current to your chosen value.



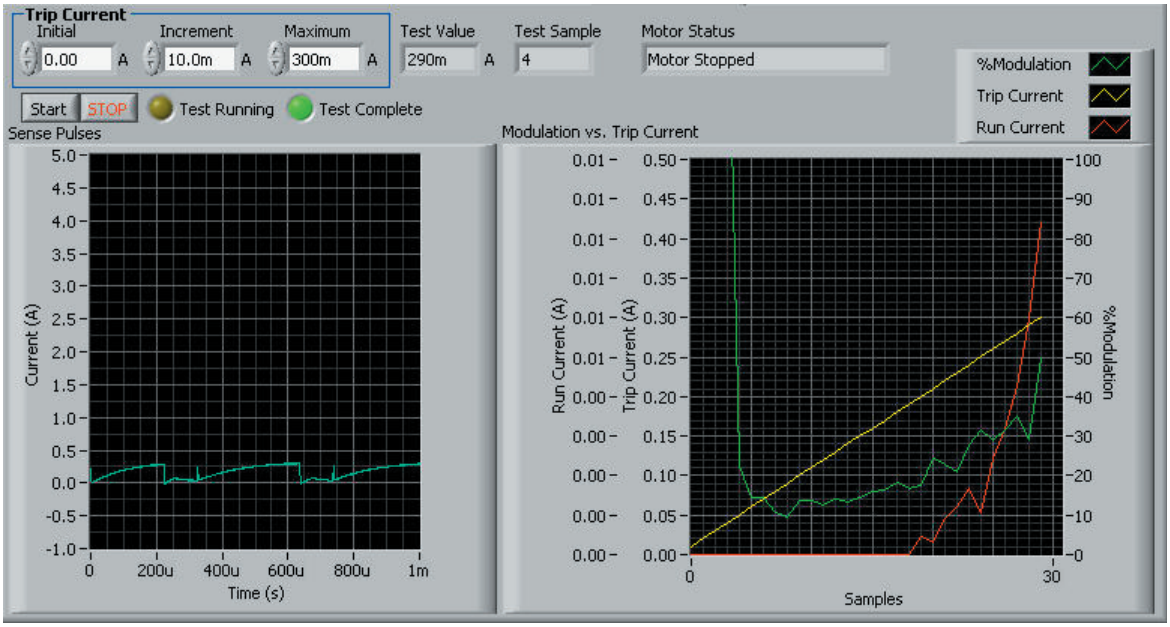
- Press the Write to Driver button.
- Your motor should be ready to run.

7. Smaller Low-voltage Motors

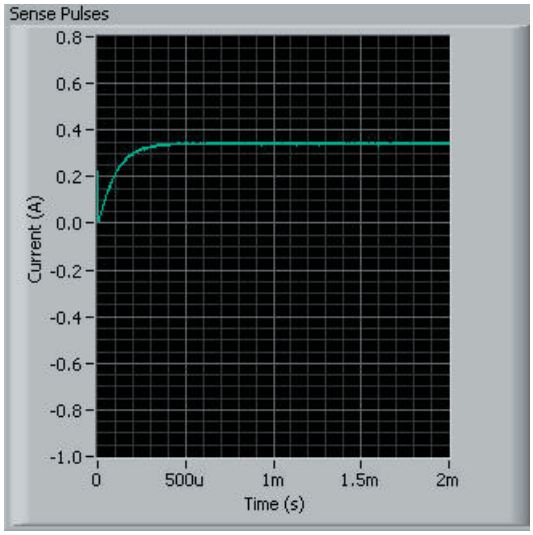
Using the Trip Current and Drive Current programs with smaller (1-inch, etc.,) low-voltage motors.

We will use a 3600RPM, 30mA, 12-pole, 3.3V, 1-inch motor for demonstration purposes.

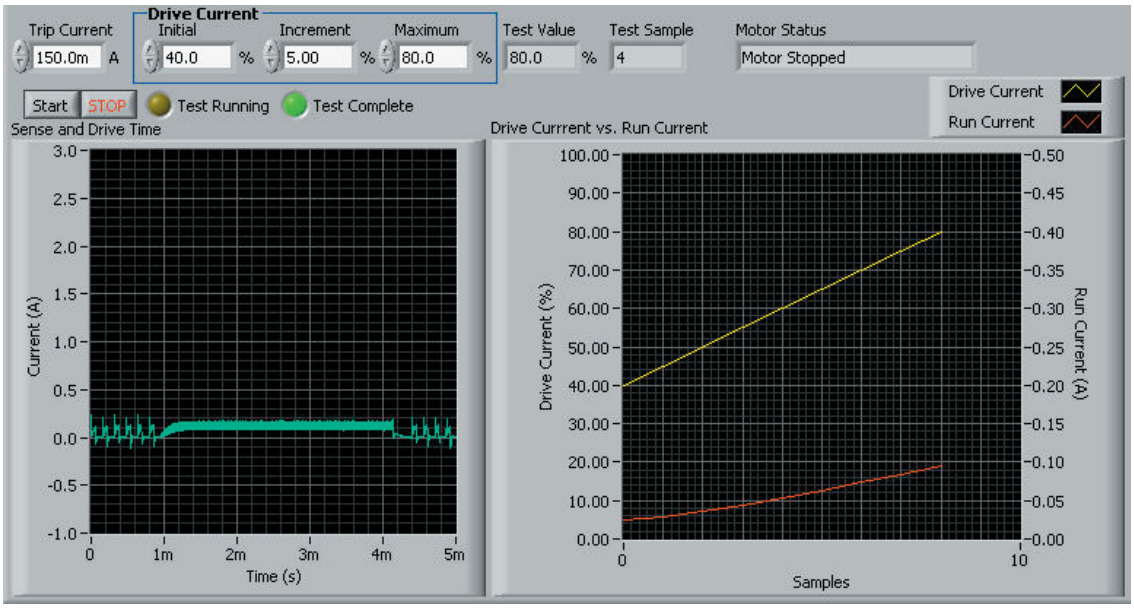
- Low voltage motors are configured the same way as other motors, but the range of Trip Current is much lower.
- Set Trip Current Parameters. After the first test, these values can be adjusted as necessary.
  - Trip Current - Initial = 0.00mA
  - Trip Current - Increment = 10.0mA
  - Trip Current - Maximum = 300mA



- The %Modulation appears stable at a Trip Current of 150mA. Note how the run current starts to quickly go higher past about 200mA. This is called motor saturation, and is to be avoided.
- If you enter a Trip Current - Maximum that is greater than what the motor is capable of, the trip does not occur and you will not see the typical 6 Sense Pulses.



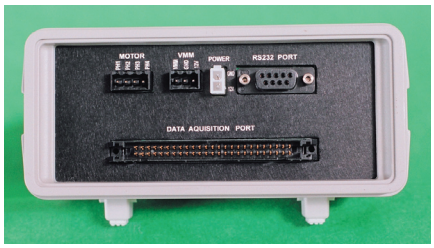
- If this happens, reset the errors and lower the Trip Current – Maximum, as explained previously.
- Set the Drive Current Parameters using the optimum Trip Current. After the first test, these values can be adjusted as necessary.
  - Trip Current - Initial = 150.0mA
  - Drive Current - Initial = 40%
  - Drive Current - Increment = 5%
  - Drive Current - Maximum = 80%



- For these motors, the Run Current during start is much higher than the Run Current during run. A value of Run Current * 3 is more typical.
- In our case, Run Current = 30mA * 3 = 90mA.
- From the graph, a Drive Current of 80% yielded a Run Current of 90mA

APPENDIX A: Hardware Connection Specifications
(3100X, 3200X, 3300X)

Following is detailed information for connecting the hardware described in Chapter One. Connections are made on the back of the Driver.



Power Connector (3100X, 3200X only)

Plug the supplied power supply into the *Power* connector. The connector is labeled with 12V and GND and supplies all logic power to the Driver. The power connector can optionally supply motor power. (See "VMM Connector")

PIN	FUNCTION	COMMENTS
1	Logic Ground	Same as GND on VMM connector
2	12V System Power	Same as 12V on VMM connector

Table 1: Power Connector

VMM Connector (3100X, 3200X only)

The VMM connector is used to separately supply power to the motor. There several options for supplying power to the motor.

►To supply power to a 12V motor using power from the Power connector:
Install a mating terminal block with a jumper connected between 12V and VMM.
►To supply power to a 3.3V or 5V5V motor using the power from the Power connector:
Install a mating terminal block with a LM78XX linear 3.3V or 5V regulator installed with:
Pin 1 connected to 12V
Pin 2 connected to GND
Pin 3 connected to VMM
►To supply power to a motor using a separate motor power supply:
Install a mating terminal block with the VMM and GND pins connected to a separate power supply.

PIN	FUNCTION	COMMENTS
1	VMM Motor Voltage	Separate voltage input for the motor
2	Logic Ground	Same as GND on Power connector
3	12V System Power	Same as 12V on Power connector

Table 2: VMM Connector

VMM Connector (3300X)

1. Plug a mating terminal block with the VMM and GND pins connected to a 24V 50W power supply into the *VMM Connector* on the rear panel of the Driver.

Motor Connector

The Motor connector connects the motor to the Driver.
NOTE: If the motor runs opposite from the desired direction, reverse any two phases

PIN	FUNCTION	COMMENTS
1	Phase 1	
2	Phase 2	
3	Phase 3	
4	Phase 4	Not used

Table 3: Motor Connector

RS232 Port

This is the communication port that connects the SmartDriver to the PC. It is needed for configuration and software control, but not for stand-alone operation.

Data Acquisition Port

The Data Acquisition Port provides signals necessary for motor analysis.

Table 4: Data Acquisition Port: Pinout

Pin Name	Type	Function	Pin Number
/MCURST	TTL IN	Microprocessor reset	1
/CONTROL	TTL IN	Motor Starts or stops on a low-going pulse (same as Start/Stop Button)	18
/STATUS	TTL OUT	Low when motor is locked else high, or oscillate low/high in error state (same as status LED)	28
POSITION0	TTL OUT	Motor position – Bit 0	19
POSITION1	TTL OUT	Motor position – Bit 1	20
POSITION2	TTL OUT	Motor position – Bit 2	21
TRIGGER	TTL OUT	See Table 5	22
TACH	TTL OUT	Once-per-electrical cycle index	25
INDEX	TTL OUT	Once-per-revolution index	26
AGND	Analog	Analog ground	30
ISENSE	Analog	1V / A motor current	31
RSH	Analog	Rsense high side	35
RSL	Analog	Rsense low side	36
RSH3K	Analog	Rsense high side 3KHz low pass	37
RSL3K	Analog	Rsense low side 3KHz low pass	38
DGND	Power	Logic Ground	39, 40, 41, 42
5V	Power	100mA available for user application	43
12V	Power	Available for user application (3100X, 3200X only)	44, 45
PH1SNS	Analog	Connected to Phase 1 through 1.0K resistor	50
PH2SNS	Analog	Connected to Phase 2 through 1.0K resistor	49
PH3SNS	Analog	Connected to Phase 3 through 1.0K resistor	48
VMMSNS	Analog	Connected to VMM through 1.0K	46

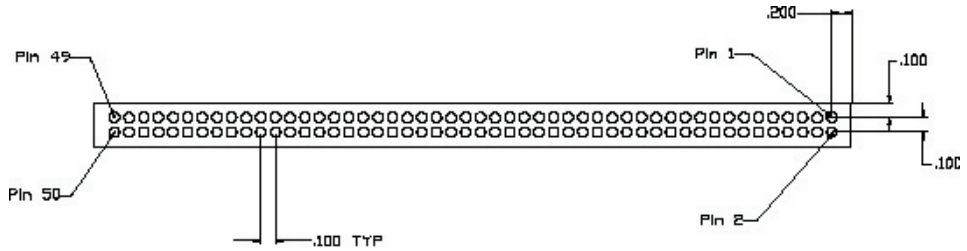
NOTE: All other pins are reserved.

Table 5: TRIGGER MODES

Start Mode	Run Mode	Coast Mode
High during first position sense pulse	Once-per-electrical cycle index	1uS high pulse upon each zero crossing

Table 6: Data Acquisition Port: Pin Functions

Pin Name	Use / Control
/MCURST	Microprocessor is reset when pulled low
/CONTROL	Motor Starts or stops on a low-going pulse (same as Start/Stop Button)
/STATUS	Low when motor is locked. Oscillates at 2Hz for error. Else off.
POSITION [0:2]	This bus indicates the motor electrical position during Start, Run, and Coast modes. The output sequence is 1, 3, 2, 6, 4, 5.
TRIGGER Start Mode	High during first position sense pulse. Used for scope trigger when setting up the posotion sense pulses in Start mode.
TRIGGER Run Mode	High once-per-electrical cycle during the commutation delay state.
TRIGGER Coast	High 1uS pulse for each motor phase zero-crossing
TACH	High pulse once-per-electrical cyce of the motor
INDEX	High pulse once-per-mechanical revolution of the motor
AGND	The ground reference for ISENSE. It is connected directly to the instrumentation amplifier that amplifies motor current to ISENSE.
ISENSE	Motor current voltage amplified to a 1V/Amp scale. This signal is filtered to 15Hz for stable motor run current measurement.
RSH / RSL	These signals are from directly across the motor current sense resistor
RSH3K / RSL3K	These signals are from across the motor current sense resistor filtered to 3.4KHz and are useful for measuring the “position sense pulses” when configuring start mode.
DGND	Digital Logic Ground. Use with digital IO signals.
5V	100mA available for user application, fused
12V	POWER available for user application, unfused (3100X, 3200X only)
PH1SNS-PH3SNS	These signals are connected to the motor phases through a 1.0K resistor and can be used to monitor the motor phases.
VMMSNS	This signal is connected to the motor voltage through a 1.0K resistor and can be used to monitor the motor voltage.



Connector Pinout

APPENDIX B: Hardware Connection Specifications
(3400X)

POWER Connector J8
Plug a mating terminal block with VMM and GND pins connected to a 24V 50W power source into J8.

J8 PIN	NAME	FUNCTION
1	+24V	24VDC @ 2A
2	GND	Power Supply Ground

MOTOR Connector J9
Plug a mating terminal block with motor phase1, phase2, and Phase3 connected to PH1, PH2, and PH3 into J9:
Note: If the motor runs in the incorrect direction, reverse any two motor phases.

J9 PIN	NAME	FUNCTION
1	PH1	Motor Phase1
2	PH2	Motor Phase2
3	PH3	Motor Phase3

RS232 Connector J3
Plug a 10-pin mating cable connector into J3 with the following adapter wiring:

J3 PIN	DB9 PIN	FUNCTION
1	1	No Connection
2	6	DSR
3	2	TXD
4	7	RTS
5	3	RXD
6	8	CTS
7	4	DTR
8	9	No Connection
9	5	GND
10	NO CONNECT	

CONTROL Connector J7
Plug a 16-pin mating cable connector into J7 with the following functions:

J7 PIN	NAME	DIRECTION	FUNCTION
1	Reserved		Do not connect to this pin
2	GND		Ground
3	/DIR_IN	Input	Go CW when low
4	GND		Ground
5	/STEP_IN	Input	Step on low going pulse
6	GND		Ground
7	/ERROR_OUT	Output	Goes low when there is an error
8	GND		Ground
9	/MCURST_IN	Input	
10	GND		Ground
11	INDEX_OUT	Output	Goes high once-per motor revolution
12	GND		Ground
13	/LOCK_OUT	Output	Goes low when the motor locks to the target speed
14	GND		Ground
15	Reserved		Do not connect to this pin
16	GND		Ground

MCUJTAG J4, LGJTAG J5, and MCISP J6 are reserved headers and should not be connected.

RockLogic
SmartDriver Board Outline
3001-101 Rev. A