Preliminary

INSTALLATION
&
OPERATION MANUAL

Omega Series

Model SMC9930
Model SMC9975

with SynqNet ® ***Interface***

Digital PWM Brush/Brushless Servo Amplifiers

GLENTEK

"Solutions for Motion Control"

Features

• **100% SynqNet® compliant**	Allows complete drive configuration, control, monitoring and firmware updates over the SynqNet® network. Synchronizes to SynqNet® network update to minimize update jitter and skew for improved motion control.
• **Digital current loops**	Current loop bandwidths up to 3 kHz.
• **Digitally tuned**	All parameters set digitally. No potentiometers to adjust. DSP control for the ultimate in high performance.
• **Silent operation**	Up to 24 kHz PWM (12.7KHz PWM Standard).
• **Complete isolation**	Complete optical isolation between signal and power stage.
• **Wide operating voltage**	110-130 VAC or 208-240 VAC (single or 3-phase, 50/60 Hz).
• **Direct AC operation**	No transformer required for stand-alone units. The stand-alone units include a DC bus power supply, regen clamp with dumping resistor, in-rush current limiting protection at power-on and cooling fans.
• **Fault protection**	Short from output to output, short from output to ground, amplifier RMS over current, amplifier under/over voltage, amplifier over temperature, motor over temperature, primary and auxiliary encoder broken wire.
• **RS-232**	High speed (115.2K baud) serial communication inter face for set-up and tuning.
• **Software Configurable**	Glentek's Windows™ based MotionMaestro™ software provides ease of set-up and tuning with no previous programming experience required. This software is Win dows™ 95/98/2000 and NT compatible. Configuration can also be performed over SynqNet®.
• **Non-volatile memory**	All parameters are stored in non-volatile memory. Up to two configurations can be stored at one time.
• **Dedicated optical inputs**	+/- limits, node disable, home and motor over temp (non-isolated).
• **Dedicated optical outputs**	Node alarm and brake.

- **General purpose inputs** — 2 optically isolated and 2 high-speed differential receivers.

- **General purpose outputs** — 2 optically isolated and 2 high-speed differential transmitters.

- **Encoder feedback** — Accepts encoder signals up to 4.3 MHz. Accepts traditional and reduced wire encoders (Panasonic, Sanyo Denki and Tamagawa).

- **Power on phase finding** — Eliminates the requirement for Hall sensor/commutation tracks for many applications.

- **Auxiliary encoder inputs** — A, B and index channels passed to the controller.

- **Status indicator** — 7-segment display indicates amplifier status and fault codes.

- **Sine encoder interpolation** (Optional) — Accepts 1Vpp sine/cosine feedback, and interpolates up to 4096 (12 bit). Max. frequency 500KHz/channel

- **External logic supply input** (SMC9915 only) — 24 to 48VDC, 600mA min @ 24VDC. Powers all amplifier logic and encoders.

- **DBN** — Divide-by-N, See page 55 for detail specification.

- **Sinusoidal commutation** — For the ultimate in efficiency and smooth motion. Com mutates from almost any resolution rotary encoder or linear scale.

- **SMT construction** — Provides ultra compact size, cost competitive package and high reliability.

- **CE compliant** — All servo amplifiers are CE marked.

Amplifier Setup Software

Motion Maestro©

MotionMaestro© is Glentek's Windows based application software that was designed to communicate with the Omega series digital amplifiers. MotionMaestro© has many dialogs with values shown in engineering units to make it easy to select and setup the features of the amplifier. MotionMaestro© utilizes the standard ASCII command set and protocols. Although it is not necessary to use MotionMaestro©, installation, setup and tuning is made easier through its use.

MotionMaestro© has many features that allow application engineers to easily configure a digital amp to an application. It has a terminal mode that operates at 115k baud transmission rates, an oscilloscope that can be used to monitor amplifier signals and a tuning dialog that can be used to control the motor input. By using the oscilloscope and tuning dialog, one can monitor step response to determine filter parameters for optimal control loop performance.

MotionMaestro© Installation

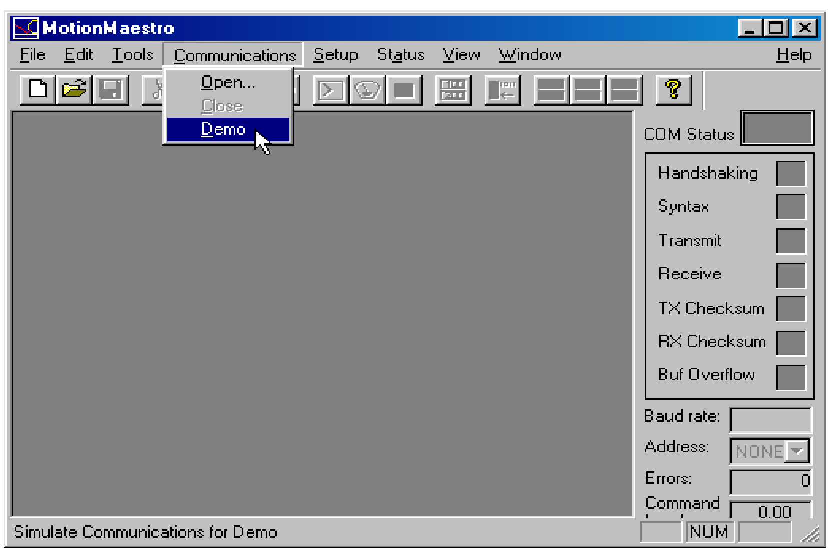
MotionMaestro© requires Windows95, Windows 98 SE, Windows ME, Windows NT 4.0, Windows 2000 or Windows XP operating system running on a PC with at least one serial port. It is suggested that you have no less than 3 megabytes of application program disk space remaining on the hard drive prior to installation. The MotionMaestro© install disk is setup to utilize Install Shield to simplify installation. There are only a few setup options offered. In general you can press NEXT or YES until installation is complete. When installation is completed, you will find a MotionMaestro© shortcut on the windows Start\Programs menu.

DO NOT RUN MOTIONMAESTRO© UNTIL YOU HAVE READ ALL OF THIS SECTION.

The MotionMaestro© installation program is named Setup.exe. It is found on disk1 of the distribution floppies or in the MotionMaestro© \disk1 directory of the distribution CD.

The installation will create a Glentek folder in the Program Files folder. A MotionMaestro©_X_X folder is created where _X_X matches the version number. You can have multiple versions of MotionMaestro© installed, if you wish, and they will be placed into their own directories.

When MotionMaestro© is directed to establish communications with the amplifier, the amplifier is queried for a model ID and Firmware version. MotionMaestro© will configure itself and select the appropriate configuration files based on the amplifier returned values.



Demo Mode - For exploring MotionMaestro without an amplifier connected

You can run MotionMaestro© without an amplifier attached and inspect the menu options and dialog. To run in demo mode pull down the Communications menu and select **Demo**. For communicating with an attached amplifier select **open** under the communications menu.

There are extensive help screens under the Help menu. Select Help Topics and you can read about the usage of MotionMaestro© and it's features.

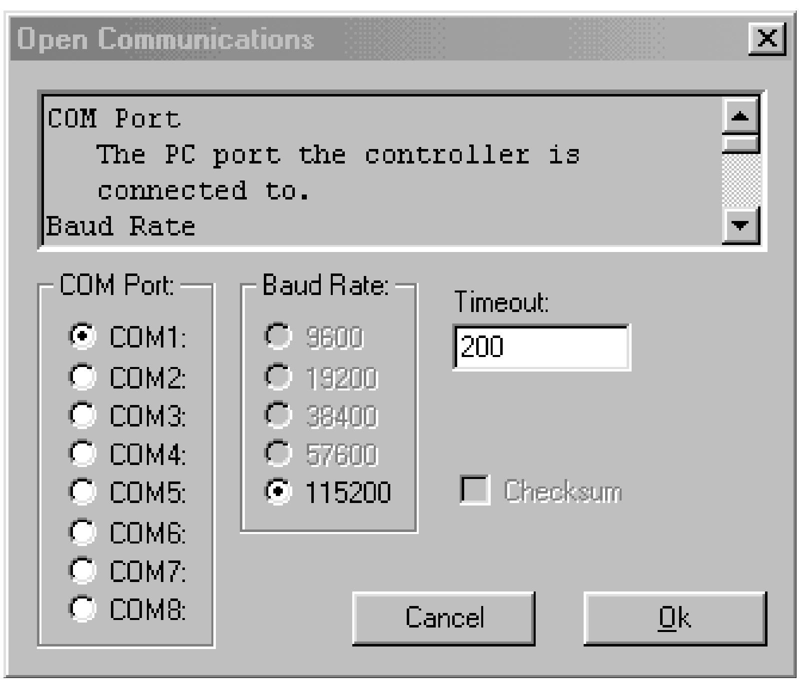
MotionMaestro© Amplifier Setup Features

This section of the manual is an introduction to MotionMaestro's© features that are required for installation and setup of the Omega series amplifiers. Only those features of MotionMaestro© required for defining motor characteristics are covered. This is not meant to be a step by step tutorial. The "System setup" section is intended as a tutorial for motor setup. You may need to refer to this section when setting up a motor. The following features are reviewed here:

1. Opening of communications.
2. Model Information.
3. Digital I/O setup.
4. Amplifier mode setup.
5. Commutation setup.
6. Encoder setup.
7. Oscilloscope
8. Terminal Window
9. Motor Parameters.
10. Motor Safety.
11. Amplifier Status.
12. Control Panel.
13. Saving parameters.
14. Backing up a copy of amplifier parameters.

Opening of Communications

Before MotionMaestro© can be used, communications must be established between the amplifier and the PC that MotionMaestro© is running on. Before opening communications in MotionMaestro©, you must have a serial communications cable wired as described in the hardware section of this manual. This can be a RS-232 or RS-485/422 wiring. You may also need to set the serial port on your computer as described in the system setup section.



Open Communications dialog box

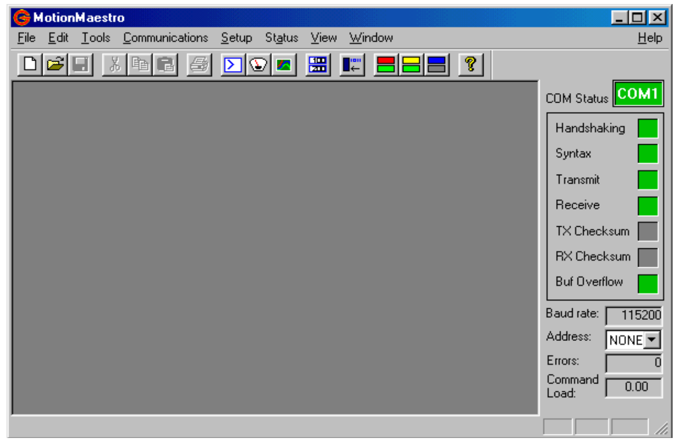
Open communications by selecting the "Open" option on MotionMaestro's© main menu tool bar.

Select the COM port that you connected the serial port cable to and ensure that a baud rate of 115200 is selected. When you press OK MotionMaestro© will query the amplifier to determine what amplifier model is connected. If communications is established, you should see a screen similar to the following with all green communications status indicators.

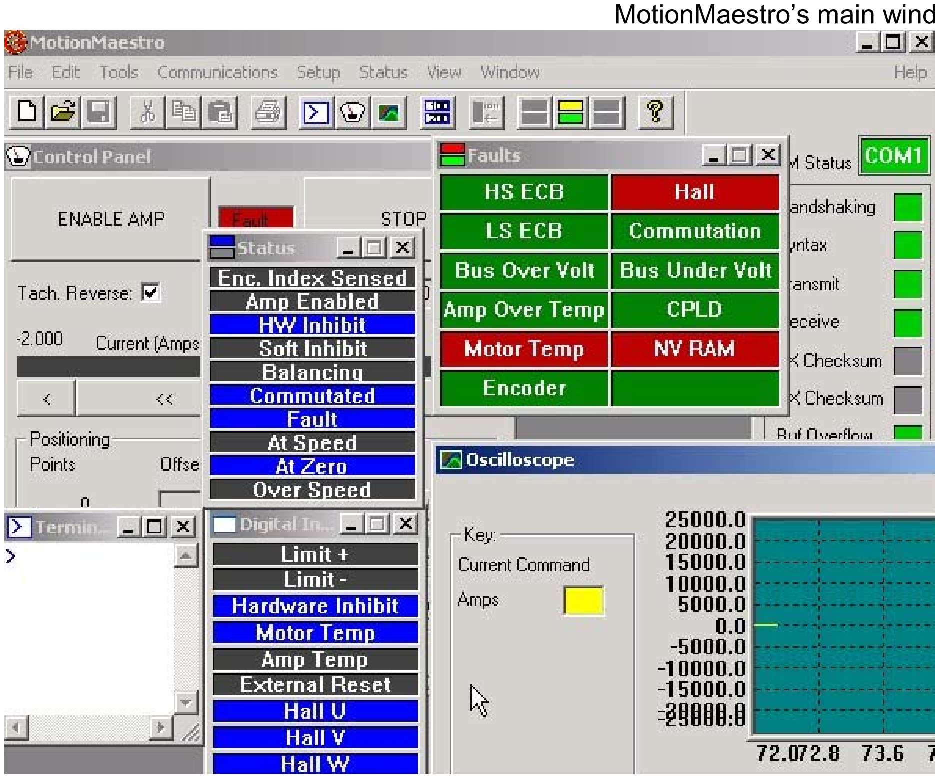
When communications cannot be opened, a dialog is presented indicating so. If you cannot open communications please check your cable, PC COM port settings and power to the amplifier.

To the right, MotionMaestro's main window is shown where communications are successfully opened.

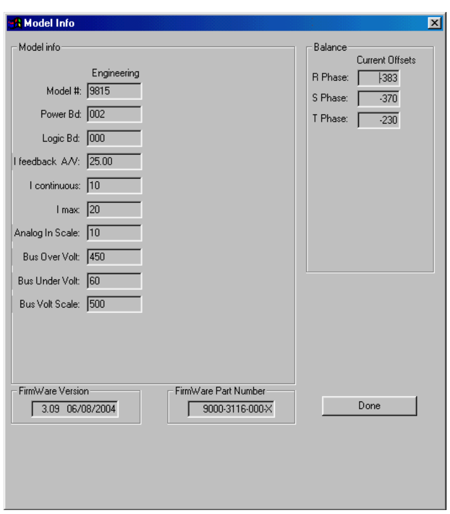
Below, various setup and monitoring screens are activated. These active screens do not necessarily need to remain within MotionMaestro's main window, they may reside anywhere on the Windows desktop.



MotionMaestro's main window



MotionMaestro's Sever activated windows.



Model Info Box.

Model Information

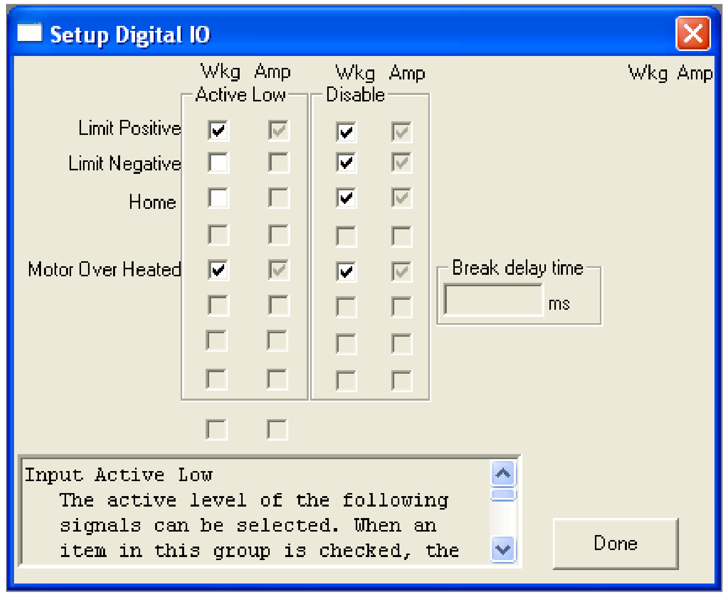
For informational purposes, you can refer to the Model Info dialog to view the design features and limits of the particular amplifier. To view this dialog, you must select the "Tools" option on MotionMaestro's© main menu tool bar, then select "Model Info".

Here you will be able to view your firmware version and date, amp model number, power board number and logic board number. In addition, MotionMaestro's Model Info dialog window will display amplifier settings. For example, on the left these settings are current balance offsets, current feedback, continuous current and peak current settings. These settings, in addition to the Bus under-voltage and over-voltage settings, are useful informational tools and are required if the user performs his own scaling of amplifier values.

Digital I/O Setup

The Digital I/O settings can be used to tailor the amplifier's digital signal inputs to the requirements of your application. Failure to properly setup the Digital I/O signals may result in the amplifier powering up in a fault condition. To view this dialog, select the "Setup" option on MotionMaestro's© main menu tool bar, then select "Digital IO...". Digital I/O signals can be active high or active low depending on the applications.

On this window there are two sets of checkboxes, for each signal, Wkg and Amp. Amp displays the current amp setting while Wkg displays the users choice. The amp is automatically updated as the Wkg box changes.



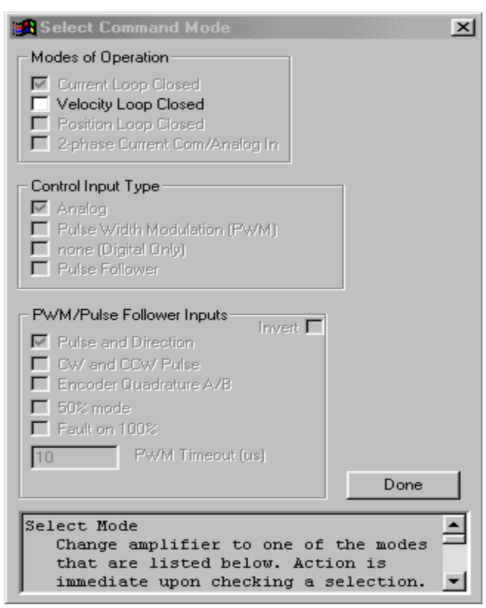
Dialog box for setting Digital I/O

If "Wkg Amp Disable" is checked when one of the digital inputs is activated, the amplifier will send a message to the SynqNet® controller, and have the SynqNet® controller take an action . In contrast, if "Wkg Amp Disable" is not checked, the amplifier will take an action before the digital input message reaches the controller.

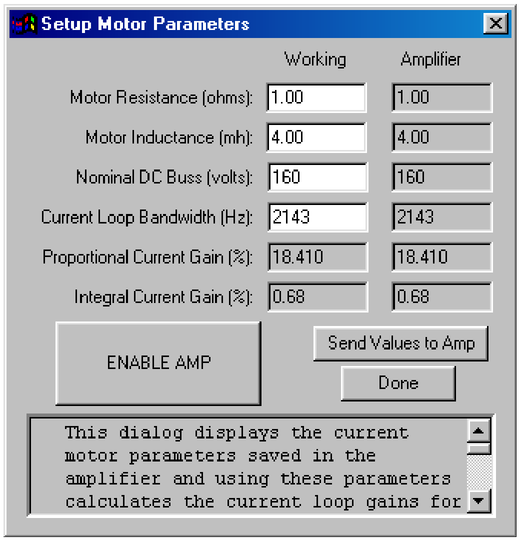
Note: It is highly recommended to check "Wkg Amp Disable" boxes, and have the SynqNet® controller control all the digital inputs.

Amplifier Mode Setup

The default mode for SynqNet® amplifiers is current mode.



Dialog box for setting amplifier mode.



Dialog box for entering motor parameters.

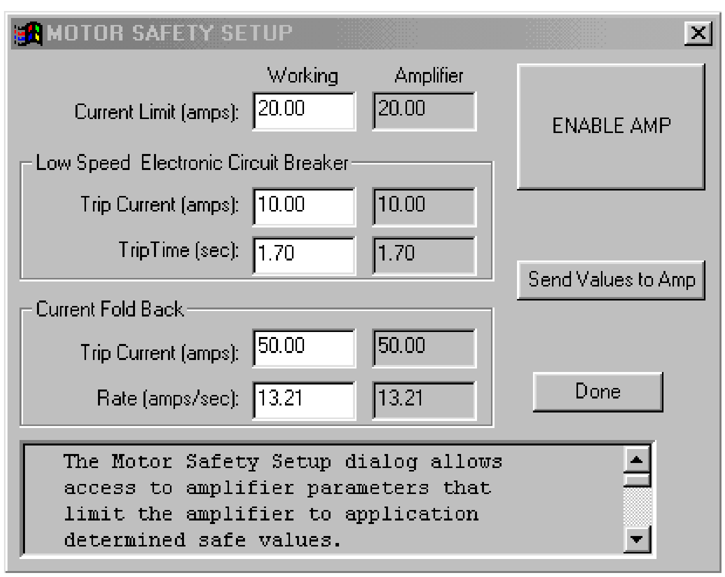
Motor Parameters

Select “Motor Parameters” on the “Setup” menu to activate the Motor Parameters dialog. The Motor Parameters dialog is used to set digital current loop gains. MotionMaestro© will calculate current loop gains based on the values entered. Select “Motor Parameters” on the “Setup” menu to activate this dialog.

Motor Resistance and Inductance are entered as phase to phase values. If these values are not indicated on the motor label, you can determine these values by measuring the resistance or inductance between two motor wires connecting two phases of the motor. Nominal DC bus voltage is the regulated bus voltage, 160 or 320 volts typically. Current loop bandwidth is a measure of the current loops responsiveness. Generally you want this to be as high as possible. A good starting point is 1500 Hz. In order to update the motor parameters in the amplifier, the amp must be disabled. You can do this by clicking on the “Disable/Enable Amp” button first, then the “Send Values To Amp” button. Pressing F1 displays the dialogs help text. After the values are sent to the amp you may test the values by enabling the amp.

Motor Safety

Motor safety is where limits to protect the motor are entered. The “Motor Safety Setup” dialog is available from the “Setup” menu. There are two sets of boxes, one labeled Working, the other Amplifier. Amplifier displays the current amp setting while Working displays the users selection. Here you can setup a maximum current limit, current foldback and low speed Motor safety is where limits to protect the motor are entered. In order to update the motor parameters in the amplifier, the amp must be disabled. You can do this by clicking on the “Disable/Enable Amp” button first then the “Send Values To Amp” button. Pressing F1 displays the dialogs help text. After the values are sent to the amp, you may test the values by enabling the amplifier.

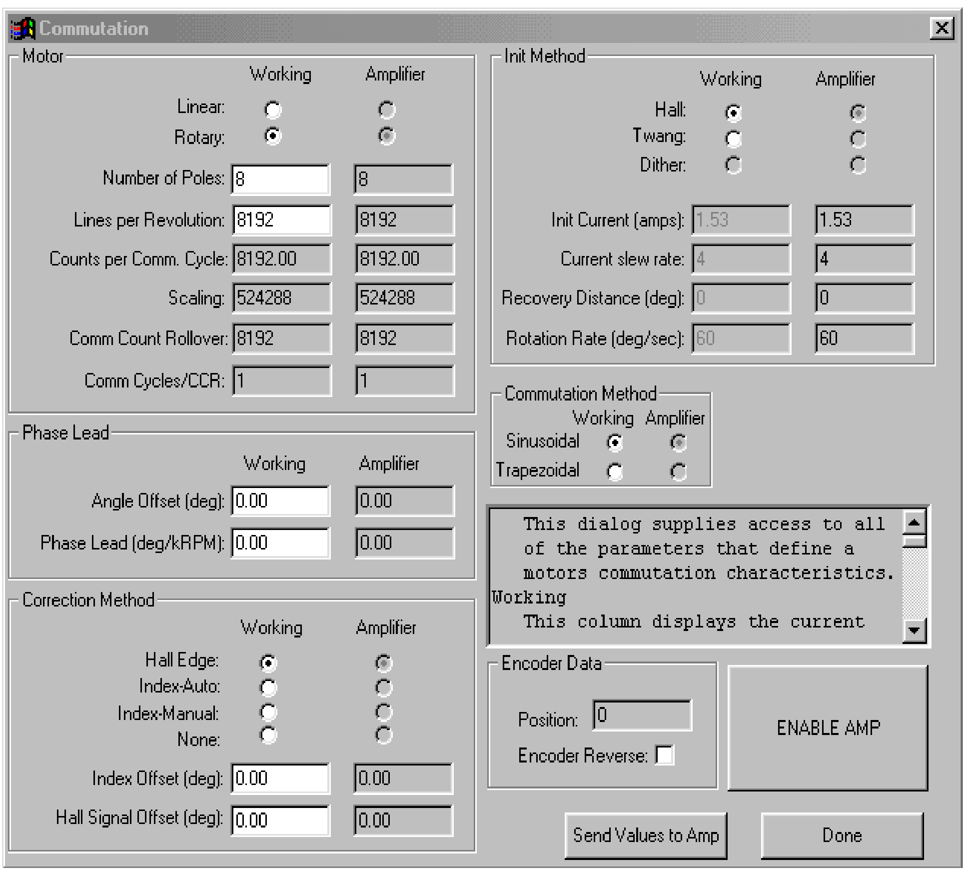


Dialog box for setting up motor safety parameters.

Commutation Setup

The Commutation dialog window allows you to define a motor's commutation characteristics. Here you specify motor commutation parameters, correction and initialization methods, and encoder positioning. In the motor section, most of the boxes are calculations based on your selected motor parameters. Select "Commutation…" on the "Setup" menu to activate the dialog shown below.

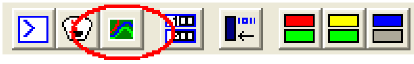
For initial setup most of the commutation screen can be ignored. For example, if Hall sensors are utilized they need to be selected under "Init Method". Then, "Hall Edge" needs to be chosen as correction type. Finally, "Number of Poles" and "Lines per Revolution" need to be entered (Rotary). Selecting linear instead of rotary will display parameters that are specific to a linear motor. Edit boxes that are not available are values that are calculated based on other parameters entered. Encoder Scaling and Remainder are automatically calculated based on the motor and encoder values entered. The working column represents modified values that are sent to the amplifier when clicking the "Send Values to Amp" button. In order to update the commutation values, the amp must be disabled. You can do this by clicking on the "Disable/Enable Amp" button. All edit box parameters are described in the help dialog at the bottom right of the window. You can activate this dialog by clicking on it and then you may scroll up and down through the help dialog with the up or down arrows. Press F1 to view the dialog help text in notepad. After the values are sent to the amplifier you may test the values by enabling the amplifier.



Dialog box for setting up motor commutation.

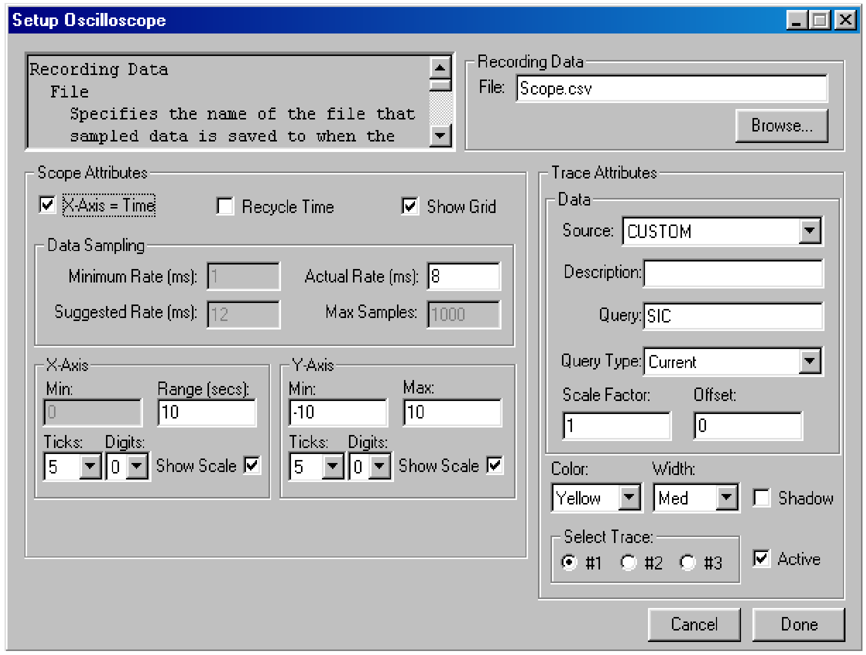
Oscilloscope Setup

The Oscilloscope can either be accessed under the "Tools" option on MotionMaestro's© main menu or via a button on the toolbar.



There is a "setup" window and a "trace display" window for the Oscilloscope. The Oscilloscope setup window provides for setup of the parameters needed to define the signals to be displayed on the Oscilloscope Display screen.

"Scope Attributes" define the X-Y attributes of the Trace display. An example is X-Axis = Time, this sets the units of the X axis to time. The range can be set for both the X and Y Axis, along with the data rate parameters.

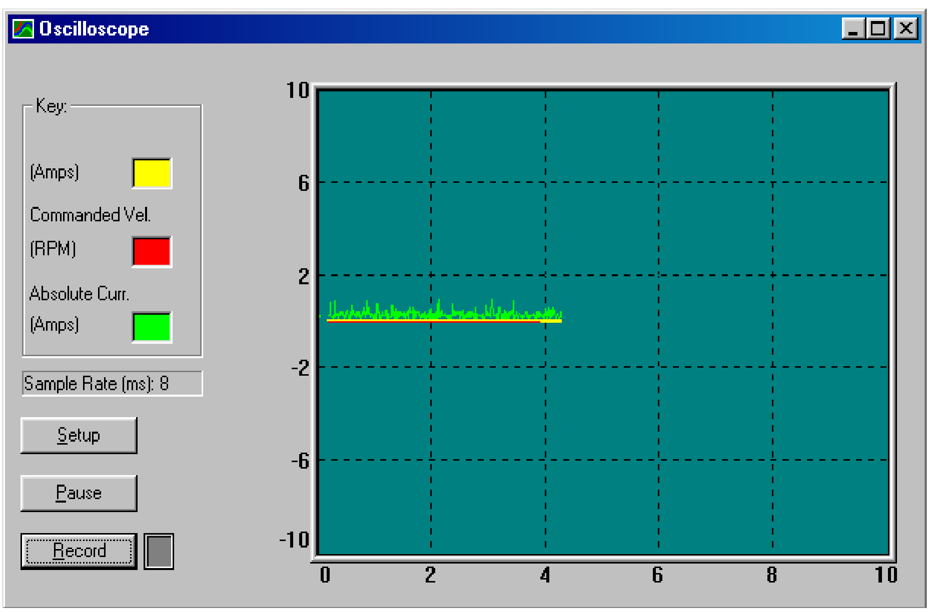


Setup Screen

"Trace Attributes" alters the data source and turns on/off different traces. You can monitor up to three traces at one time. All traces are color coded on the Oscilloscope Display screen.

The Recording Data section is useful for recording test data to a file. The "File" specifies the name of the file that sampled data will be saved to when the record button is activated on the "Trace display" window. By default these files are saved as .csv file type. When .csv is the file type, the files can be viewed with Microsoft EXCEL.

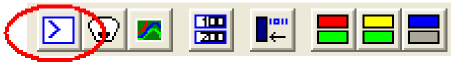
The Oscilloscope Display screen can display up to three active traces on the display. Each trace is color coded and labeled in the key. The sample rate is also displayed for convenience. The screen can be resized for versatility. Depressing the record button will allow you to record a portion of the trace waves. When record is activated a red light will be displayed near the button.



Oscilloscope Display Screen

Terminal Window

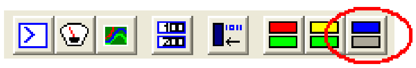
The Terminal Window can either be accessed under the "Tools" option on MotionMaestro's© main menu or via a button on the tool-bar.



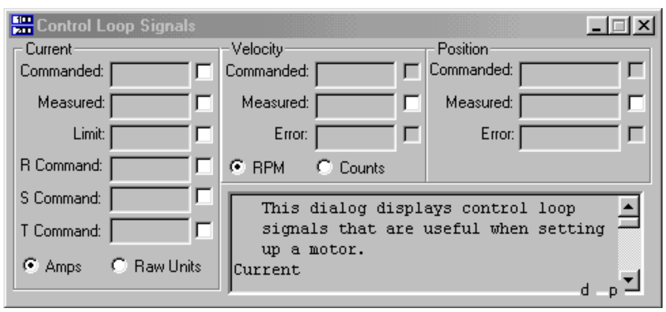
Terminal Window

The Terminal has direct communication to the amplifier. You can command the amplifier by typing commands to the terminal window. For example, typing BV then the enter key will send the request to read the Bus Voltage in the amplifier. If you wanted to change the Bus Voltage you would type BV200 then press enter. This would change the Bus Voltage to 200. Query command use just the ASCII letters of the command, where set commands use both Letters and a numerical value for an argument. **Caution must be used when this window is activated due to the possibility of entering commands which would have undesirable effects.**

Amplifier Status

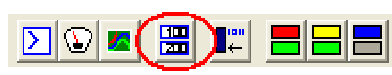


MotionMaestro© has a variety of status displays that assists the application engineer in setting up amplifier or diagnosing an amplifier setup. Rather than showing all possible status on one dialog, MotionMaestro© has been designed so that only those applicable to the situation at hand can be displayed. These dialogs continuously send queries to the amplifier to determine the amplifiers current status. The size and location of each status display is saved when exiting the display. When returning to the status the last size and position is used in positioning the window. F1 can be pressed to obtain help on the various items or status in the current dialog.



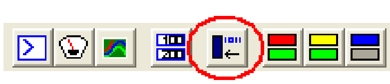
Dialog for observing control loop status

Control Loop Signals

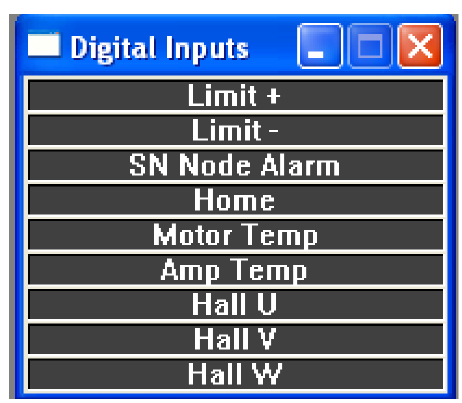


This dialog is useful for determining if an amplifier's control loop is responding properly. Commanded and measured current can be displayed as well as the motors current velocity and position. Display this dialog by selecting "Status\Control Loop Signals..." or via a button on MotionMaestro's toolbar.

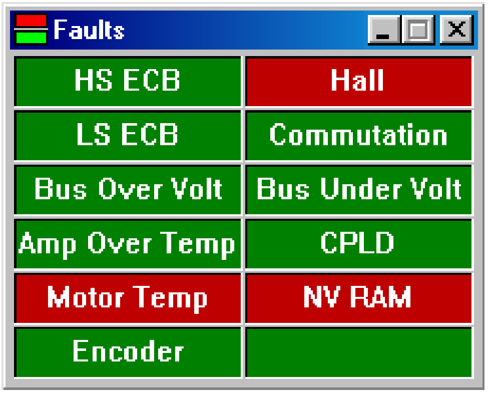
Digital Inputs



This dialog indicates the state of digital inputs coming into the amplifier. Digital inputs are those inputs that can be characterized as being active or inactive. They are typically associated with one of the controller input and output signal pins. See the associated pin in the hardware section for a description of the digital input of interest. Display this dialog by selecting "Status\Inputs\Digital…" or via a button on MotionMaestro's toolbar.

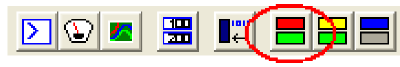


Status disply digital inputs



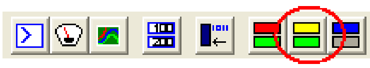
Amplifier Fault Status Display.

Faults



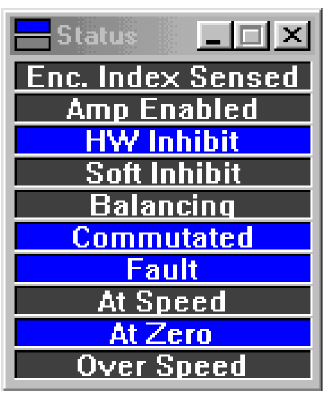
Faults occur on conditions that make it impossible to operate the amplifier in a safe and stable condition. When a fault condition occurs, the amplifier is disabled. The amplifier must be reset either with the hardware reset switch or with software (Control Panel dialog) or through the external reset pin. Conditions that cause faults are over currents, high or low bus voltages, excessive operating temperatures, and faulty sensors or amplifier hardware. An external fault can be generated by the controller through the /FAULT pin. See the hardware section for additional information on /FAULT. Display this dialog by selecting “Status\Faults ” or via a button on MotionMaestro’s toolbar.

Warnings



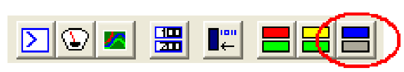
A warning status indicates that the amplifier is fully operational, but that it is operating in an unusual mode or in a condition that warrants attention. Current fold back is such a condition. Display this dialog by selecting “Status\Warnings…” or via a button on MotionMaestro’s toolbar.

The Warning Dialog



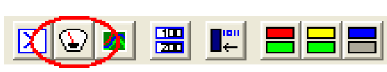
The System Status Display.

Status



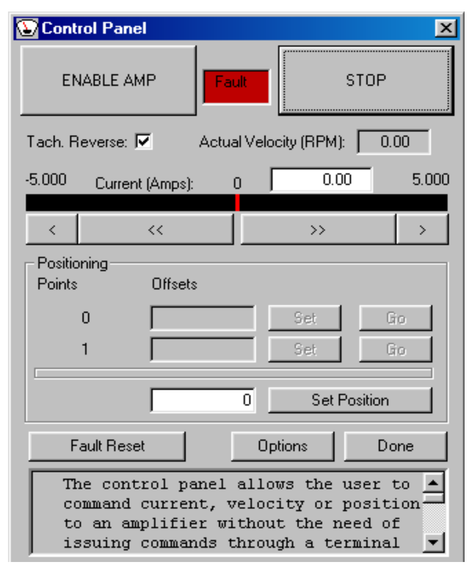
All other amplifier conditions that are not a fault or warning are displayed on the Status dialog. This status display is useful for diagnostics, setup or monitoring during operation. Display this dialog by selecting “Status\System Status…” or via a button on MotionMaestro’s toolbar.

Control Panel



A properly connected motor can be controlled using the control panel. The control panel displays the amplifiers commanded current or velocity along with the motors actual velocity. From the control panel, you can easily command the motor. The control panel can be accessed through the “Tools” pull down menu or from the control panel icon on MotionMaestro’s tool bar.

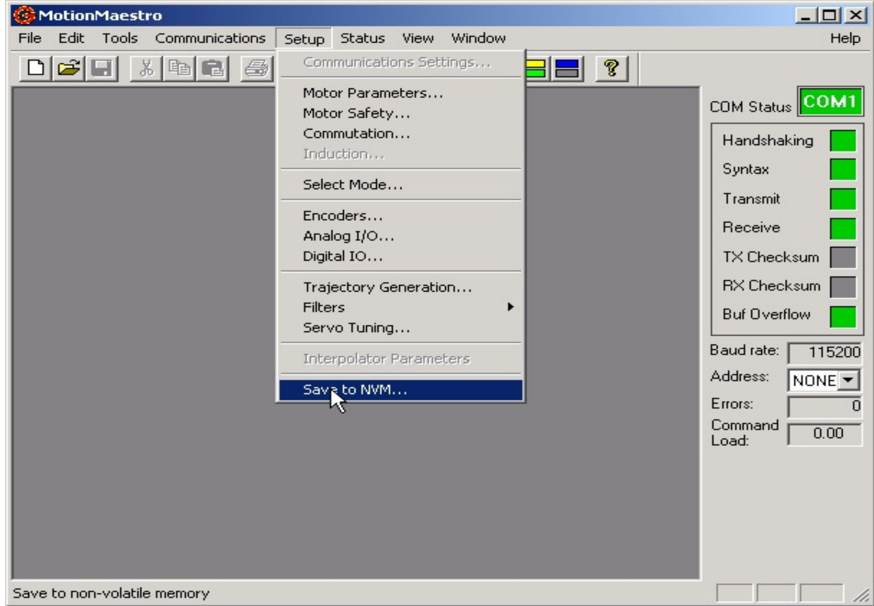
You may set positioning offsets or an exact position by depressing the “Set Position” button. The Option button will allow you to set the maximum and minimum current, velocity, and position.



The Control Panel display

Saving Parameters to Non-volatile Memory

After a motor is configured and tuned to the applications satisfaction, the parameters must be saved to the amplifier's non-volatile memory. Upon power up or reset, the last saved parameters are loaded in the amplifier. The parameters can be saved to non-volatile memory by selecting the "Save to NVM…" option on the setup menu, as illustrated to the right.

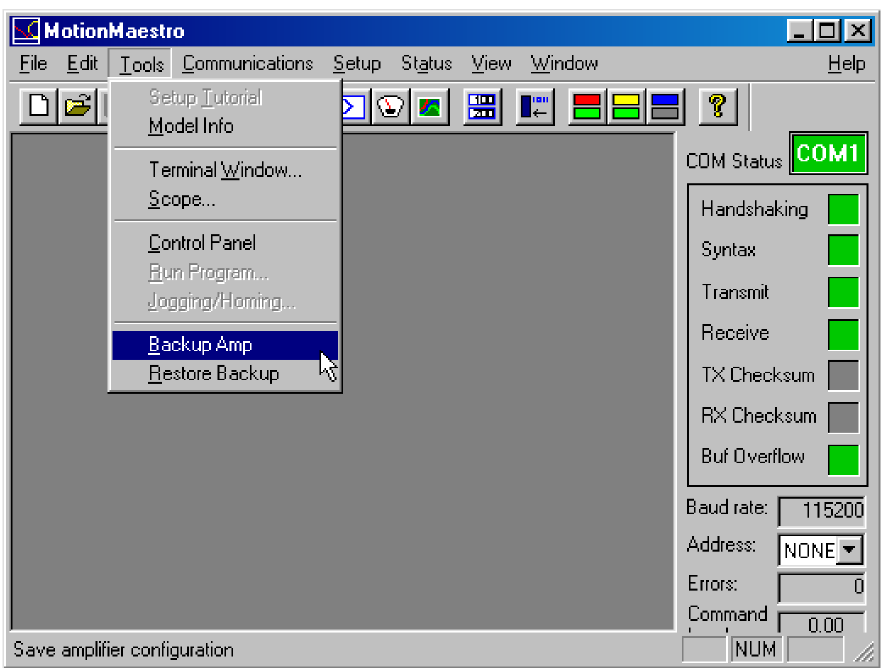


Saving Parameters to Amplifier Non-volatile Memory

Creating a Back Up Copy of Amplifier Parameters on Disk

An amplifier's current parameter settings can be saved to a disk file that can later be used to configure another amplifier or to restore an amplifier's parameter settings. This is useful in production environments or where an application has several similar motors.

Select "Backup Amp" on the "Tools" menu to backup these parameters. You will be presented with a Windows style "Save File" dialog. Here you can give the file a meaningful name and location to save the file to. Restore backed up files to an amplifier with the "Restore Backup" selection.

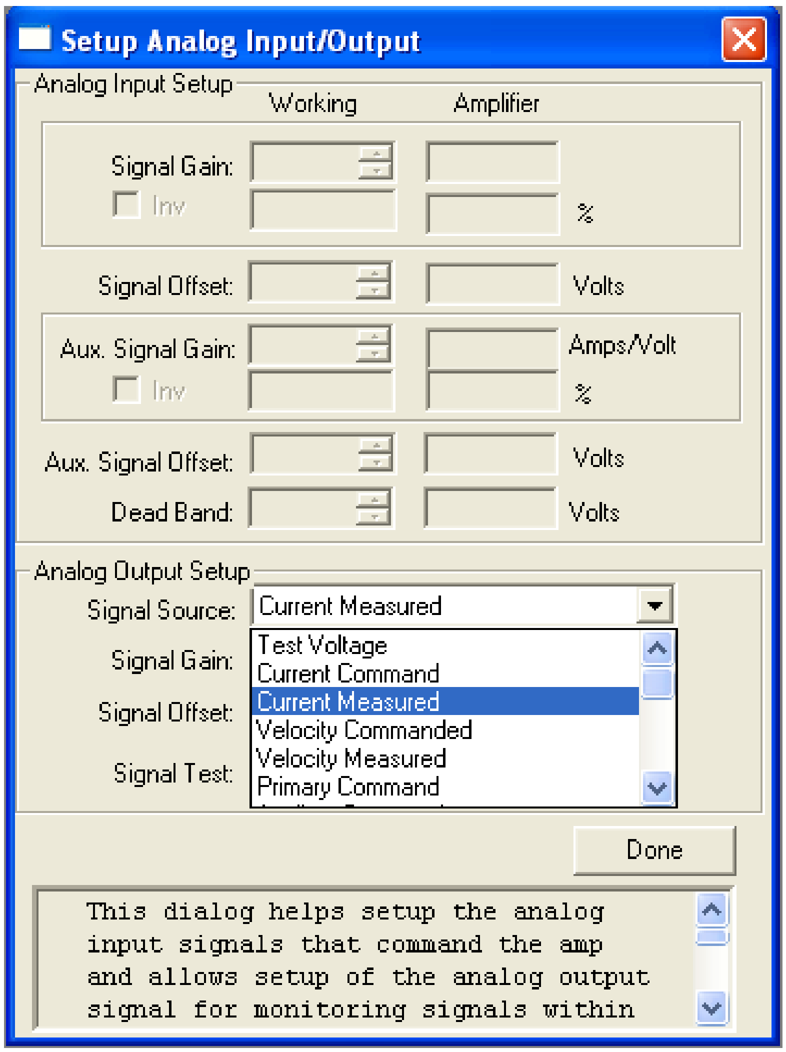


Backing Up Amplifier Parameters to a File on a Disk.

Analog output

ANALOG OUT is a user selectable analog output. The output ranges from -10 volts to +10 volts and has an 8 bit (256 step) resolution.

The analog output can be used to monitor amplifier signals at the servo update frequency. By doing so, the application engineer can determine the amplifier's true response to commanded signals. The analog output is for reference use only. It is not intended for control purposes. At power on, its value is undetermined until the power on reset has completed. During some amplifier functions, this output is temporarily disabled. These functions include saving and recalling parameters from non-volatile memory. The output is filtered to minimize the switching noise from the PWM amplifier. The analog output is updated once per PWM cycle.

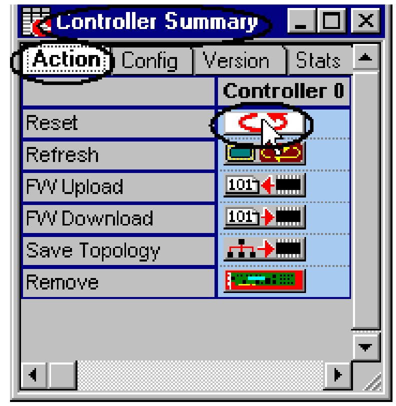


Analog Out source select

SynqNet® Setup Guide

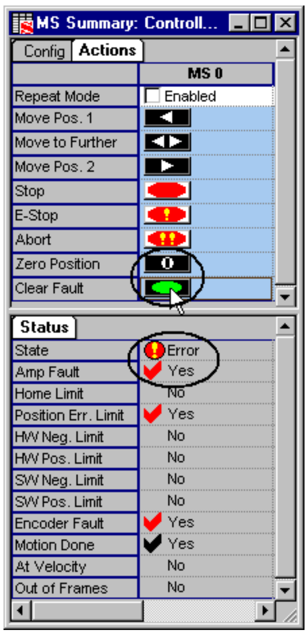
Getting Started with the SMC99XX and Motion Console

These instructions assume the user has already successfully installed MEI's Motion Console (Mocon) and has one SMB9915 drive on the network mapped as Controller0->Suupervisor0->Axis0->Motor0. This document was created using MoCon release 20021212.1.8.
Each MoCon window has a name that will be referred to in this guide. The name can be found on the window's title bar. For example, the window below is called *Controller Summary*.



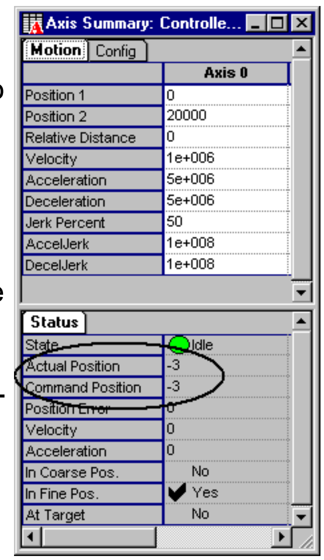
Most of the windows also have tabs like file folder tabs. Each tab selects a different set of parameters/functions that are visible in the window. The window on the right is currently displaying the *Action* tab.

To reset the amplifier, click the *Reset* button on the *Action* tab of the *Controller Summary* window. Each time the amplifier is reset, the faults must also be cleared.



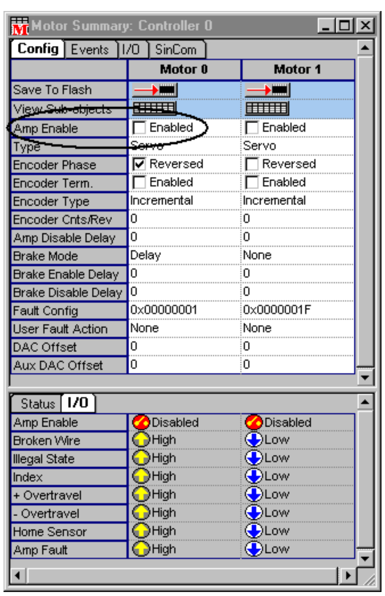
To clear the amplifier and network faults click the *Clear Fault* button on the *Actions* Tab of the *MS Summary* Window.

On the *Status* tab of the *MS Summary* window, verify that the *State* is *Idle* and the *Amp Fault* is *NO.* If the amp fault does not change to NO, use MotionMaestro to determine the cause of the fault, clear the cause and click the *Clear Fault* button again.



To zero the Actual Position, click the *Zero Position* button on the *Action* Tab of the *MS Summary* Window. The Actual position can be seen on the *Status* tab of the *Axis Summary* window.

Warning*:* If a linear motor is being driven, move the motor to the center of travel and zero the position before enabling the motor.



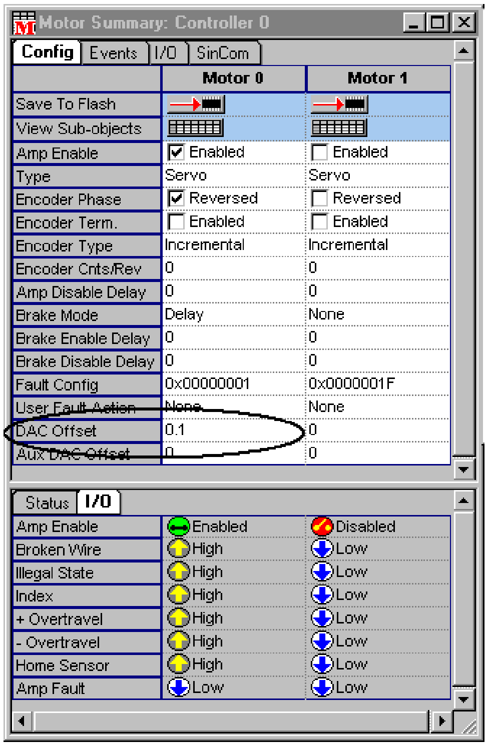
To Enable/Disable the amplifier

To enable the amplifier, verify that the faults are cleared and check the *Amp Enable* checkbox on the *Motor Summary* Window. If the box does not stay checked, then a fault must be present. If the box stays checked, but the amplifier still has a "C" on the display, use MotionMaestro to see if the Soft Inhibit is set (open the System status display). If the soft inhibit is set, type *EN 1* in the MotionMaestro terminal window or click the Enable button on the MotionMaestro Control Panel.
To disable the amplifier, un-check the Amp Enable checkbox.

Warning: If a motor is attached to the amplifier, do not enable the amplifier unless the *Commanded position* matches the *Actual position*, otherwise the motor will jump to the Commanded position. One way to force a match is by clicking the *Abort* button on the *Actions* tab of the *MS Summary* window. You will then need to clear the faults before enabling the amplifier.

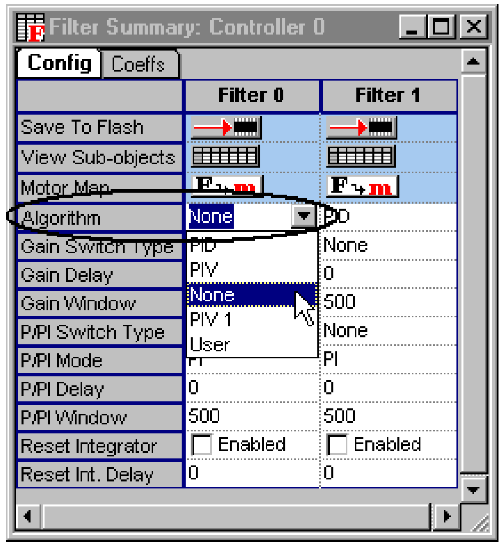
Open Loop Motor Drive Test

Disable the amplifier by un-checking the *Enabled* Check box on the MoCon Motor Summary window.

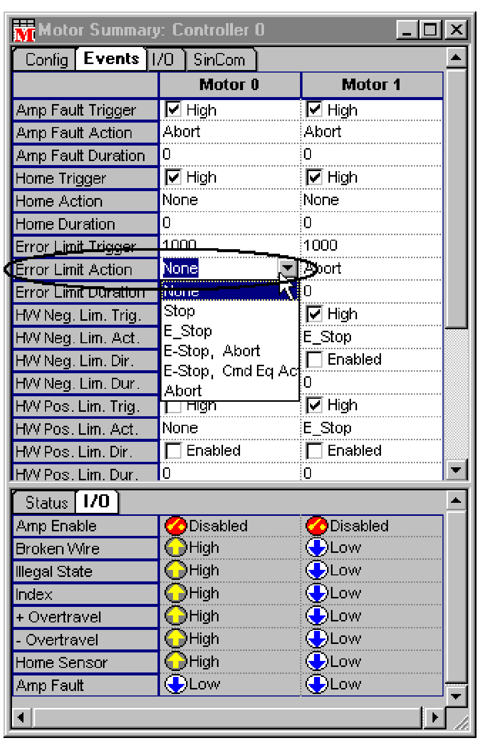


Disable the following error fault by setting the *Error Limit Action* on the *Events* Tab of the MoCon *Motor Summary* window to *None*.

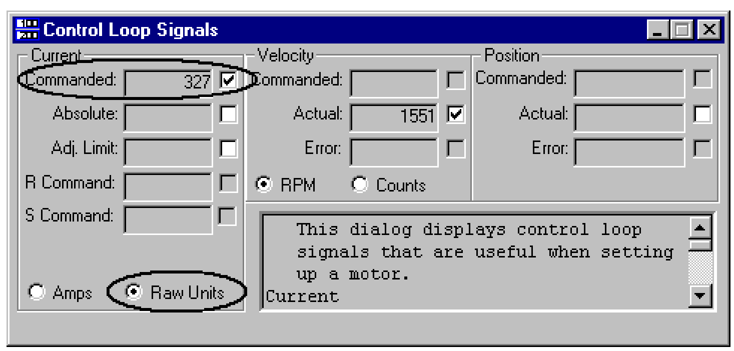
Change to Open-Loop mode by setting the *Algorithm* on the *Config* Tab of the *Filter Summary* Window to *None*.



Enable the amplifier by checking the *Enabled* Check box on the MoCon Motor Summary window. Carefully rotate the motor shaft by hand and verity the motor rotates smoothly without any cogging torque or torque bias.



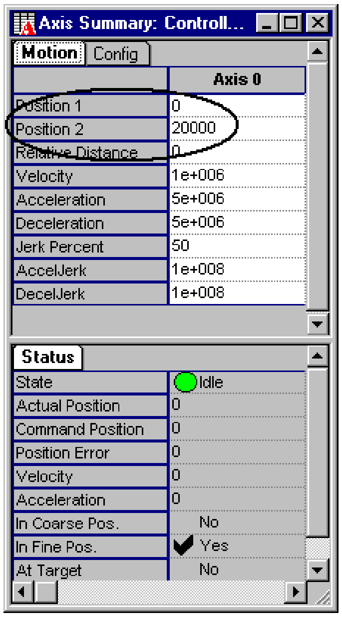
Command a small current to the motor by setting the DAC offset to approximately 0.1V which is equivalent to a digital command of 327. Verify the commanded current, raw units on the MotionMaestro Control Loop Signals Status box is 327 as shown.



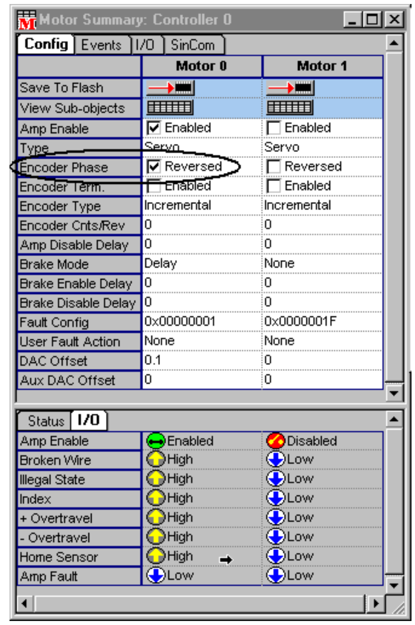
Verify that the motor spins smoothly. Depending on the motor and amp, the DAC offset may need to be increased to make the motor move.

Change the DAC offset to –0.1V and verify that the motor spins at approximately the same speed in the opposite direction.

Closed-Loop Motor Drive Test



With the amp still enabled and still in open-loop mode, change the DAC off-set back to positive with enough offset to make the motor spin.



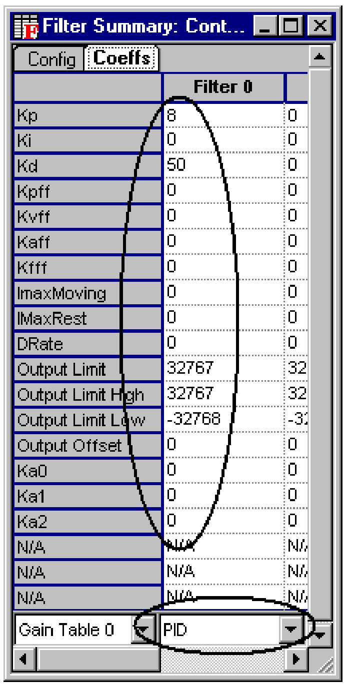
Verify that the *Actual Position* displayed on the Status Tab of the Axis Summary Window increases.

If the Actual position decreases, then change the *Encoder Phase* setting on the *Config* Tab of the *Motor Summary* Window.

Change the DAC Offset back to negative and verify that the *Actual Position* decreases.

Zero the DAC Offset.

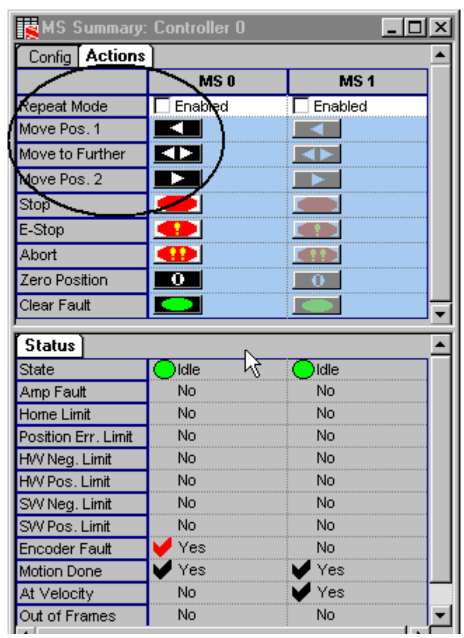
Disable the Amp.
Set the *Algorithm* on the *Config* Tab of the *Filter Summary* Window back to PID.

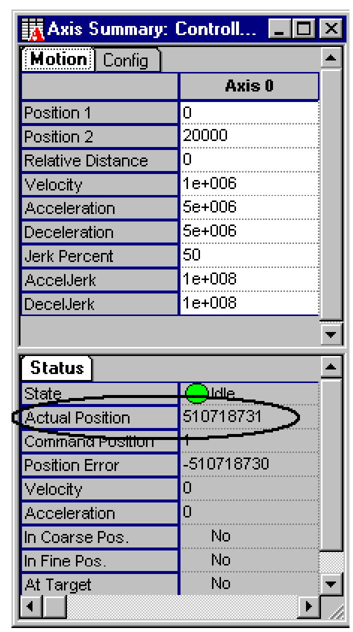


Set the *Error Limit Action* on the *Events* Tab of the MoCon *Motor Summary* window back to *Abort*.

Verify the Filter Coefficients are set to the proper values for the test motor.

If connected to a linear motor, center the motor and zero the position.





Clear any faults and Enable the amp.
Click the *Move Pos 1* button on the *Actions* Tab of the *MS Summary* Window and verify that the motor moves to *Position 1*.

Click the *Move Pos 2* button and verity that the motor moves to *Position 2*.

Check the Repeat Mode checkbox, click the Move Pos 1 button and verify that the motor cycles be-tween Position 1 and Position 2.

SMC99XX Service Channel

Node Information Parameters

These parameters contain read-only node information. The user application will have access to read.

Use Direct Command 0x19 to get/set parameter index and Direct Command 0x1A to get parameter.

Data Type specified in table:
U15: Unsigned, 15 bit integer. Valid data range is 0 to 32767 unless otherwise specified
U16: Unsigned 16 bit integer, valid data range 0 to 65535 unless otherwise specified
I16: Singed 16 bit integer
U32: Unsigned 32 bit integer
B16: Bit-mapped 16 bit register

Index	Name	Type	Comments
Mode Information			
160	Base Model Number	U16	
161	Power Board Tab	U16	
162	Pre-Amp Tab	U16	
163	Continuous Current Rating	U15	See Parameter 166 for engineering conversion
164	Peak Current Rating	U15	See Parameter 166 for engineering conversion
165	Bus Over-Voltage Threshold	U15	See parameter 169 for engineering conversion
166	Current ADC full scale Value (units of 0.01 Amps)	U16	Conversion factor for all Current parameters, 32767 =Full Scale Current, e.g. a value of 5000 corresponds to 32767 = 50.00 Amps
167	Bus Under-Voltage Threshold	U15	See parameter 169 for engineering conversion
168	Factory I/O Invert Mask	B16	This register is masked and OR'd with the User I/O Invert Mask to create an inversion register of the PIO port bits. The DSP Masks the appropriate bits from each register before OR-ing Bits in Use: Bit 3: Node Alarm Bit 9: Amp Fault Output Bit 10: Amp Temp fault.
169	Bus ADC Full Scale Value (units: DC Volts)	U16	Conversion Factor for Bus OV/UV settings, 32767=Bus Full Scale Value
170-174	Spare		

Index	Name	Type	Comments
Factory Calibration			
175	R (U) Phase ADC Offset	I16	See parameter 169 for engineering conversion
176	S (V) Phase ADC Offset	I16	See parameter 169 for engineering conversion
177	T (W) Phase ADC Offset	I16	See parameter 169 for engineering conversion
178-189	Spare		
Firmware Information			
190	Command Set	U16	Used by MotionMaestro program to identify drive type and available commands.
191	Version number	C32	4 ASCII chars, XX.XX
192	Version Day/Month	C32	4 ASCII chars, DDMM
193	Version Year	C32	4 ASCII chars, YYYY
194-199	Spare		

Node Configuration Parameters

These parameters contain read-write node data which user applications will have access to read and modify.

Use Direct Command 0x19 to get/set parameter index and Direct Command 0x1A to get/set parameter.

Data Type specified in table:
U15: Unsigned 15 bit integer. Valid data range is 0 to 32767 unless otherwise specified
U16: Unsigned 16 bit integer, valid data range 0 to 65535 unless otherwise specified
I16: Singed 16 bit integer
U32: Unsigned 32 bit integer
B16: Bit-mapped 16 bit register
C32: 32bit character string containing 4 ASCII characters

Index	Name	Type	Comments
Motor Information			
0	Inductance, phase to phase	U16	Units of 0.01 mH
1	Resistance, phase to phase	U16	Units of 0.01 Ohm
2	Encoder type	U15	0=Rotary Incremental 1=Linear Incremental
3	Motor Poles (rotary) Pole-Pitch (linear)	U16	Rotary: even numbers only Linear: pole-pitch units of 0.01 mm
4	Encoder line count (rotary) Encoder edge resolution (linear)	U16	Rotary: Lines/rev, not edges/rev Linear: A to B edge resolution units of 0.01um
5-9	Spare		

Index	Name	Type	Comments		
System Information					
10	DC Bus Voltage	U16	Units of Volts		
11-14	Spare				
Communication Settings					
15	Address (RS-485)	U16			
16-19	Spare				
Digital flags					
20	Option Register	B16	Bit	Name	State
			0	RS232 Echo	1: Echo On 0: Echo Off
			1	Trap Mode	1: Trap commutation 0: Sine commutation
			2	Velocity Method	1: traditional 0: 1/T
			3	Velocity Reverse	1: Negate velocity 0: Do not negate
			4	Encoder Reverse	1: Negate Encoder 0: Do not negate
			5	Hall Type	1: Special Halls (e.g. reduced wire encoders) 0: Standard Halls
			6, 7	Reserved	
			8	Interpolator Encoder Fault Disable (Interpolator models only)	1: Disable Encoder broken wire fault 0: Enable Encoder fault
			9-15	Spare	
21	User Digital Input Invert Mask	B16	Bit	Name	State
			0	Limit+	1: Input Invert 0: Do Not Invert
			1, 2	Spare	
			3	Limit-	1: Input Invert 0: Do Not Invert
			4	Home	1: Input Invert 0: Do Not Invert
			5	Spare	
			6	Motor Over Temp	1: Input Invert 0: Do Not Invert
			7-15	Spare	
22	User Digital Input Enable Mask	B16	Set parameter #21 for bit definitions. 1: Enable digital input 0: Disable (ignore) digital input		
23-24	Spare				

Index	Name	Type	Comments
Current Functions			
25	Peak Current Limit	U15	See Parameter 166 for engineering conversion. Valid range 0 to Peak Current Rating (see parameter 164)
26	Low Speed ECB Threshold	U15	See Parameter 166 for engineering conversion. Valid range 0 to Continuous Current Rating (see parameter 163)
27	Low Speed ECB Time	U15	Units of 0.01 seconds
28	Fold-back Threshold	U15	See Parameter 166 for engineering conversion
29	Fold-back Time constant	U15	Complicated conversion: TBD
30-34	Spare		
Trajectory Generation (Currently Unused by SynqNet Drive)			
35	Accel Limit	I16	negative values disable accel limit
36	Decel Limit	I16	negative values disable decel limit
37-39	Spare		
Commutation Settings			
40	Encoder Edges/Cycle Numerator	U32	Numerator of encoder edges/electric cycle reduced to smallest integer
41	Encoder Edges/Cycle Denominator	U15	Denominator of encoder edges/electric cycle reduced to smallest integer
42	Encoder Scale	U32	2^32/Edges/Cycle(Numerator), Used to normalize Edges/Cycle (Num) to 2^32
43	Hall Offset Angle	I16	Normalized to -180 to +180 degrees
44	Commutation Lead Angle	I16	Normalized to -180 to +180 degrees
45	Commutation Lead Gain	I16	Proportional to degrees/RPM, conversion TBD
46	Commutation Angle	I16	Normalized to –180 to +180 degrees
47-49	Spare		
Commutation Initialisation Options			
50	Initialisation Method	U15	1: Phase Search (Twang) 2: Phase Search (Dither) 3: Hall/Comm Tracks
51	Phase Search Current Limit	U15	See Parameter 166 for engineering conversion
52	Current Slew Rate	U15	Proportional to Amps/S conversion: TBD
53	Phase Vector Rotation Rate	I16	Units of electric degrees/second
54	Limit Switch Recovery Distance	I16	Distance to move away from a tripped limit switch before re-attempting phase search. Units of electric degrees.
55	Commutation Init Angle	I16	Normalized to –180 to +180 degrees Twang commutation start angle, 2nd angle is 0 degrees
56-59	Spare		
Commutation Correction Options			
60	Correction Method	U15	0: No correction 1: Phase Lock to Hall/Comm Track edges 2: Phase Lock to encoder index, Auto detect Index offset 3: Phase Lock to encoder Index, Manually set Index offset
61	Index Offset	I16	Normalized to –180 to +180 degrees
62-64	Spare		
Commutation Timing – Reduce Wire Encoders (Sanyo or Tamagawa)/ Hall Fault timeout Note: Hall implies either Hall sensors or Commutation Tracks			
65	RW Encoder Hall-Latch to Encoder Valid time Std Encoder, Halls:Fault Timeout	U15	RW: Power applied to High-Z timeout Units = PWM cycles (typical 24KHz PWM freq) Standard Halls: Units = 100uS

Index	Name	Type	Comments
66	RW Encoder End High-Z to Hall Latch time Standard Encoder/Halls: Max Commutation angle correction/ Hall or index edge (See param #60 for correction routine)	U15	Time from High-Z deactivated to Latching Hall state. Units = PWM cycles (typical 24KHz PWM freq) Conversion: 32767 = 180 degrees Factory default = 910 (5 degrees)
67	RW Encoder Hall-Latch to Encoder Valid Time Standard Encoder/Halls: Commutation angle error limit	U15	Delay time between Latching Hall data and reading encoder data.. Units = PWM cycles (typical 24KHz PWM freq) A fault will occur if the commutation angle calculated from the incremental encoder disagrees with the absolute commutation angle measured by the Halls or Index (depends on param #60) Conversion: 32767=180 degrees. Factory default = 5461 (30 degrees). Note: some error will always exist due to hysteresis of Hall devices and alignment accuracy. This limit is bypassed for the first eight edge corrections following a commutation reset (power on reset or fault reset)
68-69	Spare		
Current Loop Tuning			
70	Loop Gain	U15	0 to 32767 = 0 to 1.0
71	Proportional Gain	U15	0 to 32767 = 0 to 1.0
72	Integral Gain	U15	0 to 32767 = 0 to 1.0
73	Master Gain	U15	Integer P&I gain multiplier
74	Small Error Threshold	U15	See Parameter 166 for engineering conversion. Usually set to 0. Noise reduction method. The P-gain is reduced to the small error gain if the current error is below this threshold
75	Small Error P-Gain	U15	0 to 32767 = 0 to 1.0 Used in conjunction with Small Error Threshold
76-79	Spare		
Velocity Loop Tuning			
80	Proportional Gain	U15	0 to 32767 = 0 to 1.0
81	Integral Gain	U15	0 to 32767 = 0 to 1.0
82	Derivative Gain	U15	0 to 32767 = 0 to 1.0
83	Master Gain (Comp)	U15	Integer Multiplier, valid range: 0 to 256
84-89	Spare		
Velocity Measurement Gains			
90	Encoder Pre-scale	U15	Encoder delta count bit shift, valid range 0 to14
91	Velocity Gain	U15	0 to 32767 = 0 to 1.0
92-94	Spare		
Velocity Functions (Velocity conversions to Engineering Units: TBD			
95	Velocity Command Limit	U15	If in Velocity mode, the velocity command is limited to this value.
96-104	Spare		

Index	Name	Type	Comments
Biquad Filter Coefficients All biquad filters implement the following differential equation: y(n)=[a2*y(n-2)+a1*y(n-1)+b2*x(n-2)+b1*x(n-1)+b0*x(n)]*2^scale where y(n), y(n-1), y(n-2) is the present and past filter outputs x(n), x(n-1), x(n-2) is the present and past filter inputs The following values can be used to set the filters to No filtering: B0=32677, A2=A1=B2=B1=Scale=0			
Forward Path Filter 1 (default factory setting: No filtering)			
105	A2	I16	-32768 to 32767 = -1.0 to +1.0
106	A1	I16	-32768 to 32767 = -1.0 to +1.0
107	B2	I16	-32768 to 32767 = -1.0 to +1.0
108	B1	I16	-32768 to 32767 = -1.0 to +1.0
109	B0	I16	-32768 to 32767 = -1.0 to +1.0
110	Scale	I16	Bit shift used to scale coefficients to within +/- 1.0 range. Coefficients should be scaled by 2^-scale before storing.
Forward Path Filter 2 (default factory setting: No filtering)			
111	A2	I16	-32768 to 32767 = -1.0 to +1.0
112	A1	I16	-32768 to 32767 = -1.0 to +1.0
113	B2	I16	-32768 to 32767 = -1.0 to +1.0
114	B1	I16	-32768 to 32767 = -1.0 to +1.0
115	B0	I16	-32768 to 32767 = -1.0 to +1.0
116	Scale	I16	Bit shift used to scale coefficients to within +/- 1.0 range. Coefficients should be scaled by 2^-scale before storing.
Velocity Feedback Filter 1 (default factory setting for velocity mode = 320 Hz First order Low Pass)			
117	A2	I16	-32768 to 32767 = -1.0 to +1.0
118	A1	I16	-32768 to 32767 = -1.0 to +1.0
119	B2	I16	-32768 to 32767 = -1.0 to +1.0
120	B1	I16	-32768 to 32767 = -1.0 to +1.0
121	B0	I16	-32768 to 32767 = -1.0 to +1.0
122	Scale	I16	Bit shift used to scale coefficients to within +/- 1.0 range. Coefficients should be scaled by 2^-scale before storing.
Velocity feedback Filter 2 (default factory setting, 160Hz first order, high pass filter, used for D-gain)			
123	A2	I16	-32768 to 32767 = -1.0 to +1.0
124	A1	I16	-32768 to 32767 = -1.0 to +1.0
125	B2	I16	-32768 to 32767 = -1.0 to +1.0
126	B1	I16	-32768 to 32767 = -1.0 to +1.0
127	B0	I16	-32768 to 32767 = -1.0 to +1.0
128	Scale	I16	Bit shift used to scale coefficients to within +/- 1.0 range. Coefficients should be scaled by 2^-scale before storing.
129	Spare		
Variable Frequency Drive (Future product)			
130	Volts/Hz trajectory Gain	U15	
131	Start Voltage	U15	
132-134	Spare		

Index	Name	Type	Comments
Analog Input, currently unused by SynqNet Drive			
135	Input 1 Deadband	I16	
136	Input 1 Offset	I16	
137	Input 1 Gain	I16	
138	Input 2 Deadband	I16	
139	Input 2 Offset	I16	
140	Input 2 Gain	I16	
141-144	Spare		
Analog Output			
145	Analog Out Parameter Select	U15	0: Test Voltage (see param #148) 1: Measured Current 2: Measured Velocity 3: Commanded Velocity 4: Commanded Current 5: Primary Command (sum of all sources) 6: Phase R Commanded Current 7: Phase S Commanded Current 8: Phase T Commanded Current 9: Phase R Measured Current 10: Phase S Measured Current 11: Phase T Measured Current 12: Phase R Commanded Voltage 13: Phase S Commanded Voltage 14: Phase T Commanded Voltage 15 Aux Command (sum of all sources) 16 Measured Bus Voltage 17 Commutation Angle 18 Current Limit
146	Analog Out Offset	I16	
147	Analog Out Gain	I16	
148	Analog Out Test Voltage	I16	
149	Spare		
Future Additions			
150-159	Spare		

Parameter Save

Prompts the drive to save its parameters to non-volatile memory.
Example:
C:\MEI\XMP\BIN\WINNT>sqDriveParam -store
(or Direct command 0x1C per page 34)

Note: This command can be issued at any time.

Parameter Restore

Prompts the drive to restore its parameters to the factory defaults.
Example:
C:\MEI\XMP\BIN\WINNT>sqDriveParam -restore
(or Direct command 0x1D per page 34)

Note: This command can only be issued when Drive is disabled.

Example using “sqDriveParam” (parameter) command

```
C:\WINDOWS\System32\cmd.exe

C:\MEI\XMP\BIN\WINNT>sqDriveParam  -?
The sqDriveParam utility reads or writes a drive parameter.

sqDriveParam   [-control #] [-server #] [-port #] [-trace #] [-node #]
               [-drive #] [-motor #] [-read #] [-write #] [-action #]
               [-data #] [-type #] [-store] [-restore] [-clear]
               [-reload] [-calculate]

  -control      Controller number (default = 0).
  -server       Name of the host running server.exe.
  -port         TCP/IP port on the host computer.
  -trace        Bit mask to specify trace information outputs.
  -node         SynqNet Node address.
  -drive        Drive index relative to the node.
  -motor        Motor number associated with the drive.
  -read         Read a drive parameter.
  -write        Write to a drive parameter.
  -action       Perform the action to a drive parameter.
  -data         Data that is written to the drive parameter
  -type         The drive parameters data type. default=signed32.
  -store        Loads the current parameters into the stored parameters.
  -restore      Loads the default parameters into the current parameters.
  -clear        Load the default parameters into runtime and stored tables.
  -reload       Loads the default parameters into the current parameters.
  -calculate    The Drive calculates internal data using drive parameters now in
RAM.

C:\MEI\XMP\BIN\WINNT>sqDriveParam  -read 4 -type hex

Reading drive parameter 4 of drive 0 on node 0.

Data read is 0x200.

C:\MEI\XMP\BIN\WINNT>sqDriveParam  -write 4 -data 0x400 -type hex

Writing 0x400 to drive parameter 4 of drive 0 on node 0.

Write successful.

C:\MEI\XMP\BIN\WINNT>sqDriveParam  -store

Store the drive parameters of drive 0 on node 0.

Store successful.

C:\MEI\XMP\BIN\WINNT>_
```

Note: This example demonstrates how to read existing encoder resolution and write a new encoder resolution.

1. “-read 4”: retrieve encoder resolution setting (refer to page 27)
2. “0x200”: hex decimal number for 512 (dec.)
3. “-write 4”: change encoder resolution setting
4. “0x400”: hex decimal number for 1024 (dec.)
5. “-store”: store new parameter

Direct Commands

The direct commands supported by this drive are summarized in the following table:

Command Code	Definition	Read Write	Pipelining applicable?	Description
0x00	NOP	-	N	Null command
0x01	Get_Synq_Period / Set_Synq_Period	**R/W**	N	in units of 40ns
0x02	Get_Drive_Update_Period / Set_Drive_Update_Period	**R/W**	N	in units of 40ns
0x08	Fault_Read	**R**	N	Reads code of the existing Fault(s)
0x09	Fault_Clear	**W**	N	Clears all existing Faults
0x09	Fault_Count	**R**	N	Returns how many Faults now exist
0x0A	Warning_Read	**R**	N	Reads code of the existing Warning(s)
0x0B	Warning _Clear	**W**	N	Clears all existing Warnings
0x0B	Warning_Count	**R**	N	Returns how many Warning now exist
0x0F	Get_Monitor_A_Table / Set_Monitor_A_Table	**R/W**	N	Using the data passed, Pointer_A is set to one of the tabulated values in **Error! Reference source not found.**.
0x10	Get_Monitor_A_Memory/ Set_Monitor_A_Memory	**R/W**	N	Using the data passed, Pointer_A is set to point to a memory location in the data memory space
0x11	Get_Monitor_B_Table / Set_Monitor_B_Table	**R/W**	N	Using the data passed, Pointer_B is set to one of the tabulated values in **Error! Reference source not found.**.
0x12	Get_Monitor_B_Memory/ Set_Monitor_B_Memory	**R/W**	N	Using the data passed, Pointer_B is set to point to a memory location in the data memory space
0x13	Get_Monitor_C_Table / Set_Monitor_C_Table	**R/W**	N	Using the data passed, Pointer_C is set to one of the tabulated values in **Error! Reference source not found.**.
0x14	Get_Monitor_C_Memory/ Set_Monitor_C_Memory	**R/W**	N	Using the data passed, Pointer_C is set to point to a memory location in the data memory space
0x19	Get_Parameter_Index[1]/ Set_Parameter_Index	**R/W**	N	Returns/Sets-up the parameter pointer to point to the motor's N^{th} parameter
0x1A	Get_Parameter/ Set_Parameter	**R/W**	N	Access the value of the parameter pointed to by the parameter pointer
0x1C	Store_Parameters	**W**	N	Copies the motor's parameter table from the Drive Processor's RAM to its local EEPROM[2] or other local non-volatile memory
0x1D	Restore_Factory_Defaults	**W**	N	Loads the motor's parameter table in the Drive Processor's RAM with a set of factory default parameters
0x1E	Reload_Parameters	**W**	N	Copies the motor's parameter table in the drive Processor's local EEPROM to the Drive Processor's RAM
0x20	Config_From_Parameters	**W**	N	Causes the Drive Processor to re-compute the set of internal variables that are derived from the motor's parameter list that is now in RAM.

[1] The parameter functions provide a general way of accessing drive quantities that are not otherwise accessible by direct commands, for example gains.

[2] A local serial EEPROM attached to the Drive Processor is typical but the exact implementation of this will vary. Note that this Parameter EEPROM is distinct from the Identification EEPROM.

Service Command Error Codes

When a service command fails the following error codes will be returned:

Error Code	Cause
4	Invalid Argument
15	The amplifier is enabled but command can only be executed when the amplifier is disabled
16	The amplifier is disabled but command can only be executed when the amplifier is enabled
17	Attempt to write to a read-only parameter

Monitor Tables

This section contains all entries in the node monitor table. This table is exposed to the Motion-application programming interface (MPI). (Direct commands (Monitor_X_Table) 0x0F, 0x011, 0x013 per page 34)

Notes:

[1]Interpolator option Only.
[2]Interpolator mode must be setup & cal to monitor these channels. Sine and Cosine data are after user set gain and offsets.

Monitor_X	Data (16-bit)
0	R phase current
1	S phase current
2	T phase current
3	reserved
4	R demand voltage
5	S demand voltage
6	T demand voltage
7	Measured Bus voltage
8	reserved
9	reserved
10	measured current, 3 phase rectified =max(abs(Ir), abs(Is), abs(It))
11	measured velocity
12	reserved
13	reserved
14	motor shaft position (bits 15..0)
15	motor shaft position (bits 32..16)
16	Demand A loopback
17	Demand B loopback
18	Interpolator/DBN Status[1]
19	Interpolator Sine[1,2]
20	Interpolator Cosine[1,2]

Faults

This section lists all alarm code/bit definitions and corresponding ACSII test messages. This section also specifies the node specific retrieval algorithm:

Retrieval Information

Fault Read: (Direct Command 0x08 per page 34)
Returns a 16-bit fault.
Note: see page 37 for example

Fault Clear: (Direct command 0x09 per page 34)
Will clear all but NVRAM and CPLD faults which require a Hardware reset (i.e. a power cycle). Bus Under Voltage is now a warning.

Fault Count: (Direct command 0x09 per page 34)
Always reads as “1”; all Faults are bit-mapped into one composite Fault word.

Definitions

Alarm Bit	Message
15	High Speed Electronic Circuit Breaker (HS/ECB) – Short circuit
14	Low Speed Electronic Circuit Breaker (LS/ECB) – RMS Over Current
13	Bus Over volt
12	Amp Over temp
11	Primary encoder fault
10	Motor Over Speed
6	Motor Over Temp
5	Invalid Hall State
4	NVRAM Checksum Fault
2	CPLD Fault
1	Phase-Finding (or Commutation Initialization) failed
9,8,7,3,0	Reserved

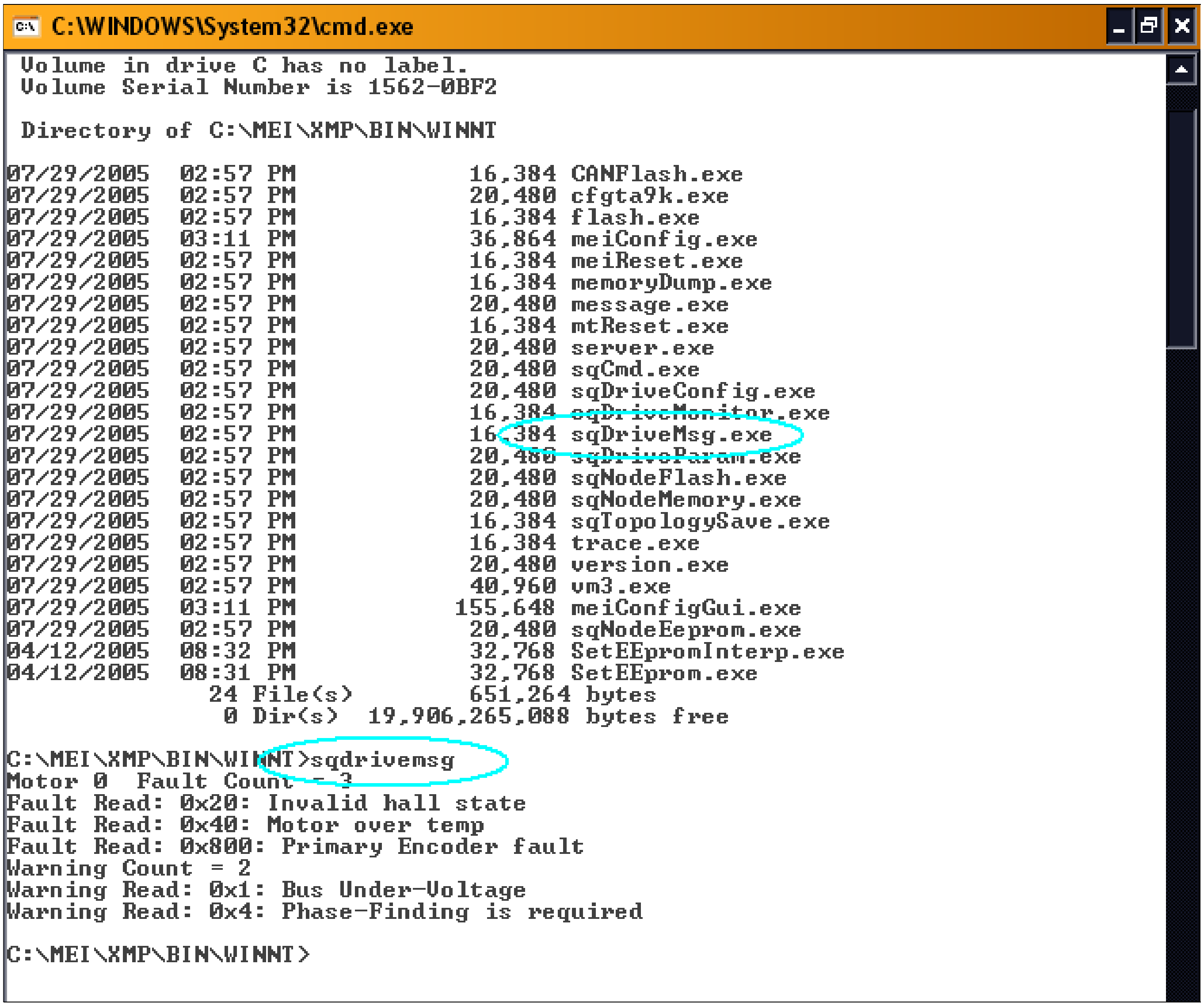
Reading Amp Fault Data by Using Direct Command

```
C:\WINDOWS\System32\cmd.exe

sqcmd   [-control #] [-server #] [-port #] [-trace #] [-addr #] [-channel #]
        [-data #] [-memory #] [-node #] [-quiet] [-read]
        [-size #] [-write]

  -control     Controller number (default = 0).
  -server      Name of the host running server.exe.
  -port        TCP/IP port on the host computer.
  -trace       Bit mask to specify trace information outputs.
  -addr        Address (or command) that is sent down to the node/drive.
  -channel     The Service channel 0, 1, 2 = drives, 0xFE=FPGA (default = 0xFE)
  -data        Data that is sent down to the FPGA/drive (default = 0).
  -memory      Memory Space. 0=Data(default), 1=Program, 2=IO, 3=Direct Command
  -node        Address of the node (default 0).
  -quiet       Stops descriptive messages from being generated.
  -read        Specifies a service channel read
  -size        The data size.  Either 8, 16, 24 or 32(default) bits.
  -write       Specifies a service channel write.

C:\MEI\XMP\BIN\WINNT>sqcmd -channel 0 -memory 3 -addr 0x08 -read

Reading direct command 0x00000008 of drive 0 on node 0.

Data read is 0x00000860.

C:\MEI\XMP\BIN\WINNT>_
```

Note: This example demonstrates how to read amp faults .

1. “0x08”: Fault Read (per page 34)
2. “0x00000860”: hex decimal number for 100001100000 (bin.)
3. Bit 5 (100001**1**00000): Invalid Hall State (per page 36)
4. Bit 6 (10000**1**100000): Motor Over Temp (per page 36)
5. Bit 11 (**1**00001100000): Primary Encoder Fault (per page 36)

Reading Amp Fault Data by Using “sqDriveMsg” Command



```
C:\WINDOWS\System32\cmd.exe

 Volume in drive C has no label.
 Volume Serial Number is 1562-0BF2

 Directory of C:\MEI\XMP\BIN\WINNT

07/29/2005  02:57 PM            16,384 CANFlash.exe
07/29/2005  02:57 PM            20,480 cfgta9k.exe
07/29/2005  02:57 PM            16,384 flash.exe
07/29/2005  03:11 PM            36,864 meiConfig.exe
07/29/2005  02:57 PM            16,384 meiReset.exe
07/29/2005  02:57 PM            16,384 memoryDump.exe
07/29/2005  02:57 PM            20,480 message.exe
07/29/2005  02:57 PM            16,384 mtReset.exe
07/29/2005  02:57 PM            20,480 server.exe
07/29/2005  02:57 PM            20,480 sqCmd.exe
07/29/2005  02:57 PM            20,480 sqDriveConfig.exe
07/29/2005  02:57 PM            16,384 sqDriveMonitor.exe
07/29/2005  02:57 PM            16,384 sqDriveMsg.exe
07/29/2005  02:57 PM            20,480 sqDriveParam.exe
07/29/2005  02:57 PM            20,480 sqNodeFlash.exe
07/29/2005  02:57 PM            20,480 sqNodeMemory.exe
07/29/2005  02:57 PM            16,384 sqTopologySave.exe
07/29/2005  02:57 PM            16,384 trace.exe
07/29/2005  02:57 PM            20,480 version.exe
07/29/2005  02:57 PM            40,960 vm3.exe
07/29/2005  03:11 PM           155,648 meiConfigGui.exe
07/29/2005  02:57 PM            20,480 sqNodeEeprom.exe
04/12/2005  08:32 PM            32,768 SetEEpromInterp.exe
04/12/2005  08:31 PM            32,768 SetEEprom.exe
              24 File(s)        651,264 bytes
               0 Dir(s)  19,906,265,088 bytes free

C:\MEI\XMP\BIN\WINNT>sqdrivemsg
Motor 0   Fault Count = 3
Fault Read: 0x20: Invalid hall state
Fault Read: 0x40: Motor over temp
Fault Read: 0x800: Primary Encoder fault
Warning Count = 2
Warning Read: 0x1: Bus Under-Voltage
Warning Read: 0x4: Phase-Finding is required

C:\MEI\XMP\BIN\WINNT>
```

Warnings

This section lists all warning code/bit definitions and corresponding ACSII test messages. This section also specifies the node specific retrieval algorithm:

Retrieval Information

Warning Read: (Direct Command 0x0A per page 34)
Returns a 16 bit warning word.

Warning Clear: (Direct Command 0x0B per page 34)
Warnings (and the warning flag) are latching; the warning code is held in a register until cleared.

Warning Count: (Direct Command 0x0B per page 34)
Always reads as “1”; all Warnings are bit-mapped into one composite warning word.

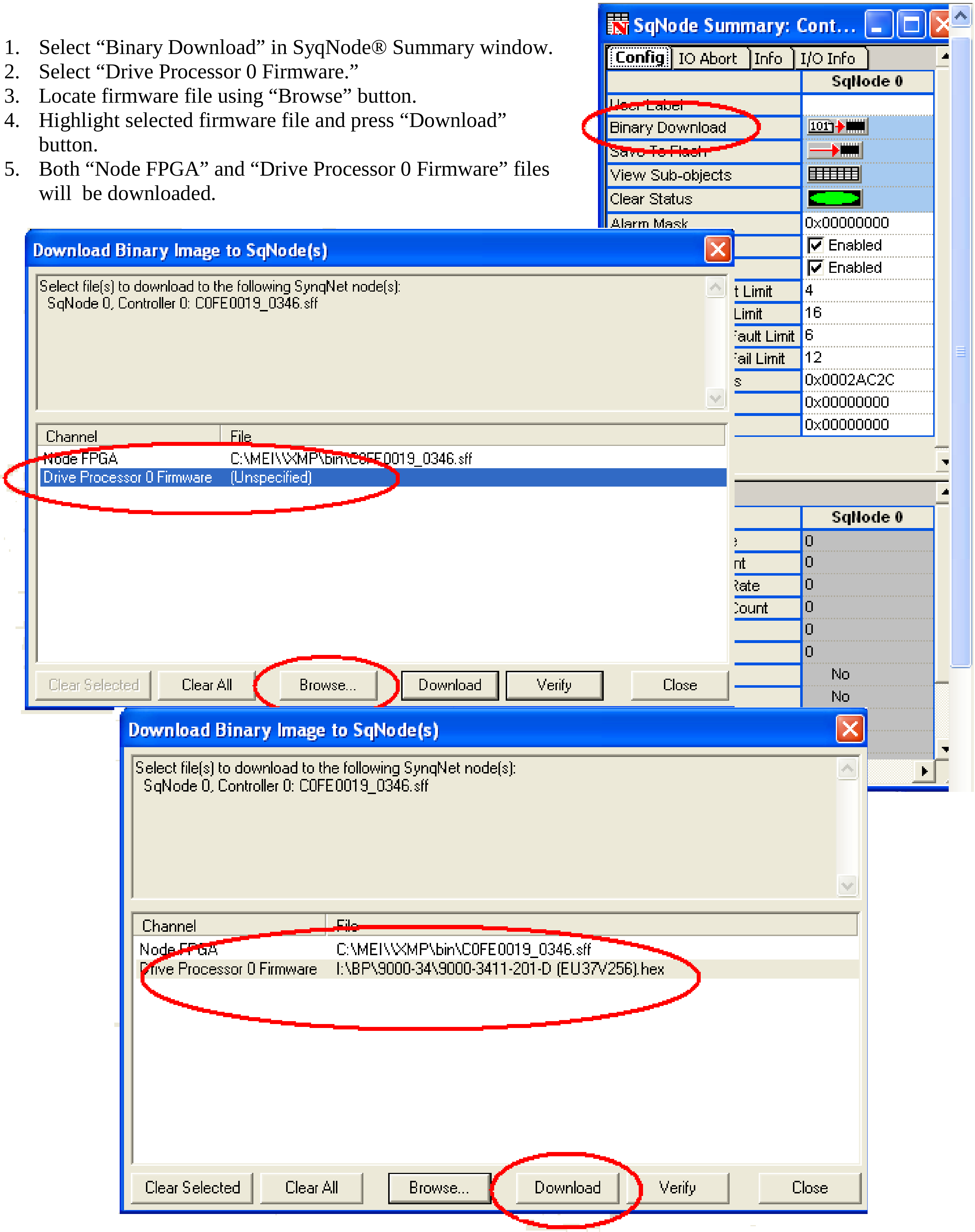
Definitions

Warning Bit	Message
15	Motor Over Speed
11	Balancing current loops
10	Current Foldback Active
2	Phase-Finding required
0	Bus Under-Voltage
1,3-9,12-14	Reserved

Note: Balancing is normally carried out once at the factory.

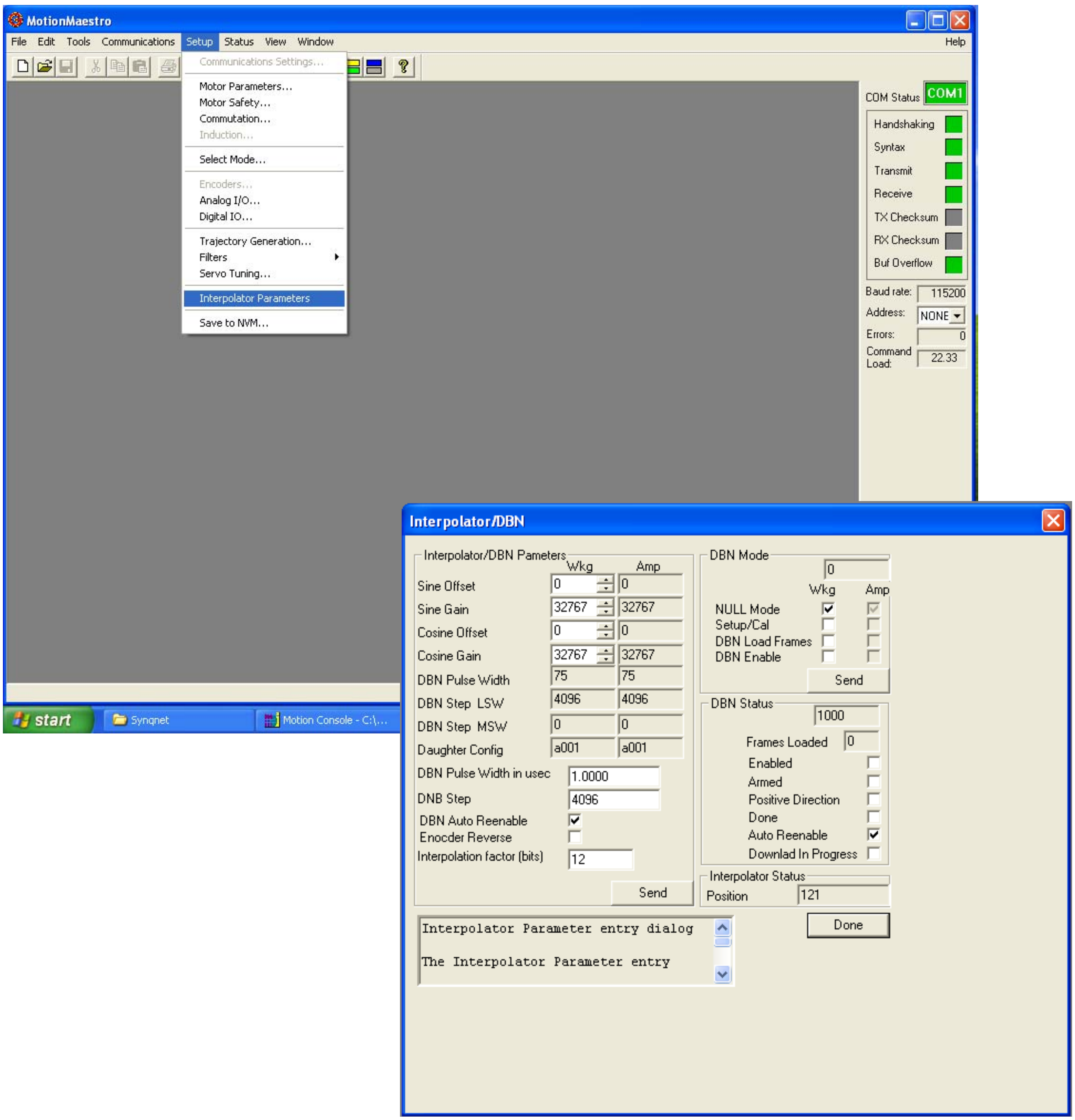
Firmware Flash Download with Using Motion Console (MoCon)

1. Select “Binary Download” in SyqNode® Summary window.
2. Select “Drive Processor 0 Firmware.”
3. Locate firmware file using “Browse” button.
4. Highlight selected firmware file and press “Download” button.
5. Both “Node FPGA” and “Drive Processor 0 Firmware” files will be downloaded.



SynqNet® with Sine Interpolator and DBN

SMC99XX-10X-001-000*

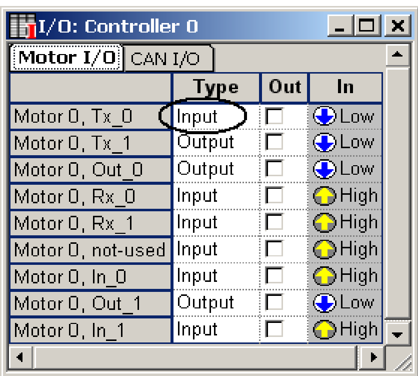


*** See page 79 for model numbering**

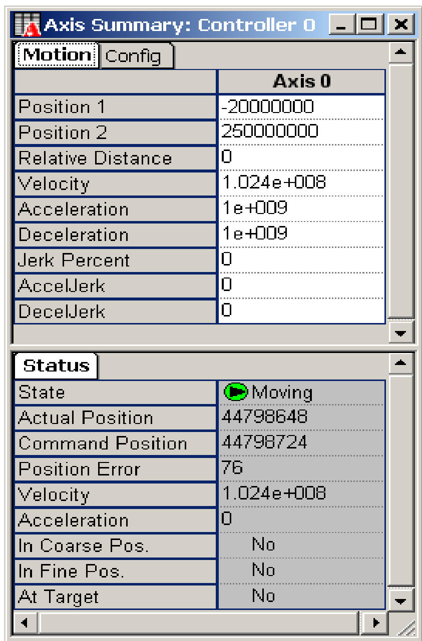
Setup example for SMC99XX SynqNet® w/Interpolator & DBN option

Note: This example uses Glentek's GMB3515 motor and a512 line sine/cosine encoder

1. Set Tx_0 to an input. This I/O is driven by the interpolator DBN output a nd must be configured as an input in the Node logic to prevent driver contention
2. Set "Encoder Type" to "Drive" to read the interpolated date from the drive
3. Set "Position1", "Position2", "Velocity", "Accel", and "Decel" as show on "Axis-Summary"
4. Start with very low filter coefficients due to the high encoder resolution. The filter coefficients show in the "Filter Summary" window are for a Glentek's GMB3515 motor with a 512 line encoder and *4096 interpolation.
5. Set "Following Error Limit" to at least 10000 (2.5 encoder lines @ *4096 interpolation)

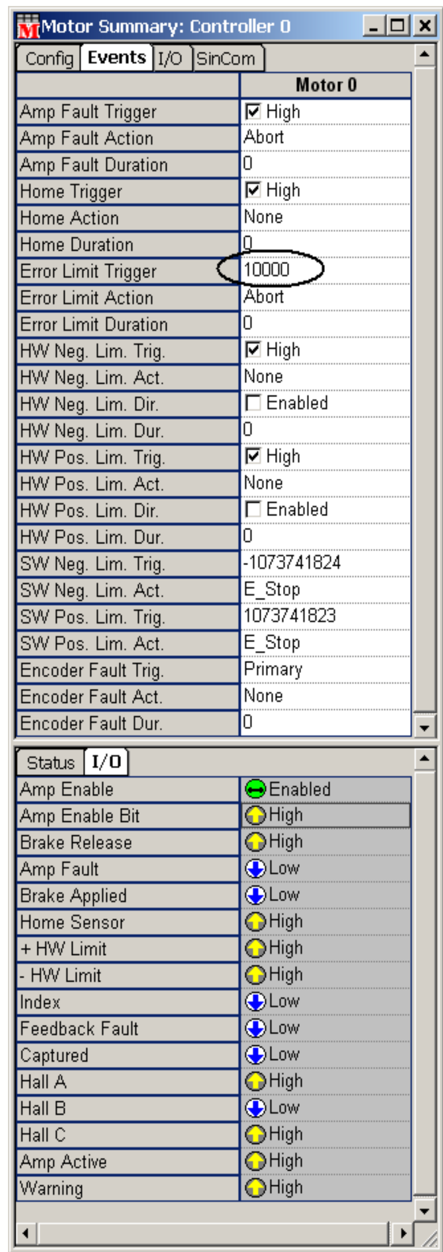

I/O: Controller 0 — Motor I/O | CAN I/O

	Type	Out	In
Motor 0, Tx_0	Input	☐	Low
Motor 0, Tx_1	Output	☐	Low
Motor 0, Out_0	Output	☐	Low
Motor 0, Rx_0	Input	☐	High
Motor 0, Rx_1	Input	☐	High
Motor 0, not-used	Input	☐	High
Motor 0, In_0	Input	☐	High
Motor 0, Out_1	Output	☐	Low
Motor 0, In_1	Input	☐	High


Axis Summary: Controller 0 — Motion | Config

	Axis 0
Position 1	-20000000
Position 2	250000000
Relative Distance	0
Velocity	1.024e+008
Acceleration	1e+009
Deceleration	1e+009
Jerk Percent	0
AccelJerk	0
DecelJerk	0

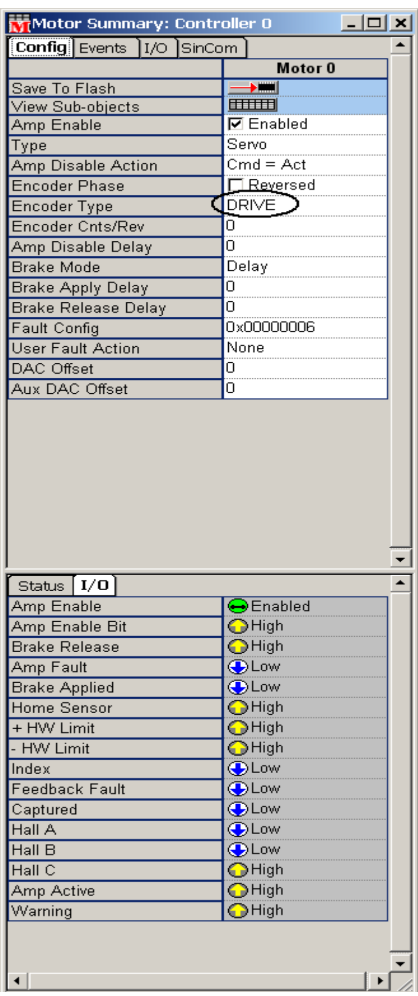
Status	
State	Moving
Actual Position	44798648
Command Position	44798724
Position Error	76
Velocity	1.024e+008
Acceleration	0
In Coarse Pos.	No
In Fine Pos.	No
At Target	No


Motor Summary: Controller 0 — Config | Events | I/O | SinCom

	Motor 0
Amp Fault Trigger	☑ High
Amp Fault Action	Abort
Amp Fault Duration	0
Home Trigger	☑ High
Home Action	None
Home Duration	0
Error Limit Trigger	10000
Error Limit Action	Abort
Error Limit Duration	0
HW Neg. Lim. Trig.	☑ High
HW Neg. Lim. Act.	None
HW Neg. Lim. Dir.	☐ Enabled
HW Neg. Lim. Dur.	0
HW Pos. Lim. Trig.	☑ High
HW Pos. Lim. Act.	None
HW Pos. Lim. Dir.	☐ Enabled
HW Pos. Lim. Dur.	0
SW Neg. Lim. Trig.	-1073741824
SW Neg. Lim. Act.	E_Stop
SW Pos. Lim. Trig.	1073741823
SW Pos. Lim. Act.	E_Stop
Encoder Fault Trig.	Primary
Encoder Fault Act.	None
Encoder Fault Dur.	0

Status | I/O

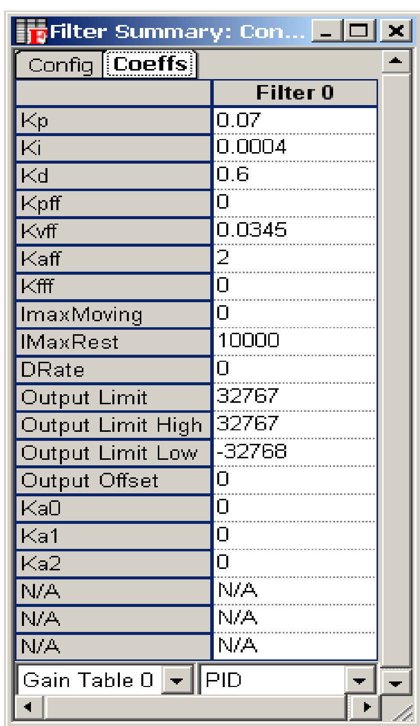
Amp Enable	Enabled
Amp Enable Bit	High
Brake Release	High
Amp Fault	Low
Brake Applied	Low
Home Sensor	High
+ HW Limit	High
- HW Limit	High
Index	Low
Feedback Fault	Low
Captured	Low
Hall A	High
Hall B	Low
Hall C	High
Amp Active	High
Warning	High


Motor Summary: Controller 0 — Config | Events | I/O | SinCom

	Motor 0
Save To Flash	
View Sub-objects	
Amp Enable	☑ Enabled
Type	Servo
Amp Disable Action	Cmd = Act
Encoder Phase	☐ Reversed
Encoder Type	DRIVE
Encoder Cnts/Rev	0
Amp Disable Delay	0
Brake Mode	Delay
Brake Apply Delay	0
Brake Release Delay	0
Fault Config	0x00000006
User Fault Action	None
DAC Offset	0
Aux DAC Offset	0

Status | I/O

Amp Enable	Enabled
Amp Enable Bit	High
Brake Release	High
Amp Fault	Low
Brake Applied	Low
Home Sensor	High
+ HW Limit	High
- HW Limit	High
Index	Low
Feedback Fault	Low
Captured	Low
Hall A	Low
Hall B	Low
Hall C	High
Amp Active	High
Warning	High


Filter Summary: Con... — Config | Coeffs

	Filter 0
Kp	0.07
Ki	0.0004
Kd	0.6
Kpff	0
Kvff	0.0345
Kaff	2
Kfff	0
ImaxMoving	0
IMaxRest	10000
DRate	0
Output Limit	32767
Output Limit High	32767
Output Limit Low	-32768
Output Offset	0
Ka0	0
Ka1	0
Ka2	0
N/A	N/A
N/A	N/A
N/A	N/A

Gain Table 0 | PID

Glentek SMC99XX SynqNet Interpolator/DBN Configuration

Revision 13Apr05

Important Setup Information

Beginning with firmware v3.14 13Apr04, TX0 may be configured as an input at the DBN processor to allow it to be controlled by the Node. See Interpolator/DBN_Config parameter #206, bit 1

Tx_0 and Tx_1(fw 5/17/2004) of the associated motor block connected to the Sine Interpolator and DBN **must be set to inputs.** The Interpolator/DBN daughter board drives these outputs and failure to configure them as inputs will result in unknown signal levels and may cause damage to the Node FPGA and/or Interpolator processor.

The DBN output is on Tx_0

Tx_1 was reserved by the DBN in firmware 9000-3411-001-B 05/17/2004, but is available to use through node control on firmware 9000-3411-001-C 06/10/2004.

The associated motor block must be setup to **select the Drive as the source for the primary encoder**

For proper function of the DBN, the interpolator position (global position) must not overflow or underflow the 32 bit boundaries (+/- 2^31).

The Interpolator sample interval is 2.0 us and the delay from sampling the signals to the DBN output is 1.4us. Therefore the DBN output will be delayed between 1.4us and 3.4us or 2.4us +/-1.0us. To achieve a more accurate DBN position, the trigger position should be set to occur 2.4us early.

The amplifier does not use the full interpolated position for commutation, it only uses the *4 quadrature position. Therefore, during commutation setup, specify the encoder line count for a rotary motor or the *4 resolution for a linear encoder as if the interpolator is not in use.

There are now two encoder reverse switches. The first is the global encoder reverse switch implemented in the interpolator processor (Interpolator/DBN_Config, Encoder Reverse bit), which simulates a physical swap of the Sin and Cosine signals. This swap may cause a step change in the interpolated position data and should only be performed when the drive is disabled. The second switch is the drive processor's local encoder reverse (MotionMaestro->Commutation Setup->Encoder reverse,), which negates the interpolated position, if required, to achieve agreement between the Hall sequence and the encoder counter used for commutation.

To properly setup the drive's commutation, the drive's local encoder reverse should be setup before enabling the drive. This switch should be set to cause the position data displayed in the MM->Commutation_Setup window to count up as the Halls cycle through a positive sequence (U, UV, V, VW, W, WU, U ...). The Hall sequence can be viewed on the MotionMaestro->Status->Inputs->Digital display panel. If the direction is reversed, the drive should be forced to re-initialize commutation by issuing the soft reset/fault reset command (RST at the terminal widow/Fault Reset button on the MM Control Panel) or by a hard reset of the drive after first saving the changes to Non-Volatile Memory.

Once the commutation is correct, the motor can be driven in open-loop mode to determine if the global position has the correct polarity to close the position loop. A positive DAC offset should result in a positive position count. If a positive DAC offset causes a negative position count, the global position should be reversed. To do this, first disable the drive to prevent any jumps and then change Interpolator/DBN_Config, reverse bit. Since a global reverse will negate the raw position data used by the drive for commutation, the drive's commutation encoder reverse bit will also require inversion to maintain proper phasing with the Halls. Once again, the drive's parameters should be saved and the drive should be reset to force a re-initialization of the commutation. The operator should re-verify the phasing of the commutation counter with the Halls and then verify the proper phasing of the interpolated position by driving the motor in open loop mode before switching to closed loop operation.

Parameters 200-207 are saved to the drive processor's Non volatile memory upon issuance of a save command and are written to the Interpolator processor at power on and following a hard reset. These parameters are also written to the Interpolator processor if the *Interpolator/DBN_Mode* is set to *Setup/Cal*.

All Interpolator/DBN Settings are implemented as Service Channel Drive Parameters and can be accessed using the *meiSqNodeDriveParamSet/Get* functions.

Read-Only Status parameters (220-222) may also be read using the cyclic message, monitor channels. The monitor data can be selected using the *MEISqNodeDriveMonitorConfig* and viewed using the *MEISqNodeMonitorValue* functions. Parameters 220-222 are located at monitor table index numbers 18-20 respectively.

Interpolator/DBN Read/Write Parameters

Index	Parameter	Range	Interpolator Mode
200	SineOffset	-32767 to +32767	Setup/Cal

Offset correction to the encoder Sine input to calibrate signal inaccuracies for improved interpolator accuracy. This parameter should be set after selecting the encoder direction since changing the encoder direction swaps the sine and cosine input channels.

Index	Parameter	Range	Interpolator Mode
201	SineGain	-32767 to +32767	Setup/Cal

Gain correction to the encoder Sine input to calibrate signal inaccuracies for improved interpolator accuracy. This parameter should be set after selecting the encoder direction since changing the encoder direction swaps the sine and cosine input channels. This parameter should be used to match the signal amplitudes of the sine and cosine channels. A value of 32767 represents a gain of 1.0. The signal with the smaller amplitude should be left with a gain of 1.0 (32767) while the signal with the larger amplitude can be multiplied by a gain of less than 1.0 to achieve matching signal amplitudes.

Example:

Sine peak to peak = 55000 counts

Cosine peak to peak = 50000 counts then

Set Cosine gain = 32767

Set Sine gain = 32767*50000/55000 = 29788.

Index	Parameter	Range	Interpolator Mode
202	CosineOffset	-32767 to +32767	Setup/Cal

Offset correction to the encoder Cosine input to calibrate signal inaccuracies for improved interpolator accuracy. This parameter should be set after selecting the encoder direction since changing the encoder direction swaps the sine and cosine input channels.

Index	Parameter	Range	Interpolator Mode
203	CosineGain	-32767 to +32767	Setup/Cal

Gain correction to the encoder Cosine input to calibrate signal inaccuracies for improved interpolator accuracy. This parameter should be set after selecting the encoder direction since changing the encoder direction swaps the sine and cosine input channels. See SineGain description for more details.

Index	Parameter	Range	Interpolator Mode
204	DBN_PulseWidth	0 to 65535	Setup/Cal

Pulse output width of DBN output, 1 count = 1/75 usec

Index	Parameter	Range	Interpolator Mode
205	DBN_Interval	signed32	Setup/Cal

Position interval/step size between DBN output pulses.

Index	Parameter	Range	Interpolator Mode
206	Interpolator/DBN_Config	16 bit, binary	Setup/Cal

Bit 0, DBN_Auto_Reenable,

1 Sequence Repeat mode: After the final DBN frame is executed reload frame 0 and continue DBN execution.

0 One shot mode: After the final DBN frame is executed reload frame 0 and **Halt** DBN execution until DBN is disabled and re-enabled by exiting and reentering *DBN_Enable* mode. See *Interpolator/DBN_Mode* command.

Bit 1, DBN_TX0_Direction,

1 Allow Node control of TX0 by configuring the Interpolator/DBN to set this I/O to an input. Set this bit only if not using the DBN function

0 Interpolator/DBN drives TX0 output (required for DBN pulse output). The Node must configure TX0 as an input to prevent driver contention.

Bit 3, Encoder Reverse

1 Swap Sine and Cosine input channels to reverse the encoder count direction.

0 Do not swap Sine and Cosine input channels.

Bits 12-15, Interpolator Factor, n = 0 to 14 Setup/Cal

Interpolation factor = *2^(n+2)

n	interpolation
0	*4 (quadrant count only, no interpolation)
1	*8
2	*16
....	
9	*2048
10	*4096
....	
14	*65536

Bits 2,4-11 reserved, must be 0

Index	Parameter	Range	Interpolator Mode
207	Reserved		
208	Reserved		
209	Num_DBN_Frames	1 to 128	N/A

Number of DBN Start/Stop frames to download and execute. This parameter must be set before changing the *Interpolator/DBN_Mode* to *DBN_Load_Frames*. DBN execution will begin at frame 0 and continue until frame *Num_DBN_Frames*-1 has completed. After the final frame has completed, frame 0 will be reloaded and the DBN will either stop or continue execution based on the state of the *DBN_Auto_Reenable* bit in the *Interpolator/DBN_Config* register.

Index	Parameter	Range	Interpolator Mode
210	Frame_Data_Index	0 to 255	N/A

Frame data pointer for use reading/writing the frame data to the drive processor. The index auto increments after each frame data read/write and wraps back to 0 if the increment exceeds 255.

Index	Parameter	Range	Interpolator Mode
211	DBN_Frame_Data	signed32	N/A

Read/Write Frame Data pointed to by *Frame_Data_Index*

Frame_Data_Index auto increments after each read or write

Index	Frame Data
0	Frame[0].start
1	Frame[0].stop
2	Frame[1].start
3	Frame[1].stop
....	
254	Frame[127].start
255	Frame[127].stop

Frame Data can be downloaded to the drive processor at any time. To transfer frame data to the Interpolator/DBN processor, the Mode must be set to *DBN_Load_Frames*, See 212

Index	Parameter	Range	Interpolator Mode
212	Interpolator/DBN_Mode	0 to 7	N/A

0 = Null Mode

1 = Setup/Cal

5 = DBN_Load_Frames

6 = DBN_Enable

2,3,4,7 = Reserved

Null

Default Mode, DBN is disabled, Interpolator is operating. Only interpolated position and interpolator/DBN status are passed from the Interpolator/DBN processor to the drive processor. No calibration or configuration data is transferred between the Interpolator/DBN processor and the drive processor.

Setup/Cal

All setup and calibration parameters are continuously downloaded from the drive processor to the Interpolator/DBN processor and the calibrated sine/cosine signals are continuously uploaded from the Interpolator/DBN processor to the drive processor and can be monitored to aid in calibration.

DBN_Load_Frames

The DBN frames are copied from the drive processor to the Interpolator/DBN processor beginning with frame 0 and ending with frame *Num_DBN_Frames*-1 (see parameter 209). Frames may be downloaded to the drive processor at any time. The number of DBN frames must be specified before entering this mode. Frames are transferred at a rate of at 1 frame/PWM_Cycle (24kHz). *The DBN_Download_In_Progress* bit will be set in the *Interpolator/DBN_Status* register while the frames are being download and will be cleared when the download has completed. The *Interpolator/DBN_Mode* should not be changed until the download has completed.

DBN_Enable

Enable DBN function. The DBN will begin execution at frame 0. Once the last frame is executed (Num_DBN_Frames-1) the DBN processor will check the *DBN_Auto_Reenable* configuration bit. If this bit is set, DBN execution will repeat beginning at frame 0. If this bit is cleared, the *DBN_Done* bit will be set will set in the *Interpolator/DBN_Status* register and the DBN will stay disabled until *DBN_Enable* mode is exited and re-entered.

Status variables, Read Only

Index Parameter Range Interpolator Mode

220 (Monitor table index 18) Interpolator/DBN_Status (updated in all modes)

Status register decoded as follows:

Bits 0-7 Number of DBN Frames loaded

Bit 8 DBN_Enabled

1 DBN is enabled

0 DBN is disabled

Bit 9 DBN_Armed

1 DBN is armed; see definition of armed in DBN operation description

0 DBN is not armed

Bit 10 DBN_Direction

1 positive, Frame.Stop > Frame.Start

0 negative, Frame.Stop < Frame.Start

Bit 11 DBN_Done

1 Sequence Completed, must exit DBN_Enable Mode to clear

0 Sequence not completed

Bit 12 DBN_Auto_Reenable

1 DBN auto re-enable bit is set in *Interpolator/DBN_Config* register

0 DBN auto re-enable bit is not set in *Interpolator/DBN_Config* register

Bit 13 DBN_Download_In_Progress

1 DBN frame download is in progress. Note: the *Interpolator_DBN_Mode* should not be changed while this bit is set.

0 DBN frame download is not in progress.

Bit 14,15 Reserved.

221 (Monitor table index 19) Sin_Cal

Calibrated Encoder Sine signal = Sin_ADC * SineGain + SineOffset

Only updated when Interpolator/DBN_Mode = Setup/Cal

222 (Monitor table index 20) Cos_Cal

Calibrated Encoder Cosine signal = Cos_ADC * CosineGain + CosineOffset

Only updated when Interpolator/DBN_Mode = Setup/Cal

Sample DBN operating sequence:

1) Write DBN Setup Data (Pulse Width, Interval, Config) to the drive processor. Set *Interpolator/DBN_Mode* to *Setup/Cal* to transfer the setup data to the DBN processor.
2) Write *Num_DBN_Frames*, n, to drive processor.
3) Set *Frame_Data_Index* to 0.
4) Write frame Data beginning with frame[0].start, frame[0].stop…frame[n-1].start, frame[n-1].stop. The *frame_data_index* will auto-increment after each write so it is not necessary to update the index unless non-sequential access is desired.
5) Set *Interpolator/DBN_Mode* to *DBN_Load_Frames.* The frames will be downloaded at 1 frame/PWM_Cycle (24kHz).
6) Monitor the *DBN_Download_In_Progress* bit if the *Interp/DBN_Status* register to determine if the download is complete.
7) When ready to begin the DBN sequence, change *Interpolator/DBN_Mode* to *DBN_Enable*.
8) Repeat steps 2-4 to download the next sequence of frames to the drive processor.
9) Wait for the executing sequence to complete by monitoring the *DBN_Done* bit of the *Interp/DBN_Status* register.
10) Repeat steps 5-9 as desired. Changing the mode to *DBN_Load_Frames* will clear the *DBN_Done* bit and allow the next sequence to execute once the mode is changed back to *DBN_Enable*.
11) If *DBN_Enable* mode is exited before the sequence has completed, the frames must be re-loaded to reset the sequence to frame 0. If the frames are not reloaded, the sequence will begin with the frame that was executing when the DBN was disabled.

DBN Arming:

<u>Start position < Stop position (Direction positive)</u>

The trigger position is set to the start position.

The DBN will arm once the absolute position is < the start position.

The first DBN pulse will occur when armed and the absolute position >= start position.

Once a trigger occurs the trigger position is updated to last_trigger_position+DBN_Interval.

If the motion is reversed before the stop position is reached and the absolute position becomes < the start position, the trigger position is reloaded with the start position.

Once the stop position has been exceeded, the next frame start position is loaded.

<u>Start position > Stop position (Direction negative)</u>

The trigger position is set to the start position.

The DBN will arm once the absolute position is > the start position.

The first DBN pulse will occur when armed and absolute position <= start position.

Once a trigger occurs the trigger position is updated to last_trigger_position-DBN_Interval.

If the motion is reversed before the stop position is reached and the absolute becomes > the start position, the trigger position is reloaded with the start position.

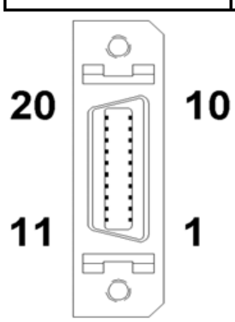
Once the stop position has been exceeded, the next frame start position is loaded.

Appendix A

A - Servo Drive Connections and Specifications

A - 1. Encoder Feedback

Pin Number	Name	Description/Specification	I/O
1	+5V	+5VDC (200mA max.) Encoder / Hall Sensor Power	O
2	Common	Encoder / Hall Sensor Common	COM
3	+5V	+5VDC Encoder / Hall Sensor Power	O
4	Common	Encoder / Hall Sensor Common	COM
5	Encoder A+ Sine +	Differential TTL Encoder channels: 26LV32 or equivalent RS422 line receiver inputs with 150 ohm differential line termination. Differential Sine/Cosine Encoder channels: (Sine interpolator option) 1Vp-p Sine/Cosine input Frequency: 500KHz max. For Index +/-: 1.7V differential (max.).	I
6	Encoder A- Sine -		
7	Encoder B+ Cosine +		
8	Encoder B- Cosine -		
9	Encoder Z+ Index +		
10	Encoder Z- Index -		
11	Hall U+	26LV32 or equivalent RS422 line receiver inputs. Compatible with differential or single-ended commutation tracks or Hall sensors. Single-ended connections should be made to the "+" input while leaving the "-" input unconnected.	I
12	Hall U-		
13	Hall V+		
14	Hall V-		
15	Hall W+		
16	Hall W-		
17	Motor Temp	Motor thermal switch input referenced to Common. Amplifier can be configured to fault on normally open or normally closed switch (active high/low).	I
18	Common	Signal common	COM
19	Common		
20	Common		



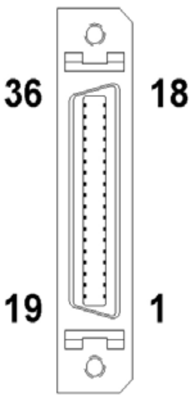
Connector Description/Type	20-Pin Male Mating Connector	20-Pin Male Mating Backshell
Mini D Ribbon, 24-30 AWG, Solder Cup, Plastic Backshell, Squeeze Latch	3M 10120-3000VE Glentek P/N: EJC10120	3M 10320-52F0-008 Glentek P/N: EJC10320

A - 2. Controller Input and Output Signals

Pin Number	Name	Description	Specification	I/O
1	POS LIM_	Positive limit	Optically isolated inputs: All optical inputs are referenced to Opto_In_Com which can be connected to the positive or negative optical supply to configure the inputs as sourcing and sinking. All signals are directly connected to the SynqNet® Node controller. Input voltage 12-28VDC referenced to Opto_In_Com. Input current: 3mA min. (8mA max.) Built in 3.3K series resistor	I
2	NEG LIM	Negative limit		
3	NODE DISABLE	Node disable		
4	HOME	Home switch input		
5	IN_0	General purpose inputs (2)		
6	IN_1			
7	ALARM-C	SynqNet® node error output	Optically isolated outputs: The collector and emitter terminals of each optical output are available at the I/O connector allowing the ability to configure each output as sourcing or sinking. All outputs are controlled by the SynNet® controller. VCE (max.) = 35V Iout (max.) = 30mA	O
8	ALARM-E			
9	BRK / APPD-C	Brake output (dedicated)		
10	BRK / APPD-E			
11	OUT_0-C	General purpose outputs (2)		
12	OUT_0-E			
13	OUT_1-C			
14	OUT_1-E			
15	RX_0+	General purpose inputs (2)	High speed differential line receiver inputs: Use industry standard 26LV32 or equivalent RS433 line receiver. All signals directly connected to SynqNet® node controller.	I
16	RX_0-			
17	RX_1+			
18	RX_1-			
19	OPTO_IN_COM	Optical input common (common for pin 1 through 6)		—
20	ANALOG OUT	Analog out monitor	0-4V analog output referenced to Common for monitoring DSP signals.	O
21	AUX_ENC_A+	Auxiliary encoder input signals	High speed differential line receiver inputs: Use industry standard 26LV32 or equivalent RS433 line receiver. All signals directly connected to SynqNet® node controller.	I
22	AUX_ENC_A-			
23	AUX_ENC_B+			
24	AUX_ENC_B-			
25	AUX_ENC_I+			
26	AUX_ENC_I-			

Pin Number	Name	Description	Specification	I/O
27	+5V	+5VDC out Short circuit protected		O
28	+5V			
29	COMMON	Analog common		—
30	COMMON			
31	RESERVED	Reserved		—
32	RESERVED			
33	TX_0+	General purpose outputs (2)*	High speed differential line driver outputs: Uses industry standard 26LV31 or equivalent RS422 line drivers. All outputs are controlled by SynqNet® Controller. Iout (max.) = 20mA	O
34	TX_0-			
35	TX_1+			
36	TX_1-			

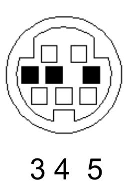
* For sine interpolator / DBN option, see page 43 for detail.



Connector Description/Type	36-Pin Male Mating Connector	36-Pin Male Mating Backshell
Mini D Ribbon, 24-30 AWG, Solder Cup, Plastic Backshell, Squeeze Latch	3M10136-3000VE Glentek P/N: EJC10136	3M10336-52F0-008 Glentek P/N: EJC10336

A - 3. RS-232 Host

Pin Number	Desctiption	I/O
3	232 TX	O
4	Common	—
5	232 RX	I

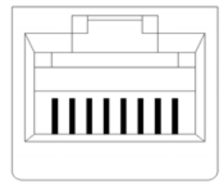


Connector Description/Type	8-Pin Male Mating Connector
Mini DIN	T & B P/N: 622-0641 Glentek P/N: EJ242F06

A - 4. SynqNet® Interface

SynqNet® In

Pin Number	Description	I/O
1	Transmit +	O
2	Transmit -	O
3	Receive +	I
6	Receive -	I
4, 5, 7, 8	Earth ground	—



8 1

Connector Description/Type	8-Pin Male Mating Connector
RJ-45	Molex P/N: 87522-8012 Glentek P/N: EJ018083

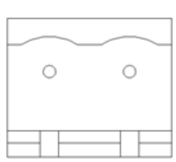
SynqNet® Out

Pin Number	Description	I/O
1	Receive +	I
2	Receive -	I
3	Transmit +	O
6	Transmit -	O
4, 5, 7, 8	Earth ground	—

A - 5. External Logic Supply Input Connector

Pin Number	Description	I/O
1	COMMON	—
2	24 to 48VDC, 600mA max. @ 24VDC Powers all amplifier logic and encoder	I

Connector Description/Type	2-Pin Female Mating Connector
Right angle	Phoenix P/N: GMVSTBW 2,5/2-ST-5,08 Glentek P/N: EJ741V02



1 2

A - 6. SMC9930 Power I/O Connector

Pin#	Name	Description	I/O
1	AC 1	AC	I
2	AC 2	AC	I
3	AC 3	AC	I
4	Ext. Regen Out	Reserved	O
5	Ext. Regen Out	Reserved	O
6	R	Motor Phase R	O
7	S	Motor Phase S	O
8	T	Motor Phase T	O

A - 7. SMC9975 Power I/O Connector

Pin#	Name	Description	I/O
1	AC 1	AC	I
2	AC 2	AC	I
3	AC 3	AC	I
4	R	Motor Phase R	O
5	S	Motor Phase S	O
6	T	Motor Phase T	O

Appendix B

B - Status Display

A diagnostic LED is provided for determining the general operating condition of the amp. It is a 7-segment LED display. When 5 volts are being supplied to the logic section of the amp, the decimal point is lit.

When Hall sensors are being used and the amp is operating normally, one of the outer six segments is lit. Each of the six outer segments represent one of the six Hall states in a commutation cycle of a motor. A commutation cycle consists of two poles. In an 8-pole motor the LED will cycle through its six outer segments 4 times for one revolution of a rotary motor. When Hall sensors are not being used the display will show a 0, all outer segments of the LED are lit.

When the motor current is clamped, (i.e. held to zero), or the amplifier is in a fault condition, one of the characters that are listed below will be displayed as is appropriate to the fault or state:

Display	Name	Description
1	EEPROM Fault*	Parameter EEPROM checksum fault
2	RAM Fault*	Power up RAM read/write test failed
3	CPLD Fault*	CPLD communication timeout
4	Interpolator Fault* (Sine interpolator option only)	Interpolator processor not responding
8	Reset (Flashing)	N/A
b	Bus Over Voltage	DC bus exceeded 450VDC nominal (for 320VDC input) DC bus exceeded 230VDC nominal (for 160VDC input)
C	Clamp (Disabled)	Output stage disabled
E	Encoder Fault	Encoder fault detected
F	Foldback	Foldback condition active
H	Heatsink Over Temperature	Heatsink thermal switch tripped (65ºC typical)
h	Motor Over Temperature	Motor thermal switch / thermister tripped
L	LS/ECB	Motor RMS over current
0	Normal Operation	Amp enabled (no Hall only)
S	HS/ECB	Output short circuit detected (50A for standard power)
U	Bus Under Voltage	DC bus below 150VDC nominal (for 320VDC input) DC bus below 80VDC nominal (for 160VDC input)
=	Hall Fault	Invalid hall state (000 or 111)
≡	Commutation Fault	Hall angle does not match encoder counter angle No Halls: Phase finding routine failed
.	Decimal Point Only	Drive processor is in reset Logic power indicator
Single outer segment	Amp Enabled, Hall	Amp enabled Segment indicates one of six hall states

APPENDIX C

C - SMC9930 / SMC9975 Ratings and Specifications

This appendix contains specifications for the application engineer which are necessary to utilize the SMB / SMC 9900 series amplifiers.

C - 1. Power, Input and Output

Amplifier Model Number	Input Power	Output Power	
		Rated	Peak
SMC9930-100	135-260VAC	30	60
SMC9930-103	135-260VAC	30	60
SMC9975-100	50-135VAC	75	150
SMC9975-103	50-135VAC	75	150

For External 24VDC Input:

SMC99XX amplifiers require external +24VDC to power up the logic board.

1. Input range: +24VDC ~ +48VDC
2. Current: 600mA

C - 2. Sine Interpolator Option

Divided-by-N (DBN)	
Pulse Output Width	0.0133 to 873.8 μsec. (1 count—1/75 μsec.) Programmable to 1/75 μsec. intervals
Pulse Output Interval	Up to 4,294,967,296 encoder counts (32 bit) Min. time interval = 2 μsec.
Pulse Latency From Sine/Cosine Sampling	1.4 μsec.
Number of DBN Frames	Up to 128 Start/Stop frames
Auto DBN rearming capability with or without pre-stored frames	

Sine Encoder Interpolation	
Sine / Cosine Input	Max frequency: 500KHz/channel Gain and offset can be adjusted by software
Sampling Rate	500KHz (2μsec.)
Interpolation	Selectable, up to 4096 (12 bit)

C - 3. Controller I/O

Optically Isolated Inputs: Dedicated (4): Pos Limit, Neg Limit, Node Disable Home General Purpose (2): In0, In1	All optical inputs are referenced to Opto_In_Com which can be connected to the positive or negative optical supply to configure the inputs as sourcing or sinking. All signals are directly connected to the SynqNet® Node controller. Input voltage 12 – 28VDC referenced to Optp_In_Com. Input current: 3mA min, 8mA max, built in 3.3K series resistor.
Optically Isolated Outputs: Dedicated (2): Node Alarm, Brake (-C/E) General Purpose (2): Out0, Out1 (-C/E)	The collector and emitter terminals of each optical output are available at the I/O connector allowing the ability to configure each output as sourcing or sinking. All outputs are controlled by the SynqNet® controller. Vce (max) = 35V Iout (max) = 30mA
High Speed Differential Line Receiver Inputs: Dedicated (3): Aux Encoder A, B, I +/- General Purpose (2): RX0, RX1 +/-	Uses industry standard 26LV32 or equivalent RS422 line receiver. All signals directly connected to SynqNet® Node controller. Includes broken wire detection on Aux Encoder A & B channels.
High Speed Differential Line Driver Outputs: Dedicated (1): TX0 +/- General Purpose (1): TX1 +/-	Uses industry standard 26LV31 or equivalent RS422 line driver. Iout (max) = 20mA TX0 is controlled by the interpolator and should be configured as an input on the controller. Divide-by-N function. TX1 is controlled by the SynqNet® controller.
ANALOG OUT	0 – 5V analog output referenced to common for monitoring DSP signals, output source selectable using MotionMaestro™ setup software.
COMMON	Reference ground for non-isolated signals including AUX ENCODER, RX0, RX1, TX0, TX1 and ANALOG OUT

C - 4. Motor Feedback, Encoder, Commutation, and Motor temp switch

+5V	5VDC +/-10%, 200mA max Encoder/Hall supply voltage (output)
Common	5V supply return and return for Motor Temp Switch
Sin, Cos +/- (Sine interpolator option)	1Vpp Sine/Cosine Input, Frequency: 500KHz (max) 1Vpp (norminal), 1.2Vpp (max)
Index +/- (Sine interpolator option)	1.7V differential (max)
Encoder A, B, Z +/-	26LV32 or equivalent RS422 line receiver inputs with 150 ohm differential line termination. Supports incremental, differential, TTL encoders. Accepts encoder signals up to 4.3MHz.
Hall U, V, W +/-	26LV32 or equivalent line receiver inputs. Compatible with differential or single-ended commutation tracks or Hall sensors. Single-ended connections should be made to the “+” input while leaving the “-“ input unconnected. Power-on phase-finding routines available for operation without commutation tracks or Hall sensors.
Motor Temp	Motor thermal switch input referenced to common, amplifier can be configured to fault on normally open or normally closed switch (active high/low)

APPENDIX D

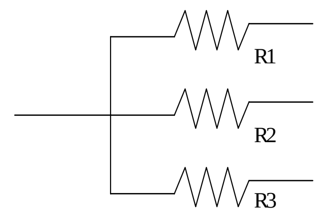
D - Matching motor phase leads to amplifier commands using Hall sensors.

Below you will find the steps necessary to insure that the command phases of a digital amplifier are properly matched to any three-phase motor that has Hall sensors. This method applies to a fully digital amplifier with digital current loops. Section labeled "System Setup" must have been completed before attempting this appendix.

Please read this procedure prior to working with the motor and amplifier.

It is intended that this procedure be done once by the engineering staff, whereupon they will incorporate the findings into production drawings, wiring labels and procedures.

A) Locate or prepare the required equipment.
1. A 2 channel oscilloscope
2. A 3-phase Y-connected resistive load as illustrated below.
3. A computer with MotionMaestro© installed.

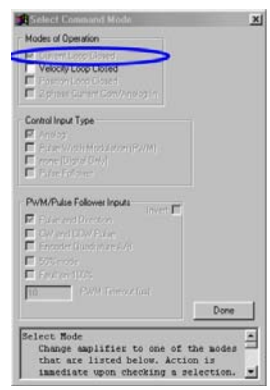


R1, R2 and R3 = 20K 10watt resistors.

Specification for resistive load

B) With the power off, connect the motor encoder outputs and the Hall sensor outputs to the amplifier. **Leave the motor power leads disconnected**. Connect the RS232 serial cable from the amplifier to the serial port on the computer (MotionMaestro©).

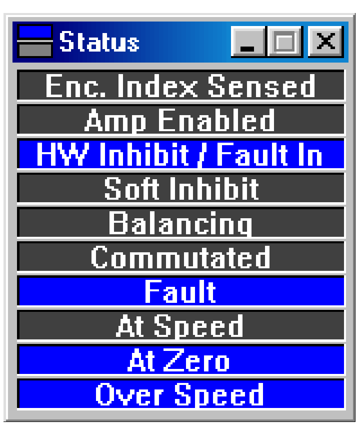
C) Apply power to the amplifier and establish communications between the amplifier and MotionMaestro©.

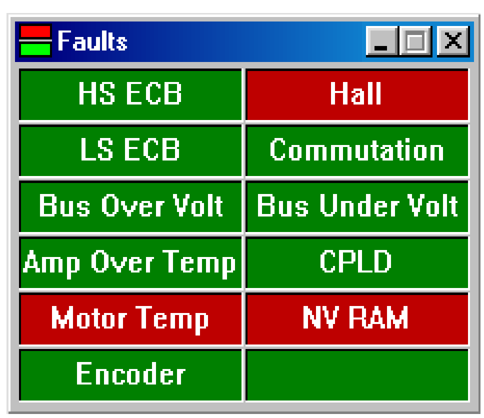


D) Prepare the amplifier using the following dialogs.

1.) Insure that the amplifier is in **current mode**. Deselect all modes except the **current mode**.

2.) Check then clear all faults by referring to the Amplifier Faults and Amplifier Status displays on the toolbar. For example, if there is an External Inhibit status warning you must open the Setup Digital IO dialog and check the inhibit box, then fix all remaining amplifier faults. After all faults have been corrected a fault reset must be completed. You may perform a reset with SynqNet® controller by using Mocon. **Commutation alignment can not begin until all faults are cleared.**



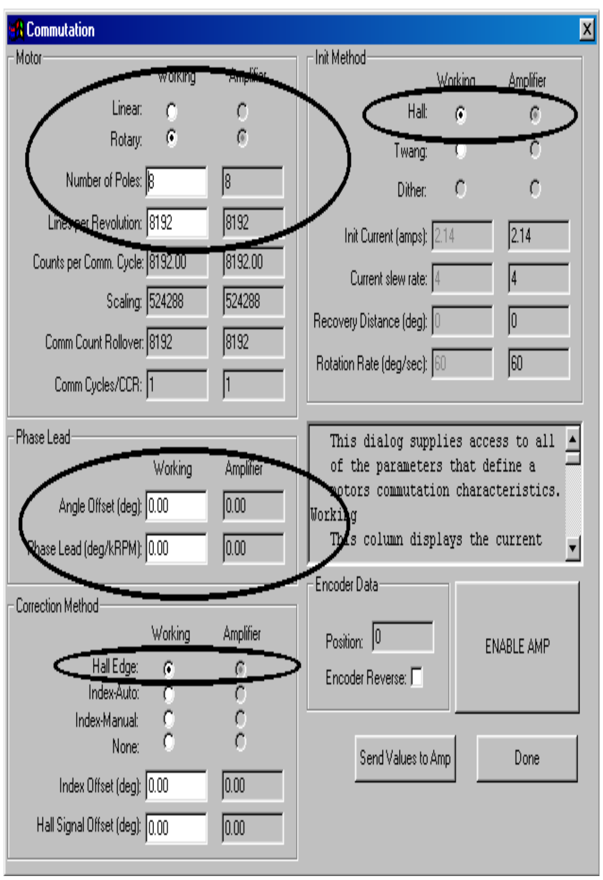


E) From the MotionMaestro© "Setup" menu, open the "Commutation" dialog and setup the following items:

1) Motor type. Are you phasing a rotary or linear motor?
2) **Number of Poles.
3) **Encoder resolution.
4) Commutation angle offset = 0
   (-30 degrees if Halls aligned phase to neutral?)
5) Commutation phase advance gain = 0
6) Init Method = Hall
7) Correction Method = Hall
8) Depress "Send Values To Amp" button

NOTE: ** Refer to Appendix E if motor Poles and Encoder Resolution are unknown.

F) With the Commutation dialog still open, enable the amplifier. You will see on the amp, one segment lit on the seven segment display. This display segment indicates the Hall state. Rotate the motor shaft by hand, such that the segments rotate clockwise as viewed from the top of the drive. Verify the Encoder Data Position counts up in the Commutation dialog. If not, check the Encoder Data Reverse box. The Encoder Data Position should now count up as the seven segment display cycles clockwise.

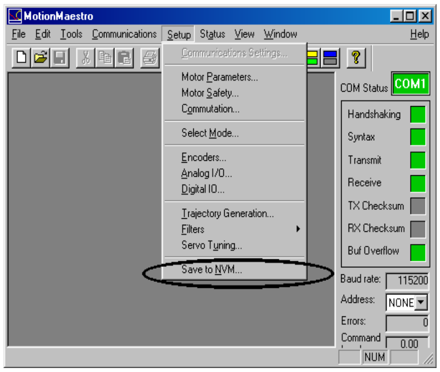


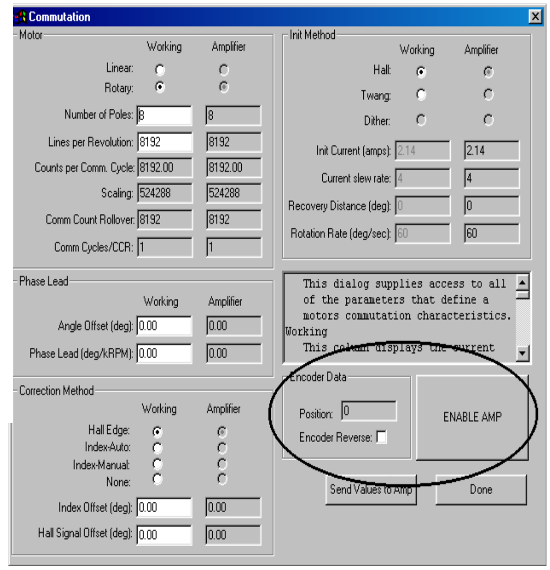
G) Save the new settings by selecting "Save to NVM" from the Setup menu. Answer Yes when prompted to save.

H) Connect the 3-phase Y-connected resistor load to the **Motor** power leads for monitor ing the motor back EMF (BEMF). **NOTE: do not connect the motor leads or the resistor load to the amplifier.**

I) Connect the channel 1 scope probe to the amplifiers Analog Out pin. Connect the channel 1 scope common to the amplifiers Common pin. Set the channel 1 vertical scale to around **2V per division**. From the "Setup Analog Input/Output" dialog, Set the Analog Output Signal Source to "R Current Command" and directly below change the Analog Output Signal Gain to 100 percent.

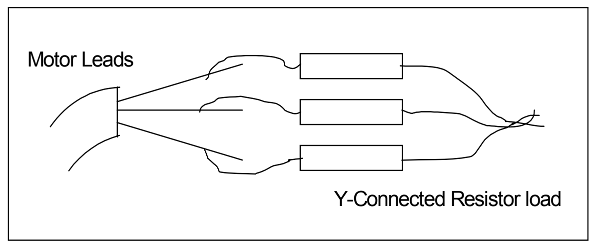
J) Connect the channel 2 scope probe to one of the motors leads. Connect the channel 2 scope common to the center of the Y-connected resistor load. Set the channel 2 vertical scale to around **2V per division**. Set the horizontal scale to around **100 ms per division**. Scaling may need to be changed in order to best see the data.





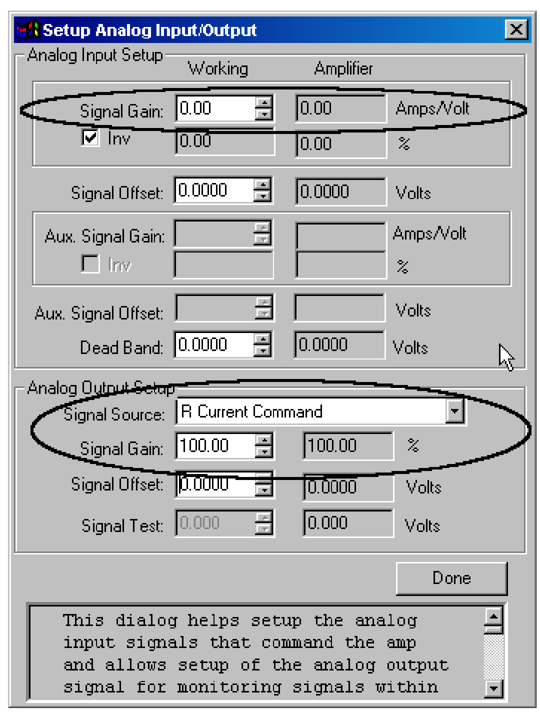
K) Open the Control Panel. The square colored status box will give you the amplifier status. If the box is yellow or disabled then press the "Enable/Disable Amp" button. If the box is red the amp has a fault and must be cleared before you can proceed.

L) From the Control Panel, apply a digital current command of **10 amps** to the amplifier. To do this you may have to expand the range that can be commanded from the control panel by selecting the Options button.



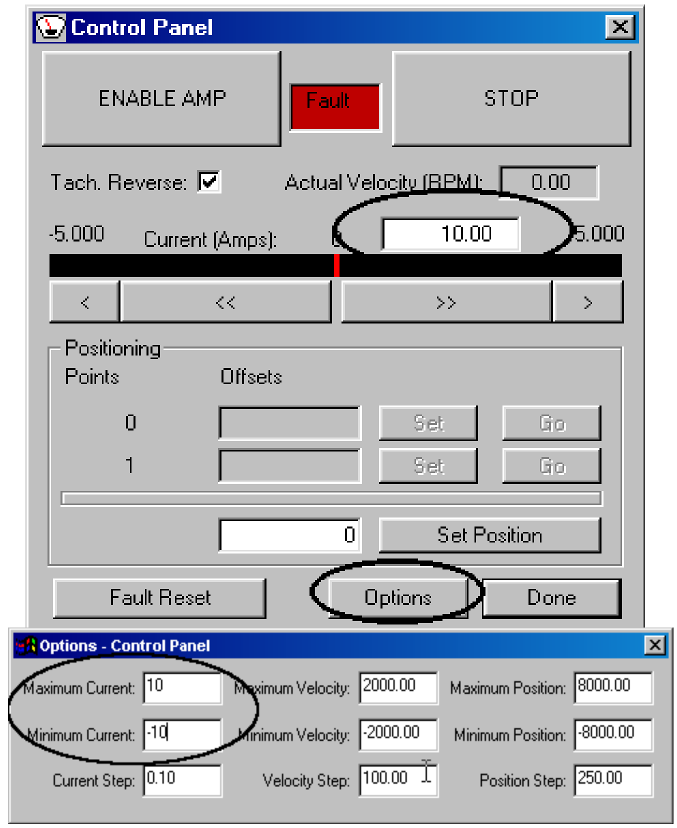
3-phase Y-connected resistor load

M) **Find the phase R motor lead.**
Rotate the motor by hand and verify the trace on channel 1 (phase R current command) follows a sinusoidal pattern. Move the channel 2 scope probe to each motor lead to determine which BEMF waveform is in phase or 180° out of phase with the phase R command. Label this lead Phase R.



NOTE: For each phase, R, S and T, one direction of rotation should cause the back EMF (BEMF) to be in phase with the command while the reverse rotation direction should cause the BEMF to be 180° out of phase. Determine which direction of rotation is in phase for the phase R motor lead, then rotate the motor in that same direction when determining the S and T motor leads. Once the phases are labeled, double check that the phase R and S motor leads result in waveforms that are in phase with the corresponding digital current commands on the amplifier when rotating the motor in the same direction for both.

ALSO: This method of matching motor leads to the amplifier requires that the motor's Hall sensors transitions are aligned with the motor phase to phase BEMF zero crossings. If the Hall sensors are aligned with the motor's phase to neutral BEMF, then the commutation offset angle must be set to ±30 degrees (you have to try both) before comparing the commands to the BEMF waveforms.



N) **Find the phase S motor lead.**
In MotionMaestro©, change the Analog Output Signal Source *S Current Command*. Place the channel 2 scope probe on one of the two remaining motor leads. Rotate the motor in the same direction that was used for phase R above. Determine which of the remaining two leads of the motor result in a waveform that is in phase with the phase S command. Label this lead Phase S. Move the channel 2 probe to the remaining motor lead.

O) **Find the phase T motor lead.**
Same procedure as above with the analog output source set to *T Current Command*. If phase R and phase S where properly found, phase T will be the remaining motor wire. Label this lead phase T.

P) Set the current command back to **0 by clicking the STOP button on the Control Panel.** Reset any current limits, foldback thresholds to the desired operational settings. Reset the Control Panel options to appropriately safe values. Set the Analog Input Signal Gain back to the desired operational value.

Q) Save the settings by selecting "Save to NVM" from the Setup menu.

R) Remove the amplifier's power. Remove the scope probes. Connect the motor R, S, and T leads to the amplifier's R, S, and T terminals respectively.

S) Apply power to amplifier. The amplifier should still be in **Current Mode** and **Enabled** (unless the external inhibit is active). From the Control Panel, see following picture, issue a digital current command of **0.5 to 2 amps**, enough so the motor begins to rotate.

T) While the motor is rotating, verify that the sign of the actual velocity matches the sign of the commanded current. If NOT mark the **Tach Reverse** checkbox on the control panel and verify that the signs now match. Command the opposite polarity current to the motor, **-.5 to -2.0 amps** and verify that the motor reverses direction and runs at approximately the same speed. The signs of the current command and actual velocity should still match.

U) Set the current command back to 0 by clicking on the **STOP** button of the Control Panel. Save the settings by selecting "Save to NVM" from the setup menu.

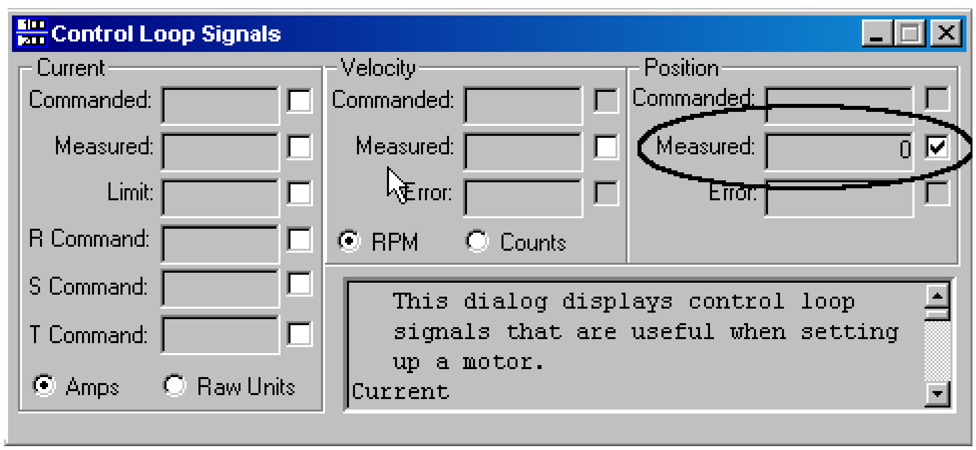
The motor should now be properly commutated and phased.

APPENDIX E

E – Determining Encoder Resolution and Number of Poles.

A) **Encoder Resolution**
From the MotionMaestro© Status menu, open the "Control Loop Signals" dialog . Check the box that allows you to monitor "Measured" "position" of the encoder, then mark a start position on the motor shaft. Turn the shaft 360 degrees clockwise and monitor the encoder position in the Control Loop Signals dialog. Note the change in encoder counts. Take the change in encoder counts per 1 revolution (360 degrees) and divide by four (4). This is your Lines of Resolution that you will enter in your Commutation dialog. (Note: For better accuracy, you may rotate by 10 turns and divide by 40 instead of 4.)

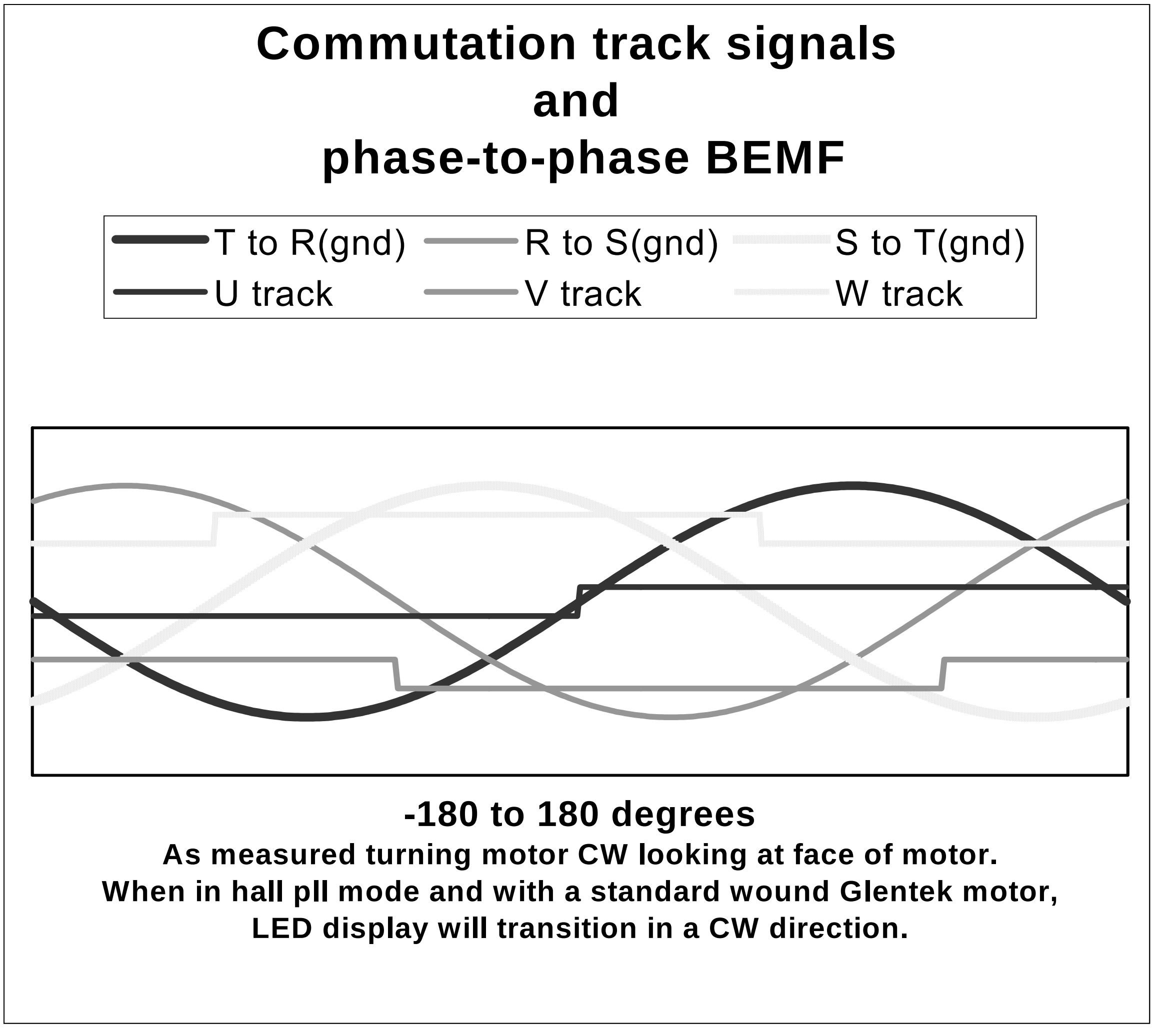
Common encoder line counts include but are not limited to 250. 256. 500, 512, 1000, 1024, 2000. 2048, 2500, 4096, 5000, 8192, and 10,000 lines/revolution.



B) **Number of Poles** (Note: requires Hall sensors)
Enable the amplifier. Mark a start position on the motor shaft. You will be monitoring the seven segment display on the amplifier as shaft is rotated. Note the lit segment before rotating the motor shaft, now turn the shaft 360 degrees clockwise. As you are rotating shaft, count the number of times the seven segment display goes through a full led rotation. Take the number of full LED cycles and multiply by two. This is the Number of Poles that you will enter in your Commutation dialog.

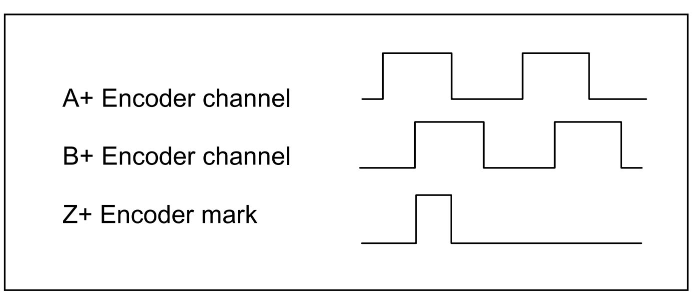
APPENDIX F

F – Commutation track signals and phase-to-phase BEMF.



Encoder Outputs

The following illustrates the encoder signals for a standard Glentek motor that is correctly commutated where the encoder is not reversed (FER=0) and the tachometer feedback is reversed (TR=1).



APPENDIX G

G – European Union EMC Directives

Electromagnetic Compatibility Guidelines For Machine Design

This document provides background information about Electromagnetic Interference (EMI) and machine design guidelines for Electromagnetic Compatibility (EMC).

Introduction

Perhaps no other subject related to the installation of industrial electronic equipment is so misunderstood as electrical noise. The subject is complex and the theory easily fills a book. This section provides guidelines that can minimize noise problems.

The majority of installations do not exhibit noise problems. However, these filtering and shielding guidelines are provided as counter measures. The grounding guidelines provided below are simply good grounding practices. They should be followed in all installations.

Electrical noise has two characteristics: generation or emission of electromagnetic interference (EMI); and response or immunity to EMI. The degree to which a device does not emit EMI, and is immune to EMI is called the device's Electromagnetic Compatibility (EMC).

Equipment, which is to be brought into the European Union legally, requires a specific level of EMC. Since this applies when the equipment is brought into use, it is of considerable importance that a drive system, as a component of a machine, be correctly installed.

"EMI Source-Victim Model" shows the commonly used EMI model. The model consists of an EMI source, a coupling mechanism and an EMI victim. A device such as servo drives and computers, which contain switching power supplies and microprocessors, are EMI sources. The mechanisms for the coupling of energy between the source and victim are conduction and radiation. Victim equipment can be any electromagnetic device that is adversely affected by the EMI coupled to it.

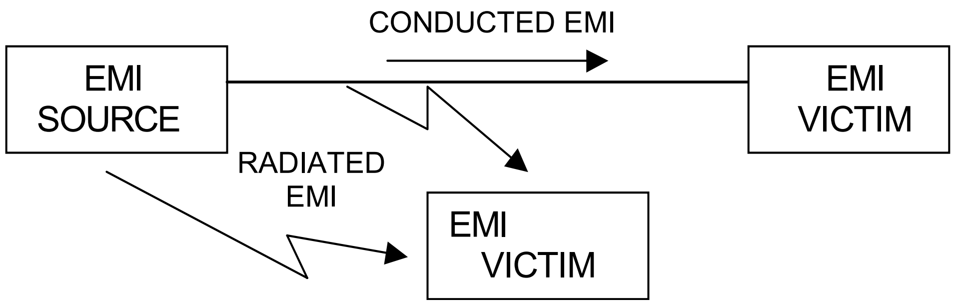


Figure 1- EMI Source-Victim Model

Immunity to EMI is primarily determined by equipment design, but how you wire and ground the device is also critical to achieving EMI immunity. Therefore, it is important to select equipment that has been designed and tested for industrial environments. The EMI standards for industrial equipment include the EN61000-4-X series (IEC 1000-4-X and IEC8O1-X), EN55011 (CISPR11), ANSI C62 and C63 and

MIL-STD-461. Also, in industrial environments, you should use encoders with differential driver outputs rather than single ended outputs, and digital inputs/outputs with electrical isolation, such as those provided with optocouplers.

The EMI model provides only three options for eliminating the EMC problem:

- Reduce the EMI at the source,
- Increase the victim's immunity to EMI (harden the victim),
- Reduce or eliminate the coupling mechanism,

In the case of servo drives, reducing the EMI source requires slowing power semiconductor switching speeds. However, this adversely affects drive performance with respect to heat dissipation and speed/torque regulation. Hardening the victim equipment may not be possible, or practical. The final and often the most realistic solution is to reduce the coupling mechanism between the source and victim. Filtering, shielding and grounding can achieve this.

Filtering

As mentioned above, high frequency energy can be coupled between circuits via radiation or conduction. The AC power wiring is one of the most important paths for both types of coupling mechanisms. The AC line can conduct noise into the drive from other devices, or it can conduct noise directly from the drive into other devices. It can also act as an antenna and transmit or receive radiated noise between the drive and other devices.

One method to improve the EMC characteristics of a drive is to use an isolation AC power transformer on the amplifier's input power. This minimizes inrush currents on power-up and provides electrical isolation. In addition, it provides common mode filtering, although the effect is limited in frequency by the interwinding capacitance. Use of a Faraday shield between the windings can increase the common mode rejection bandwidth, (shield terminated to ground) or provide differential mode shielding (shield terminated to the winding). In some cases an AC line filter will not be required unless other sensitive circuits are powered off the same AC branch circuit.

NOTE:" Common mode" noise is present on all conductors that are referenced to ground. "Differential mode" noise is present on one conductor referenced to another conductor.

The use of properly matched AC line filters to reduce the conducted EMI emitting from the drive is essential in most cases. This allows nearby equipment to operate undisturbed. The basic operating principle is to minimize the high frequency power transfer through the filter. An effective filter achieves this by using capacitors and inductors to mismatch the source impedance (AC line) and the load impedance (drive) at high frequencies.

For drives brought for use in Europe, use of the correct filter is essential to meet emission requirements. Detailed information on filters is included in the manual and transformers should be used where specified in the manual.

AC Line Filter Selection

Selection of the proper filter is only the first step in reducing conducted emissions. Correct filter installation is crucial to achieving both EMIL attenuation and to ensure safety. All of the following guidelines should be met for effective filter use.

1) The filter should be mounted to a grounded conductive surface.

2) The filter must be mounted close to the drive-input terminals, particularly with higher frequency emissions *(5-30* MHz). If the distance exceeds 600mm (2 feet), a strap should

be used to connect the drive and filter, rather than a wire.

3) The wires connecting the AC source to the filter should be shielded from, or at least separated from the wires (or strap) that connects the drive to the filter. If the connections are not segregated from each other, then the EMI on the drive side of the filter can couple over to the source side of the filter, thereby reducing, or eliminating the filter effectiveness. The coupling mechanism can be radiation, or stray capacitance between the wires. The best method of achieving this is to mount the filter where the AC power enters the enclosure. "AC Line Filter Installation" shows a good installation and a poor installation.

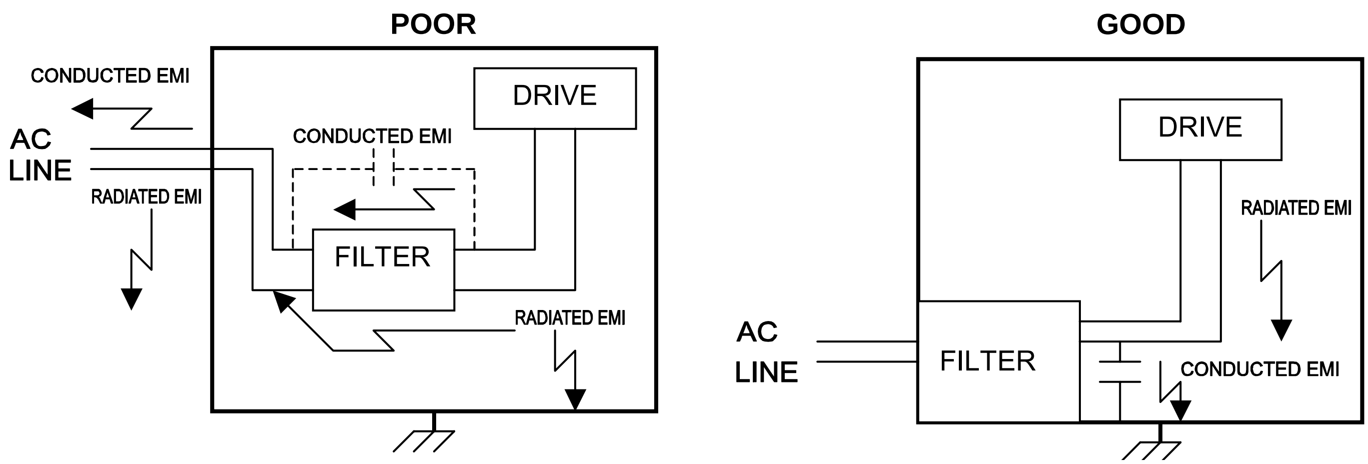


Figure 2- AC Line Filter Installation

When multiple power cables enter A unfiltered line can contaminate a filtered line external to the enclosure. Therefore, all lines must be filtered to be effective. The situation is similar to a leaky boat. All the holes must be plugged to prevent sinking.

WARNING

Large leakage currents exist in AC line filters. They must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels prior to handling the equipment. Failure to observe this precaution could result in severe bodily injury.

If the filter is mounted excessively far from the drive, it may be necessary to mount it to a grounded conductive surface, such as the enclosure, to establish a high frequency (HF) connection to that surface. To achieve the HF ground, direct contact between the mounting surface and the filter must be achieved. This may require removal of paint or other insulating material from the cabinet or panel.

The only reasonable filtering at the drive output terminals is the use of inductance. Capacitors would slow the output switching and deteriorate the drive performance. A common mode choke can be used to reduce the HF voltage at the drive output. This will reduce emission coupling through the drive back to the AC line. However, the motor cable still carries a large HF voltage and current. Therefore, it is very important to segregate the motor cable from the AC power cable. More information on cable shielding and segregation is contained in the section on shielding.

Grounding

High frequency (HF) grounding is different from safety grounding. A long wire is sufficient for a safety ground, but is completely ineffective as a HF ground due to the wire inductance. As a rule of thumb, a wire has an inductance of 8 nH/in regardless of diameter. At low frequencies it acts as constant impedance, at intermediate frequencies as an inductor, and at high frequencies as an antenna. The use of ground straps is a better alternative to wires. However the length to width ratio must be *5:1,* or better yet 3:1, to remain a good high frequency connection.

The ground system's primary purpose is to function as a return current path. It is commonly thought of as an equipotential circuit reference point, but different locations in a ground system may be at different potentials. This is due to the return current flowing through the ground systems finite impedance. In a sense, ground systems are the sewer systems of electronics and as such are sometimes neglected.

The primary objective of a high frequency ground system is to provide a well-defined path for HF currents and to minimize the loop area of the HF current paths. It is also important to separate HF grounds from sensitive circuit grounds. "Single Point Ground Types" shows single point grounds for both series (daisy chain) and parallel (separate) connections. A single point, parallel connected ground system is recommended.

Figure 3-Single Point Ground Types

A ground bus bar or plane should be used as the "single point" where circuits are grounded. This will minimize common (ground) impedance noise coupling. The ground bus bar (GBB) should be connected to the AC ground, and if necessary, to the enclosure. All circuits or subsystems should be connected to the GBB by separate connections. These connections should be as short as possible and straps should be used when possible. The motor ground conductor must return to the ground terminal on the drive, not the GBB.

Shielding and Segregation

The EMI radiating from the drive enclosure drops off very quickly over distance. Mounting the drive in an enclosure, such as an industrial cabinet, further reduces the radiated emissions. The cabinet should have a high frequency ground and the size of the openings should be minimized. In addition, the drive is considered an "open" device that does not provide the proper IP rating for the environment in which it is installed. For this reason the enclosure must provide the necessary degree of protection. An IP rating or Nema rating (which is similar to IP) specifies the degree of protection that an enclosure provides.

The primary propagation route for EMI emissions from a drive is through cabling. The cables conduct the EMI to other devices, and can also radiate the EMI. For this reason, cable segregation and shielding are important factors in reducing emissions. Cable shielding can also increase the level of immunity for a drive. For example:

- Shield termination at both ends is extremely important. The common misconception that shields should be terminated at only one end originates from audio applications with frequencies <20 kHz. RF applications must be terminated with the shield at both ends, and possibly at intermediate points for exceptionally long cables.

- When shielded cables are not terminated at the cable connection and pass through the wall of a cabinet, the shield must be bonded to the cabinet wall to prevent noise acquired inside the cabinet from radiating outside the cabinet, and vice versa.

- When shielded cables are terminated to connectors, the shield must be able to provide complete 360^0 coverage and terminate through the connector backshell. The shield must *not* be grounded inside the connector through a drain wire. Grounding the shield inside the connector couples the noise on the shield to the signal conductors sharing the connector and virtually guarantees failure to meet European EMC requirements.

- The shield must be continuous. Each intermediate connector must continue the shield connection through the backshell.

- All cables, both power and signal should use twisted wire pairing.

The shield termination described above provides a coaxial type of configuration, which provides magnetic shielding, and the shield provides a return path for HF currents that are capacitively coupled from the motor windings to the frame. If power frequency circulating currents are an issue, a 250 VAC capacitor should be used at one of the connections to block 50/60 Hz current while passing HF currents. Use of a properly shielded motor cable is essential to meet European EMC requirements.

The following suggestions are recommended for all installations.

1. Motor cables must have a continuous shield and be terminated at both ends. The shield must connect to the ground bus bar or drive chassis at the drive end, and the motor frame at the motor end. Use of a properly shielded motor cable is essential to meet European EMC requirements.

2. Signal cables (encoder, serial, and analog) should be routed away from the motor cable and power wiring. Separate steel conduit can be used to provide shielding between the signal and power wiring. Do not route signal and power wiring through common junctions or raceways.

3. Signal cables from other circuits should not pass within 300 mm (1 ft.) of the drive.

4. The length or parallel runs between other circuit cables and the motor or power cable should be minimized. A rule of thumb is 300 mm (1 ft.) of separation for each 10 m (30 ft.) of parallel run. The 300 mm (1 ft.) separation can be reduced if the parallel run is less than 1 m (3 ft.).

5. Cable intersections should always occur at right angles to minimize magnetic coupling.

6. The encoder mounted on the brushless servomotor should be connected to the amplifier with a cable using multiple twisted wire pairs and an overall cable shield. Encoder cables are offered in various lengths that have correct terminations.

Persistent EMI problems may require additional countermeasures. The following suggestions for system modification may be attempted.

1. A ferrite toroid or “doughnut” around a signal cable may attenuate common mode noise, particularly RS-232 communication problems. However, a ferrite toroid will not help differential mode noise. Differential mode noise requires twisted wire pairs.

2. Suppress each switched inductive device near the servo amplifier. Switch inductive devices include solenoids, relay coils, starter coils and AC motors (such as motor driven mechanical timers).

3. DC coils should be suppressed with a “free-wheeling” diode connected across the coil.

4. AC coils should be suppressed with RC filters (a 200 Ohm 1/2 Watt resistor in series with a *0.5* uF, 600 Volt capacitor is common).

Following these guidelines can minimize noise problems. However, equipment EMC performance must meet regulatory requirements in various parts of the world, specifically the European Union. Ultimately, it is the responsibility of the machine builder to ensure that the machine meets the appropriate requirements as installed.

RECOMMENDATIONS FOR GLENTEK AMPLIFIERS

All amplifiers installed in a NEMA 12 enclosures or equivalent with wiring in metal conduit or enclosed metal wire trough (see Shielding and segregation).

Use Glentek shielded feedback and motor cables.

An AC line filter properly installed in a NEMA 12 enclosure or equivalent (see Filtering).

AC line filters for single-phase applications

1A-15A	input current, 120-250VAC use: Corcom 15ET1 or equivalent.
15A-25A	input current, 120-250VAC use: Corcom 25FC10 or equivalent.
25A-36A	input current, 120-250VAC use: Corcom 36FC10 or equivalent.

AC line filters for 3-phase applications

1A-25A	input current, 120-250VAC use: Corcom 25FCD10 or equivalent.
25A-36A	input current, 120-250VAC use: Corcom 36FCD10 or equivalent.
36A-50A	input current, 120-250VAC use: Corcom 50FCD10 or equivalent.
50A-80A	input current, 120-250VAC use: Corcom 80FCD10 or equivalent.

APPENDIX H

H - Amplifier Terms and Technology

This appendix contains information that describes and explains the terms and concepts referred to in this manual. The information contained here is generic to amplifiers and motion control technology in general and does not apply specifically to the SMA9800 series amplifiers. The TERMS section is a glossary that defines the terms used when discussing amplifiers. The TECHNOLOGY section describes methods or concepts that involves the usage of multiple terms.

TERMS

Analog Current Command Mode

Analog current mode, also called Torque mode or Current mode, indicates that the amplifier is being commanded by an analog signal and that the amplifiers' control loop is controlling current. This command mode is used when one needs to control torque. The analog signal, in volts, is a scaled representation of desired current as measure at the output. For instance -10 volts to 10 volts at the analog input becomes -15 amps to 15 amps at the amplifiers output. The scaling is different for different amplifiers.

Command Mode

A term used to refer to the method by which a command is given to an amplifier. The amplifier uses this command in its' control loop as a target to be achieved. The command mode usually includes how the amplifier is to interpret the command. That is, is the command to represent current, velocity or position. There are many forms and methods by which commands are submitted to an amplifier. Traditionally the command was given as an analog voltage input to the amplifier. Today there is analog, digital, serial communications or some combination of these.

Commutation

Commutation is the term used to describe the method by which current is applied to the windings of a motor such that the applied current moves the motor in a desired direction, or to a desired position, with the minimum current. Brushes are the method of commutation in a brush motor. In a three phase brushless motor, Sinusoidal Commutation is the usual method of commutation. See Sinusoidal Commutation.

Commutation Initialization Method

In order to properly commutate a brushless motor, the servo drive must know the absolute position of the rotor with respect to the motor windings in the stator. Since incremental shaft encoders only supply "relative" rotor position, the servo drive must perform a power-on, phase-finding scheme to determine the absolute position of the shaft. This is known as commutation initialization. Once the absolute position is determined, the position from the encoder can be used to maintain the absolute position. The SMA9800 amplifiers have three power-on commutation initialization methods available for finding the absolute position of the rotor. The first two methods, Twang and Dither, require the rotor to move; the third scheme, Hall, does not require motion. The Hall method does require the addition of Hall sensors or commutation tracks. Commutation tracks are simulated Hall sensors built into the shaft encoder.

Hall Commutation Initialization

Hall commutation initialization is a method that relies on sensors to give an approximation of the initial commutation angle of a motor. Hall initialization uses Hall sensors or commutation tracks (simulated Hall sensors built into the shaft encoder) to determine the rotor angle. In a brushless motor three Hall sensors are used to detect rotor position. The three Hall sensors employed are commonly named U, V and W; S1, S2 and S3; or A, B and C. The I sensors are digital (on/off) devices and therefore the combination of the three can result in eight different states. The sensors are aligned with the motor in a way that causes the output of the sensors to transition through six of the eight possible states as the motor is rotated through 360 electrical degrees. Each Hall state corresponds to 60 electrical degrees. Only one sensor changes states at any given transition.

At power up, the servo drive reads the state of the Hall sensors and from this state can determine within ±30 electrical degrees where the motor shaft is located. This is close enough to start commutating the motor, so the servo drive uses this approximation as the actual rotor position. Once motion is commanded (position, velocity or torque), the servo drive starts commutating with this value and watches for a transition of the Halls state. Upon this transition, the servo drive knows the exact location of the rotor shaft and updates the commutation angle based on this known location.

This method, unlike Twang or Dither, does not move the rotor shaft at power up. Instead, it uses a non-optimal commutation angle at start-up and corrects to the optimal commutation angle upon the first Hall state transition once motion is commanded.

Phase Lead

Phase lead is a gain applied to the commutation angle based on the velocity of the motor. Units are usually in degrees of commutation angle per 1000 rpm (degrees/krpm). Usually the phase angle is advanced for a positive velocity. An ideal phase lead at a given rpm in a specific application will minimize current in the motor. Phase lead is useful in applications where a velocity is held constant for a long period of time, particularly if the velocity is held at or near the rated speed of the motor. Spindle motors are a good application where phase lead is used. Appropriately used phase lead will reduce power consumption. This being said, most applications do not make use of phase lead.

Sinusoidal Commutation

In sinusoidal commutation a sinusoidal current is applied to each phase of the motor to cause the motor to rotate. In a three phase motor, the relationship of the currents applied in the three phases for a positive rotation of the rotor is:

$$IR(\theta e) = I * \sin(\theta e),$$
$$IS(\theta e) = I * \sin(\theta e - 120°),$$
$$IT(\theta e) = I * \sin(\theta e - 240°);$$

where:

IR, IS, and IT are the currents applied to phase R, S, and T respectively,
I is the amplitude of the commanded current,
θe is the “electrical angle” of the applied currents.

The relationship between the electrical angle, θc, and the mechanical angle (the angle of the rotor), θm, is:

$$\theta m = \theta c \times 2/N,$$

where

N is the number poles in the motor.

For example, a 4-pole motor (two North poles and two South poles) will rotate 180 mechanical degrees as the currents applied are varied through 360 electrical degrees.

Twang Commutation Initialization

Twang commutation initialization is a method that moves the motor twice to find and set the initial commutation angle of a brushless motor. When a fixed set of motor currents is applied to the three phases of the motor, the rotor will rotate to an electrical angle with a known relationship to the applied current. Since there are N/2 (N is the number of motor poles) electrical cycles per mechanical revolution of the motor, the actual rotor position can be 1 of N/2 mechanical locations. In "Twang" initialization, at power up, the servo drive applies current to all three motor phases in such a way that the motor rotor is forced to move to a known electrical position with respect to the stator. The rotor position can actually end up in one of two locations: The first is a stable equilibrium position and the second is an unstable equilibrium position. Since the servo drive cannot be certain at which of these two points the motor has stopped, it applies a second set of currents which will rotate the motor to another known location. This location will always be a stable equilibrium position and therefore results in one unique initial commutation angle.

The first set of currents applied will cause the rotor shaft to rotate up to ±180 electrical degrees (±180*2/N mechanical degrees). The second set of currents will cause the motor to rotate either 60 or 120 electrical degrees, depending upon which of the two locations the motor stopped at when the first set of currents was applied.

TECHNOLOGY

Selection of a commutation initialization method

The first step in selecting a commutation initialization method is to determine whether motion can be tolerated upon power up. If motion is not acceptable, then the motor must be equipped with Hall sensors or commutation tracks and Hall initialization should be used. If motion is acceptable at power up, then the second item which will prevent Twang initialization and Dither initialization from working properly is the presence of large external torque applied on the motor rotor. If large external torque exist which either resist rotor motion (such as a break or excessive friction), or cause the rotor to rotate (such as a gravity), then Twang and Dither can result in a non-optimal commutation angle. This occurs because these modes both rely upon finding equilibrium between the applied motor current and the rotor position; an external torque will alter this equilibrium position. If a large enough current is applied during initialization, this external torque can be overcome and an acceptable commutation angle can be achieved.

If motion is acceptable on power up and external torque is minimal, then either Twang or Dither initialization can be used. Dither is the quickest and requires the least motion. As the motion is very different between these two modes, the operator should try each one and determine which works best for his application.

If Twang or Dither initialization is selected, the amount of current applied to the motor during initialization must be set. This value can be set from MotionMaestro's commutation dialog. Typical values range from 2.5 amps to 5.0 amps. This value should be set as small as possible while still being large enough to overcome external torque. If too small a value is used, the motor will not be optimally commutated, and this will result in rough motion and larger than normal current required to move the motor.

APPENDIX I

I - Amplifier Model Numbering

This appendix explains the model numbering system for Glentek's Omega Series SynqNet® servo amplifiers. The model numbering system is designed so that you, our customer, will be able to quickly and accurately create the model number for the amplifier that best suits your needs. This manual contains complete model numbering information for the following amplifier types:

SMC9930

SMC9975

In order to accurately select a complete part number, please follow the steps shown below:

1. Select the amplifier type which meets your power requirements (i.e. SMC9930 or SMC9975) and proceed to that section of model numbering.

2. Select the feedback type which meets your requirements (I.e. Standard TTL encoder or 1Vpp Sine/Cosine encoder).

3. Utilize the model number key in conjunction with the tables at the beginning of each section to select the complete model number for your requirements. Note: A complete model number example follows the model number key and includes a full description of the individual codes which make up the complete model number.

SMC9930/SMC9975 Amplifier
Standard SynqNet® Model Numbering

The following tables are used to fill in the different parts of the model number. Refer to these when constructing a model number for your requirements.

XXX	Power Input Voltage	Amplifier	Continuous Current (Amps)	Peak Current (Amps)
100	135 - 260VAC	SMC9930	30	60
		SMC9975	75	150
103	50 - 135VAC	SMC9930	30	60
		SMC9975	75	150

Note: For brush type configurations, please contact Glentek.

YYY	Logic Board Description	Connector
000	Standard	Mini DIN 8
001	Sine Interpolator Preamp Board Option	Mini DIN 8

SMC9930/SMC9975 Stand Alone Amplifier with TTL Encoder Feedback Numbering Key

SMC9930 - XXX - YYY - 1B - 1 or SMC9975 - XXX - YYY - 1B - 1

Model number key:

SMC9930 or SMC9975 Designates an Omega Series SynqNet® Amplifier.

XXX Power Board Configuration Code.

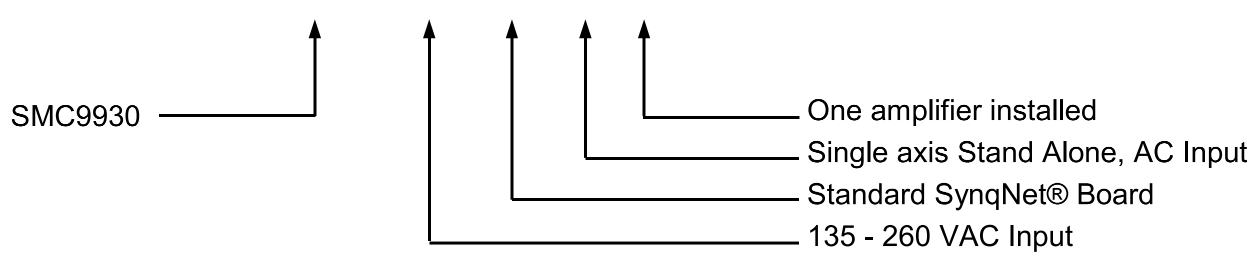
YYY Logic Board Configuration Code.

1B Mounting Configuration Code, Single Axis Stand Alone.

1 Single Amplifier Module.

Example:

SMC9930 - 100 - 000 - 1B - 1



SMC9930/SMC9975 Amplifier with Sine Interpolator Model Numbering

The following tables are used to fill in the different parts of the model number. Refer to these when constructing a model number for your requirements.

XXX	Power Input Voltage	Amplifier	Continuous Current (Amps)	Peak Current (Amps)
100	135 - 260VAC	SMC9930	30	60
		SMC9975	75	150
103	50 - 135VAC	SMC9930	30	60
		SMC9975	75	150

YYY	Logic Board Description	Connector
000	Standard	Mini DIN 8
001	Sine Interpolator Preamp Board Option	Mini DIN 8

ZZZ	Sine Interpolator Board
000	DBN Option
001	No DBN Option

SMC9930/SMC9975 Stand Alone Amplifier With Sine Interpolator Numbering Key

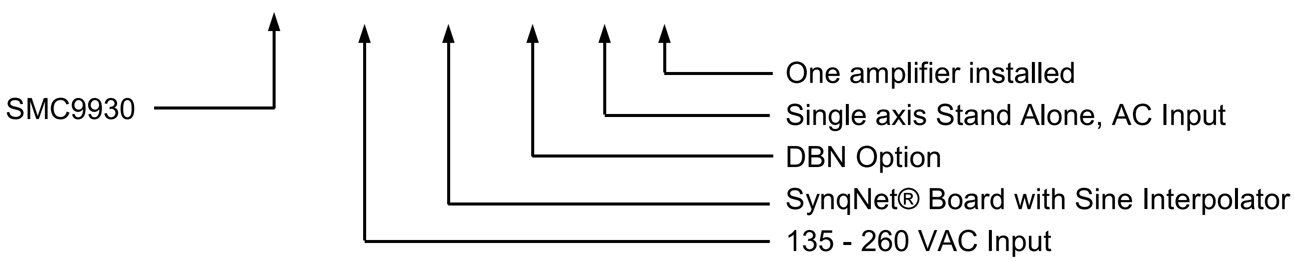
SMC9930 - XXX - YYY - ZZZ - 1B - 1 or SMC9975 - XXX - YYY - ZZZ - 1B - 1

Model number key:

SMC9930 or SMC9975	Designates an Omega Series SynqNet® Amplifier.
XXX	Power Board Configuration Code.
YYY	Logic Board Configuration Code.
ZZZ	Sine Interpolator Board Configuration Code.
1B	Mounting Configuration Code, Single Axis Stand Alone.
1	Single Amplifier Module.

Example:

SMC9930 - 100 - 001 - 000 - 1B - 1



Appendix J
Factory Repair & Warranty

Factory Repair

Should it become necessary to return a servo drive to Glentek for repair, please follow the procedure described below:

1. Reassemble the unit, if necessary, making certain that all the hardware is in place.
2. Tag the unit with the following information:
   A. Serial number and model number.
   B. Company name, phone number, and name of representative returning the unit.
   C. A brief notation explaining the malfunction.
   D. Date the unit is being returned.
3. Repackage the unit with the same care and fashion in which it was received. Label the container with the appropriate stickers (e.g.: FRAGILE: HANDLE WITH CARE).
4. Contact a Glentek representative, confirm that the unit is being returned to the factory and obtain an RMA (Return Material Authorization) number. The RMA number must accompany the unit upon return to Glentek.
5. Return the unit by the best means possible. The method of freight chosen will directly affect the timeliness of its return.

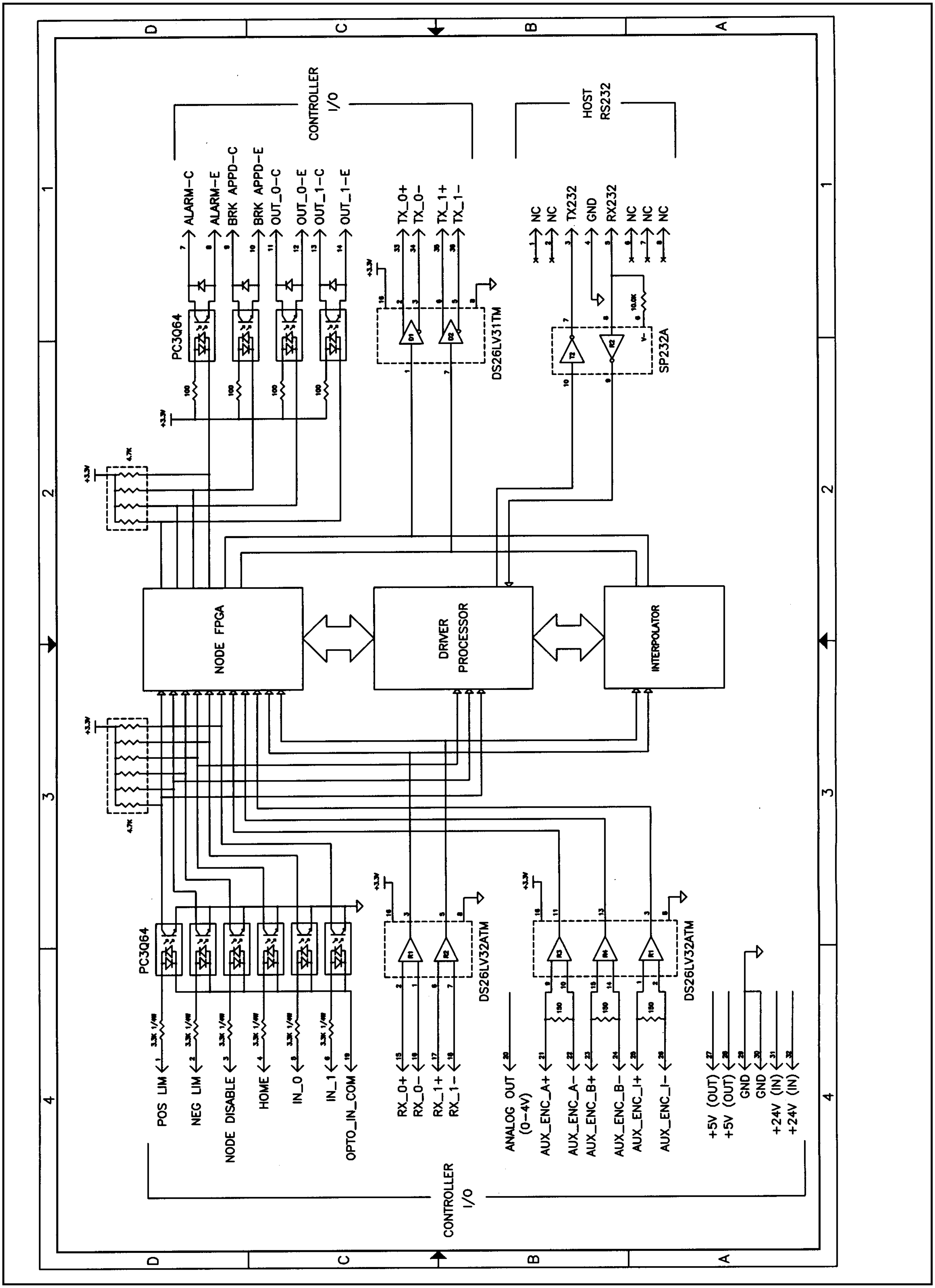
Glentek also offers a 24-48 hour repair service in the unlikely event that your system is down and you do not have a replacement servo drive.

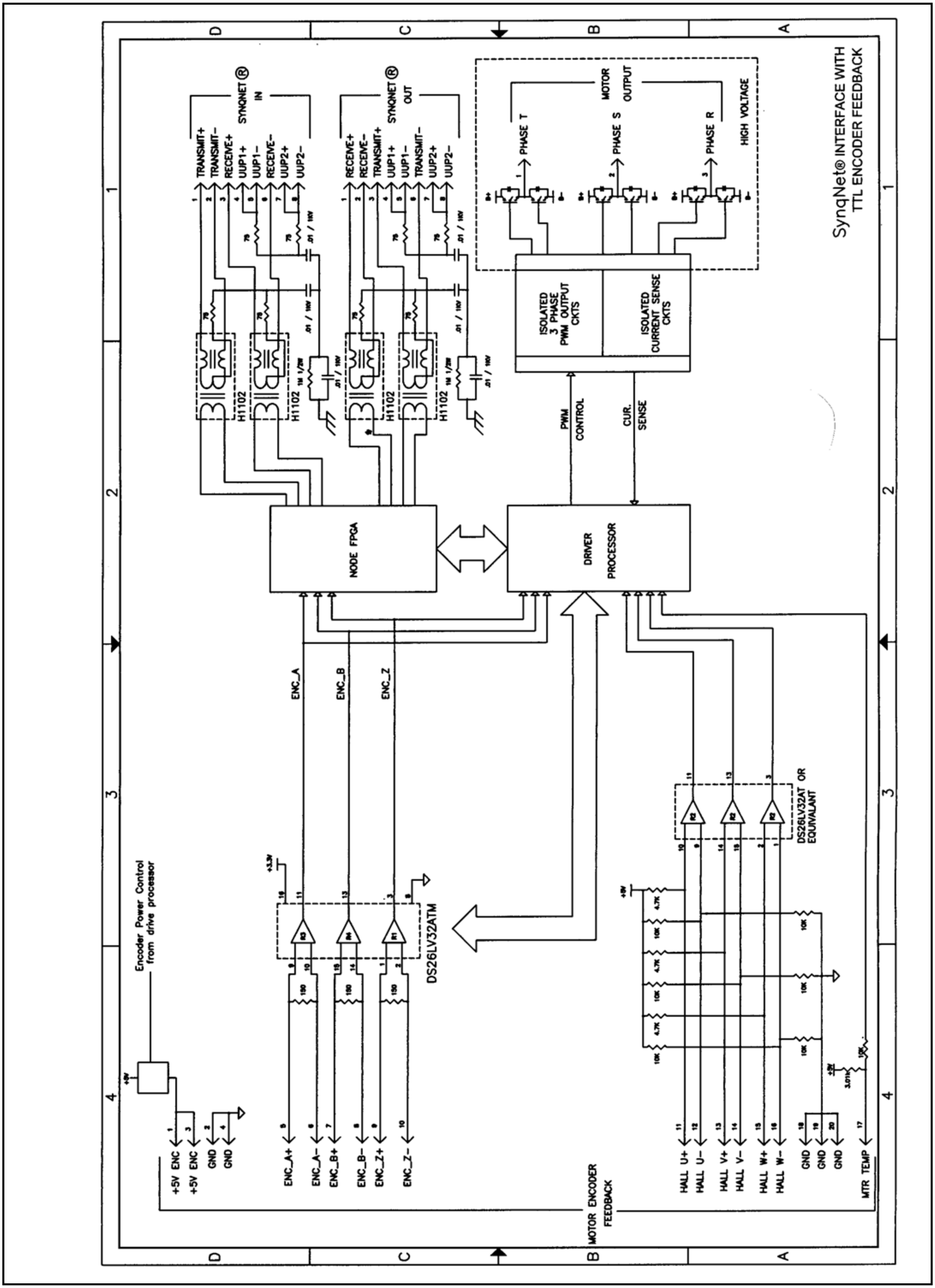
Warranty

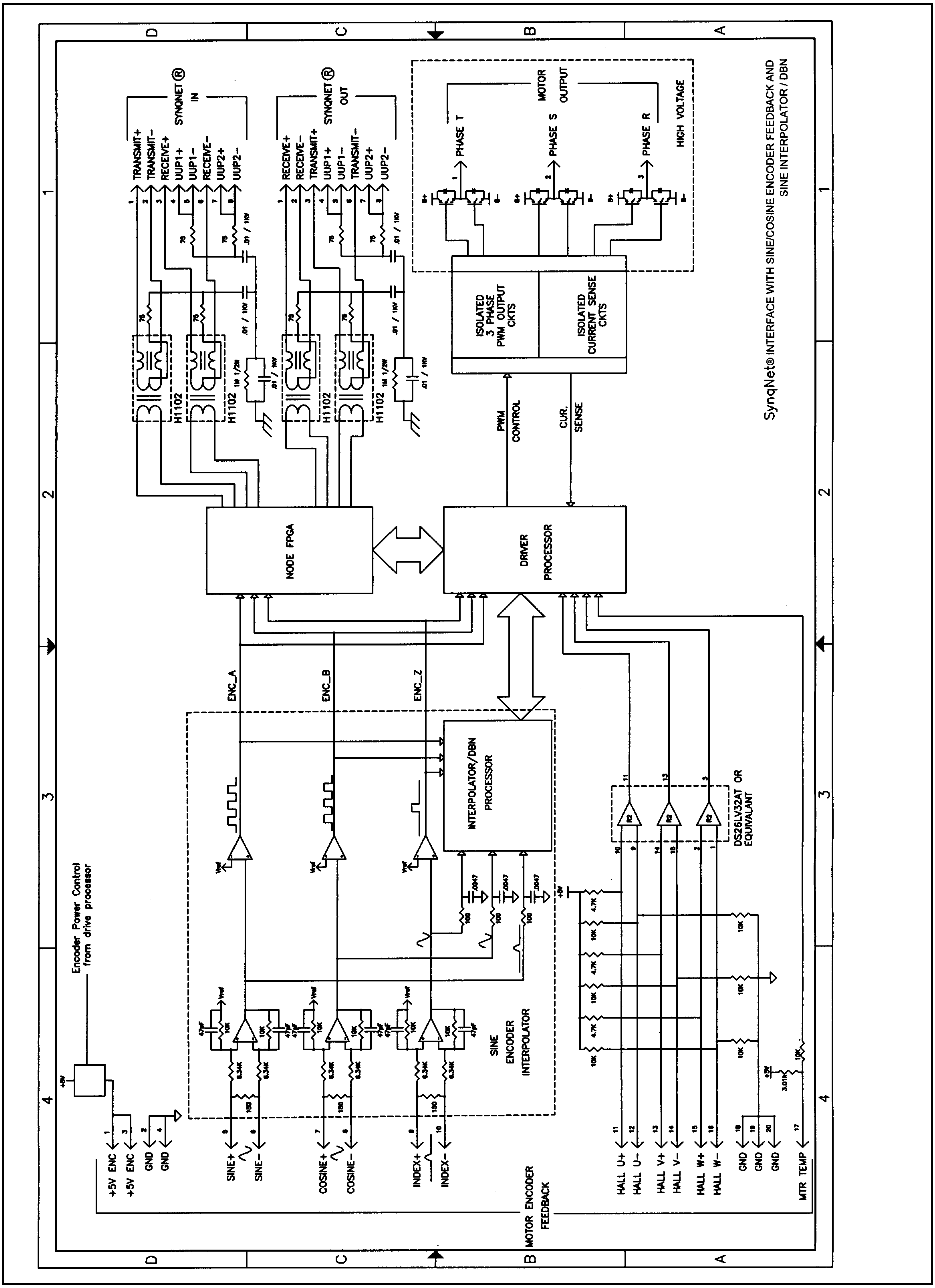
Any product, or part thereof, manufactured by Glentek, Inc., described in this manual, which under normal operating conditions, in the plant of the original purchaser, thereof proves defective in material or workmanship within one year from the date of shipment by us, as determined by an inspection by us, will be repaired or replaced free of charge, FOB our factory, El Segundo, California, U.S.A. provided that you promptly send to us notice of the defect and establish that the product has been properly installed, maintained, and operated within the limits of rated and normal usage, and that no factory sealed adjustments have been tampered with. Glentek's liability is limited to repair or replacement of defective parts.

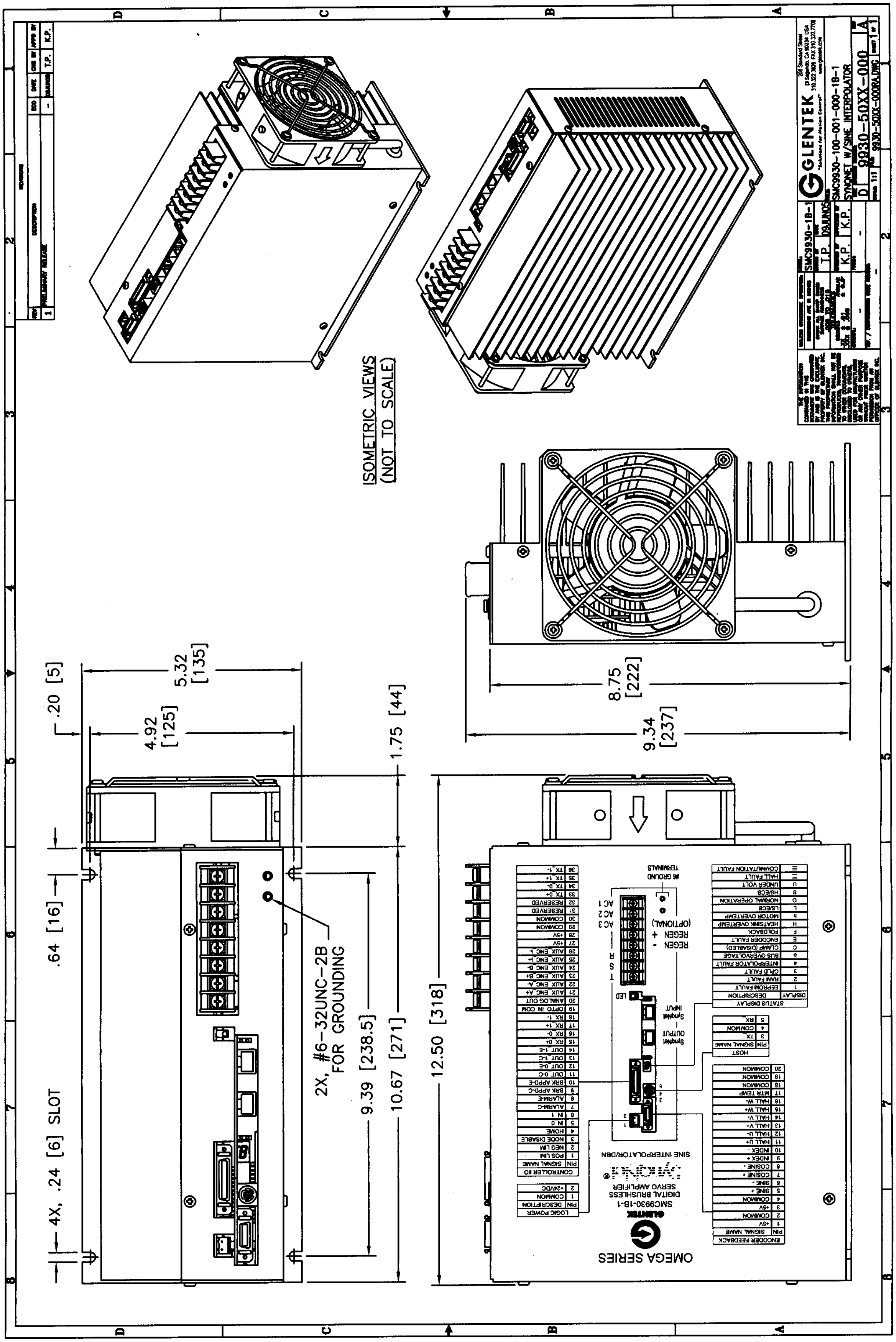
Any product or part manufactured by others and merely installed by us, such as an electric motor, etc., is specifically not warranted by us and it is agreed that such product or part shall only carry the warranty, if any, supplied by the manufacturer of that part. It is also understood that you must look directly to such manufacturer for any defect, failure, claim or damage caused by such product or part.

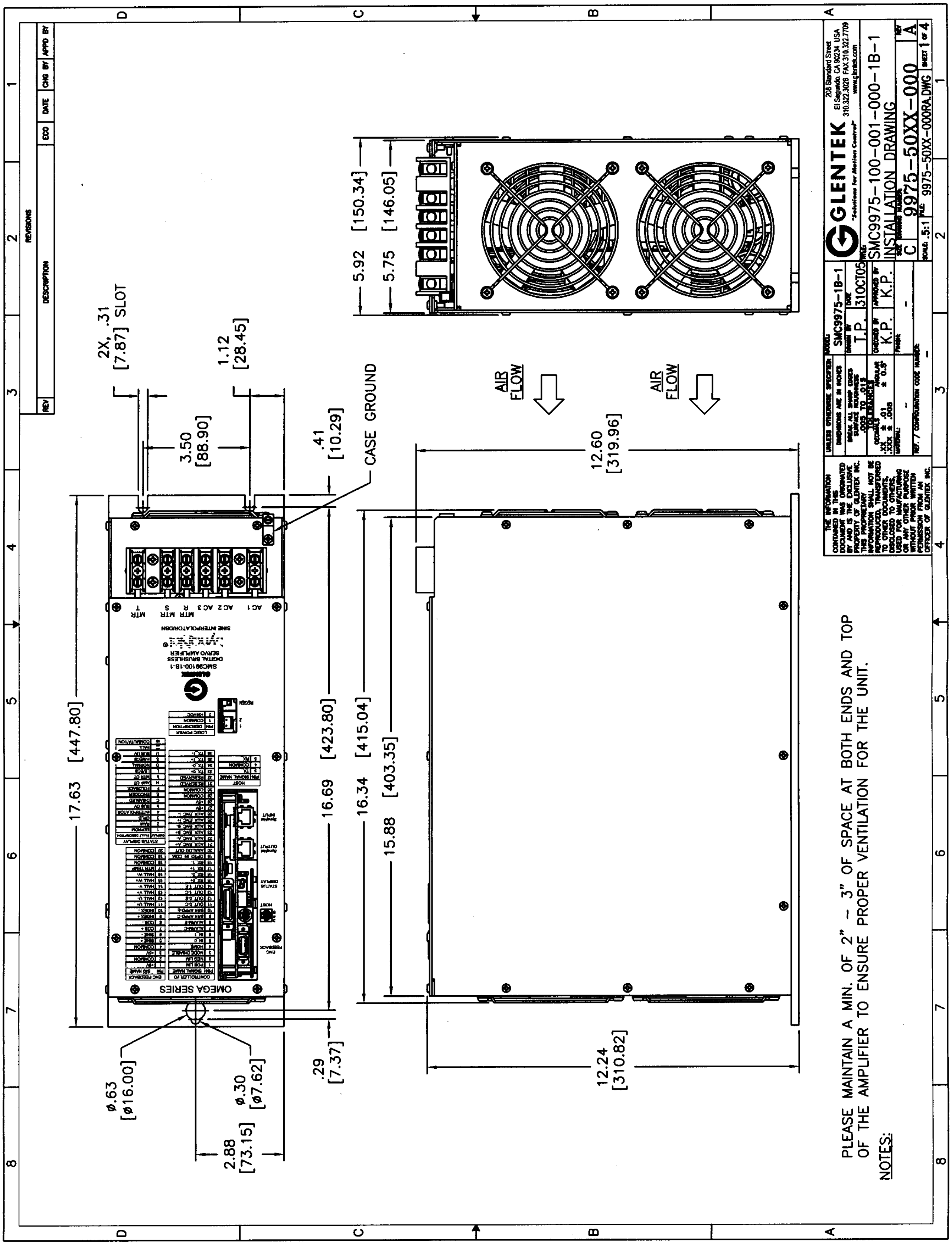
Under no circumstances shall Glentek, Inc. or any of our affiliates have any liability whatsoever for claims or damages arising out of the loss of use of any product or part sold to you. Nor shall we have any liability to yourself or anyone for any indirect or consequential damages such as injuries to person and property caused directly or indirectly by the product or part sold to you, and you agree in accepting our product or part to save us harmless from any and all such claim.


CONTROLLER I/O
ALARM–C
ALARM–E
BRK APPD–C
BRK APPD–E
OUT_0–C
OUT_0–E
OUT_1–C
OUT_1–E
PC3Q64
TX_0+
TX_0–
TX_1+
TX_1–
DS26LV31TM
HOST RS232
NC
TX232
GND
RX232
SP232A
NODE FPGA
DRIVER PROCESSOR
INTERPOLATOR
POS LIM
NEG LIM
NODE DISABLE
HOME
IN_0
IN_1
OPTO_IN_COM
RX_0+
RX_0–
RX_1+
RX_1–
DS26LV32ATM
ANALOG OUT (0–4V)
AUX_ENC_A+
AUX_ENC_A–
AUX_ENC_B+
AUX_ENC_B–
AUX_ENC_I+
AUX_ENC_I–
+5V (OUT)
GND
+24V (IN)
4.7K
3.3K 1/4W
150
100
10.0K
+3.3V


SynqNet® INTERFACE WITH
TTL ENCODER FEEDBACK
SYNQNET® IN
SYNQNET® OUT
TRANSMIT+
TRANSMIT−
RECEIVE+
UUP1+
UUP1−
RECEIVE−
UUP2+
UUP2−
RECEIVE−
TRANSMIT−
H1102
MOTOR OUTPUT
PHASE T
PHASE S
PHASE R
HIGH VOLTAGE
ISOLATED 3 PHASE PWM OUTPUT CKTS
ISOLATED CURRENT SENSE CKTS
PWM CONTROL
CUR. SENSE
NODE FPGA
DRIVER PROCESSOR
ENC_A
ENC_B
ENC_Z
DS26LV32ATM
DS26LV32AT OR EQUIVALANT
Encoder Power Control from drive processor
+5V ENC
GND
ENC_A+
ENC_A−
ENC_B+
ENC_B−
ENC_Z+
ENC_Z−
HALL U+
HALL U−
HALL V+
HALL V−
HALL W+
HALL W−
MTR TEMP
MOTOR ENCODER FEEDBACK


SynqNet® INTERFACE WITH SINE/COSINE ENCODER FEEDBACK AND SINE INTERPOLATOR / DBN
SYNQNET ® IN
SYNQNET ® OUT
TRANSMIT+
TRANSMIT-
RECEIVE+
UUP1+
UUP1-
RECEIVE-
UUP2+
UUP2-
H1102
NODE FPGA
DRIVER PROCESSOR
ISOLATED 3 PHASE PWM OUTPUT CKTS
ISOLATED CURRENT SENSE CKTS
PWM CONTROL
CUR. SENSE
MOTOR OUTPUT
PHASE T
PHASE S
PHASE R
HIGH VOLTAGE
ENC_A
ENC_B
ENC_Z
INTERPOLATOR/DBN PROCESSOR
SINE ENCODER INTERPOLATOR
DS26LV32AT OR EQUIVALANT
Encoder Power Control from drive processor
+5V ENC
GND
SINE+
SINE-
COSINE+
COSINE-
INDEX+
INDEX-
HALL U+
HALL U-
HALL V+
HALL V-
HALL W+
HALL W-
MTR TEMP
MOTOR ENCODER FEEDBACK


ISOMETRIC VIEWS
(NOT TO SCALE)
8.75
[222]
9.34
[237]
5.32
[135]
4.92
[125]
.20 [5]
1.75 [44]
.64 [16]
4X, .24 [6] SLOT
2X, #6-32UNC-2B
FOR GROUNDING
9.39 [238.5]
10.67 [271]
12.50 [318]
OMEGA SERIES
GLENTEK
SMC9930-1B-1
DIGITAL BRUSHLESS
SERVO AMPLIFIER
SINE INTERPOLATOR/DBN
REGEN -
REGEN +
(OPTIONAL)
AC 1
AC 2
AC 3
GLENTEK
SMC9930-100-001-000-1B-1
SYNONET W/SINE INTERPOLATOR
D 9930-50XX-000 A


NOTES:
PLEASE MAINTAIN A MIN. OF 2" – 3" OF SPACE AT BOTH ENDS AND TOP OF THE AMPLIFIER TO ENSURE PROPER VENTILATION FOR THE UNIT.
AIR FLOW
AIR FLOW
CASE GROUND
2X, .31 [7.87] SLOT
1.12 [28.45]
3.50 [88.90]
.41 [10.29]
17.63 [447.80]
16.69 [423.80]
16.34 [415.04]
15.88 [403.35]
12.60 [319.96]
12.24 [310.82]
5.92 [150.34]
5.75 [146.05]
ø.63 [ø16.00]
ø.30 [ø7.62]
.29 [7.37]
2.88 [73.15]
OMEGA SERIES
GLENTEK
208 Standard Street El Segundo, CA 90245 USA
SMC9975-1B-1
T.P.
31OCT05
K.P.
K.P.
SMC9975-100-001-000-1B-1
INSTALLATION DRAWING
C
9975-50XX-000
A
9975-50XX-000RA.DWG
.5:1
1 of 4
REVISIONS

Omega Series Digital PWM Brushless Servo Amplifiers

- PWM (Pulse-Width-Modulated) Brushless servo amplifiers to 20KW

Analog Brush Type Servo Amplifiers

- Linear Brush type servo amplifiers to 2.6KW
- PWM (Pulse-Width-Modulated) Brush type servo amplifiers to 28KW

Analog Brushless Servo Amplifiers

- Linear Brushless servo amplifiers to 3.5KW
- PWM (Pulse-Width-Modulated) Brushless servo amplifiers to 51KW

Permanent Magnet DC Brush Type Servo Motors

- Continuous Torques to 335 in. lb.
- Peak Torques to 2100 in. lb.

Permanent Magnet DC Brushless Servo Motors

- Continuous Torques to 1100 in. lb.
- Peak Torques to 2200 in. lb.

GLENTEK
"Solutions for Motion Control"

MANUAL#: 9930-3040-000
REVISION: (A)
DATE: 04 DEC 2006

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