AUTOMOTION
INFRANOR GROUP COMPANY

MODEL ACS300-XXXX

Hardware User's Manual

Digital Torque/Velocity/Position Mode Servo Drive

This manual covers the use and maintenance of the model ACS300 series Torque, Velocity, and Position mode brushless motor control product family.

READ ENTIRE USER MANUAL FIRST BEFORE ATTEMPTING TO USE THIS PRODUCT. DO NOT RETURN PRODUCTS WITHOUT OBTAINING PRIOR AUTHORIZATION DIRECT FROM AUTOMOTION.

This manual describes the installation and operation of the ACS300 series of digital low voltage servo-amplifiers manufactured by Automotion, Inc.

This document applies to serial numbers ending with xxxx0105.

We reserve the right to modify our products at any time. Information, specifications, and material data that appear within this user manual are subject to change without notice. For the latest revision of this manual please check our web site at www.automotioninc.com or contact Automotion.

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Firmware Revision History

Release Number	Date	Product	Comments
3.1	1/5/07	ACS300 firmware ver. #50014006 September 5, 2006	Initial Release Date of ACS300 Product.
	1/23/09	Corrected text 10amp to 15amp pwr	

Document Filename: A11014 ACS300 UM Rev 3.1 1-29-07.doc
Document Control #: A11014

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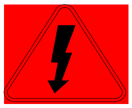
 

READ THIS <u>ENTIRE</u> SECTION BEFORE ATTEMPTING TO USE THE ACS300 SERVO DRIVE! GIVE SPECIAL ATTENTION TO ALL BOLD PRINT ITEMS.

To operate the ACS300 successfully, these safety precautions MUST be followed to reduce the risk of injury to the operator and damage to motor or ACS300 control.
Failure to observe all safety precautions could result in serious bodily injury, including death in extreme cases.

1.1 LIFE SUPPORT POLICY

Automotion's products are not authorized for use as critical components in life support devices or systems without the express written approval of the President of Automotion Incorporated.

As described herein:

Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the User's Manual and in the labeling, can be reasonable expected to result in a significant injury to the user.

A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

1.2 Other safety issues

1.2.1 DO NOT touch any of the output connector pins for connectors P1 (DC Input) or P2 (Motor Output) when power is applied. Bare wires from adjacent connector pins must never be allowed to touch one another. Connector P1, pin 4, must be connected to an external earth ground. Follow wiring procedures carefully.

1.2.2 Always operate the ACS300 within the prescribed voltage limits. Any attempt to operate outside these bounds may result in damage to the ACS300 control.

1.2.3 Do not parallel multiple motors off of the same control.

1.2.4 Under no circumstance should a phase output from the control be connected to anything other than a passive inductive/resistive load. See manual for minimum inductance requirements. Short circuit protection for the ACS300 is limited to momentary conditions only! Repetitive short-circuits on any of the output pins for connector P2 (Motor Output) will likely cause permanent damage to the ACS.

1.2.5 Excessive speed and/or current can destroy some DC brushless motors and possibly injure the user. Check that motor manufacturer's specifications to ensure that maximum current and voltage output for the ACS300 does not exceed their limitations.

1.2.6 External failsafe methods are recommended to limit both maximum speed and travel of motion of the motor and its load. Whenever the ACS300 drive is disabled for any reason, the motor is placed into a free-spinning coast mode.

1.2.7 Do not remove the connectors P1, P2, J1 to J7, from the control while the motor is operating.

1.2.8 Read Automotion's Life Support Policy in Section 1.1 for application limitations.

1.2.9 Do NOT use the ACS300 in environments where it is likely to be exposed to strong and/or frequent static discharge.

1.2.10 DO NOT LOCATE ANY ACS300 IN A POSITION WHERE IT WOULD HAVE CONTACT WITH LIQUIDS, WATER CONDENSATION, CORROSIVE CHEMICALS OR WHERE FOREIGN MATERIALS WOULD BE ALLOWED TO FALL INTO AND COLLECT INSIDE THE ACS300.

1.2.11 DO NOT MOUNT THE ACS300 DIRECTLY UPON OR NEAR FLAMMABLE MATERIALS.

1.2.12 DO NOT OPERATE THE ACS300 IN AN EXPLOSIVE ATMOSPHERE OR IN THE VICINITY OF EXPLOSIVE MATERIALS. KEEP THE INSTALLATION VENTILATED SO THAT CLEAN FRESH AIR CAN MOVE FREELY THROUGH AND AROUND THE ACS300.

1.2.13 Avoid frequently plugging connector P1 (DC Logic Input) into the control while live power is applied to the connecting cables. Ignoring this precaution will cause electrical arcing at the connector pins, which can cause permanent connector damage. AUTOMOTION recommends using a disconnect switch ahead of P2 and P1 if the ACS300 must be disconnected often.

1.2.14 Keep external auxiliary shunt resistor board far away from flammable materials. Read Section 6.6 carefully for more details on the auxiliary shunt installation.

2 Unpacking and Repacking the ACS300

When your package arrives, inspect the shipping box and the unit carefully, and save ALL packing materials. Contact the carrier promptly if damage is discovered. Your ACS300 has arrived carefully packaged from Automotion in an antistatic bag. As you unseal this bag inspect the contents carefully. There should not be any loose or damaged parts inside.

Compare the packing slip against all items included in the box. Any shortages or other inspection problems should be reported to AUTOMOTION immediately.

Never attempt to operate or power-up the ACS300 if there is any visible external damage or if it sounds as though there are loose materials inside the chassis. While unpacking, if you discover any loose or damaged parts, notify AUTOMOTION within two working days.

AUTOMOTION recommends that all packing materials be saved in case the ACS300 ever needs to be shipped again. Always place the ACS300 in the same antistatic bag used in the original shipment. Abundant anti-static filler material should always be placed around the ACS300 bag so that it cannot shift inside the box. Extreme care should be exercised when placing packing material around all external connectors to prevent mechanical stress damage.

All material to be returned to AUTOMOTION must have a Return Material Authorization (RMA) tracking number assigned before shipment. This may be obtained by contacting the AUTOMOTION Service Dept. Any product returned without this number will be rejected by AUTOMOTION.

Always insure your shipment for the proper replacement value of its contents. AUTOMOTION will not assume responsibility for any returned goods that have been damaged outside of our factory because of improper packaging or handling. All goods shipped to AUTOMOTION must be shipped FREIGHT PREPAID.

Use of ACS300 Jumpers JU201 and JU202 – DC Operating Voltage

Note, the ACS300 has two jumpers that must be set according to the desired input DC operating voltage range.

Failure to set these jumpers correctly can result in permanent damage to the ACS300. Please see section 3.3 “Use of ACS300 Jumpers JU201 and JU202” and select the proper jumper setting for your application before applying power to the ACS300.

Use of ACS300 Jumpers JU1, JU2, JU3, JU4 – Use of Encoder Feedback

If you have differential encoder feedback A, A!, B, and B!, you can leave Z and Z! open.

If you only have single ended encoder feedback A and B, (and not the A! and B!), you need to short the four jumpers on the daughter card that are right next to the encoder connector. These are JU1, JU2, JU3 and JU4. You can then leave Z and Z! open.

If you only have Halls and no encoder at all, leave the encoder connector open.

See Figure 34, J4 Encoder Interface Circuitry, for additional information.

3 ACS300 Introduction

3.1 Amplifier

The ACS300 is a fully digital servo amplifier that uses DSP technology to provide a powerful feature set that is fully configurable by means of a RS232 serial port. The ACS300 servo drive is configurable as a Torque, Velocity, or Position mode servo amplifier. The ACS300 is designed to operate a single 3-phase Brushless DC or AC, permanent magnet motor. The motor may have either a WYE or Delta wound stator. The ACS300 provides commutation using Hall sensors or encoder feedback.

Principal features of this product:

- User configurable operation modes: Torque, Velocity, and Position.
- Selectable BLAC (sine wave, flux vector) or BLDC (Six step, trapezoidal) commutation.
- 4 Quadrant performance.
- 3 Phase output, PWM controlled output.
- Full digital control of all loops
- Variable servo rate from up to 16 kHz.
- Loop tuning via serial interface (No pots!).
- Drive setup & status information available serially via RS232 link.
- 12Vdc – 48 Vdc input power supply range.
- Output current of 15 Amps continuous, 30 Amps peak.
- Compact package size.
- ***AutoMotionPLUS***™ Graphical Windows Interface for Set-up, Configuration and Tuning.

The ACS300 Current, Velocity or Position modes accept +/- 10 volt DC analog or digital PWM.

3.2 Theory of operation

The ACS300 operates as a “mode configurable” digital servo amplifier. This product is typically applied as a component within an end use industrial application. Within industry, application requirements for servo amplifiers vary widely. For example, one application may require an amplifier with an analog input reference for speed. Another application may require an amplifier that offers torque control and Hall sensor commutation only. For this reason the ACS300 offers a choice of many different servo-operating modes. This flexibility is made possible because all of the control functions within the ACS300 are implemented in software. The ACS300 physical I/O and closed loop functionality are selected using the ***AutoMotionPLUS***™ Windows Setup utility. See Section 4, Introduction to the ***AutoMotionPLUS***™ software, and the ***AutoMotionPLUS***™ software User Manual for additional information on using this software.

The internal firmware architecture of the ACS300 is modular. ACS300 software is built as a series of components (or modules) that are linked together to form an ACS300 servo-operating mode. ACS300 software components are stored in flash memory. These components exist as Reference input modules, Feedback modules, PI (D) control modules, commutation modules and firmware extension modules. A detailed list of these components is found in Section 4 of this manual.

An internal digital signal processor is used to read I/O signals, motor feedback signals and to process serial communication messages. Flash memory inside the ACS300 is used to store a library of modular software components. RAM memory is used for data logging and graphical tuning of the ACS300. The serial EEPROM provides nonvolatile memory for retention of user-configured parameters and operating mode.

3.3 Use of ACS300 Jumpers JU201 and JU202

Jumpers JU201 and JU202 are located next to the power input connector P1.

JU201: Install JU201 when powering the ACS300 motor and logic inputs with the same supply through connector P2, pins 1 and 2. When JU201 is installed, Automotion recommends that JU202 is **NOT** installed.
With this jumper installed it is not necessary to bring logic power in through connector P1. Logic power will be supplied from the connector P2, pins 1 and 2.

JU202: Install JU202 when the voltage supplied to the logic power input connector (P1) is between +12Vdc and +24Vdc. Remove JU202 when the voltage supplied to the logic power input is greater than +24Vdc.

The standard configuration is that JU202 is NOT installed (left open). When installed, JU202 bypasses some circuitry that protects the internal logic power supplies from voltages above +48V.

3.4 ACS300 I/O.

Drive specific I/O operates independent of the user selected operating mode. Dive specific I/O signals have fixed functionality. These signals are used to interface the ACS300 to an outside control system. They provide “hand shaking” signals for enabling, disabling, and monitoring the status of the ACS300. For physical reference to the ACS300 hardware see Figure 16, ACS300 Package Outline.

J1 User Digital I/O Control, MOLEX Sherlock 35362-1010

Pin	Description
1	+5 Volts DC Power Output; Supplied regulated +5VDC power. 250mA Total available from drive from all pins.
2	+5 Volts DC Power Output; Supplied regulated +5VDC power. 250mA Total available from drive from all pins.
3	Enable/!Reset Control Signal Input; TTL compatible. +5.5 VDC maximum signal amplitude. 0 Volts minimum. 10K ohm internal pull down. Positive true logic. Forces a master hardware reset for entire drive on a falling edge. Drive recovers beginning after rising edge. Drive remains disabled while logic "0" is applied to this input.
4	Run Command Signal Input; TTL compatible. 5.5 VDC maximum signal amplitude. 0 Volts minimum. 10K ohm internal pull down. Positive true logic. A logic "1" state will allow motor commutation once some level of current is commanded. A logic "0" state places motor into a coast state.
5	Step Input; 0 to +5 VDC logic signal. TTL compatible. 10K ohm internal pull down. Used in step and direction mode. Used with direction input.
6	Direction Input; Zero to +5 Volt logic signal. TTL compatible. +5.5 VDC maximum signal amplitude. 0 Volts minimum. 10K Ohm internal pull down. Selects relative direction of “Step” command. High is “positive” direction.
7	Enabled Output; 0 to +5 VDC logic signal. Logic 0 when drive is in “Reset”. Logic 1 when drive is enabled and initialized.
8	Ready Output; 0 to +5 VDC logic signal. Logic 0 when drive is in “Standby” or “Reset”. Logic 1 when drive is in “Run” mode and ready to deliver current.
9	COMMON Return.
10	COMMON Return.

Connector J2 – User Analog I/O Control, MOLEX Sherlock 35362-0710

Pin	Description
1	AN1+ Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.
2	AN1- Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.
3	COMMON Return.
4	AN2+ Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.
5	AN2- Differential Input; Zero to ±10 Volt external command signal input. The polarity of this signal controls the relative applied direction of output motor torque. Input is protected to ±24 Volt maximum.

6	COMMON Return.
7	COMMON Return.

Connector J3 - RS-232 Communication Interface, Molex Sherlock 35362-0510

Pin	Description
1	RS232 TXD Output; Standard RS-232 compatible output.
2	RS232 RXD Input; Standard RS-232 compatible input.
3	CTS Input; This input not implemented as a ‘Clear to Send” and is only used for programming flash.
4	RTS Output; This output is not currently implemented.
5	COMMON Return.

Connector J4 - Encoder interface, MOLEX Sherlock 35362-0910

Pin	Description
1	+5 Volts DC Power Output; Supplied regulated +5VDC power. 250mA Total available from drive from all pins.
2	Encoder "A" Signal Input; Zero to +5 Volt logic signal.
3	Encoder "A!" Signal Input; Zero to +5 Volt logic signal.
4	Encoder "B" Signal Input; Zero to +5 Volt logic signal.
5	Encoder "B!" Signal Input; Zero to +5 Volt logic signal.
6	Encoder "Z" Marker Signal Input; Zero to +5 Volt logic signal.
7	Encoder "Z!" Marker Signal Input; Zero to +5 Volt logic signal.
8	COMMON Return.
9	COMMON Return.

Note – Please see Figure 34, J4 Encoder Interface Circuitry for more information.

Connector J5 - Hall Interface, MOLEX Sherlock 35362-0610

Pin	Description
1	+5 Volts DC Power Output; Supplied regulated +5VDC power. 250mA Total available from drive from all pins.
2	Hall Signal Input S1; Zero to +5 Volt logic signal. 2.2K ohm internal pull up to +5v.
3	Hall Signal Input S2; Zero to +5 Volt logic signal. 2.2K ohm internal pull up to +5v.

4	Hall Signal Input S3; Zero to +5 Volt logic signal. 2.2K ohm internal pull up to +5v.
5	COMMON Return.
6	COMMON Return.

Connector J6 and J7 - CAN Communications, MOLEX Sherlock 35362-0310

Pin	Description
1	CAN HI; CAN Bus Communication.
2	CAN LO; CAN Bus Communication.
3	COMMON Return.

Connector P1 - DC Logic Input

Pin	Description
1	DC Input; +12 to +48 VDC Logic power, User Supplied.
2	COMMON Return.

Connector P2 – DC Input / Motor Output, Phoenix Screw Terminal

Pin	Description
1	DC Input; 0 to +48 VDC Motor and Logic (Optional) Power.
2	DC COMMON Return.
3	Motor Phase U Output. Peak voltage out of this terminal is dependent upon the incoming voltage on connector P2 pin 1. Peak amperage is model dependent.
4	Motor Phase V Output. Peak voltage out of this terminal is dependent upon the incoming voltage on connector P2 pin 1. Peak amperage is model dependent.
5	Motor Phase W Output. Peak voltage out of this terminal is dependent upon the incoming voltage on connector P2 pin 1. Peak amperage is model dependent.
6	Frame Ground.

Connector P4 – Motor Temperature Input

(Ref. Section 8.1.1 Motor Temp Circuit Description and Fig. 39 for more information)

Pin	Description
1	Temp + Input; 4.99K ohm internal pull up to +5V.
2	Temp – Input; motor temperature input. PTC, NTC, or switch.

3.5 ACS300 Status LEDs

In normal operation, the ACS300 is either in a "Ready" state or in an "Error" state. When power is first applied, the green LED will come on steady, meaning that power is applied. The Yellow LED should be flashing, meaning that the drive is enabled.

When the run command is given the flashing Yellow LED will come on steady.

3.5.1 Status LED (Yellow)

FLASH CODE	DESCRIPTION	POSSIBLE CAUSE	RESULT	RECOVERY METHOD
ON Steady	ACS300 is in RUN mode.	• User commanded RUN mode via user interface	• Clear all faults and STATUS flags • Enable three-phase PWM	• Not applicable
OFF	Processor is inoperable.	• Drive is in reset • Processor fault • Improper user supplied +5Volts • Drive is being reprogrammed	• ACS300 will stay in a DISABLED mode	• Disconnect power from the ACS300 for 1 min. to reset the microprocessor. Then re-apply power to allow microprocessors to operate
1	Drive is in Standby mode	• The user commanded standby mode from the user interface • A drive error placed the drive in standby mode.	• The drive is placed in standby mode	• Command run mode • Toggle the run line, see Note 1
2	Over Current Fault	• Current is over the designated drive current for more than 0.5mS	• The drive is placed in standby mode	• Toggle the run line, see Note 1
3	Reserved			
4	Logic Supply fault	• Internal logic power supplies out of spec (+15V and +5V) Rail voltage > +60V	• The drive is placed in standby mode	• Toggle the run line, see Note 1
5	Reserved			
6	EEPROM Fault Check sum fault	• The user EEPROM has a checksum error • DSP program memory error	• The drive is placed in standby mode (hard fault)	Check the error using the "CF' command in the terminal page. If the error is "MEMORY EEPROM", issue the command "CR23130". If the error is "MEMORY DSP FLASH", reprogram the DSP. ➢ Warning: Either operation will reset all drive parameters to default state. Reload parameter file after these operations
7	Locked rotor fault	• Delivered current is greater than user specified current for mote than user specified time with no hall transitions.	• The drive is placed in standby mode	• Toggle the run line, see Note 1

Note 1: To toggle the run command set the Run/! Standby signal logic '0' state for 100mS, then back to a logic '1'.

3.5.2 Power LED (Green)

LED	Description	Possible Cause	Result	Recovery Method
ON	+5 VDC Power Indicator	• On if user power is on	• Required to Run	• N/A
OFF	+5 VDC Power Indicator	• No logic power	• Drive will not Run	• Apply +12 – 48VDC
DIM	+5 VDC Power Indicator	• Logic voltage input to low	• Drive may not run properly	• Apply +12VDC minimum

4 Introduction to the *AutoMotionPLUS*™ software:

The ***AutoMotionPLUS***™ software can be used to:
• …Configure the Drive’s Operation Mode.
• …Configure the Drive for operation of different motors.
• …Tune the Position, Velocity and Current control loops.
• …Save and Load parameter files to and from the drive.
• …Graph application variables like Velocity, Position, Current and Motor Voltage.
• …Update the Drive’s internal firmware.

The following sections are intended to familiarize the user with the basic operation of this software only. A complete user manual for the ***AutoMotionPLUS***™ software is still under development at Automotion.

About Parameters and Variables:
Drive parameters are used to configure the drive for different operating modes and to tune the control structure that each operating mode presents. Variables are internal values that change while the Drive is running. For example, “Position Proportional Gain” is a parameter and motor “Position” is a variable. Parameters can be changed using the different parameter screens available in the Automotion Plus program. Variables can NOT be changed, except in certain cases, the commanded current, the commanded velocity or the commanded position may be changed. Variables can be recorded using the Graph Window. Variables are graphed in the loop tuning tools to evaluate the effectiveness of set Parameters.

4.1 Getting started

Connect the Comm Port Cable from your PC to the Drive. Locate the program file named “AutomotionPlus.exe” that you extracted from the supplied zip file and saved on your PC. Double-click on this file to run the program. The following screen will be displayed:

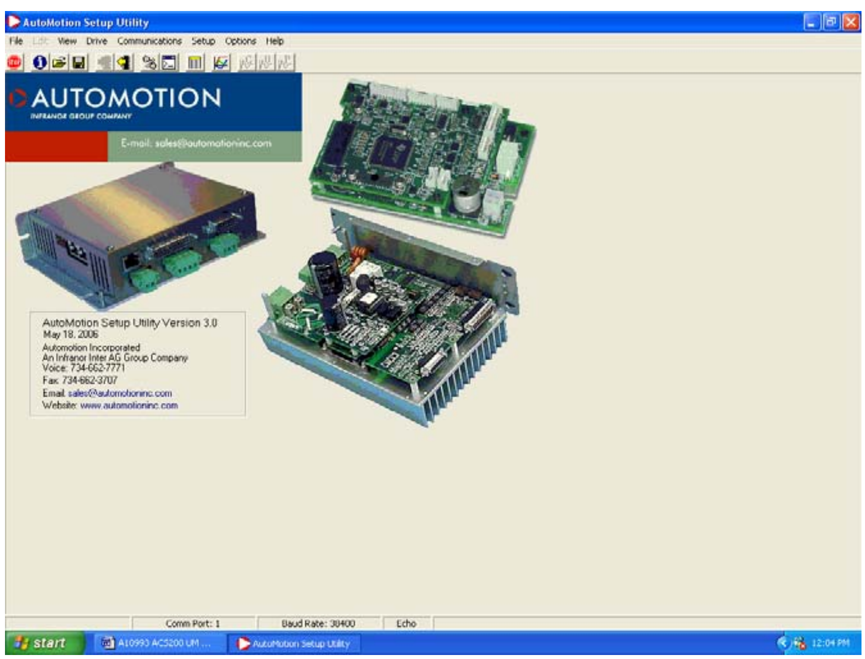


Figure 1 AutoMotionPLUS™ Screen

Select the Communications tab from the tool bar, and then click on Comm Port Settings.

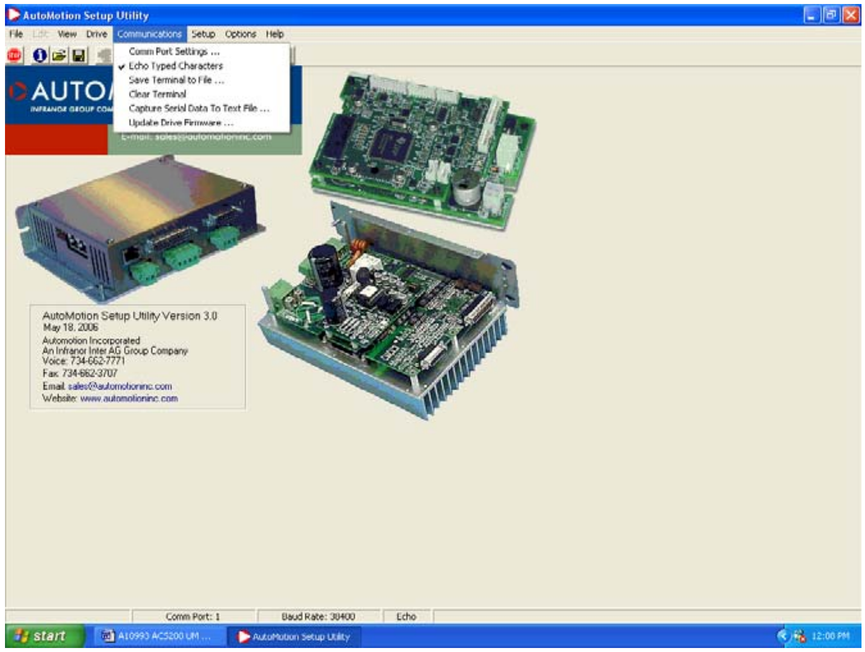


Figure 2: Communications Tab Screen

Use the drop box to select an available Com Port on your PC. Typically Com Port 1 or 2 is selected.

Note that for the ACS300 product line, the required communications Baud Rate is 38,400. If you select any other Baud Rate you will get a communications error message.

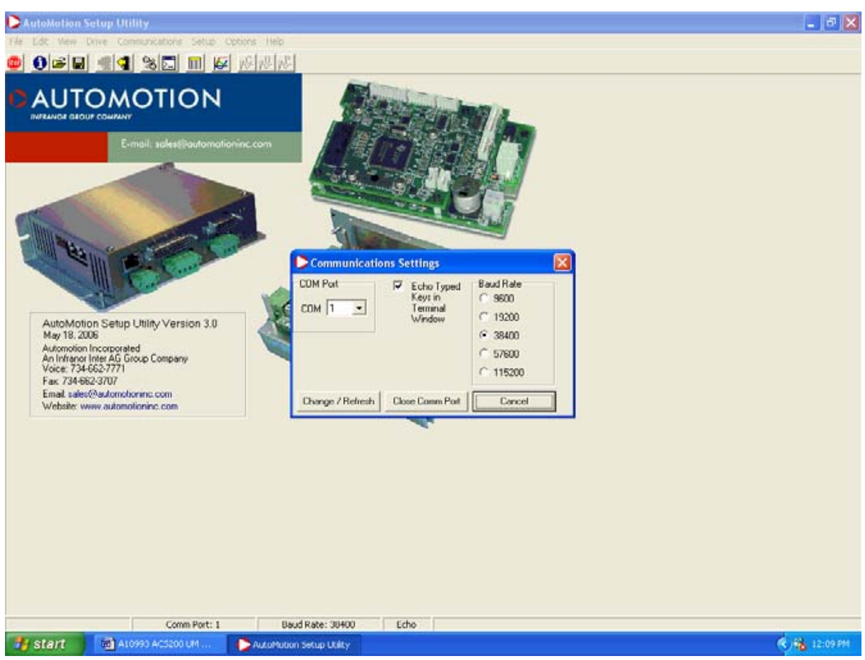


Figure 3: Communications Drop Down Box

After establishing communications with the drive, you can now read the existing drive parameters stored in the drive. Click on the “Read Parameters from Drive” icon button on the tool bar, or use the file menu to select “Drive” and then “Retrieve Parameters from Drive” option.

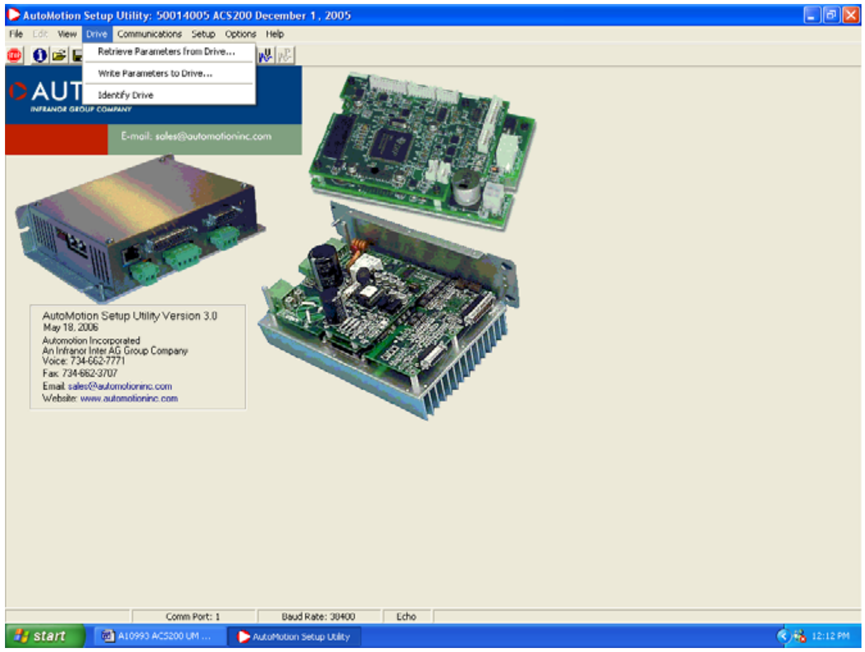


Figure 4: Read Parameters from File

Alternatively, you can load drive parameters from a file or disk, by clicking on the “Load Parameters from Disk” icon on the tool bar or “File” “Open” from the menu.

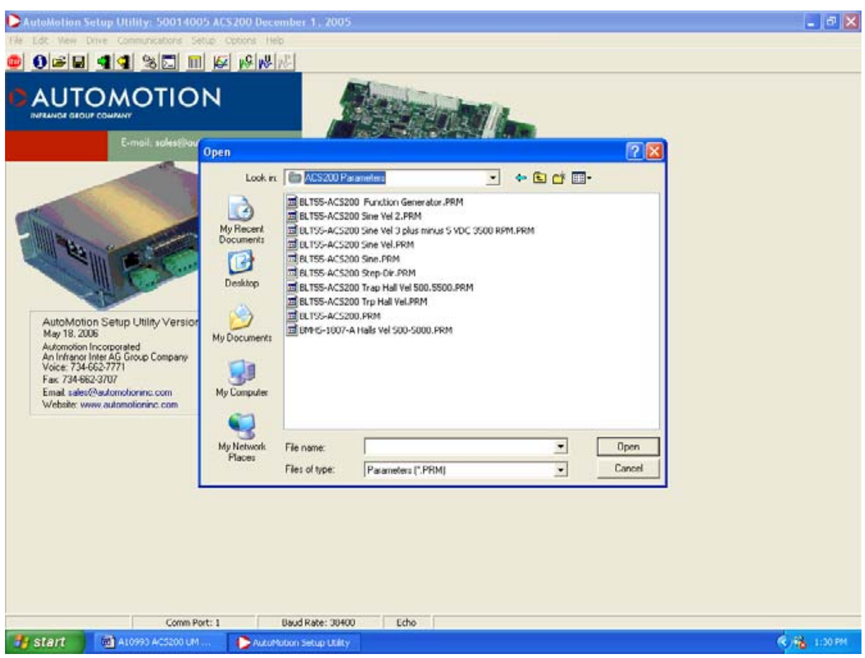
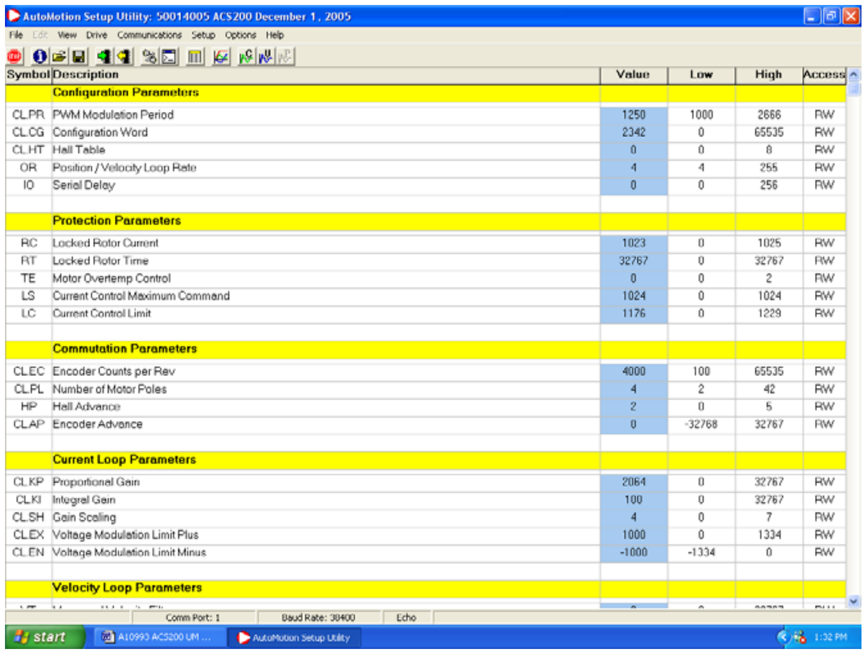


Figure 5: Load Parameters from File

In the above file open example, you can select from pre-loaded parameter file sets that have been established for use with this drive when using the Infranor Mavilor motors.

Once communications have been established and the drive parameters have been retrieved, they can be displayed by clicking the "Parameters" icon on the tool bar, or selecting the "View" and then "Parameters" selection from the menu.

The following table of drive parameters will then be displayed.


AutoMotion Setup Utility: 50014005 ACS200 December 1, 2005

Symbol	Description	Value	Low	High	Access
	Configuration Parameters				
CLPR	PWM Modulation Period	1250	1000	2666	RW
CLCG	Configuration Word	2342	0	65535	RW
CLHT	Hall Table	0	0	8	RW
OR	Position / Velocity Loop Rate	4	4	255	RW
IO	Serial Delay	0	0	256	RW
	Protection Parameters				
RC	Locked Rotor Current	1023	0	1025	RW
RT	Locked Rotor Time	32767	0	32767	RW
TE	Motor Overtemp Control	0	0	2	RW
LS	Current Control Maximum Command	1024	0	1024	RW
LC	Current Control Limit	1176	0	1229	RW
	Commutation Parameters				
CLEC	Encoder Counts per Rev	4000	100	65535	RW
CLPL	Number of Motor Poles	4	2	42	RW
HP	Hall Advance	2	0	5	RW
CLAP	Encoder Advance	0	-32768	32767	RW
	Current Loop Parameters				
CLKP	Proportional Gain	2064	0	32767	RW
CLKI	Integral Gain	100	0	32767	RW
CLSH	Gain Scaling	4	0	7	RW
CLEX	Voltage Modulation Limit Plus	1000	0	1334	RW
CLEN	Voltage Modulation Limit Minus	-1000	-1334	0	RW
	Velocity Loop Parameters				

Comm Port: 1 Baud Rate: 38400 Echo

Figure 6: Drive Parameter Table

The parameter table lists all of the user accessible drive parameters, grouped by function type. The current drive parameter value is displayed along with the range of acceptable values, Low to High, and the parameter's access level, i.e. R/W stands for Read/Write. For R/W access parameters the user can both read the value as well as write a new value.

4.2 How to Save and Load Drive Parameter Files

Before you change any parameters, it is recommended that you first save the original parameters to a file so that you can restore them if needed at a later time. Notice the menu bar located on the top of the window. Either click the Diskette icon shown for "Save Parameters to Disk", or click the File menu, then "Save Parameters". Either selection will bring up a Windows "Save as" dialog box. If a "Parameter File" does not already exist on your PC, create one, and then name your file, i.e. "default.prm", and save it. The file will be saved on your PC.

To open this saved "default.prm" file from your PC, or any previously saved parameter files already on your PC or on a separate diskette, click the File Folder (Load Parameters from Disk) icon from the top of your Windows screen, or select the File menu, then "Open" and search for the desired parameter file on your PC or diskette.

Note: Opening a file will load the parameters from your PC or diskette to the ***AutoMotionPLUS***™ Windows program only. A pop-up dialog box will appear any time you open a new parameter file from your PC or diskette, which will ask if you wish to write the parameters to the drive. See example below.

If you are not certain that you want to replace the drive parameters with the new parameters just opened, select No. The new parameters will be loaded into the Windows program where you can refer them and change them if desired (any parameter which you change will be written to the drive), but will not be uploaded to the drive.

When you are ready to upload the new parameters, you can then use the “write Parameters to Drive icon on the Tool bar, or select “Drive”, “Write Parameters to Drive”, from the menu line.

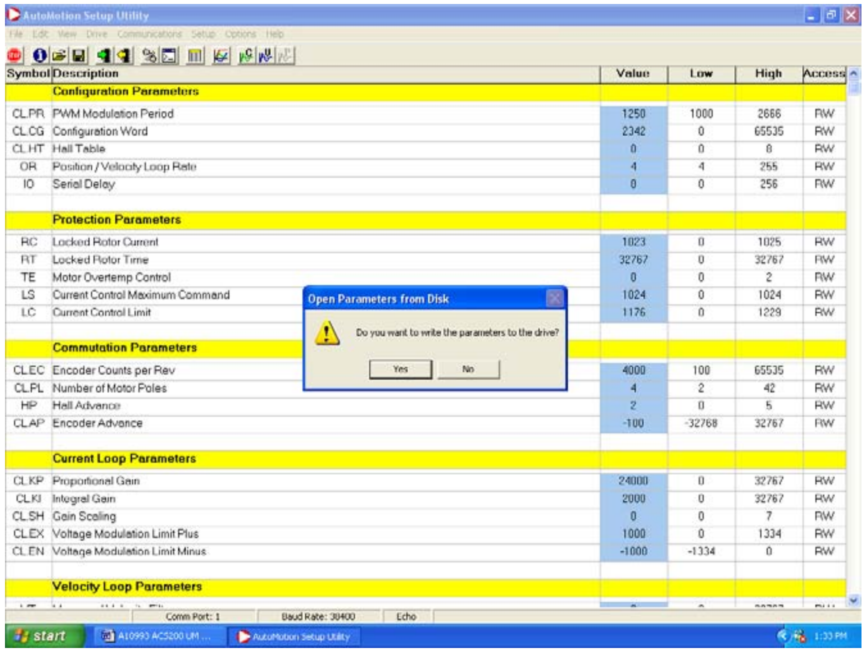


Figure 7: Uploading New Parameters

4.3 How to Change Individual Drive Parameters

Some Drive parameters can be changed while the Drive is running the motor. For example, Proportional, Integral and Derivative Gain parameters in any control loop may be changed at any time, and will take immediate effect.

However, some Drive parameters, if changed, will require you to reset the drive before proceeding. For example, the “Position/Velocity Loop Rate” parameter on this page is used to set the processing frequency for these control loops. The Drive must be placed into “Standby” using the Run/Stop! Switch when changing this parameter. After this parameter is changed, the drive must be Reset to function properly.

For example, to change the “Velocity Proportional Gain” parameter (VL.KP) found under the “Velocity Loop Parameters” section, move your mouse pointer over the displayed value box and then click on it. This will bring up a pop-up dialog box as shown in the next frame.

To change the value simply type in the new value and hit OK. When the OK key is pressed the new parameter value will be uploaded to the drive immediately, so that the value shown on the Windows Parameter table is always the same as it is in the drive.

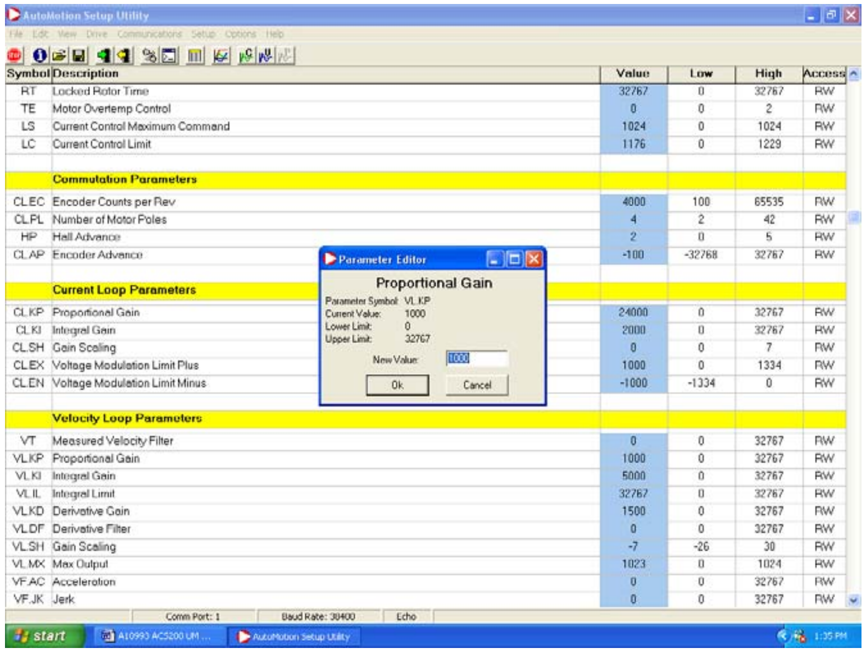


Figure 8: Changing Parameter Values

Note: When parameters are stored or written to the Drive, they are automatically saved in nonvolatile memory. If power is removed and re-applied, the Drive will retain any changed values. To restore the default drive values, Open and load the "default.prm". See 3.6.2 How to Save and Load Parameter files.

4.4 Drive Configuration

The ACS300 drive can be configured in one of four operational servo modes, torque, velocity, position without velocity, or position with velocity.

To determine the default configuration of the current drive select the "**Configuration Word**" CLCG value from the Configuration Parameters section of the Parameter table. The Configure Dialog pop-up box will appear. See Windows screen below.

You will use this Configure Dialog box to set up the drive for the desired operational mode, as well as to define the motor feedback, analog feedback, and position and auxiliary command feedback.

The torque mode of servo operation is the most basic set-up for this servo and it is set as the default drive mode. Torque mode is also required for operation of the other three servo modes.

The commutation mode can be one of three choices. The first, Trapezoidal, uses Hall feedback only. The other two, Sine, which operate the drive in Sinusoidal mode, offer operation with either "Sine with Halls Synchronized" or "Sine with Encoder Synchronized".

Sine commutation modes require "Halls and Encoder" commutation signals. Velocity and position feedback must be configured as "Use Encoder for Position & Velocity".

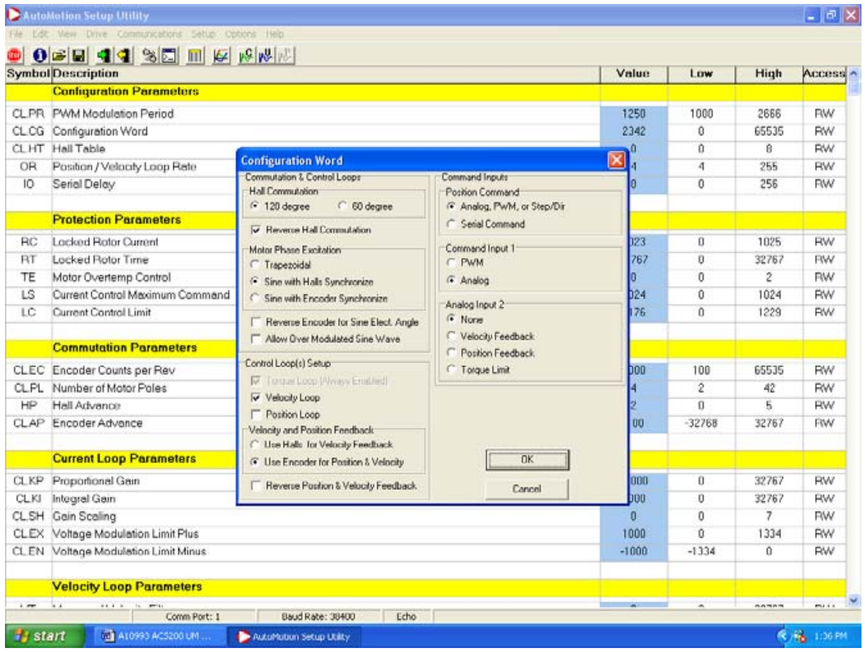


Figure 9: Drive Configuration Set-up

4.4.1 Setting up the ACS300 for torque, velocity, or position loops via the RS232 input.

What are the procedures and commands needed to set up the ACS300 drive to follow torque, velocity, or position commands via RS232 input?

To get the ACS300 to respond to torque (current), velocity, and/or position commands from RS232, first you need to set VF.GN to 0. To get the ACS-200 to respond to position commands, the “Position Command” box must also be set to “Serial Command”. This sets the analog gain to 0 and tells the ACS300 to ignore the analog command input.

The VF.GN value is found under the “I/O Configuration” section of the ACS300 Parameter Table.

Then, if in torque (current) mode the command "CC####" will set the "Current Command". CC0 will deliver zero current. CC1023 will deliver max positive and CC-1023 will deliver max negative current.

If in Velocity mode, the command "VL.CM####" will set the speed. If using hall only velocity (no encoder) the command is in RPM (this is also dependant upon motor pole count). If using encoder velocity, the command is (# of encoder counts per velocity loop) * 256. The "*256" allows us 8 bits of fractional velocity control.

If in Position mode, the command is "PL.CM####". The number is in encoder counts.

At any time, if you type the command without a number, the ACS300 will display the existing setpoint.

4.4.2 Requirements for Torque Mode Operation

To properly set up the ACS300 drive's operating mode, for all possible operating configurations, you will use the "Configuration Word" (CL.CG) found under "Configuration Parameters" section of the main "Parameter Page" of the Windows program.

If you click on the "Value" figure in the right hand column of this "Configuration Word" parameter, a pop up "Configuration Dialog" box will appear on the screen, as explained under section 4.4, adn shown in Figure 9, above.

Note, for the drive to be configured properly with a new motor you will need to run the Auto-Phasing tool found under "Motor Setup", described in section 5.2. This utility will correctly set the Hall Commutation, the Reverse Encoder for Sine Elec. Angle, and the Reverse Position & Velocity Input in the Configuration Word. It will also set the Hall Advance and Hall Table parameters.

Note: Before you run the "Motor Setup" routine, which determines the proper phasing for the commutation and the encoder feedback relationship, you first should set up the rest of the "Configuration Word".

4.4.2.1 Setting up for Torque Mode with Halls Only (no Encoder)

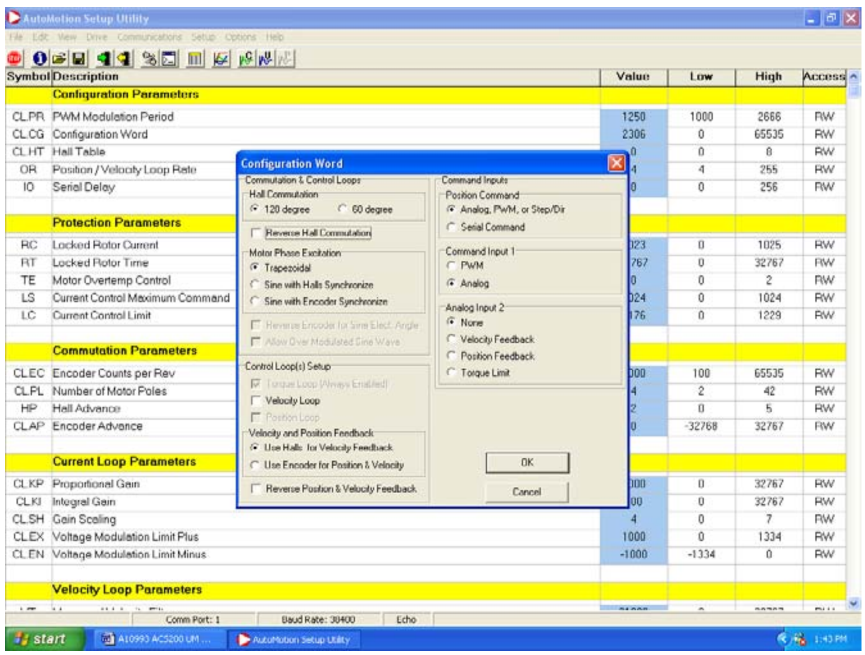


Figure 10: Set-up for Torque Mode with Halls

In this Torque Mode only configuration example, the motor is selected for Trapezoidal commutation. It does not have an encoder.

Control Loop(s) Setup is set for Torque Loop (always enabled).

The Velocity Loop option is unchecked, as we are planning to run in Torque Mode only. Velocity feedback is selected for "Use Halls for Velocity Feedback". The "Number of Motor Poles" must be set correctly for velocity to read in RPM.

“Command Inputs” have been selected for the ACS300 drive product.

The Position Command is defaulted to Analog, PWM , or Step/Dir Input. Note, this is not used for the Torque Mode operation.

Command Input #1 is set for Analog (default for ACS300). For the ACS300 product this is also called Analog Input #1 in the documentation. Other ACS300 hardware options offer an alternate PWM command input. Contact factory for more information.

Analog Input #2 is selected for “None” as we are not planning to use an auxiliary analog input. An example of where we could use this additional analog input is as a flow control or pressure loop feedback application.

4.4.3 Requirements for Velocity Mode Operation

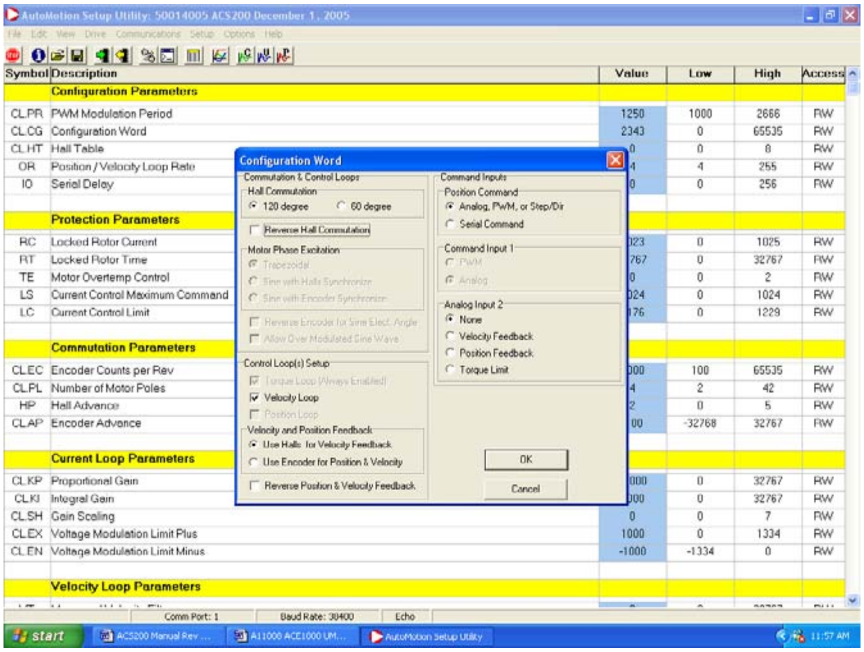


Figure 11: Set-up for Velocity Mode with Halls

4.4.3.1 Velocity Mode Operation Using Halls Only

In this example we desire to run the drive in a closed loop Velocity mode using the Halls as our only velocity feedback.

Control Loop(s) Setup is set for Velocity Loop (Torque Loop is always enabled).

Feedback is selected for “Use Halls for Velocity Feedback” since we are only running Halls at this time.

“Command Inputs” have been selected for the ACS300 drive product.

Command Input #1 is set for Analog (default for ACS300). For the ACS300 product this is also called Analog Input #1 in the documentation. Other ACS300 hardware options offer an alternate PWM command input. Contact factory for more information..

Analog Input #2 is selected for “None” as we are not planning to use an auxiliary analog input. An example of where we could use this additional analog input is as a flow control or pressure loop feedback application.

4.4.3.2 Sine Wave Velocity Mode Operation Using Encoder Feedback

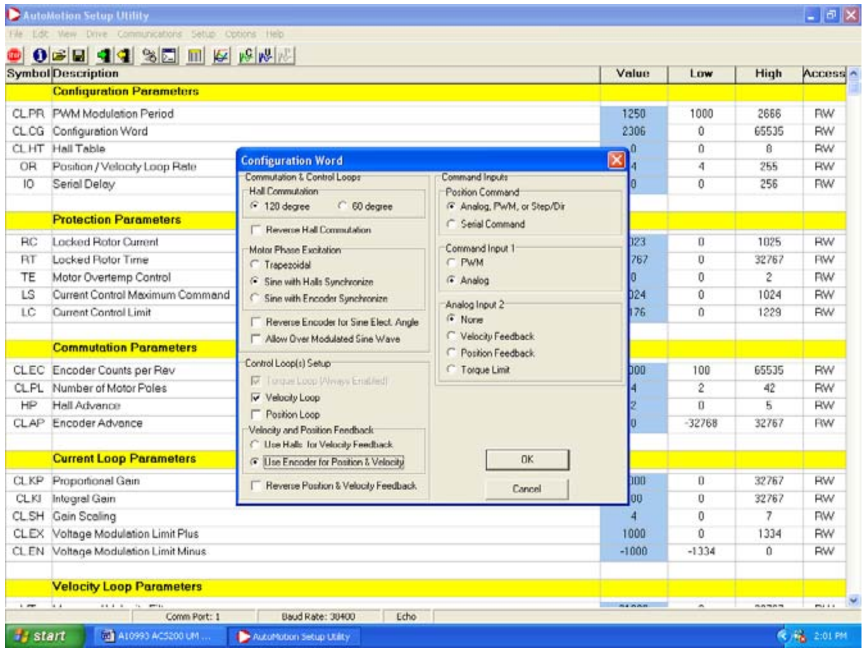


Figure 12: Set-up for Sine Velocity Mode with Encoder

In this Velocity Mode with Encoder Feedback example, the motor is equipped with an encoder.

Motor Phase Excitation is set for “Sine with Halls Synchronized” so that we can run in sine wave commutation. As an alternate, if desired, we could also run the Velocity Loop closure using encoder feedback in Trapezoidal or Sine Mode commutation.

Control Loop(s) Setup is set for Torque Loop (always enabled).

The Velocity Loop option is checked, as we are planning to run in Velocity Mode.

Feedback is now selected for “Use Encoder for Position & Velocity”.

“Command Inputs” have been selected for the ACS300 drive product.

Command Input #1 is set for Analog (default for ACS300). For the ACS300 product this is also called Analog Input #1 in the documentation. Other ACS300 hardware options offer an alternate PWM command input. Contact factory for more information.

Analog Input #2 is selected for “None” as we are not planning to use an auxiliary analog input. An example of where we could use this additional analog input is as a flow control or pressure loop feedback application.

4.4.4 Requirements for Position Mode Operation

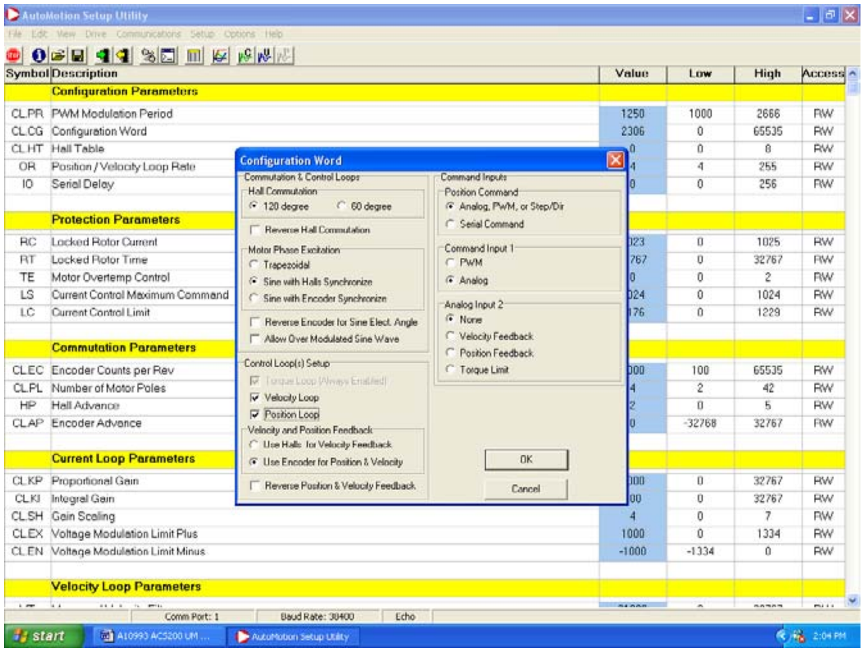


Figure 13: Set-up for Position Mode with Encoder

In this final example, we are setting the drive up for Position Mode with Step & Direction input.

For this mode the motor must have an encoder for position feedback.

Motor Phase Excitation is set for “Sine with Halls Synchronized” so that we can run in sine wave commutation. As an alternate, if desired, we could also run the Position Loop in trapezoidal commutation.

Control Loop Setup is set for Torque Loop (always enabled), and the Velocity Loop option is checked.

In additon, the Position Loop is now checked and enabled.

Feedback is selected for “Use Encoder for Position & Velocity”.

“Command Inputs” have been selected for the ACS300 drive product.

The Position Command is defaulted to Analog, PWM , or Step/Dir Input. For Step and Direction to be selected, “Command Gain” in I/O Configuration must be set to zero, otherwise Analog or PWM will be used.

Analog Input #2 is selected for “None” as we are not planning to use an auxiliary analog input. An example of where we could use this additional analog input is as a flow control or pressure loop feedback application.

4.5 How to Graph Drive Variables

All of the variables discussed in the preceding section can be captured and displayed graphically using the Graph screen. In this way, control loop tuning can be evaluated.

4.5.1 Initial Graph Channel Set-up

Select “View->Graph” from the AutomotionPlus menu bar. The following screen will be displayed:

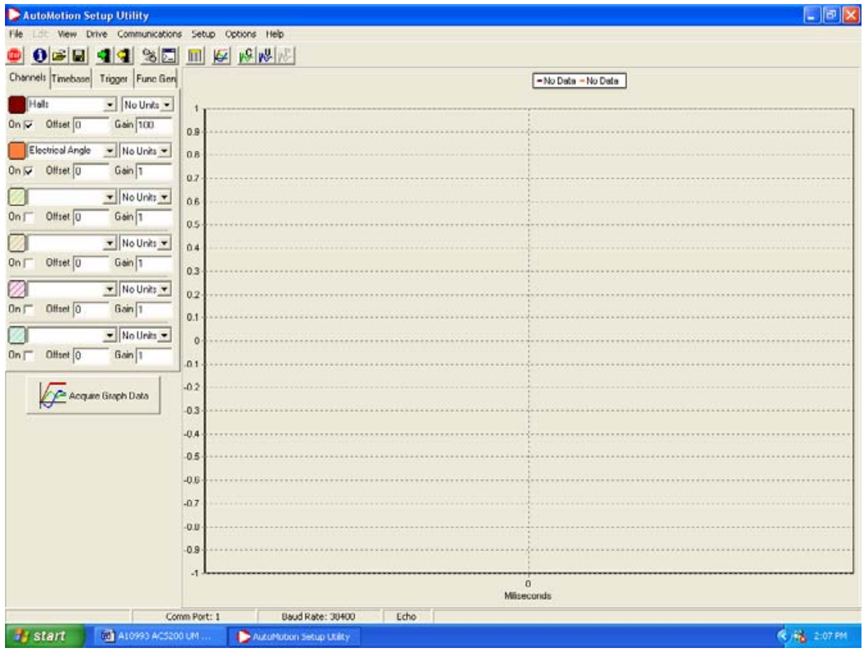


Figure 14: Graph Channel Set-up

Use the drop down list box in the upper left corner of this screen to select a variable to be graphed. For example select the variable named “Position Error” by scrolling down with your

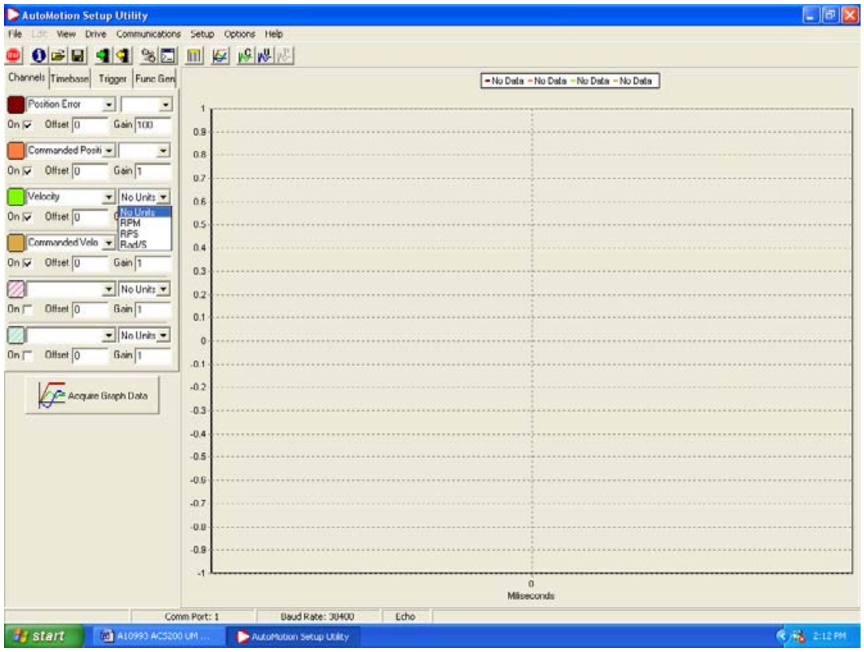


Figure 15: Selecting Variables to Graph

mouse and then clicking on it. You can then click on the second drop down box to select a second variable to graph, such as “Commanded Position”. Additional variables of interest can be selected in a similar fashion.

Note that a check mark appears in the “On” box located just below the selected variables. This means that these variables are enabled for data collection. You can disable a variable by clicking on this box.

You can also select the “units” you desire the variable to be displayed in from the box adjacent to each variable. For example, the ‘Velocity” variable can be displaced as RPM, RPS, or Rads/S.

You can use the “Offset” and “Gain” boxes to scale each variable as desired. This feature is useful for displaying variables with different user units, or different numerical ranges, on a single graph for viewing.

You can also change the color of the Data being displayed on the graph by clicking on the color box associated with each variable for easier viewing.

Click in the Graph window and drag a box from the upper left, to the lower right. A zoomed view of the graph will appear. To zoom out, click and drag a box from the lower right, to the upper left. Click and hold the right mouse button to PAN the graph. Additional view functions are also available by right mouse clicking on the graph.

4.5.2 Graph Timebase Set-up

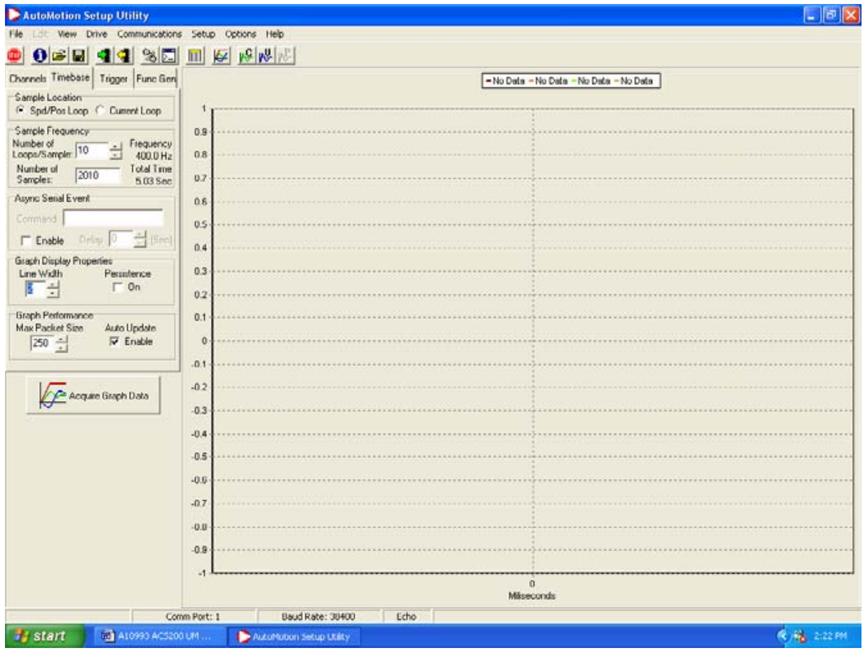


Figure 16: Graph Timebase Set-up

After selecting the initial variables to include in your graph, you will need to select the timebase for your data collection.

Within the Timebase set-up you first must select your Sample Location, either from within the Speed/Position Loop, or from within the Current Loop.

Next you determine your Sample Frequency. This is influenced by your Sample Location selection above, and is determined by both the number of loops per sample used, as well as the number of sample points desired.

Note that as the “Number of loops per sample” figure is adjusted, both the frequency as well as the total time for the samples to be collected will change. When just the “Number of Samples” is adjusted after setting the number of loops per sample, just the “Total Time” required to collect the sample data will change. The “Number of Samples” is limited by the variables selected and can vary from about 2700 to about 32000. If a number larger than the limit is entered, the “Number of Samples” will be set to the limit.

In the Graph Display Properties box you can select the thickness of the graph display lines, and also determine if you will retain the last graph data to be overlaid by the next graph run using the “Persistence On” feature. This feature is useful when wishing to compare two consecutive data runs results on the same graph.

Finally, the “Graph Performance” box allows the user to adjusted the maximum data packet size from 20 to 500 for best upload performance, while the Auto Update Enable allows incoming data to be displayed as it is received, rather than waiting until all data is collected. This can be turned off when desirable. Graphing will run somewhat faster if “Auto Update” is turned off.

4.5.3 Graph Trigger Set-up

The ***AuotMotionPLUS***™ graphing utility is supplied with an additional data trigger feature to allow the user to more easily capture specific events of interest.

While data can be captured any time that the drive is in Run mode, by clicking on the “Acquire Graph Data” button at the bottom left of any graph screen, this special trigger feature allows the user to start data capture upon a particular event or action.

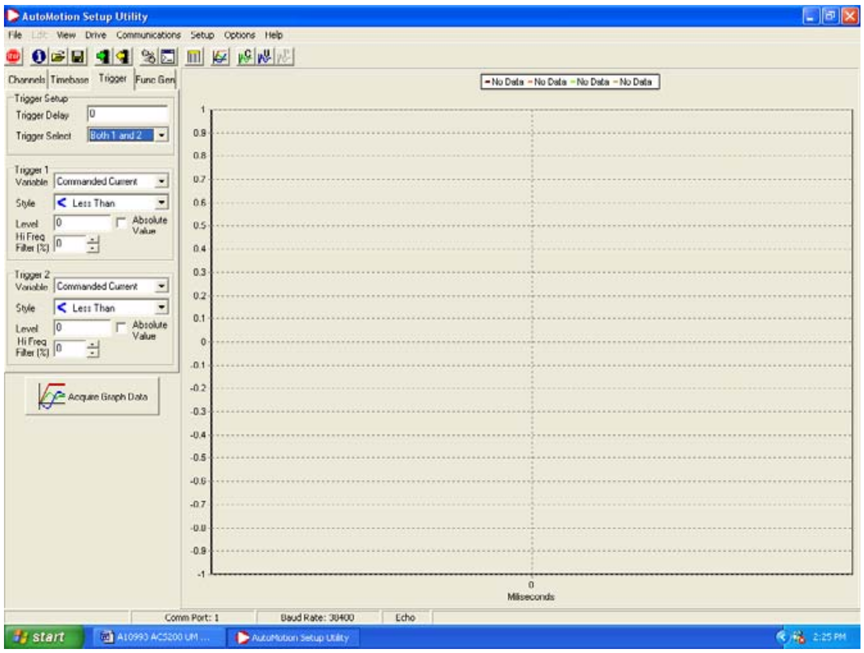


Figure 17: Graph Trigger Set-up

The first step in using the graph trigger function is to turn on the trigger function by selecting one of the five options in the drop down box. In the example above, Both 1 and 2 trigger functions has been selected, activating the Trigger 1 and Trigger 2 set-up boxes.

At the same time the “Trigger Delay” function can be selected to better capture the exact moment of the event you are looking for. The figures inserted into this box are in “number of samples”, not time. This figure can be either positive or negative. A negative number would be used in the case where it was desirable to capture some data ahead of the event you are looking for. As an example, if 500 samples had been selected in the Timebase set-up (see section 4.2 Graph Timebase Set-up) and you chose to collect 100 samples prior to your trigger event, you would insert a minus 100 (-100) into the Trigger Delay box. In this case the total of 500 samples would be spread over the selected tripper event with 100 samples displayed before the event took place, and 400 samples displayed after the trigger event occurred. The actual amount of time that elapses over the 100-sample size will be dependent upon the sample location and the number of loops per sample as explained in section 4.2.

In each Trigger box a desired Variable to trigger the graph on can be selected from among the variables offered in the drop down display box.

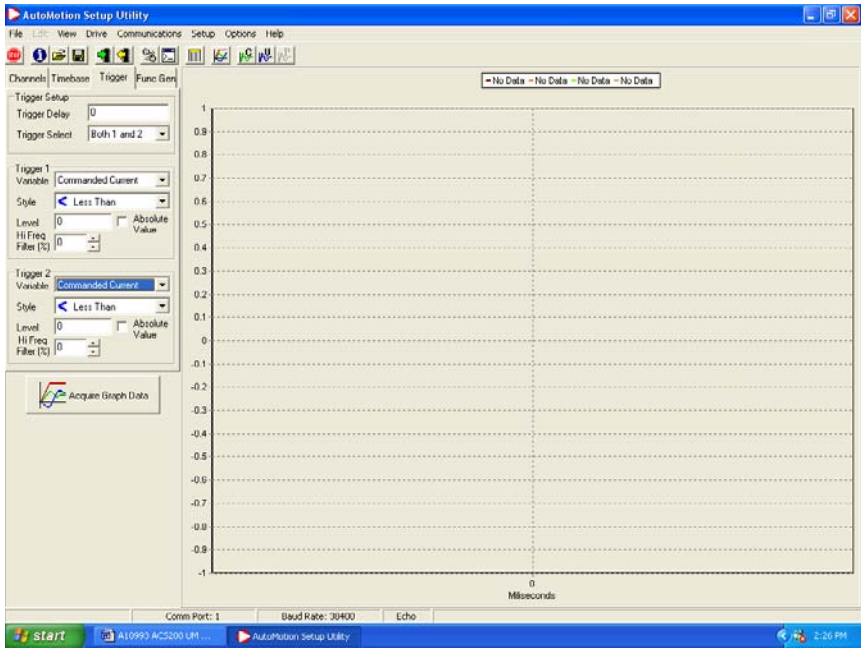


Figure 18: Selecting Trigger Variable to Graph

4.5.4 The Function Generator

4.5.4.1 Function Generator Overview

To tune the drive's current, velocity, and/or position loops, you can make use of the built-in function generator feature found in the Graph window menu.

Note: To stimulate the Velocity or Position control loops using the function generator, these loops must first be enabled in the Configuration word. By default, the current (torque) loop is always enabled.

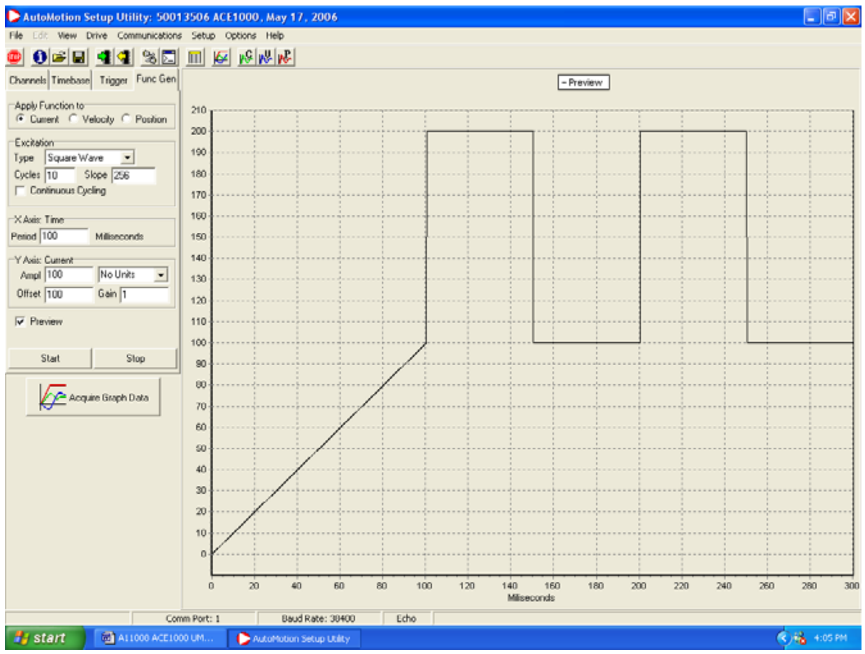


Figure 19: The Graph Function Generator Screen

4.5.4.2 Enabling the function generator

Place the drive into standby. Select "Function generator" from the menu bar on the Graph page to enable the function generator. The function generator is used to output a user configured reference signal to either the current, velocity or position control loops. To stimulate the Velocity or Position control loops using the function generator, these loops must first be enabled in the Configuration word.

(Hint: It is best to reset the drive when any changes have been made to the configuration word)

When the "Start" button is pressed in the function generator window, the drive's Command input signal (as determined by the configuration word) is replaced with the function generator signal, the drive is enabled in software and graphing begins automatically.

(Hint: Before pressing the start button, loop variables and other recording options should first be selected in the graph window.)

4.5.4.3 Configuring the Graph window:

In the example below, Commanded Current, Current and Commanded Voltage are recorded in the current loop. The variable "Command current" has been replaced with the function generator.

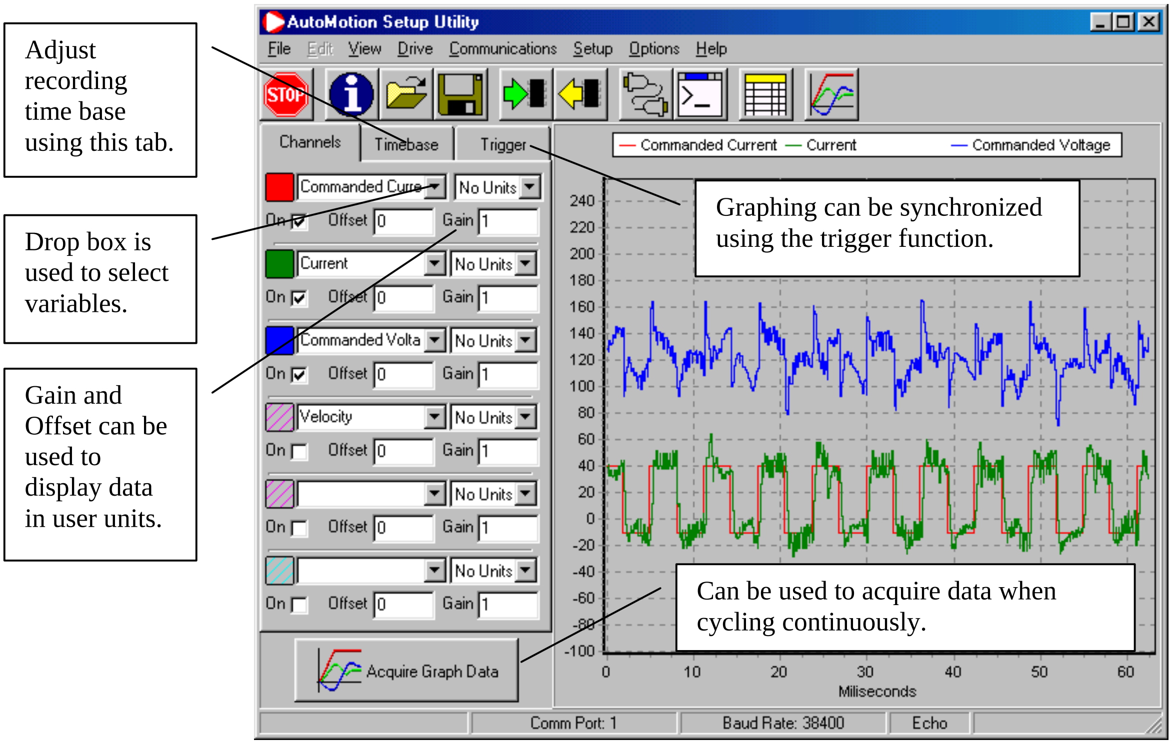


Figure 20: Configuring the Graph Window for the Function Generator

4.5.4.4 Configuring the Function Generator

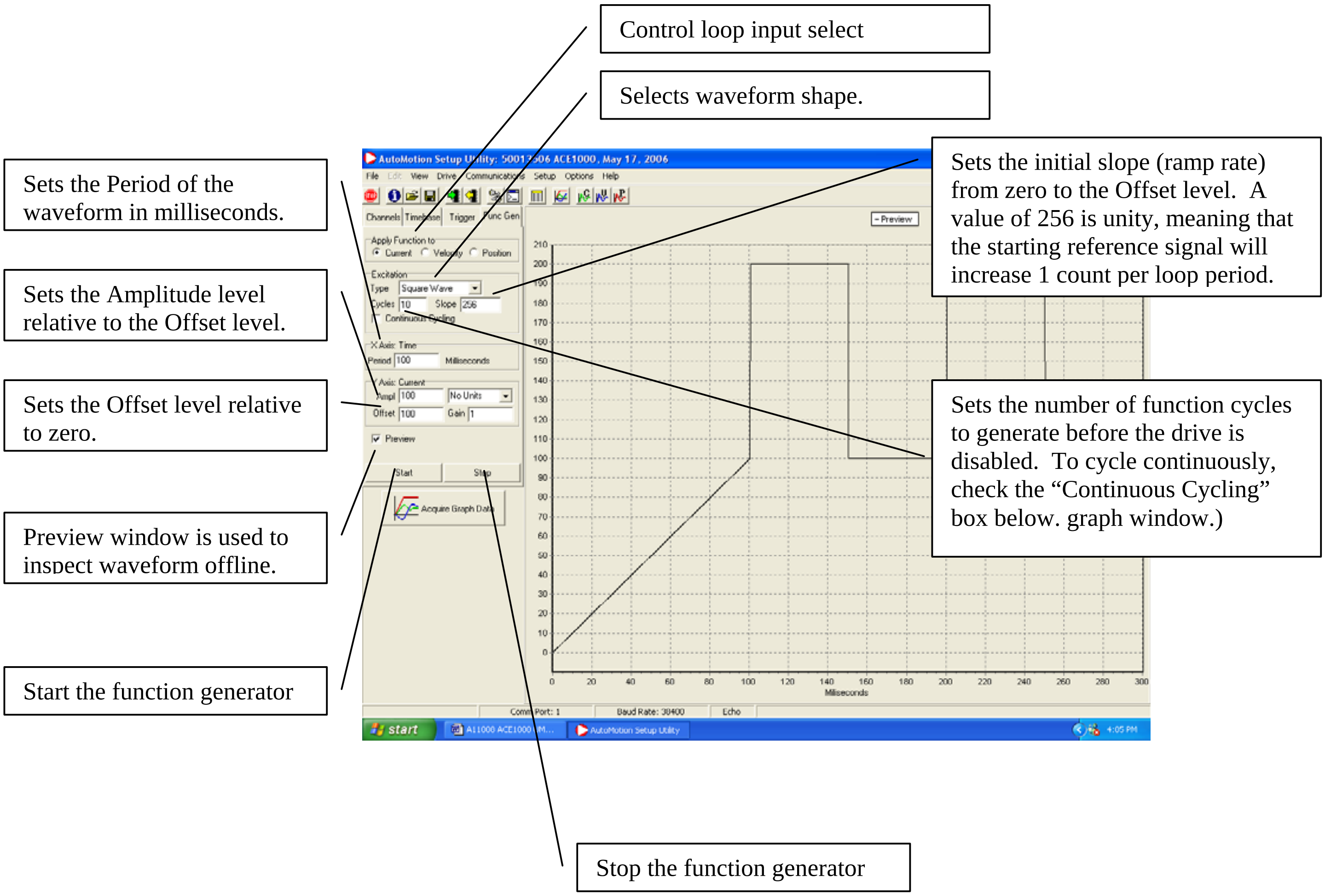


Figure 21: Configuring the Function Generator Screen

A typical graph of the current loop tuning with square wave excitation.

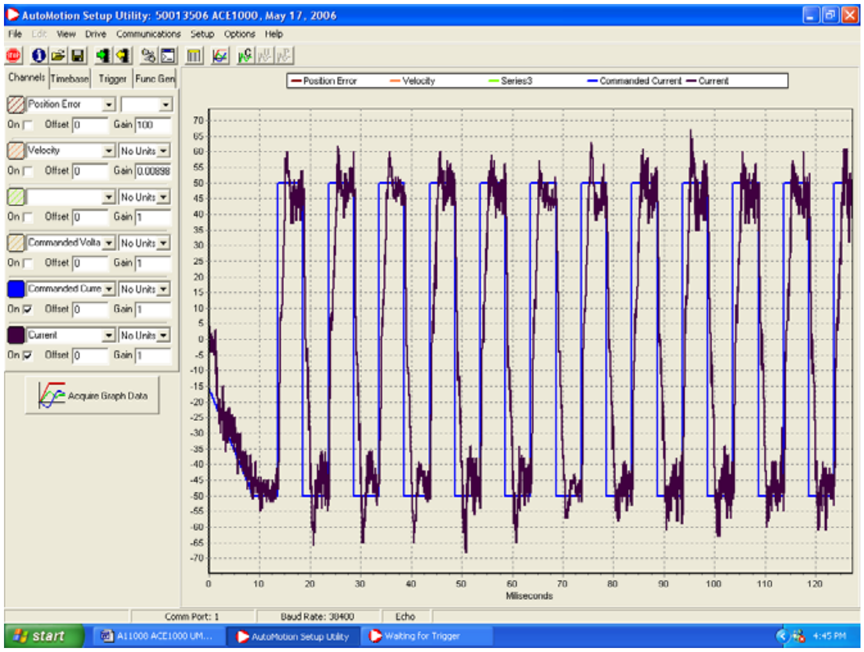


Figure 22: Sample Graph of Current Loop Tuning In Function Generator

5 Working with the ACS300 – Helpful Notes and Procedures

5.1 Recommended Wiring Hookup and Shielding

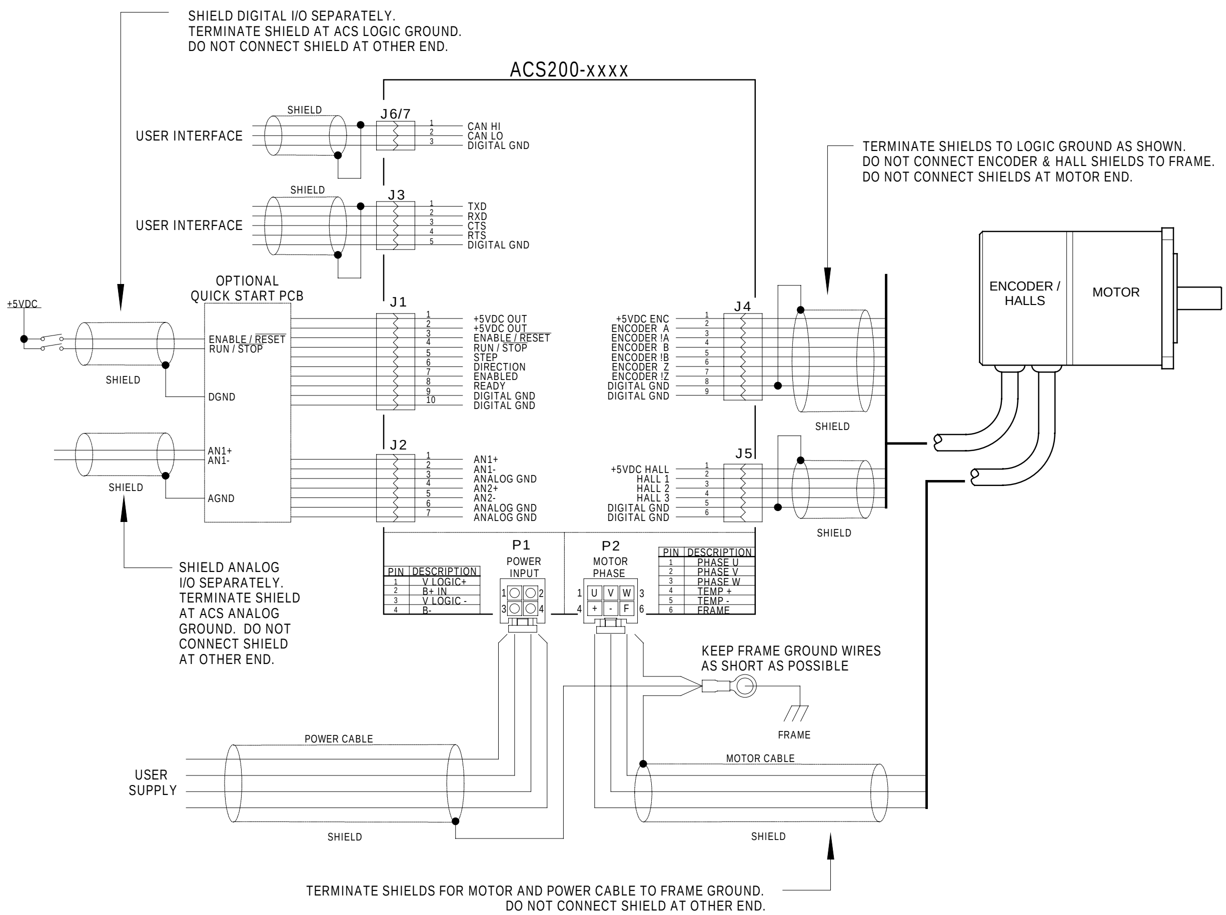


Figure 23: Recommended Wiring Hookup and Shielding

5.2 First time operation

5.2.1 Phasing the Motor

Automotion has determined the correct motor phasing for all Mavilor motors sold by Infranor Inter AG. If your drive was ordered with a Mavilor motor specified, the correct parameter set for the mating Mavilor motor in your system was loaded into your drive at the factory prior to shipment.

Alternate Mavilor motor parameters can be selected from the motor selection file on the software disk supplied with your drive, or you can contact Automotion for these files.

In addition, Automotion has established the correct motor phasing relationships for many other popular US and foreign motor manufacturers. A listing of these additional motor manufacturers may be obtained from Automotion upon request.

5.2.2 *AutoMotionPLUS™* Motor Set-up Auto-Phasing Tool

5.2.2.1 Getting Started

Please refer to the *AutoMotionPLUS*™ Windows Motor Set-up screen, figure 17 below. To establish the correct motor phasing for a new or unknown motor Automotion has provided a new feature called Motor Setup. To make use of this feature proceed as follows:

1. Connect all phase and hall wires to the drive.

2. Place drive into standby

3. Connect power and establish communications (38400 baud rate required)

4. Load a starting parameter set from Automotion motor tables or drive defaults.

5. On the ***AutoMotionPLUS***™ Windows menu, select "Setup" -> "Motor setup"
   On the Motor setup screen check to see that the number of poles shown for the motor you are using is correct. If not, put in the correct value.
   If you are using an encoder, check to see that the encoder resolution shown is correct. If not, change it as required. If you started from default parameters, perform the current loop tuning as described in section 5.4.1.

6. Select "Start Auto Config" button in lower right corner of "Motor Setup" window.

7. Select "close" button in lower right corner of "Motor Setup" window

8. The motor should now be properly phased for the ACS300. You can now proceed with drive loop tuning.

5.2.2.2 Error Messages During Auto-phasing

1. "Encoder resolution and motor pole count do not match detected value". Possible causes for this error include, wrong value given for encoder counts, wrong number of motor poles selected. Place drive in standby. Check motor nameplate information to confirm encoder resolution and number of poles used. You can also manually rotate motor shaft while drive is in standby and observe the "Raw Encoder Position" count on display. Check to see how many counts are indicated for one complete 360° rotation of the motor. If different than the value entered under Encoder Resolution change to match observed value and try again.

2. "Halls Sequence Cannot be matched". Possible causes for this error include, excessive vibration or oscillation of the motor shaft, or a failure of the shaft to move steadily. Try

changing the "Applied Current" or clicking the "Advanced >>" button and then adjusting the "Refresh Rate or "Electrical Angle Increment".

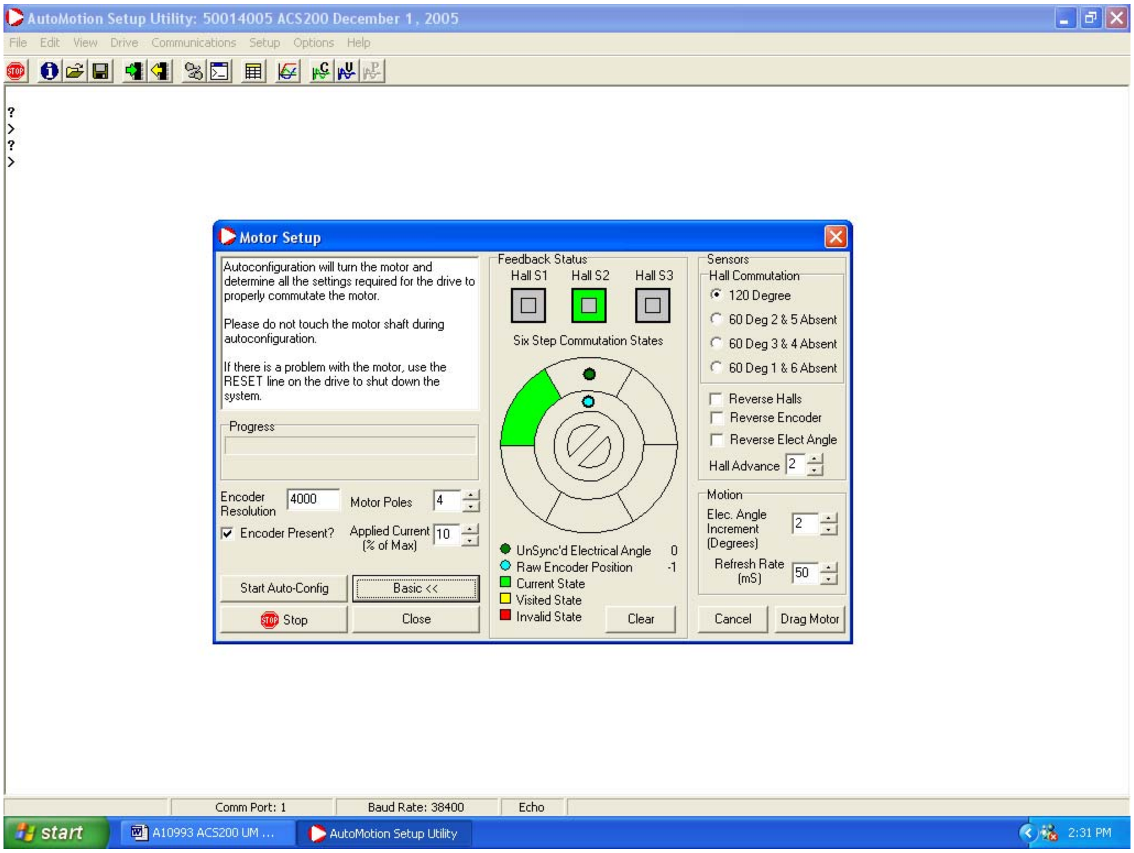


Figure 24: Motor Set-up Screen

5.2.3 Scaling the Analog Inputs

To properly adjust the analog inputs to match the desired input analog command voltage range with the desired output (i.e. Current, Velocity, etc.) you must first calculate the proper analog gain and offset values for entry into the drive’s parameter page, under “I/O Configuration”.

To assist you in this conversion Automotion has developed a tool under the Setup tab in the menu bar called “Analog/PWM Setup” This tool will automatically convert your calculated or measured analog input values to the required analog gain and offset values in the Configuration Table to achieve the desired command input ranges.

5.2.3.1 Analog Input for Current Control – AN1 Analog Input

A “pop up” form will appear once you selected the “Analog/PWM Setup” option from the menu item, Setup.

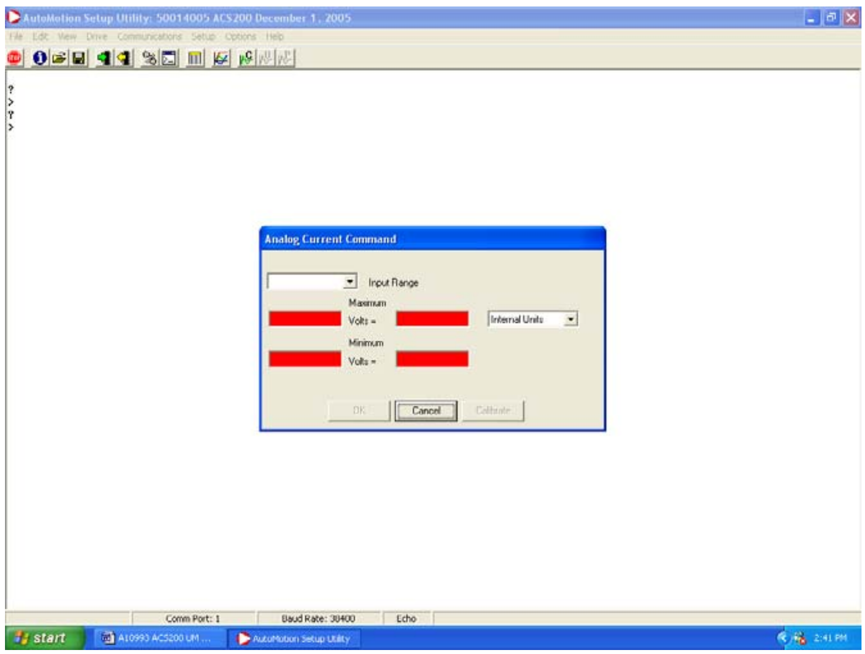


Figure 25: Analog Current Command Set-up Screen

This form will appear either as an Analog Current Command form, an Analog Velocity Command form, a Analog Position Command form, a PWM Current Command form, a PWM Velocity Command form, or PWM Position Command form, depending upon which mode of operation you have previously selected in the Configuration Word for your drive.

The analog voltage “Input Range” value for the Analog Command can be selected from one of the standard inputs in the drop down box, such as 0 – 5 VDC, +/- 10 VDC, etc., whichever represents your analog input signal, or you can select the Custom option if you are using a range not listed. In the “Custom” selection, you may use the “Calibrate” button to allow the drive to directly read the voltages and find the maximum and minimum while you manually vary the voltage.

After selecting the Input range that matches your desired Analog Command input, you can then select the drive output format that this command will represent.

In the example below we have selected the Input Analog Command to be 0 to +5 VDC. We wish for this input voltage range to represent 0 to 90% current output of the amplifier’s nameplate rating.

Once this information has been entered and the OK button selected, the required internal values for Command Offset (VF.OF) and Command Gain (VF.GN) of Analog input (AN1) are calculated and placed into the drive's configuration page under the I/O Configuration section.

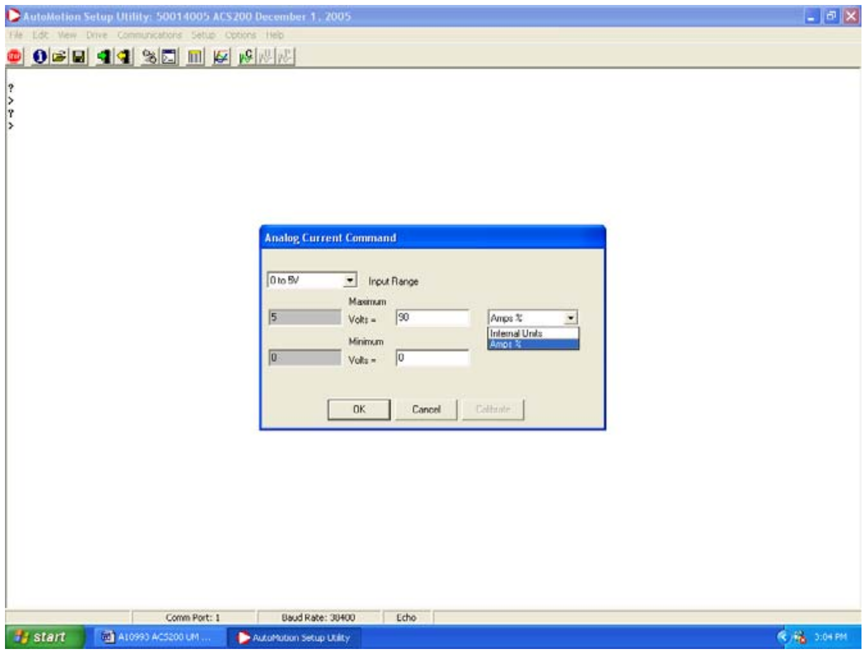


Figure 26: Analog Current Command Output Selection

5.2.3.2 Analog Input for Current Mode Operation – AN2 Analog Input

To set up and scale the Aux Analog Input (AN2) for the ACS300 follow the same procedures as outlined above for the Analog Current Command using the "Aux Analog Setup" option under the "Setup" menu. This option will appear only if "None" is not selected in the "Analog Input 2" box of the "Configuration Word".

5.2.4 Scaling the Analog Input Commands for Velocity and Position

5.2.4.1 Analog Input Command for Velocity Control

An "Analog Velocity Command" or a "PWM Velocity Command" input "pop up" menu box will appear once you selected the "Analog/PWM Setup" option from the menu bar item, Setup, assuming that you have already selected the Velocity configuration in the drive Configuration Word set-up box.

In the example below we have chosen a +/- 10 VDC signal as our position analog command source.

We have selected the desired output to be in motor RPM's. Other options are RPS and Rad/s.

We wish to have +10 VDC analog input command equal 5000 RPM (forward direction), and –10 VDC analog input command equal –5000 RPM (in the opposite direction).

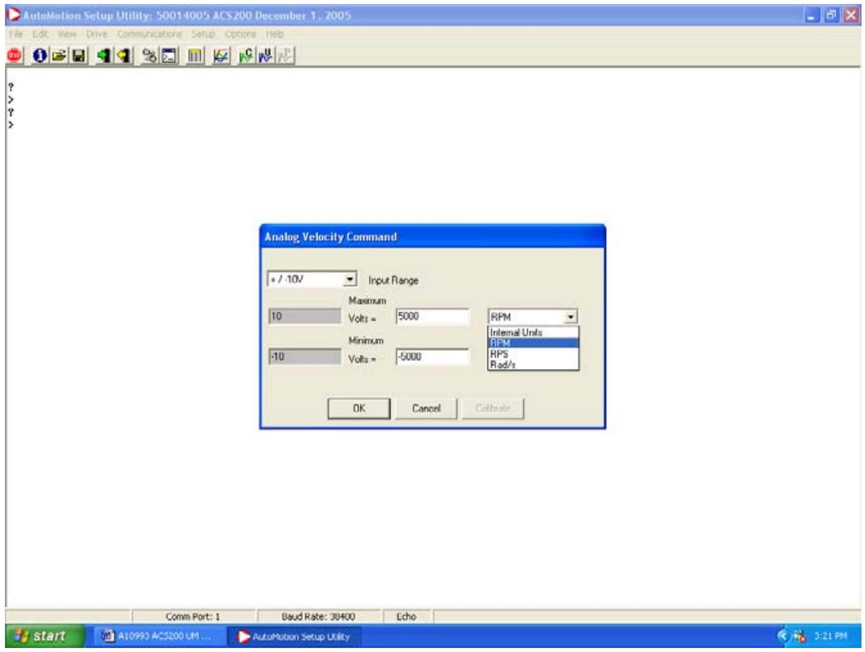


Figure 27: Analog Velocity Command Selection Screen

5.2.4.2 Analog Input Command for Position Control

An ACS “Analog Position Command” input “pop up” menu box will appear once you selected the “Analog/PWM Setup” option from the menu bar item, Setup, assuming that you have already selected the Position configuration in the Drive configuration set-up box.

In the example below we have chosen a +/- 10 VDC signal as our input analog command source.

We have selected the desired output to be in motor degrees. Other options are Revs and Radians.
We wish to have +10 VDC analog input command equal 500 degrees (forward direction), and –10 VDC analog input command equal –500 degrees (in the opposite direction).

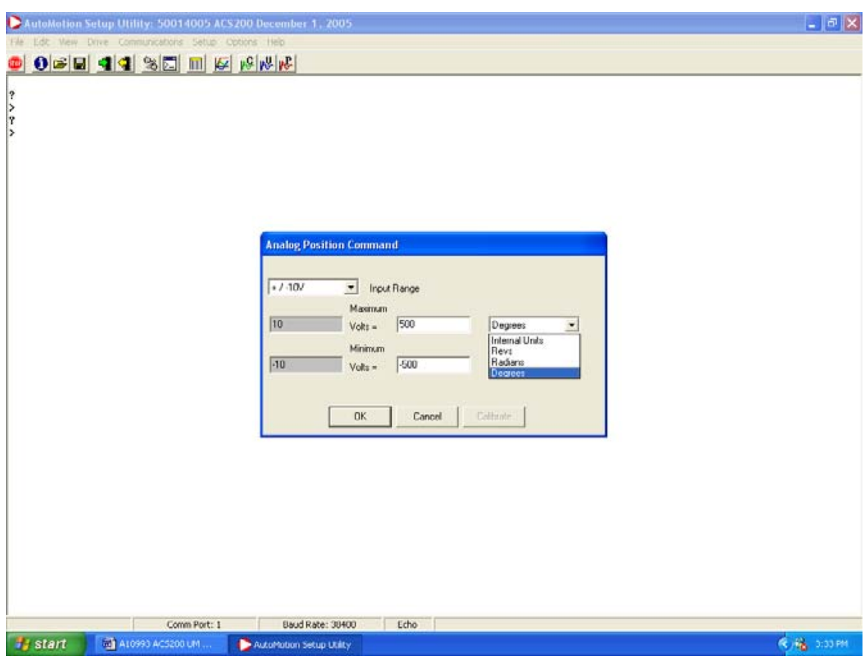


Figure 28: Analog Position Command Selection Screen

5.2.5 Initial Drive Parameter Calculations

If your drive was supplied with a Mavilor motor initial parameters for that motor may already be loaded in the ACS300 drive, or a set of factory default parameters may be loaded.

From assistance in determining an initial set of drive parameters to begin your evaluation please contact Automotion applications support.

5.3 Tuning the Control Loops

To assist you in tuning the drive's control loops; Current, Velocity, and Position, for your specific motor and load, Automotion has developed a set of tuning tools that incorporate a built-in function generator (to excite the motor and load), graphing function, and slide bar adjustments for selecting various amounts of selected loop tuning parameters, to achieve the best possible closed loop servo performance.

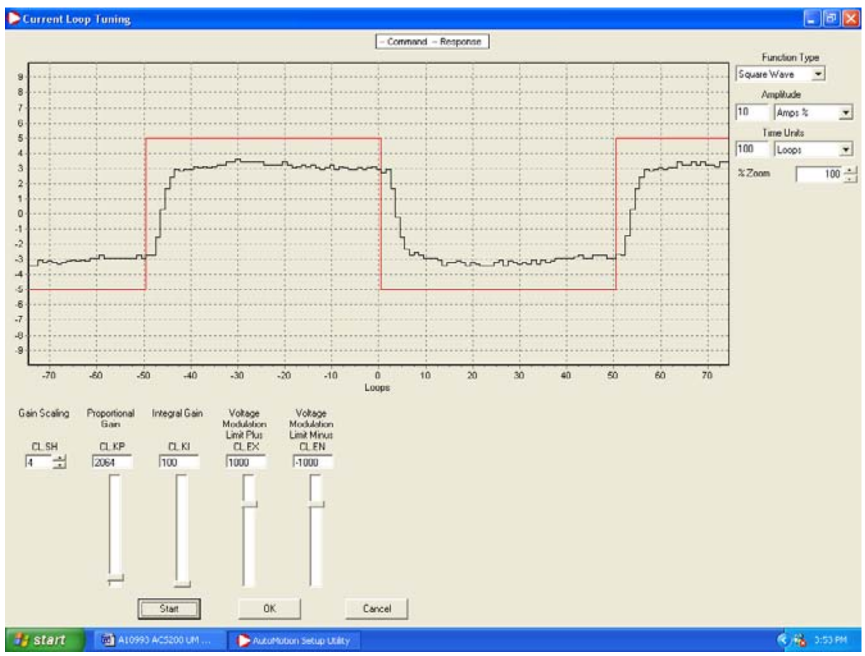


Figure 29: Current Tuning Screen

5.3.1 Tuning the Current Loop

In the example above, we have selected the Current loop for tuning by clicking on the Current tuning icon button found in the tool bar.

Note- If our drive were configured for current mode operation only, the other tuning icons for Velocity and Position would be grayed out and inaccessible.

Set the excitation of the function generator to Square Wave. Set the frequency to 100 loops or 100 Hz typically.

Set the amplitude of the applied current to no more than 10% of the drive's continuous current rating. Verify that the amplitude of the applied current is not excessive for the motor.

Note- For very high friction motors you may have to increase this applied current value to obtain better results.

Start the function generator by clicking on the start button at the bottom of the pop-up window.

Then use the parameter slide bars shown to adjust the current loop proportional gain (CL.KP) by first:

a) setting the current loop integral gain (CL.KI) to zero.

b) Increase or decrease the proportional gain (CL.KP) until the desired step response is obtained. Typically, the desired result is little or no overshoot with a 100 Hz, low-current square wave applied.

c) If the proportional gain (CL.KP) is too large, ringing may occur. If the proportional gain is set too low, the response bandwidth will suffer, i.e. decrease.

Next, adjust the current loop integral gain (CL.KI) from zero until the desired settling time is obtained.

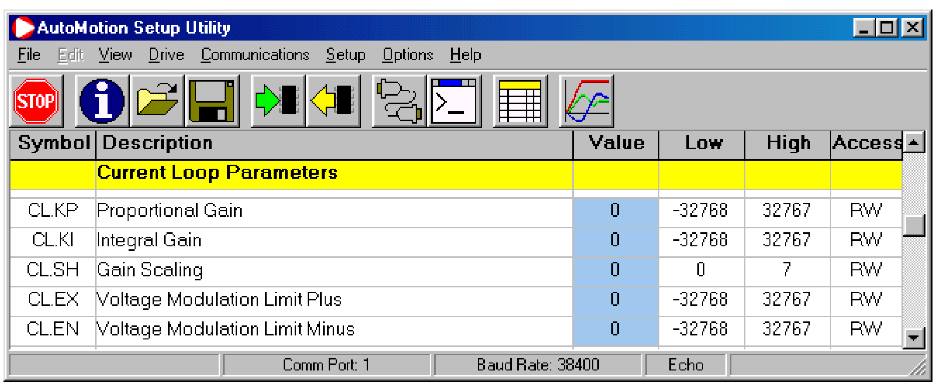
Once the desired current step response is obtained for the selected motor, save the values of CL.KI and CL.KP to the drive by first stopping the function generator by clicking on the Stop button. Then select the OK button to save these value.

If you wish to exit the tuning program without saving the new current tuning values select Cancel instead of OK.

If the amplifier is to be used in current mode only, you can skip the velocity and position loop tuning steps, sections 5.5 and 5.6.

The Gain Scaling Parameter

Proportional and Integral gains operate on the variable *Current Error*. Proportional and Integral gain are integer values between 0 and +32767, representing 0 to 100% gain. (Note: gains can be set to negative values but this practice is not recommended)



The gain scaling parameter, CL.SH, is a binary multiplier applied to both the Proportional (KP) and Integral (KI) gain values. For example, If CL.SH=1 then KP & KI range of 0 to 32767 represents 0 to 200% gain. If CL.SH=2 then the KP & KI range of 0 to 32767 represents 0 to 400% gain, etc.

When adjusting current loop gain values, Automotion recommends using the lowest possible value for CL.SH. For example, use KP=10000, Ki=2000 and SH=0, rather than KP=5000, Ki=1000 and SH=1. If the “Gain Scaling” is changed, the other variables will be changed if possible to values which retain the same operating characteristics.

The variable *commanded voltage* is the output signal of the current control loop. This signal is compared to an internal modulator to produce applied motor PWM (i.e. voltage). CL.EX and CL.EN can be used to limit the maximum PWM (i.e. voltage) applied to the motor.

Automotion recommends initially setting CL.EX and CL.EN as follows:

If PosLimit is max positive voltage output, NegLimit is max negative voltage output, Rail is the motor supply voltage, and ModPeriod is the “PWM Modulation Period’, then:

CL.EX = (PosLimit * ModPeriod) / Rail
CL.EN = (NegLimit * ModPeriod / Rail

Tee variable *Commanded voltage* can also be displayed in the graph window in units of volts. The “variable gain” in graph window is calculated as follows:

Commanded voltage Gain $_{\text{(located in graph window)}}$ = Rail / ModPeriod

Note: Gain and Offset values in the Graph window are not stored in the drive. These values are only used in the windows interface to manipulate displayed data.

5.3.2 Tuning the Velocity Loop

In the example below we have selected the Velocity loop for tuning by clicking on the Velocity tuning icon button found in the tool bar.

Note- If our drive were configured for Velocity mode operation only, the Position tuning icon will be grayed out and inaccessible.

Set the excitation of the function generator to Square Wave. Set the frequency to 5 Hz typically.

Set the amplitude of the applied current to no more than 10% of the drives maximum velocity value. Verify that the amplitude of the applied velocity value is not excessive for the motor.

Note- The Velocity loop typically needs to be tuned with the load attached. This may require you to increase the applied drive velocity value to obtain better results.

Set the maximum output as follows:
If the maximum current desired is MaxCur and the rated current is RatedCur:
(1024 *MaxCur) / RatedCur

The integral limit is commonly set to 32768. It may be set lower to limit integral wind up.

Start the function generator by clicking on the start button at the bottom of the pop-up window and adjust the velocity loop proportional gain (VL.KP) and the velocity loop integral gain (VL.KI) to obtain the desired waveform.

Using the adjustable slide bars adjust the velocity loop proportional gain (VL.KP) by first:

a) setting the velocity loop integral gain (VL.KI) to zero.

b) Increase or decrease the velocity loop proportional gain (VL.KP) until the desired step response is obtained. Typically, the desired result is little or no overshoot with a 5 Hz, slow-speed square wave applied.

Next, adjust the velocity loop integral gain (VL.KI) from zero until the desired settling time is obtained.

Once the desired velocity step response is obtained for the selected motor, save the values of VL.KI and VL.KP before proceeding to the next step, position loop tuning, by clicking on the stop button, and then the OK button.

If the amplifier is to be used in velocity mode only, you can skip the position loop tuning step in section 5.6.

5.3.3 Tuning the Position Loop

To tune the position loop, minimize the following error and any oscillations by running profiles and adjusting the position proportional gain (PL.KP), position integral gain (PL.KI), and position derivative gain (PL.KD), and other settings to obtain the desired performance.

Set the maximum output if there is no velocity loop as follows:
If the maximum current desired is MaxCur and the rated current is RatedCur:
(1024 *MaxCur) / RatedCur
otherwise:

If the maximum velocity command is MaxCmnd set the maximum output to:
MaxCmnd / 16
The integral limit is commonly set to 32768. It may be set lower to limit integral wind up.

6 ACS300 Hardware Reference

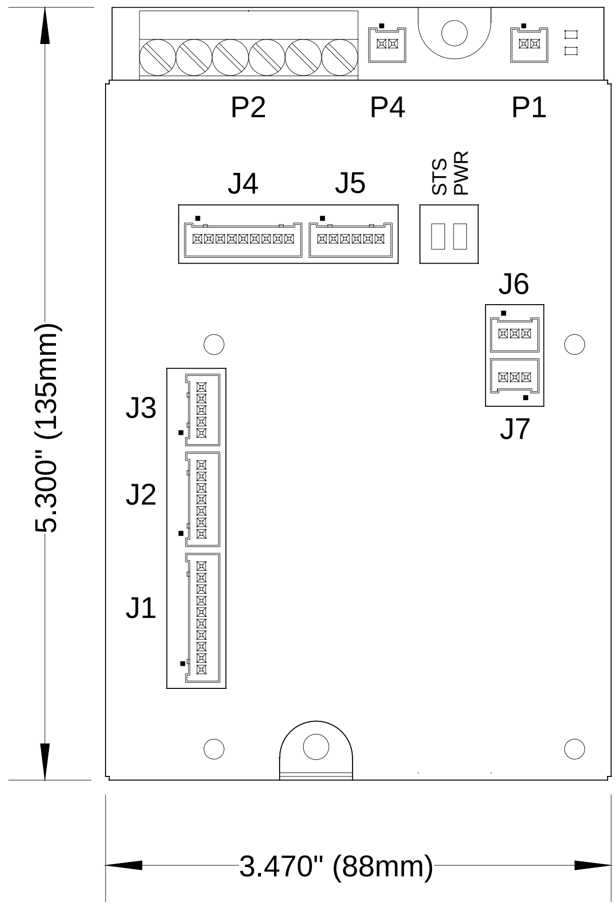
6.1 ACS300 electrical ratings

Ratings at Tamb = 0…50°C, (unless otherwise noted)

Parameter	Conditions	Min.	Max.	Units
Supply				
Supply voltage	Transient peak	-.03	+60	VDC
Supply voltage	Nominal operating	12	+48	VDC
Supply current, surge	Inrush pulse duration <=100mS		30	A
Supply current, idle	No load condition.	40	340	mA
Supply current, operating		16	32	A
Over Voltage protection	Internal peak supply limited.	58	62	VDC
Reversed polarity withstand	Continuous; supply current externally limited to:		-30	A
+5VDC Supply regulation	Encoder Inputs, Hall Inputs and Digital I/O	4.75	5.25	V
+5VDC Supply current available for external use	Encoder Inputs, Hall Inputs and Digital I/O		250	mA
Motor Outputs – P2				
Output current, continuous	No additional heatsink	-15	+15	Arms
Output current, peak		-30	+30	A
Short circuit withstand	Phase-to-phase, phase-to-ground, phase to- supply threshold.	+/- 16	+/- 25	Amp
Short circuit protection delay		5	20	uS
On state voltage drop	Phase current = +/-5Amp	-500	+350	mV
Off-state leakage current	Phase Voltage = +/-48V.	-500	+500	uA
PWM frequency	Programmable, PWMPER		30	kHz
Digital I/O Maximum Ratings – J1				
Input voltage	All inputs (opto-isolated); referenced to +COM	-9	+5	V
Input current	All inputs (opto-isolated); referenced to +COM	-20	+20	mA
Output voltage	All outputs	-0.3	+7	V
Output current	All outputs		48	mA
Digital Inputs – J1				
On state voltage threshold	Referenced to +com	-5	-3	V
Off state voltage threshold	Referenced to +com	-1	0	V
On state current	Input = -5V	-8	-12	mA
On state pulse width	Off voltage = 0V , On voltage = -3V	10		uS
Off state pulse width	On voltage = -5V , Off voltage = -1V	15		uS
Digital Outputs) – J1				
On state current	Referenced to +com	10	15	mA
On state voltage drop	On state current = 15 mA	0.2	0.4	V
Off state voltage	Sustained	5	7	V
Off state leakage current	Off state = 5.5V	5	20	uA
Analog Inputs – J2				
Input voltage Common-mode	Referenced to AGND	-12	+50	V
Input voltage differential	Nominal operating	-10	+10	V
Input impedance	Differential	24		K Ohm
Input impedance	Common mode, referenced to AGND	12		K Ohm
Analog ground current	Maximum AGND to GND	-25	+25	mA

Encoder Inputs – J4				
Input voltage, Max.	Common-mode, referenced to GND	-25	+25	V
Input voltage, Max.	Differential peak A to A , B to B , Z to Z	-30	+30	V
Input voltage, differential	RS422 receiver, A to A , B to B , Z to Z operating.	-5	+5	V
Halls – J5				
Input voltage range	Transient peak	-0.3	+5.3	V
Low level voltage	Operating	0	+1.8	V
Low level input current	Internal 1 K pull up to +5V	4	5	mA
Input hysteresis		0.2	0.5	V
Other				
Thermal resistance	Base Plate to ambient	1.24		°C/W
Frame isolation voltage withstand	GND to Frame.		250	V
Operating temperature	powered	0	+50	°C
Storage temperature	Not powered	-20	+85	°C
Humidity	Non-condensing	5	95	%RH
Weight	Cold Plate Model	0.49 /222		Lb./g

6.2 ACS300 Package Outline



Height with Cold Plate 1.0 inches (25 mm); Height with Heatsink 2.125 inches (54 mm)

Figure 30: ACS300 Package Outline

6.3 List of ACS300 mating connectors

Ref.	Connector name	Manufacturer	P/N Housing	P/N Crimp Pin
J1	User Digital I/O Control	10 Pin MOLEX Sherlock	35507-1000	50212-8100
J2	User Analog I/O Control	7 Pin MOLEX Sherlock	35507-0700	50212-8100
J3	RS232 Communications	5 Pin MOLEX Sherlock	35507-0500	50212-8100
J4	Encoder Interface	9 Pin MOLEX Sherlock	35507-0900	50212-8100
J5	Hall Interface	6 Pin MOLEX Sherlock	35507-0600	50212-8100
J6 & J7	CAN Communications	3 Pin MOLEX Sherlock	35507-0300	50212-8100
P1	DC Logic Input	2 Pin MOLEX Sherlock	35507-0200	50212-8100
P2	DC Input / Motor Output	Phoenix Screw Terminal		
P4	Motor Temp Input	2 Pin MOLEX Sherlock	35507-0200	50212-8100

6.4 Interface circuitry

6.4.1 J1 – Digital I/O

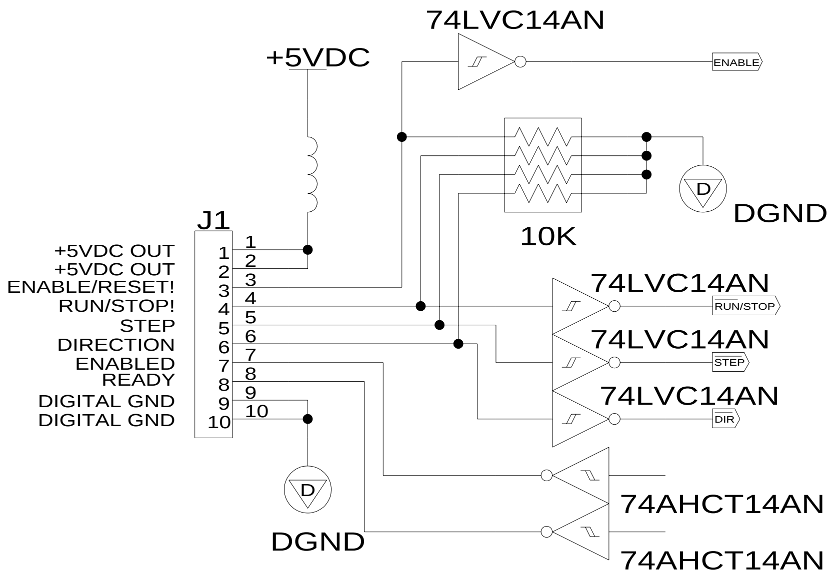


Figure 31: ACS300 J1 Digital I/O Control Circuitry

6.4.2 J2 – Analog I/O Control

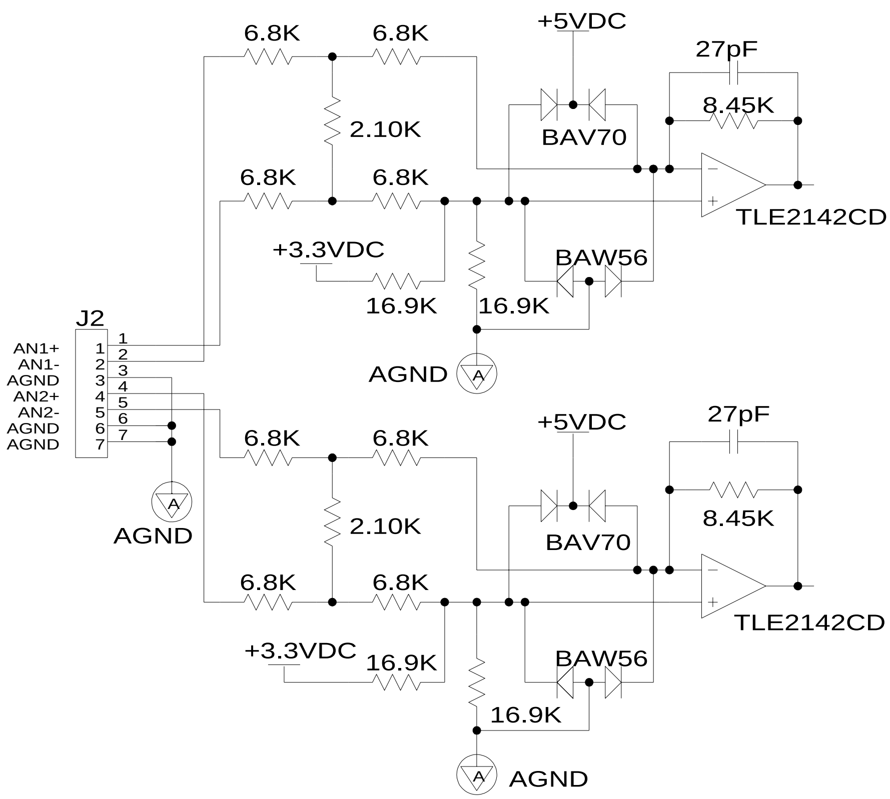


Figure 32: ACS300 J2 Analog I/O Control Circuitry

6.4.3 J3 RS232 Communications Interface

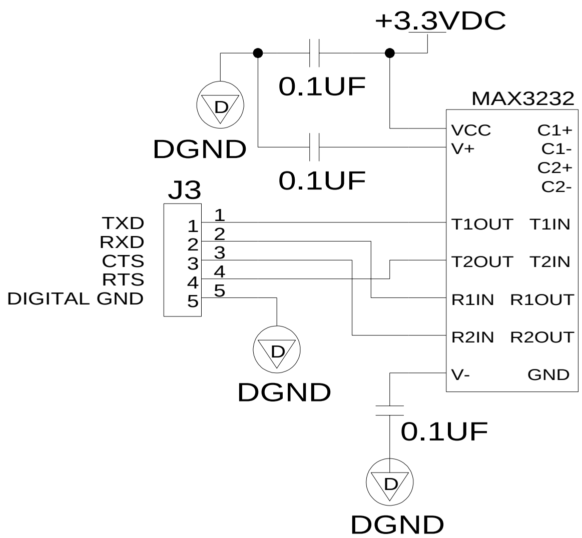


Figure 33: ACS300 J3 RS232 Communications Interface Circuitry

6.4.4 J4 Encoder Interface

If you have differential encoder feedback A, A!, B, and B!, you can leave Z and Z! open.
If you only have single ended encoder feedback A and B, (and not the A! and B!), you need to short the four jumpers on the ACS daughter card that are right next to the encoder connector.
These are JU1, JU2, JU3 and JU4. You can then leave Z and Z! open.

If you only have Halls and no encoder at all, leave the encoder connector open.

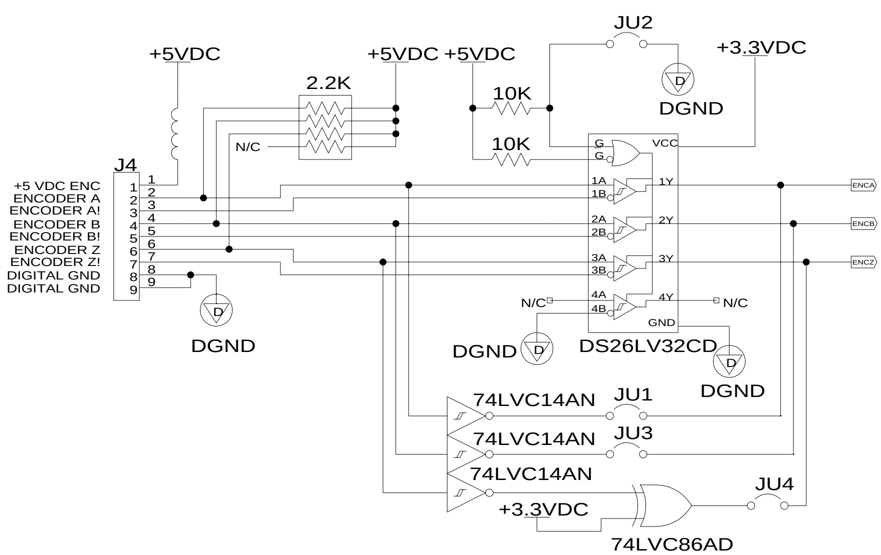


Figure 34: J4 Encoder Interface Circuitry

6.4.5 J5 Hall Interface

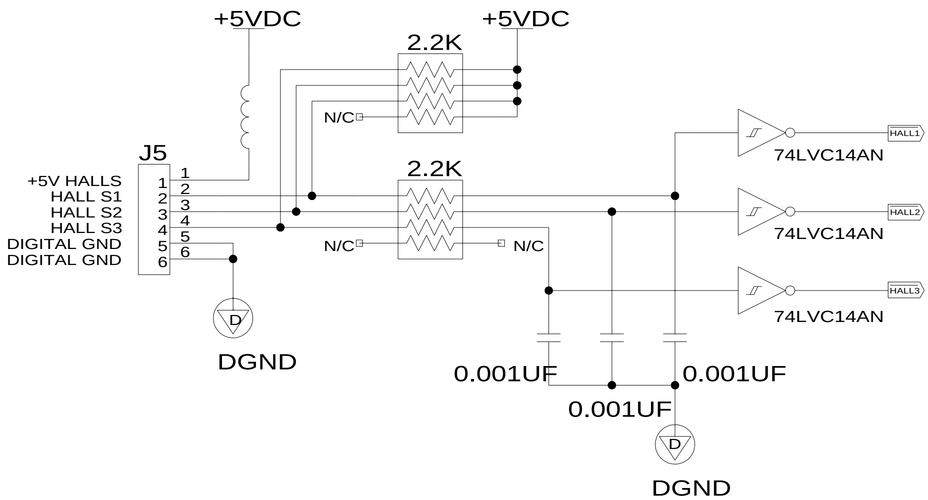


Figure 35: J5 Hall Interface Circuitry

6.4.6 J6, J7 CAN Communications

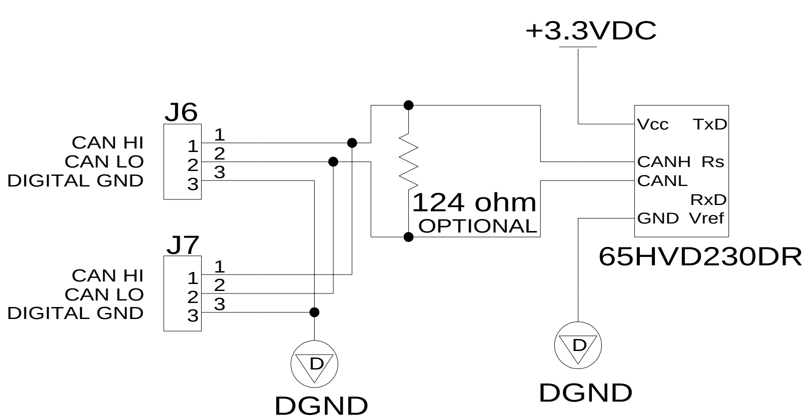


Figure 36: J6, J7 CAN Communications Circuitry

6.5 Recommended Cabling and Installation

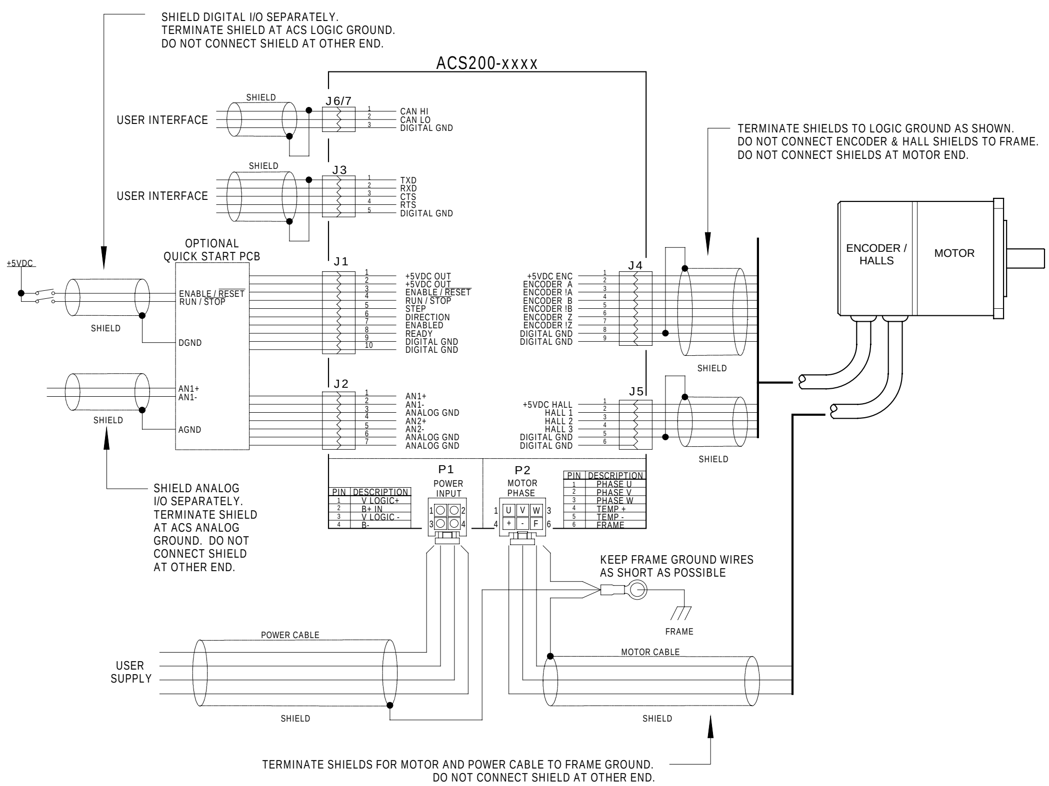
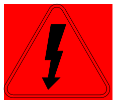


Figure 37: Recommended Cabling and Installation

6.6 The ACS300 Shunt Board

6.6.1 Use Of The Optional ACS300 Shunt Board



CAUTION! SHOCK HAZARD! FIRE HAZARD!

WHEN THIS PRODUCT USES THE OPTIONAL SHUNT BOARD WITH AN EXTERNAL RESISTOR, PRECAUTIONS MUST BE FOLLOWED TO PREVENT A POSSIBLE FIRE AND SHOCK HAZARD.

Shunt resistors function using electrical power. Avoid physical contact with them whenever the ACS300 is powered. Shunt resistors can also become extremely hot. Follow the precautions stated below to help prevent a fire hazard.

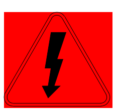
In some applications when heavy dynamic braking and/or regenerative braking is involved, the ACS300 may require an external shunt resistor. To connect such a resistor requires the use of the optional ACS300 Shunt board. See Figure 25 below.

If the customer wishes to use his own external shunt board and resistor, consult Automotion for design assistance.

When the ACS300 shunt board is used it is wired between the ACS300 P1 DC Input connector and the DC power source.

It is important that the external shunt resistor used in conjunction with the ACS300 Shunt Board be adequately sized to be reliable. It is also essential that this external resistor be located where it cannot cause a fire hazard should it ever overheat. AUTOMOTION recommends that the shunt resistor be placed in a well ventilated location and be kept far away from flammable materials.

The optional ACS300 shunt board and external resistor operate in conjunction with a transistor switch that places the resistor across the DC power rail. Should the transistor ever fail in the ON condition the external resistor would remain powered continuously. This could result in the external shunt resistor becoming very hot. A user-supplied heat shield for this external shunt resistor may be required to limit a possible fire hazard.



CAUTION! FIRE HAZARD!

Never mount the external shunt resistor where it can make contact with flammable materials, flammable liquid and/or flammable chemicals. Never use the ACS300, either with or without an external shunt board and resistor in an explosive atmosphere. Never place the shunt board and/or its external resistor in the proximity of flammable materials that could melt or drop upon the shunt board, the resistor, or the ACS300 drive.

The electrical terminals of this shunt board and the attached external resistor are also a shock hazard. Electricity is present on these terminals whenever the ACS300 is powered. A safety cover or shield is recommended to avoid a shock hazard.

The selected wattage rating for the external shunt resistor is application dependent. Usually a heavy-duty wire wound resistor will work best. However, not all wire wound resistors are suitable for shunt service. Through years of experience, AUTOMOTION has found the Ohmite type 250 series works reliably in many shunt applications.

If the user is supplying their own shunt resistor contact AUTOMOTION for further application advice.

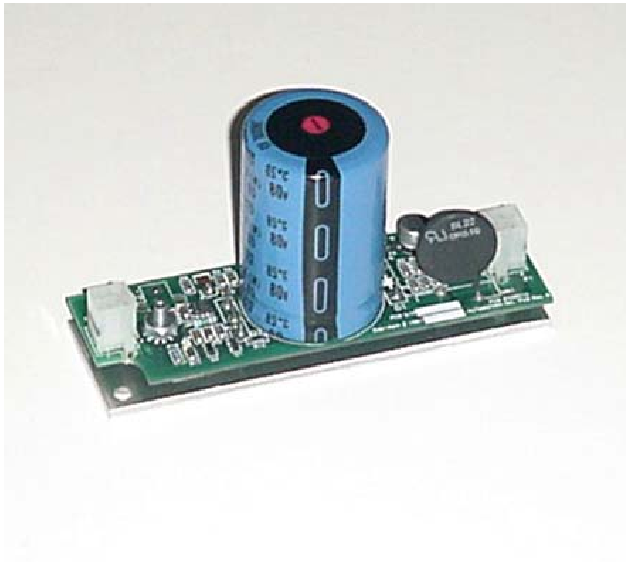


Figure 38: ACS300 Shunt Board

6.6.2 Connecting the Optional ACS300 Shunt Board

The shunt board is designed to plug directly between the ACS300 and the users power supply.

To install, unplug the power supply from the ACS300 drive and plug it into P1 on the shunt board. Then plug a cable from P2 on the shunt board to the ACS300. Both P1 and P2 connectors have the same pin out.

P1 - Power input from Power Supply.
P2 - Power output to ACS300.
pin1 - +12v to +48v drive logic supply (pass through connection from P1 to P2)
pin2 - 0 to +48v drive motor supply (blocking diode at P1 isolates all shunt board operations from power supply)
pin3 - Drive logic supply common (pass through connection from P1 to P2)
pin4 - Motor supply common (pass through connection from P1 to P2)

Note: If ACS300 is setup to operate off a single supply for both logic and motor, only the motor supply (pins 2 and 4) need to be connected.

P3 - Shunt resistor connection. A minimum of 4 Ohms is required. Higher resistance values may be used.

The shunt "turn-on" threshold is approximately 56V and the "turn-off" threshold is approximately 52V. A blocking diode in the shunt board prevents the excess voltage from feeding back to the power supply. As the drive "regenerates", the shunt board will cycle on and off to dispose of the excess energy through the shunt resistor. Care should be taken to ensure the shunt resistor is not mounted next to any flammable material, as it could get hot.

6.7 Model Identification

ACS300 - X X X X

Model Designator

Drive Customization Code

Final Assembly Code

7 Description of ACS300 parameters and variables

General: Each command entry is headed by the ASCII command followed by its descriptive label. The allowable value range follows. That is followed by the applications that can make use of this parameter or variable. Finally, the scaling and use of the variable follows.

In any formula, the value entered is denoted by 'X'. The parameters are not typically changed once the user has tuned the drive to a specific application.

To read the value: From the terminal page type the ASCII command followed by a return.

To write a new value: From the terminal page type the ASCII command followed by the new value (X) and a return. Backspace allows you to start over in case a mistake is made. From the parameters page, except for the Configuration Word, which pops up a form, click in the value column, type in the new value and click OK.

7.1 The Parameter Page

7.1.1 Configuration Parameters

CL.PR **PWM (Current) Modulation Period**

Range: 1000 to 2666

Applications: All

Use: The current loop and PWM rates in hertz are $2*10^7$ / X. Values below 1250 may cause problems.

CL.CG **Configuration Word**

Range: 0 to 65535

Application: All DSP based drives.

Use: This command is used to specify what servo loops are running and to control other features of the drive. When this field is clicked in the user interface, a popup appears to allow the user to set this configuration word.

Bits	Usage
0	On if the position loop is to be used. The position loop will not be used if the velocity feedback is analog.
1	On if the velocity loop is to be used
2	On if velocity feedback is to be computed from halls edges or off if velocity is to be computed from encoder edges. On the ACE-1000, this must only be changed if a hardware change is also made. This bit is overridden by analog velocity feedback.
3,12,13	If these bits are 8 hex (3 on, 12, 13 off), velocity feedback is from analog input (AN2). If these bits are 1000 hex (3 off, 12 on, 13 off), position feedback is from analog input (AN2). If these bits are 1008 hex (3, 12 on, 13 off), the torque limit is from analog input. This is not used for a current mode drive.
4	On if position command is to be supplied from the serial port.
5	On if sine commutation is to be used synchronized from a halls edge.

Bits	Usage
6	On if sine commutation is to be used synchronized from the encoder index. Bits 4 and 5 cannot both be on. Note that sine mode is available on the ACE1000 only if a hardware change is made.
7	On to allow sine mode over modulation.
8 and 9	Halls table to use. These bits can be overridden by the Hall Table command CL.HT. If these bits are 0, use the standard 120 degree table. If these bits are 100 hex, use the 120 degree table with hall S1 and S3 swapped. If these bits are 200 hex, use the standard 60 degree table. If these bits are 300 hex, use the 60 degree table with hall S1 and S3 swapped.
10	On if encoder direction is reversed.
11	ACE1000 only. On if command input is analog (AN1). Off for PWM command input.

OR **Position/Velocity Loop Rate**

Range: 3 to 255

Application: Encoder based, velocity mode, or position mode drives.

Use: The velocity loop rate is ‘current loop rate’ / X.

IO **Serial Delay**

Range: 0 to 256

Application: All

Use: For most late model host machines this is typically set to “0”. However, for slower host processors this value inserts a delay in the characters to avoid overflowing the host buffer.

7.1.2 Protection Parameters

RC **Locked Rotor Current**

Range: 0 to 1023

Applications: All

Use: Used in conjunction with ‘Locked Rotor Time’ to check for locked rotor. If X is zero, the locked rotor check is not performed. Otherwise, the current is checked at every current loop. If the current level is greater or equal to the current level specified for the amount of time specified by locked rotor current without a halls change, a locked rotor fault occurs. The current level is ‘Rated output’ * X / 1024.

RT **Locked Rotor Time**

Range: 0 to 32767

Applications: All

Use: Used in conjunction with ‘Locked Rotor Current’ to check for locked rotor. If the current level is greater or equal to the current level specified for the amount of time specified by locked rotor current without a halls change, a locked rotor fault occurs. X is the time in milliseconds.

TE — **Motor Temp Control**

Range: -32767 to 32767

Use: All.

Application: This is used to configure and enable the motor over temperature fault. If a PTC, NTC, or switch is used, for R = resistance in ohms at critical temperature or 3000 for a switch, compute:
C = 49648485 / (R + 7000)

Set TE to

0 to ignore motor temperature
C for PTC or open switch for motor over temperature
-C for NTC or closed switch for motor over temperature

LS — **Current Control Maximum Command**

Range: 0 to 1024

Use: All drives

Application: If the absolute value of current command (CC) is greater than LS, then the current command is set to LS or –LS depending on the sign of CC.

LC — **Current Control Limit**

Range: 0 to 1229

Use: All drives

Application: If the current feedback (DI) greater than or equal to LC, then the current control filter multiplies the current error (current command – current feedback) by 4. This gives the effect of increasing the current loop gain by 4 when the current is greater than LC. LC is typically set to 1.15 * LS.

7.1.3 Commutation Parameters

CL.EC — Encoder Counts per Rev

Range: 100 to 65535

Applications: All applications using an encoder.

Use: Used for sine wave modulation. Also used by the PC front end to convert internal velocity to RPM. X is the number of encoder counts per mechanical revolution of the motor. (four times the number of encoder lines)

CL.PL — Number of Motor Poles

Range: 2 to 42 (must be even)

Applications: All applications using an encoder.

Use: Used for sine wave modulation and in halls velocity calculations.
X is the number of motor poles.

HP **Halls Advance**

Range: 0 to 5

Applications: All drives.

Use: Advances the 6 step modulation by X states. This parameter is set by Motor Setup

CL.AP **Encoder Advance**

Range –32768 to 32767

Applications: Sine mode

Use: Advances the electrical angle by X encoder counts. Used to phase the sine wave output to the motor angle if the halls are not aligned correctly or for index synchronization. If Adv is the number of degrees to advance the encode angle, set CL.AP to ADV * 1024 / 360. For sine mode with halls mode, this should normally be set to zero.

7.1.4 Current Loop Parameters

Note that current is expressed as units of full scale / 1024. However, if the current is commanded through the analog input, the result is divided by 16 before moving it to the current.

CL.KP **Current Proportional Gain**

Range: 0 to 32767

Use: All drives.

Application: This is performed every current loop. The Proportional portion of the Voltage Modulation output value is set to KP*‘Current error.

CL.KI **Current Integral Gain**

Range: 0 to 32767

Use: All drives.

Application: This is performed every current loop. ‘Current error’ * KI/32 is added to ‘working current integral’.
Note: changing the KI value will not change the ‘working current integral’.

CL.KP **Current Proportional Gain**

Range: 0 to 32767

Use: All drives.

Application: This is performed every current loop.
The Proportional portion of the Voltage Modulation output value is set to KP*‘Current error.

CL.SH — Current Gain Scaling

Range: 0 to 7

Use: All drives.

Application: This is performed every current loop. The Voltage Modulation output value is multiplied by 2^{SH}.

CL.EX — Voltage Modulation Limit Plus

Range: -32768 to 32767

Use: All drives.

Application: This is an additional restraint to the Voltage Modulation output. CL.DO<= CL.EX <= CL.MX

CL.EN — Voltage Modulation Limit Minus

Range: -32768 to 32767

Use: All drives.

Application: This is an additional restraint to the Voltage Modulation output. CL.DO>=CL.EN>=CL.EX

7.1.5 Velocity Loop Parameters

Hall based velocity: The velocity is computed using the 1/T method along with a filter to even out the irregularities in the timing of the halls signals. Internal velocity for halls based is in RPM. Acceleration in RPM per second is 'internal acceleration' * 'velocity loop rate' / 8. Jerk in RPM per second per second is 'Jerk' * 'velocity loop rate'^{2} / 2048.

Encoder based velocity: The velocity is computed using the 1/T method or counting the number of counts in a velocity loop. The method is changed dynamically when it is deemed advantageous. The internal velocity is in units of 'counts per velocity loop' * 256. Therefore, velocity in RPM is 'internal velocity' * 'velocity loop rate' * (60 / 256) / 'Encoder Counts per Rev'. Acceleration in RPM per second is 'internal acceleration' * 'velocity loop rate^2 * (60 / 32,768) / 'Encoder Counts per Rev'. Jerk in RPM per second per second is 'Jerk' * 'velocity loop rate^3 * (60 / 2^{23}) / 'Encoder Counts per Rev'.

Analog based velocity: The velocity is supplied by the analog 2 value which will be filtered and have a gain and offset applied. This value may represent velocity or some other physical value such as pressure.

A serial command, an analog signal, or the output of the position loop can supply 'velocity command'. If there is no position loop and the command gain is zero, then the velocity command is from a serial command.

The 'velocity error' is 'velocity command' – 'velocity'.

The 'velocity integral' is the sum of the 'velocity errors'. This value is limited by the 'Velocity Integral Limit' * 256. The 'velocity limit' is not summed if the current or velocity loop is saturated.

The 'velocity derivative' is ('old velocity derivative' * 'Velocity Derivative Filter' + (32768 – 'Velocity Derivative Filter) * ('velocity error' – 'old velocity error')) / 32768.

The output of the velocity loop goes to the current command.

VT **Measured Velocity Filter**

Range: 0 to 32767

Use: Halls velocity drives.

Application: Every time a new hall or encoder based velocity is computed, the result is filtered. The computed velocity is ('old computed velocity * X + 'new velocity' * (32768 – X)) / 32768.

VL.KP **Velocity Proportional Gain**

Range: -32768 to 32767

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop.
'Working current correction' is set to 'velocity error' * X.

VL.KI **Velocity Integral Gain**

Range: -32768 to 32767

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop.
'Velocity integral' * X / 256 is added to 'working current correction'.

VL.IL **Velocity Integral Limit**

Range: 0 to 32767

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop. The absolute value of 'velocity integral' is limited to 256 * X.

VL.KD **Velocity Derivative Gain**

Range: -32768 to 32767

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop. 'Velocity Derivative' * X is added to 'working current correction'.

VL.DF **Velocity Derivative Filter**

Range: 0 to 32767

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop. The 'velocity derivative is set to ('old velocity derivative' * X + ('velocity error' – 'old velocity error') * (32768 – X)) / 32768.

VL.SH **Velocity Gain Scaling**

Range: -26 to 30

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop. 'Working current correction' is multiplied by 2^{X-4}.

VL.MX **Velocity Max Output**

Range: 0 to 1023

Use: Velocity mode or position mode drives.

Application: This is performed every velocity loop. The absolute value of 'working current correction' is limited to X and placed in 'commanded current'.

VF.AC **Acceleration**

Range: 0 to 32767

Application: All applications for which an analog from AN1 (or PWM for the ACE1000) is used for the command.

Use: This command is used every velocity loop. If X is zero, then the velocity command is the output of the analog command. If X is nonzero and 'Jerk' is zero, X/128 represents the absolute value of the change in command every velocity loop. If X is nonzero and 'Jerk' is nonzero, X represents the maximum absolute value the internal acceleration can attain. In that case, the internal acceleration divided by 128 represents the change of the velocity command.

VF.JK Jerk

Range: 0 to 32767

Application: Velocity mode drives.

Use: This command is used every velocity loop. This command is not used unless 'Command Gain' is zero and 'Acceleration' is nonzero. The jerk is used to generate an s-curve velocity command profile. The amount that the absolute value of the internal acceleration changes is X/256.

7.1.6 Position Loop Parameters

The position feedback will be from the encoder if the analog gain is zero. The position measurement will then be the number of encoder counts. Otherwise, the position feedback will be from analog. The position always starts at zero.

For the ACS300 position command may come from a step and direction signal, an analog signal, or a serial command. The command is from step and direction if the drive is not configured for a serial position command and command gain is zero.

The ‘position error’ is ‘position command’ – ‘position’.

The ‘position integral’ is the sum of the ‘position errors’. This value is limited by the ‘Position Integral Limit’ * 256. The ‘position limit’ is not summed if the current loop or the position loop are saturated.

The ‘position derivative’ is (‘old position derivative’ * ‘Position Derivative Filter’ + (32768 – ‘Position Derivative Filter) * (‘position error’ – ‘old position error’)) / 32768.

The output of the position loop goes to the velocity command if there is a velocity loop. Otherwise, it is divided by 16 and put in the current command.

PL.KP **Position Proportional Gain**

Range: 0 to 32767

Use: Position mode drives.

Application: This is performed every velocity loop. ‘Working velocity correction’ is set to ‘velocity error’ * X.

PL.KI **Position Integral Gain**

Range: 0 to 32767

Use: Position mode drives.

Application: This is performed every velocity loop. ‘Position integral’ * X / 256 is added to ‘working velocity correction’.

PL.IL **Position Integral Limit**

Range: 0 to 32767

Use: Position mode drives.

Application: This is performed every velocity loop. The absolute value of ‘position integral’ is limited to 256 * X.

PL.KD **Position Derivative Gain**

Range: 0 to 32767

Use: Position mode drives.

Application: This is performed every velocity loop. ‘Position derivative’ * X is added to ‘working current correction’.

PL.DF **Position Derivative Filter**

Range: 0 to 32767

Use: Position mode drives.

Application: This is performed every velocity loop. 'Position derivative is set to ('old position derivative' * X + ('position error' – 'old position error') * (32768 – X)) / 32768.

PL.SH **Position Gain Scaling**

Range: -30 to 30

Use: Position mode drives.

Application: This is performed every velocity loop. 'Working velocity correction' is multiplied by 2^X.

PL.MX **Position Max Output**

Range: 0 to 32767

Use: Position mode drives.

Application: This is performed every velocity loop. The absolute value of 'working velocity correction' is limited to X * 16. 'Commanded velocity' is set to ('position command' – 'old position command') * 256 + 'working velocity correction'

PL.SC **Steps per Revolution**

Use: Position mode drives. Command Gain (VF.GN) must be zero and the Configuration word must not be set for serial position command.

Application: This is performed every velocity loop. Every step pulse while the drive is in run, the desired position is incremented or decremented (depending on the direction signal) by Encoder Counts per Rev (CL.EC) / Steps per Revolution. The calculation is accurate to within one encoder count both within one revolution and long term. This will try to position the motor as if it were a stepper motor with the correct number of steps for one revolution. Unfortunately, because of an error in the DSP silicon, the first step is always lost. If velocity feedback is encoder, the velocity command is incremented by 256 * encoder count difference in addition to the velocity command from the position PID loop.

7.1.7 I/O Configuration

VF.FL **Command Filter**

Range: 0 to 32767

Application: All applications for which an analog from AN1 is used for the command.

Use: This is used every velocity loop unless the drive is in current mode only in which case it is used every current loop. This is used for the first operation in converting the analog command to an actual command. The output of this command is used as the input to the 'Command Offset'. This command may represent position, current, velocity, or a value represented by the analog feedback signal. The output of the filter is ('Old Value' * X + 'New Value' * (32768 – X)) / 32768.

VF.OF **Command Offset**

Range: -32768 to 32767

Application: All applications for which an analog from AN1 is used for the command.

Use: This command is used every velocity loop unless it is a current mode drive in which case it is used every current loop. Used as the second operation in converting the analog command to an actual command. The output of this command is used as the input to the 'Command Gain'. X is added to the input to get the output.

VF.GN **Command Gain**

Range: -32768 to 32767

Application: All applications for which an analog from AN1 is used for the command.

Use: This command is used every velocity loop unless it is a current mode drive in which case it is used every current loop. Used as the third operation in converting the analog command to an actual command for the outer loop used. If the gain is zero, then there is no analog command and the command must be provided serially or by step and direction for position mode. Note that step and direction is not available on the ACE1000. The output is 'input' * X / 4096 for current command or 'input' * X / 256 for velocity or position command. The output is the command in internal units.

CF.FL Aux Analog Filter

Range: 0 to 32767

Application: Analog input 2 not set to none.

Use: This is used every velocity loop unless the drive is in current mode only in which case it is used every current loop. This is used for the first operation in converting the analog feedback to an actual feedback. The output of this command is used as the input to the 'Aux Analog Offset'. This feedback may represent position, velocity, or a current limit. The output of the filter is ('Old Value' * X + 'New Value' * (32768 – X)) / 32768. The input range is 0 to 8191.

CF.OF **Aux Analog Offset**

Range: -32768 to 32767

Application: Analog input 2 not set to none.

Use: This is used every velocity loop unless it is a current mode drive in which case it is used every current loop. Used as the second operation in converting the analog feedback to an actual feedback. The output of this command is used as the input to the ‘Command Gain’. X is added to the input to get the output.

CF.GN **Aux Analog Gain**

Range: -32768 to 32767

Application: Analog input 2 not set to none.

Use: This is used every velocity loop unless it is a current mode drive in which case it is used every current loop. Used as the third operation in converting the analog feedback to an actual feedback. The output is ‘input’ * X / 256. The output is the feedback in internal units.

7.2 Graphing Variables

General: The following are operational variables are used for data gathering and graphing. Any parameter or variable that can be read can be graphed. These are the variables used by the Windows interface.

CL.CC	**Commanded Current** The commanded current can have values from –1024 to 1023. Units are full scale current / 1024. Commanded current can only be written if there is no position or velocity loop and command gain is zero.
PL.CM **PL.CH**	**Commanded Position (PL.CM low order, PL.CH high order)** The commanded position can have a value from –2147483648 to 2147483647. PL.CM when not used as a data gathering variable returns the value of both words together. Both PL.CM and PL.CH need to be used while setting up data gathering to get both words. Units are encoder counts if serial position command is off and command gain is zero, filtered analog with gain and offset if serial position command is off and command gain is not zero, or a serial command. Commanded position may be written only if there is a position loop and the serial position bit of the configuration is set.
VL.CM **VL.CH**	**Commanded Velocity (VL.CM low order,VL.CH high order)** The commanded velocity can have a value from –2147483648 to 2147483647. VL.CM when not used as a data gathering variable returns the value of both words together. Both VL.CM and VL.CH need to be used while setting up data gathering to get both words. Units are: 1 RPM for halls based velocity 2 Encoder counts per position servo cycle * 256 for halls based velocity. 3 Filtered analog with gain and offset for if there is no position loop. Commanded velocity may be written only if there is no position loop, a velocity loop and the command gain is zero.
CL.DO	**Commanded Voltage**
DI	**Current**
CL.ER	**Current Error** This variable is read only. Current error is commanded current – current.
CL.IN **CL.IH**	**Current Integral (CL.IN low order, CL.IH high order)** This variable is read only. The current integral is the sum of the current errors. The integral is not summed if the current loop is saturated. The current integral can have a value between –2147483648 to 2147483647. . IN or CL.IN when not used as a data gathering variable returns the value of both words together. Both IN or CL.IN and IH or CL.IH need to be used while setting up data gathering to get both words.

VF.VD
VF.VA

Filtered Command (VF.VD low order, VF.VA high order)

This variable is read only. See command filter (VF.FL) for details about how the filter operates. When not used as a data gathering variable, VF.VA returns the integer part of the filtered command and VF.VD returns both the integer and fractional parts * 65536.

CF.VD
CF.VA

Filtered Feedback (CF.VD low order, CF.VA high order)

This variable is read only. See aux. analog filter (CF.FL) for details about how the filter operates. When not used as a data gathering variable, CF.VA returns the integer part of the filtered feedback and CF.VD returns both the integer and fractional parts * 65536.

PL.DD
PL.DE

Filtered Position Derivative (PL.DD low, PL.DE high order)

This variable is read only. See position loop description and position derivative filter (PL.DF) for descriptions of the position derivative. When not used as a data gathering variable, PL.DE returns the integer part of the position derivative and PL.DD returns both the integral and fractional parts * 65536.

VL.DD
VL.DE

Filtered Velocity Derivative (VL.DD low, VL.DE high order)

This variable is read only. See velocity loop description and velocity derivative filter (VL.DF) for descriptions of the velocity derivative. When not used as a data gathering variable, VL.DE returns the integer part of the velocity derivative and VL.DD returns both the integral and fractional parts * 65536.

CL.ID

Flux Current

Sine mode only. This variable is read only. The DSP program calculates this value. It is the amount of current that is flowing in the drive that is perpendicular to the torque producing current. Because this current causes the motor to generate heat, the ideal value should be zero.

CL.DV

Flux Voltage

Sine mode only. This variable is read only. The DSP program calculates this value. It is the leading (+) or lagging (-) voltage that the drive is applying to the motor to reduce the flux current.

CH

Halls

This value is read only. The three hall signals are displayed as 0 or 1 in the order of s3,s2 & s1 and is the actual value of the three halls signals as read at the DSP.

MP

Motor Phase

This value is read only. Value is from 0 to 5 and is the motor phase derived from the halls.

DU **Phase U Current**

This value is read only. Value is from –32768 to 32767 and is proportional the phase U current. To calculate the actual current multiply by (IR)* (drive rating in amps)/2017152.

DV **Phase V Current**

This value is read only. Value is from –32768 to 32767 and is proportional the phase V current. To calculate the actual current multiply by (IR)* (drive rating in amps)/2017152.

DW **Phase W Current**

This value is read only. Value is from –32768 to 32767 and is proportional the phase W current. To calculate the actual current multiply by (IR)* (drive rating in amps)/2017152.

PL.AC
PL.AH **Position (PL.AC low order PL.AH high order)**

This variable is read only. Position can have a value from –2147483648 to 2147483647. PL.AC when not used as a data gathering variable returns the value of both words together. Both PL.AC and PL.AH need to be used while setting up data gathering to get both words. Units are encoder counts if analog position feedback command is off or filtered analog with gain and offset if analog position feedback command is off.

PL.ER **Position Error**

This variable is read only. Position error can have a value of –32768 to 32767. It is commanded position – position.

PL.IN
PL.IH **Position Integral (PL.IN low order PL.IH high order)**

This variable is read only. Position integral is the sum of the position errors. It is not accumulated if the position loop or current loop is saturated. The position integral can have a value between –8388352 to 8388352. PL.IN when not used as a data gathering variable returns the value of both words together. Both PL.IN and PL.IH need to be used while setting up data gathering to get both words.

CL.DS **Scaled Current Integral**

VL.AC
VL.AH **Velocity (VL.AC low order VL.AH high order)**

This variable is read only. Velocity can have a value from –2147483648 to 2147483647. VL.AC when not used as a data gathering variable returns the value of both words together. Both VL.AC and VL.AC need to be used while setting up data gathering to get both words. Units are:

1 RPM for halls based velocity
2 Encoder counts per position servo cycle * 256 for halls based velocity.
3 Filtered analog with gain and offset for if analog velocity is set in the configuration word.

VL.ER **Velocity Error**

This variable is read only. Velocity error can have a value of –32768 to 32767. It is commanded velocity – velocity.

VL.IN
VL.IH **Velocity Integral (VL.IN low order VL.IH high order)**

This variable is read only. Velocity integral is the sum of the velocity errors. It is not accumulated if the velocity loop or current loop is saturated. The velocity integral can have a value between –8388352 to 8388352. VL.IN when not used as a data gathering variable returns the value of both words together. Both VL.IN and VL.IH need to be used while setting up data gathering to get both words.

CL.EA **Electrical Angle**

Sine mode only. The electrical angle is a value between 0 and 1023 with 1024 representing 360 degrees. The electrical angle may be set to a value and that value will be held regardless of the position until it is changed by writing a new value or released by writing a negative number to the electrical angle.

7.3 Data Gathering Variables

7.3.1 Setting up Triggering

7.3.1.1 No Trigger

If there is no trigger, a sample is collected every sample period after a delay of a specified number of sample periods. A sample is a snapshot of the variables specified during the data gathering setup. A sample period is a specified number of current or velocity loops. There are 32768 words available to store the samples. The space required to store all the samples is # of variables * (number of samples + 1). Note that double precision variables such as commanded velocity require two words to store. To set up data gathering, set the start up delay and the sample rate as desired followed by a data specification start, then list the variables in order that you want, then the data specification end.

7.3.1.2 Using Trigger

If triggering is desired, then a negative sample delay is the number of samples before the trigger event to be displayed and a positive sample delay is the number of samples after the trigger event to delay. No data will be sent until the trigger event occurs. Each single precision trigger control entry takes five words from the 32768 word data gathering area. Each double precision trigger control takes seven words from the 32768 word data gathering area.

DG.TC **Clear trigger table**

This must be the first command before setting up the trigger table if there is to be one. This command clears both the trigger table and the data gathering table.

DG.TR **Set the trigger control word**

This sets the trigger control word. The trigger control word cannot be read. This command must be directly followed by a command which is the command to read the data variable. If the variable is double precision, use the variable name for the lower word only. The data variable must be followed by a DG.CN command.

Control information format:

Bits Description
15 Must be set to zero.

13-14 Comparison type which takes one of these four values:
- 0: Variable < constant
- 1: Variable > constant
- 2: Falling edge, Variable was greater or equal to constant, now is less
- 3: Rising edge, Variable was less or equal to constant, now is greater

11-12 Relationship type which takes one of these four values:
- 0: Last entry in table
- 1:Both this comparison and the next one must be true
- 2: Either this comparison or the next must be true
- 3: This comparison must become true and then the next one must become true

9-10 Variable type which takes one of the following three values:
- 0: Variable and constant are unsigned

- 2: Variable is signed, constant is unsigned and comparison is absolute value
- 3: Variable and constant are signed

8 On for double precision variable and constant

0-7 Filter

Filter operation:

Let FO be the old filtered value (with fraction), FN be the new filtered value, F be the filter and V be the actual variable value. Then: FN = (V * F + (256 – F) * FO) / 256.

DG.CN Set the trigger constant

This sets the trigger constant. The constant is signed or unsigned and single or double precision depending on the value of the DG.TR command. The trigger constant cannot be read. This command must be directly preceded by a command that specifies the data variable desired.

7.3.2 Setting up Data Gathering

DG.DW **Start up Delay**

The number of sample periods to delay before starting the first sample. This variable may have a value from 0 to 32767. If there is triggering, the value may be from –32767 to 32767. If the value is negative, its absolute value must be less than of equal to the number of samples able to be collected (see DG.DE).

DG.DR **Sample Rate**

The number of current or position loops – 1 between each sample period. This variable may have a value from 0 to 65535.

DG.DS **Data Specification Start**

Specifies current loop (1) or position loop (0). After this command the variables desired must be entered. This variable must have a value, either 1 or zero. If triggering is to be used, it must be set up before this command is issued.

DG.DE **Data Specification End**

Specifies the number of samples to collect. All the variables desired must be entered before this command. This variable must have a value from zero to 32767. Each sample has the number of variables entered between the data specification start and the data specification end. Note that if a variable is double precision, the location of the variable and the location of the high order of the variable must both be specified. The maximum number of samples is (32767 – 5 * Number of single precision triggers – 7 * Number of double precision triggers) / Number of variables specified.

7.3.3 Retrieving Data Gathering Words

DG.RM **Data Read**

This variable is read only. Read a word of data from data gathering memory. The value is returned in hexadecimal. The values are returned in sample number order and within samples in order by the data variables entered.

DG.ST **Data Read Streaming**

This command starts data streaming. The number of samples to be returned are in the command parameter. Each variable is returned as two 8 bit characters. After all data is streamed, a carriage return followed by a line feed is put out. It is up to the user to make sure the number of points specified are available before issuing this command (see DG.PA). The values are sent in the same order as DG.RM.

DG.PA **Data Points Remaining**

This variable is read only. Returns the total number of points which have been collected but not read.

DG.DA **Data Address**

This variable is the number of words which have been read. This can be used in conjunction with data CRC to set the back to the place where the CRC was last valid in case the CRC does not match.

DG.CR **Data CRC**

For every word which is read by way of a read data command, a CRC is computed by the code shown below. When Data CRC is written, it is written to the upper 16 bits of GraphCRC. When DataCRC is read, it is read from the upper 16 bits of GraphCRC. By setting GraphCRC to a known number from 0 to 65535 (65535 is recommended) and keeping track of the CRC as each data word is sent, the data can be verified with a very small probability of undetected error.

```
unsigned long int GraphCRC;
unsigned short int Data;

Graphic CRC += Data;
for (Ix = 0; Ix < 16; Ix++)
{
if ((long int)GraphCRC < 0)
GraphCRC ^= 0xC0028000;
GraphCRC <<= 1;
}
```

7.3.4 Operational Values for Data Gathering

Any parameter or variable that can be read can be graphed. These are the variables used by the AutoMotionPLUS Windows interface.

CL.CC or CC — **Commanded Current**

The commanded current can have values from –1024 to 1023. Units are full scale current / 1024. Commanded current can only be written if there is no position or velocity loop and command gain is zero.

PL.CM — **Commanded Position (low order)**
PL.CH — **Commanded Position (high order)**

The commanded position can have a value from –2147483648 to 2147483647. PL.CM when not used as a data gathering variable returns the value of both words together. Both PL.CM and PL.CH need to be used while setting up data gathering to get both words. Units are encoder counts if serial position command is off and command gain is zero, filtered analog with gain and offset if serial position command is off and command gain is not zero, or a serial command. Commanded position may be written only if there is a position loop and the serial position bit of the configuration is set.

VL.CM — **Commanded Velocity (low order)**
VL.CH — **Commanded Velocity (high order)**

The commanded velocity can have a value from –2147483648 to 2147483647. VL.CM when not used as a data gathering variable returns the value of both words together. Both VL.CM and VL.CH need to be used while setting up data gathering to get both words. Units are:

4 RPM for halls based velocity
5 Encoder counts per position servo cycle * 256 for halls based velocity.
6 Filtered analog with gain and offset for if there is no position loop, a velocity loop and analog velocity is set in the configuration word.

Commanded velocity may be written only if there is no position loop, a velocity loop and the command gain is zero.

CL.DO or DO — **Commanded Voltage**

DI — **Current**

CL.ER or ER — **Current Error**

This variable is read only. Current error is commanded current – current.

CL.IN or IN — **Current Integral (low order)**

CL.IH or IH — **Current Integral (high order)**

This variable is read only. The current integral is the sum of the current errors. The integral is not summed if the current loop is saturated. The current integral can have a value between –2147483648 to 2147483647. . IN or CL.IN when not used as a data gathering variable returns the value of both words together. Both IN or CL.IN and IH or CL.IH need to be used while setting up data gathering to get both words.

CL.EA Electrical Angle

Sine mode only. The electrical angle is a value between 0 and 1535 with 1536 representing 360 degrees. The electrical angle may be set to a value and that value will be held regardless of the position until it is changed by writing a new value or released by writing a negative number to the electrical angle.

VF.VD Filtered Command (low order)
VF.VA Filtered Command (high order)

This variable is read only. See command filter (VF.FL) for details about how the filter operates. When not used as a data gathering variable, VF.VA returns the integer part of the filtered command and VF.VD returns both the integer and fractional parts * 65536.

CF.VD Filtered Feedback (low order)
CF.VA Filtered Feedback (high order)

This variable is read only. See aux. analog filter (CF.FL) for details about how the filter operates. When not used as a data gathering variable, CF.VA returns the integer part of the filtered feedback and CF.VD returns both the integer and fractional parts * 65536.

PL.DD Filtered Position Derivative (low order)
PL.DE Filtered Position Derivative (high order)

This variable is read only. See position loop description and position derivative filter (PL.DF) for descriptions of the position derivative. When not used as a data gathering variable, PL.DE returns the integer part of the position derivative and PL.DD returns both the integral and fractional parts * 65536.

VL.DD Filtered Velocity Derivative (low order)
VL.DE Filtered Velocity Derivative (high order)

This variable is read only. See velocity loop description and velocity derivative filter (VL.DF) for descriptions of the velocity derivative. When not used as a data gathering variable, VL.DE returns the integer part of the velocity derivative and VL.DD returns both the integral and fractional parts * 65536.

CL.ID Flux Current

Sine mode only. This variable is read only. The DSP program calculates this value. It is the amount of current that is flowing in the drive that is perpendicular to the torque producing current. Because this current causes the motor to generate heat, the ideal value should be zero.

CL.DV **Flux Voltage**

Sine mode only. This variable is read only. The DSP program calculates this value. It is the leading (+) or lagging (-) voltage that the drive is applying to the motor to reduce the flux current.

CH **Halls**

This value is read only. The three hall signals are displayed as 0 or 1 in the order of s3,s2 & s1
And is the actual value of the three halls signals as read at the DSP.

MP **Motor Phase**

This value is read only. Value is from 0 to 5 and is the motor phase derived from the halls.

DU **Phase U Current**

This value is read only. Value is from –32768 to 32767 and is proportional the phase U current. To calculate the actual current multiply by (IR)* (drive rating in amps)/2017152.

DV **Phase V Current**

This value is read only. Value is from –32768 to 32767 and is proportional the phase V current. To calculate the actual current multiply by (IR)* (drive rating in amps)/2017152.

DW **Phase W Current**

This value is read only. Value is from –32768 to 32767 and is proportional the phase W current. To calculate the actual current multiply by (IR)* (drive rating in amps)/2017152.

PL.AC **Position (low order)**
PL.AH **Position (high order)**

This variable is read only. Position can have a value from –2147483648 to 2147483647. PL.AC when not used as a data gathering variable returns the value of both words together. Both PL.AC and PL.AH need to be used while setting up data gathering to get both words. Units are encoder counts if analog position feedback command is off or filtered analog with gain and offset if analog position feedback command is off.

PL.ER **Position Error**

This variable is read only. Position error can have a value of –32768 to 32767. It is commanded position – position.

PL.IN **Position Integral (low order)**
PL.IH **Position Integral (high order)**

This variable is read only. Position integral is the sum of the position errors. It is not accumulated if the position loop or current loop is saturated. The position integral can have a value between –8388352 to 8388352. PL.IN when not used as a data gathering variable returns the value of both words together. Both PL.IN and PL.IH need to be used while setting up data gathering to get both words.

CL.DS or DS — Scaled Current Integral

VL.AC — Velocity (low order)
VL.AH — Velocity (high order)

This variable is read only. Velocity can have a value from –2147483648 to 2147483647. VL.AC when not used as a data gathering variable returns the value of both words together. Both VL.AC and VL.AC need to be used while setting up data gathering to get both words. Units are:

4 RPM for halls based velocity
5 Encoder counts per position servo cycle * 256 for halls based velocity.
6 Filtered analog with gain and offset for if analog velocity is set in the configuration word.

VL.ER — Velocity Error

This variable is read only. Velocity error can have a value of –32768 to 32767. It is commanded velocity – velocity.

VL.IN — Velocity Integral (low order)
VL.IH — Velocity Integral (high order)

This variable is read only. Velocity integral is the sum of the velocity errors. It is not accumulated if the velocity loop or current loop is saturated. The velocity integral can have a value between –8388352 to 8388352. VL.IN when not used as a data gathering variable returns the value of both words together. Both VL.IN and VL.IH need to be used while setting up data gathering to get both words.

7.3.5 Function Generator

A built in function generator allows an easy check of the servo response of any of the loops to a generated signal. The generator ramps from the current command to the base of the response signal so that a gradual initial change is provided.

FG.SL **Function Generator Ramp Slope**

This is the slope of the initial ramp. Units are signal change per loop divided by 256. This is an unsigned number that will adjust the signal upward or downward until the base value is reached.

FG.BS **Function Generator Base Value**

This is the base of the wave. It is a double precision signed value.

FG.AM **Function Generator Amplitude**

This is the amplitude of the wave. It is a double precision signed value. The signal value for the main part of the wave generation is between the base and base plus amplitude. Therefore, if the amplitude is negative, the signal will start at the top after the ramp.

FG.CY **Function Generator Cycle Time**

This is the cycle time for the complete wave. It is a single precision unsigned value. The value is in number of loops. The actual cycle time may be close to this value, but not necessarily exact.

FG.CT **Function Generator Control Word**

This is the word which controls the operation of the function generator. Its format follows:

Bits	Value	Description
0-1	0	No motion generator
	1	Input to current loop
	2	Input to velocity loop
	3	Input to position loop
2-3	0	Square wave
	1	Triangle wave
	2	Sawtooth wave
	3	Sine wave (starts at 270°)
4-5	0	This field must be set to zero by the user

FG.ST **Start Function Generation**

This command validates the parameters, does some necessary computations, and starts the function generator. If the drive is in standby when this command is issued, the function generator will start when the drive goes into run.

FG.SP **Stop Function Generation**

This command stops the function generator. Going into standby mode will also disable the function generator.

FG.NC — **Number of Cycles**

This command specifies the number of cycles to run before stopping. After stopping, the drive will be placed in standby unless this parameter is zero, in which case, the function generator will run until the drive is placed into standby.

7.3.6 Diagnostic Commands and Variables

Caution: Some of the commands and variables described here require specific knowledge and may cause problems if used incorrectly. These should be used only by someone knowledgeable about the drive.

DG.RS — **Reset Drive**

This command will reset the drive if a 47802 is written to it, i.e. DG.RS 47802. Otherwise, it will return an error.

CV — **Get Version String**

This is read only. Responds with the version string. The version string has the software ID number, version number, date, and description of drive type.

LR — **Allow Low Rail Voltage**

If LR is zero, the drive may be enabled even if the rail voltage is too low or entirely absent. The user must assure that the voltages needed for drive operation are present.

CF — **Display Fault String**

This is read only. Displays a string describing the state of the drive: run/standby, brake, and any faults.

CR — **Restore Default Parameters**

This is read only. Restores factory default parameters and writes them to EEPROM. The previous parameters will be lost. On versions released after December 8, 2004, the command will be accepted only if typed as “CR23130”.

SR — **Run Switch**

This sets the value of the run/standby switch.

0	Drive in standby with run line low or an error.
1	Drive in run with run line high.
2	Drive forced into standby regardless of the state of the run line.
3	Drive forced into run if there are no errors regardless of the state of the run line.

TT — **Test Time**

Pulses for the specified number of current loop times. The test current is sent to the control loop and the test voltage overrides the output of the control loop if it is not zero. If the drive faults during the test the value of TT is equal to the remaining current loops.

TC	**Test Current** Used in conjunction with the test time command to set the test current.
TV	**Test Voltage** Used in conjunction with the test time command to set the test modulation voltage. Must be set to zero to use test current.
IO	**Set Output Delay** Sets the time in milliseconds to delay between each character transmitted to the serial port. Normally should be zero (0).
AD.FV	**5 Volt Monitor** Read only. Monitors the 5 volt bus. Range from 0 to 65535.
AD.RL	**Rail Voltage** Read only. Range from 0 to 65535.
AD.VF	**15 Volt Monitor** Read only. ACE only. Monitors the +15 volt bus. Range from 0 to 65535.
AD.FN	**15 Volt Monitor** Read only. ACE only. Monitors the -15 volt bus. Range from 0 (0V) to 65535.
AD.IT	**Motor Temperature** Read only. ACS only. Monitors the raw AD reading of motor temperature. Range from 0 to 65535.
AD.IA	**Analog Input 1** Read only. For ACS, this is the raw AD reading. Range from 0 to 65535. For ACE, this is the PWM input or the raw AD input. Range from –4095 to 4095.
AD.IB	**Analog Input 2** Read only. For ACS, this is the raw AD reading. Range from 0 to 65535. For ACE, this is the raw AD input. Range from 0 to 8191.
AD.EA	**Encoder Angle** Read only. ACS and ACE. This is the motor mechanical angle. It is not initialized. Its range is from 0 to Encoder counts per Revolution minus 1.

CL.MN **Actual Voltage Minimum**

Read only. The actual minimum value the modulation voltage is allowed to attain.

CL.MX **Actual Voltage Maximum**

Read only. The actual maximum value the modulation voltage is allowed to attain.

CL.FD **Current Feedback**

Read only.

8 Addendums to ACS300 User Manual

8.0 ACS Motor Temp Input Circuit

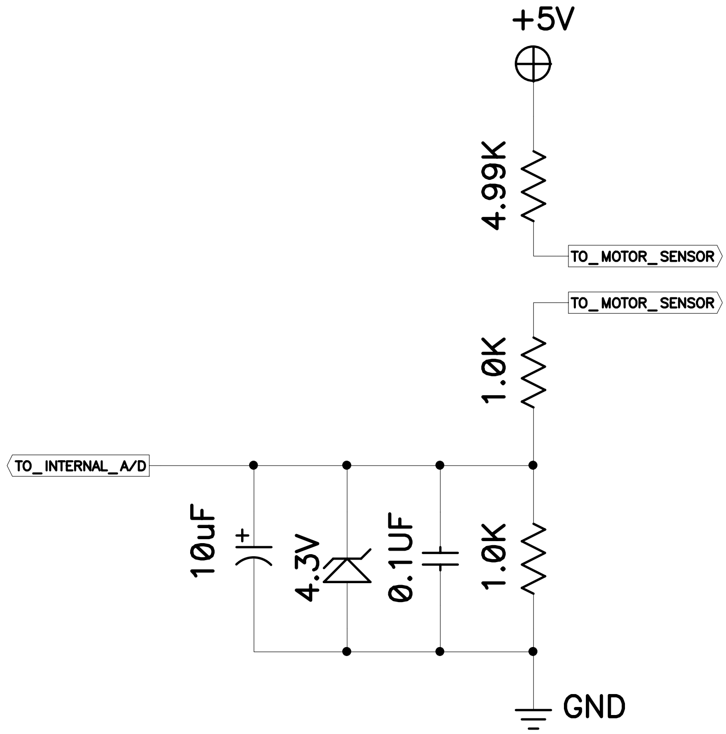


Figure 39: ACS300 Motor Temp Input Circuit

8.1.1 Motor Temp Circuit Description

The parameter "TE" sets the function of the motor overtemp input.

TE = 0 : A ZERO value disables the motor overtemp fault

TE > 0 : When TE is a positive number, a fault is recognized if the internal DSP analog to digital converter reading is above the TE value.

TE < 0 : When TE is a negative number, a fault is recognized if the internal DSP analog to digital converter reading is below the TE value. Note that the absolute value of TE is used as the threshold value.

When using a normally closed motor temp switch, use TE = -3500. While the temp switch is closed, the internal A/D value will be above 3500. When the temp switch opens, the A/D sensing voltage will drop via the 1K pull down resistor, and the A/D value will drop close to zero. This will cause a fault condition.

When using a normally open motor temp switch, use TE = 3500.

For PTC and NTC type sensors, TE is calculated as follows:

TE = 49648.5 * 1K / (4.99K + 1K + 1K + sensor_resistance_at_temperature)

If fault is desired on falling edge of temp input (or rising sensor resistance), make TE a negative number.