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SERVOSTAR

INSTALLATION AND SETUP MANUAL

M-SU-000-H ISSUE 2 FOR S(X)XX2XX MODELS

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RECORD OF REVISIONS

(INSTALLATION AND SETUP MANUAL M-SU-000-H)

ISSUE NO. (Revision)	DATE	CHANGED PAGES/BRIEF DESCRIPTION OF CHANGE	CHANGE NO.
0	--	Preliminary Issue for Review	
1	1/5/98	Initial release of UCB hardware and firmware version 2.0.1	
2	3/13/98	Added UCB features with firmware version 2.1.0	

ERRATA

1. The version of MotionLink software (version 2.5.0) provided in this issue does not fully support Opmodes other than 0-3. Support of Opmodes 4-8, as they become available in SERVOSTAR firmware, will be strictly limited to the MotionLink Terminal Screen (i.e. to set Opmode 8 position loop parameters GP and GPI, use the Motion Link Terminal Screen to do so since these functions are not supported in the other Motion Link screens). As future versions of the ServoStar firmware and the MotionLink program are released, this incompatibility will be resolved.

2. Under certain conditions the ServoStar will display an "A" in the LED display (instead of a "P") when a short circuit condition exist. Use the ERRHIST command to determine total fault sequence.

3. Electronic gearing is now supported in OPMODE 4. The signal can be applied to either the Differential Input of C8 or the Digital Inputs of C3. However, the Digital Inputs can only be operate to a 2.5kHz squarewave (20uS pulse width). Use the Differential Input when higher frequencies are desired (up to 3MHz)

4. The Analog Differential Input currently has only a 12 bit resolution (14 bit will be available in future releases).

5. The TUNE command produces less than satisfactory results in some applications (one or more variables may be miscalculated). If this occurs, refer to the manual tuning methods described in the Theory section of the user's manual.

6. Old motor compensations using the CURCOEF variable are no longer compatible with this UCB version. Use the new motor database provided in MotionLink.

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7. Notice: When running in the serial velocity operation mode, communication to the drive through connector C1 can cause audible "ticks" from the motor in some applications. This does not affect servo performance and is only found in 2.1.1 firmware.

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INTRODUCTION

HOW TO USE THIS MANUAL

This Installation and Setup Manual is designed to help you properly install a SERVO**STAR** Servo System. You do not have to be an expert in motion control to operate the system, however, this manual does assume you have a fundamental understanding of basic electronics and motion control concepts and safety.

The SERVO**STAR** is a computer configurable servo loop controller. An understanding of computer operation techniques will be beneficial to most users, however, this product is designed to be used without prior computer knowledge.

It is recommended that you read this ENTIRE manual before you attempt to install the SERVO**STAR**. This will familiarize you with the system components and their relationship to one another.

After installation check all system parameters to insure you have configured your SERVO**STAR** properly.

Be sure to follow all instructions carefully and pay special attention to safety.

INSTALLATION AND START-UP GUIDELINES

In order to ensure proper operation of the SERVO**STAR**, it is recommended that the installation and setup information in this manual be read and followed while mounting and wiring the unit. Failure to follow warnings, cautions, notes, and recommendations may affect system performance, safety, and may void the product warranty.

REFER TO THE FOLLOWING SECTIONS TO ENSURE PROPER INSTALLATION OF THE SERVO**STAR**:

Paragraph 1.5 Specifications and Ratings
Paragraph 1.6 Power Supplies (including Table 1-2)
Section 2. Installation
Section 3. System Start-Up
Section 8. SERVO**STAR** MotionLink

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WARNING

Dangerous voltages, currents, temperatures, and energy levels exist in this product and in the associated servo motor(s). Extreme caution should be exercised in the application of this equipment. Only qualified individuals should attempt to install, set-up, and operate this equipment. Ensure that the motor, drive, and the end-user assembly are all properly grounded per NEC requirements.

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EUROPEAN COMMUNITY (EC) DECLARATION OF CONFORMITY

We, Kollmorgen Corporation Industrial Drives Division, 201 Rock Rd, Radford, VA, USA, declare: under sole responsibility, this equipment is exclusively designed for incorporation in another machine. The operation of this equipment is submitted to the conformity of the machine in which it is incorporated, following the provisions of the EC Electro-Magnetic Compatibility (EMC) directive 89/392/EEC.

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ABBREVIATIONS

A/D	Analog-to-Digital Converter
ADC	Analog-to-Digital Converter
CCW	Counter Clockwise*
CMR	Common Mode Rejection
CNC	Computer Numerical Control
Cont.	Continued
CW	Clockwise*
CR-LF	ASCII Carriage Return, Line Feed
D/A	Digital-to-Analog Converter
D/L	Direction Limit
DAC	Digital-to-Analog Converter
EMF	Electro-Motive Force
EMI	Electro-Magnetic Interference
ESD	Electrostatic Discharge
GC	Goldline Cable
GCS	Goldline Cable Set
Hz	Hertz
I	Current
I/O	Input / Output
kHz	KiloHertz
KW	KiloWatts
LED	Light Emitting Diode
NEC	National Electrical Code
PC	Personal Computer
P/N	Part Number
PK	Peak
PLC	Programmable Logic Control
PWM	Pulse Width Modulation
R/D	Resolver-to-Digital
Regen	Regeneration
RMS	Root Mean Square
Tach	Tachometer
TL	Test Limits
UL	Underwriters Laboratories

* Clockwise and counterclockwise reference as viewing the motor output shaft.

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SECTION 1

PRODUCT DESCRIPTION

1.1 INTRODUCTION

The SERVO**STAR** product line is described. Product features are explored and the part numbering system is explained. This basic information will enable you to understand the SERVO**STAR**'s basic functionality. These concepts will develop a fundamental understanding required for the rest of the manual.

1.2 PRODUCT LINE DESCRIPTION

The SERVO**STAR** is a Digital Servo Motor Drive Amplifier that meets the needs of a majority of servo applications. It is configurable to be utilized in one of five user selectable modes of operation:

1. Torque Mode Controller (Serial or Analog)
2. Velocity Mode Controller (Serial or Analog)
3. SERCOS Interface

The SERVO**STAR** is ideal for use in a wide variety of servo motion control applications. Some examples are:

- Machine Tooling
- Packaging
- Electronic Assembly
- Document Handling

The SERVO**STAR** Product line offers:

- A choice of six amplifiers having current ratings of 3, 6, 10, 20, 30, 55, and 85 amperes. Encoder with hall, or resolver feedback devices are compatible.
- A choice of seven power supplies having current ratings of Logic-only, 8, 14, 28, 50, 75, and 85 amperes. Optional Regen resistors.
- Power and feedback cables for B, EB, H, M, RBE, Linear, and Platinum XT.
- MotionLink™ Windows™ based set-up environment.
- Standard motor combinations on disk.
- Optional SERCOS interface Version.

In addition, Kollmorgen Industrial Drives provides comprehensive Technical Manuals and Applications Notes. Technical support and field service personnel are always available to assist in resolving any system operating problems which may occur.

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1.3 FEATURES

The SERVO**STAR** offers a wide feature set to accommodate real-world requirements:

FULLY DIGITAL : The SERVO**STAR** is fully digital which provides extreme stability with respect to age, temperature, and application. The SERVO**STAR** is tuned using exact numbers based on analytical models not subjective potentiometer adjustments.

UNIVERSAL EXPANSION PORT : An option port connector is provided which allows connection to future peripheral devices such as a Sinusoidal Encoder Interface Module.

UNIVERSAL CONTROL : Control capability includes:

1. Synchronous Permanent Magnet Motors (in any pole count)
2. Linear Permanent Magnet Motors

ADVANCED CONTROL ALGORITHMS : The SERVO**STAR** employs a high-order state-feedback compensator. This is an improvement over the standard pseudo-derivative-feedback (PDF) and proportional-integral-derivative (PID) compensators. In addition, this pole placement compensator includes anti-windup and automatic offset compensation algorithms. The compensator is designed to allow PDF or PI implementations in not-so-demanding applications. The drives are sinusoidal output and incorporate patented control algorithms related to increased feedback resolution and maximum torque utilization.

ERGONOMIC USER INTERFACE : The SERVO**STAR** Motion Link is a Microsoft Windows ™ (the standard for PC based interface programs) based program which incorporates intuitive graphics and pull-down menus for operation and debugging. A portion of this program is dedicated to data acquisition and interactive tuning for the compensator algorithm.

MODULAR CONSTRUCTION : The SERVO**STAR** system consists of a selection of:

1. One or more 3, 6, 10, 20, 30, 55 or 85 Amp @230 VAC continuous output power drive amplifier(s).
2. A Logic-only, 8, 14, 28, 50, 75, or 85 Amp continuous input power supply. Softstart is standard on all models for direct line connection. The 14, 28, 50, 75 and 85 Amp power supplies include Regen capability.

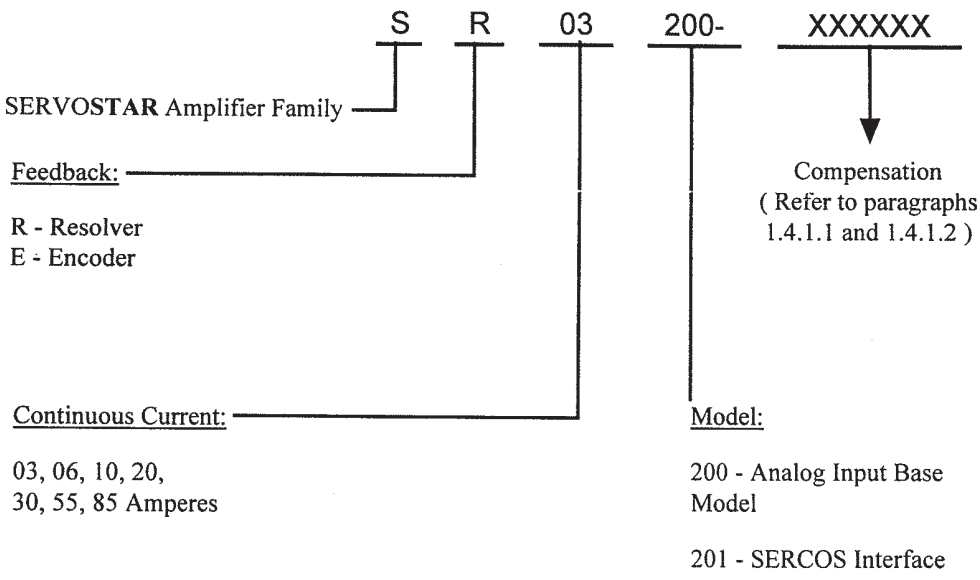
FEEDBACK DEVICES : Variations of the SERVO**STAR** are provided for use with encoder or resolver feedback types.

COMMUNICATION BUS : A drive-to-drive bus (Daisy Chain) allows the host computer's RS232 port to function as though it were a multidrop bus.

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1.4 PART NUMBER DESCRIPTION

1.4.1 SERVOSTAR Model Number

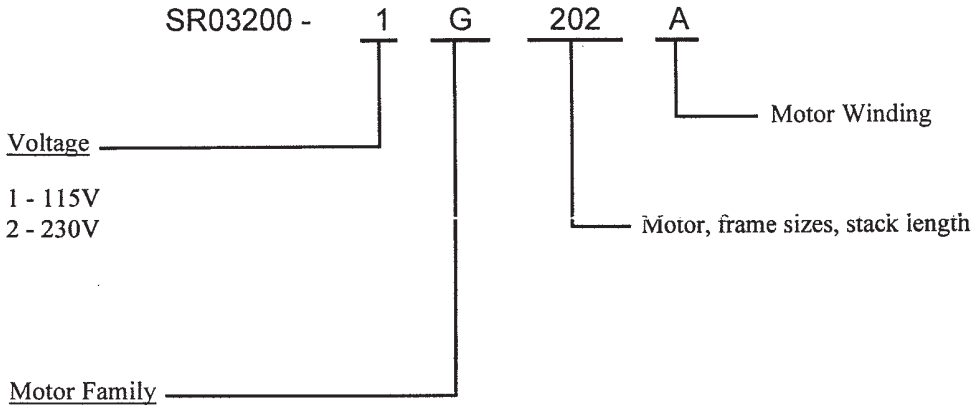


CONNECTOR KIT :

CK100 . . . . Mating connectors for C1, C2, C4, and C8 (C3 and C5 included with Amplifier).

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1.4.1.1 SERVOSTAR Standard Compensations

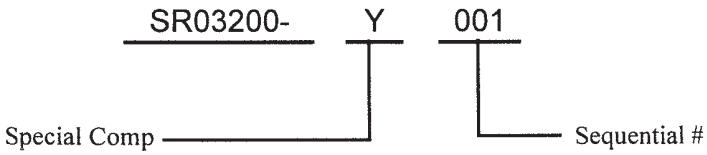


G - B, EB, or M series
R - RBE, RBEH series
H - H series
P - Platinum XT series
IC - Linear Iron Core series
IL - Linear Ironless (Slotless) series

Notes:
Standard compensation will be shipped $J_L / J_m = 1$

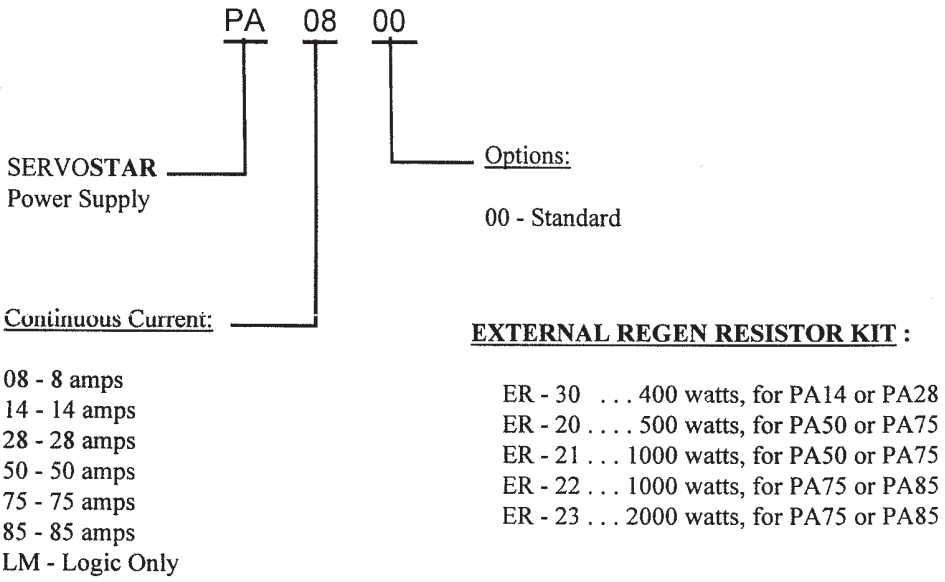
See System Technical Publications for Complete Ordering Information.

1.4.1.2 SERVOSTAR Special Compensations



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1.4.2 Power Supply Model Number



1.4.3 Part Number Label

A model number label is located on the SERVOSTAR Units, and Power Supply Units. The model number identifies how the equipment is configured.

MODEL NO:

SERIAL NO:

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1.4.4 SERVOSTAR GOLDLINE MOTOR Cable Sets

CS - SS - R G A 1 2 - 03

Cable Set

Amplifier Family

SS - SERVOSTAR
SL - SILVERLINE

Feedback Type

E - Encoder / Hall
R - Resolver

Motor End - Feedback Connections

G - GOLDLINE (MS, bayonet type)
A - GOLDLINE, (MS, screw type)
P - Platinum XT (cpc, bayonet type)
S - SILVERLINE (cpc, bayonet type)
U - Unterminated

Amplifier End - Connections

A - SERVOSTAR : 3, 6, 10, 20 amps
B - SERVOSTAR : 30 amps
C - SERVOSTAR : 55 amps
D - RO / ROL
E - BJRL 200 volt
F - BJR 20 - 40 V
U - Unterminated

Wire Size - Power cable

1 - 14 awg : SL(H-23X, H-34X)
GL(M1, M2A)
Platinum(U9BL-C, U12BL-C, U16BL-D)
2 - 12 awg GL(M2B, M4A, M6A)
3 - 10 awg GL(20 - 30 A)
4 - 8 awg GL(M4B, M6B, M8A)
5 - 6 awg
6 - 4 awg GL(M8B)

Length in meters (03, 06, 09. . .)

(30 meter max) - encoder feedback
(100 meter max) - resolver feedback

Motor End - Power Connections

1 - Platinum XT screw connector
2 - GL M1, M2A GL bayonet connector
3 - M4A, M2B GL bayonet connector
4 - 4B, 6B, 6A GL bayonet connector
5 - 8A GL bayonet connector
6 - 8B GL bayonet connector
7 - M4A GL screw type connector
8 - 4B, 6B, 6A GL screw type connector
9 - 8A GL screw type connector
A - 8B GL screw type connector
S - SILVERLINE H Series (cpc)
U - Unterminated

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1.5 SPECIFICATIONS AND RATINGS

Table 1-1. SERVOSTAR *Specifications*

	Amplifier Model	Sx03	Sx06	Sx10	Sx20	Sx30	Sx55	*Sx85
Main Input Power	BUS Voltage (Vdc)	125 to 360	125 to 360	125 to 360	260 to 360	260 to 360	260 to 360	260 to 360
	Input power @ dc (kW)	0.63-1.4	1.26-2.79	1.96-4.34	8.68	13.33	24.45	37.20
	UNDERVOLTS trip (power-up)	90 Vdc	90 Vdc	90 Vdc	255 Vdc	255 Vdc	255 Vdc	255 Vdc
	UNDERVOLTS trip (normal)	90 Vdc	90 Vdc	90 Vdc	125 Vdc	125 Vdc	125 Vdc	125 Vdc
	OVERVOLTS trip	430 Vdc	430 Vdc	430 Vdc	430 Vdc	430 Vdc	430 Vdc	430 Vdc
Control Input Power	Logic Supply Voltage (Vdc) ±5%	8	8	8	8	8	8	8
	Logic Supply Current (Amp)	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	15V Supply (Vdc)	+15/-15	+15/-15	+15/-15	+15/-15	+15/-15	+15/-15	+15/-15
	15V Supply Current (mA)	370	370	380	500	470	580	580
Output Power	Continuous Power (kw) (45°C ambient) @ 115 Vac 1 phase	0.55 kw	1.1 kw	1.7 kw	n/a	n/a	n/a	n/a
	Continuous Power (kw) (45°C ambient) @ 230 Vac 3 phase	1.1	2.2	3.6	7.3	11	20	33
	Control method	Sinusoidal PWM current control						
	Rated output current (amps)	3	6	10	20	30	55	85
	Max. current for 2 sec. (amps)	6	12	20	40	60	110	170
	PWM switching frequency (kHz)	16	16	16	8	8	8	8
	Motor current ripple (kHz)	32	32	32	16	16	16	16
	Form factor (rms/avg.)	≤1.01	≤1.01	≤1.01	≤1.01	≤1.01	≤1.01	≤1.01
Protective Functions	Over Current, Over Volts, Under volts, Control Volt Loss, Feedback Loss, Over Speed, Resolver loss, Over Temp							
	Over temperature trip (°C)	3 to 20 amp drives 118 °c and 90 °c for 30, 55, and 85 amp drives						
Diagnostics	ROM/RAM check on power-up, Checksum EEPROM storage, Software and Hardware watchdog timers.							
	Display	Seven segment display for operation mode, drive status, and fault display						
Commutation	Update rate	62. us (16 kHz)						
	Output Waveform	Sinusoid						
Current Loop Specifications	Current loop update rate	62.5 uS (16kHz)						
	Current loop BW (Hz) (Max)	<2000Hz						

* Available in 3rd quarter of 1998

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Table 1-1. SERVOSTAR *Specifications Continued*

	Amplifier Model	Sx03	Sx06	Sx10	Sx20	Sx30	Sx55	*Sx85
Velocity Loop Specifications	Control Algorithm	PI PDFF/Standard Pole Placement/Advanced Pole Placement						
	Velocity loop update rate	250 us (4 KHz)						
	Velocity loop BW	up to 400 Hz						
	Speed control range	0 to 16383						
	Speed command Input	Serial/Analog: 12 Bit (Optional 14 Bit)						
	Maximum speed	500 Hz						
	Minimum speed	1 RPM serial or 1/2048 VMAX in analog mode						
	Long term speed regulation	.01% (µP clock tolerance)						
Remote Enable and User Inputs	Input voltage (max.) Min. on Max. off	12 to 24 V Nominal 10 V 1 V						
(Bi-Polar LEDS)	Input current @ 24 volts	20 mA						
Digital Output (Open Collector)	Output voltage (max.) Min. on	0 to 48 V Nominal 0.7 V						
	Max Drive Current	60 mA						
Analog Output	Resolution	12 Bit						
	Voltage range	±10V						
Analog Input	Maximum voltage	13 V differential						
	Input Resolution	12 Bit (Optional 14 Bit)						
	Sensitivity	4.9mV @12Bit						
	Voltage range	-8 to +8V (Standard) / -10 to +10 V (Rescaled)						
	Input impedance	> 10 K ohms						
	CMR	50 dB						
	Long term drift	100 ppm (0.075%/°C)						
Encoder Output (RS485 standard)	Output voltage (high-level)	3.75 V @ 20 milliamps @ 25° C						
	Output voltage (low-level)	1.10V @ 20 milliamps @ 25°C						
	Line driver type	AM26LS31						
Status Relay	Capacity	2 A @ 28 Vdc						
Environment	Internal heat dissipation (watts) in 45° ambient @ continuous current (not including regen)	37 w	84 w	120 w	240 w	254 w	465 w	675 w
	Operation temperature (°C)	0 to 45						
	Storage temperature (°C)	-20 to 70						
	Humidity (non-condensing)	10% to 90%						
	Atmosphere	With no Corrosive gasses or dust						
	Altitude	3300 feet max. without derate						
	Vibration	0.5 g						
Package	Weight lb (kg) (Typical)	6.3 (2.85)	6.3 (2.85)	7.3 (3.3)	9.9 (4.5)	11.5 (5.2)	14.3 (6.5)	TBD
	Height in (mm) (Max)	10.41 (264.4)	10.41 (264.4)	10.41 (264.4)	10.41 (264.4)	11.89 (302)	11.89 (302)	12.38 (315)
	Width in (mm) (Max)	3.03 (77)	3.03 (77)	3.63 (92.2)	4.7 (120)	5.59 (142)	6.53 (166)	6.75 (172)
	Depth in (mm) (Max)	7.95 (202)	7.95 (202)	7.95 (202)	7.95 (202)	8.35 (212)	8.35 (212)	8.62 (219)

* Available in 3rd quarter of 1998

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Resolver Requirements	
Type	Control Transmitter
Transformation Ratio	0.47
Frequency	7-8 kHz
Input Voltage (From Drive)	4.25 Vac
Max DC Resistance	120 Ohms
Max Drive Current	55 mA ac-rms
Output Voltage (To Drive)	2 Vac

Note: Kollmorgen has tested cable lengths up to 750 ft. without degradation of performance. However, performance may vary depending on motor and resolver type. Tests were performed with standard Kollmorgen cable and its low-impedance Goldline motor resolver. Please consult factory for cable and resolver impedance specifications when long cable runs are desired.

Encoder Requirements	
Required Signals	Encoder Types: A-Quad-B with or without Marker with or without Halls Channels (Halls may be integral or discrete)
Signal Type: A-quad-B and Marker	Differential Line Drivers Only
Signal Type: Halls	Open Collector or Line Drivers
System Voltage	5 Vdc
Maximum Frequency	3 MHz
Maximum Cable Length	System Dependent: 50ft Recommended
Maximum Line Count	10,000,000 Lines per Motor Electrical Cycle
Maximum Supply Current from SERVOSTAR	200 mA
Protection	Separate Voltage Regulator, Broken wire detector for A, B, and M and Hall channels, Illegal Hall Code Detection

Note: Long encoder cables tend to have high DC resistance that may create significant voltage drops in the supply lines to the encoder. Please consider this carefully when designing the system. Quadrature signals returned to the drive are differentially connected which normally do not constitute a problem with longer cable lengths.

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1.6 POWER SUPPLIES

The following information describes the power supplies used with the SERVOSTAR.

1.6.1 Logic Supply Module PA-LM

The Logic Supply Module is designed to supply power for up to two SERVOSTAR drives. It does not supply Motor Bus Power. It is used where the application requires more axis of drives running from the same power supply than the power supply is capable of driving or where bus power is derived elsewhere.

1.6.2 Power Supply PA08xx

This modular power supply has two sections, a main dc bus, and logic power.

The main dc bus section consists of input line filters, three-phase diode bridge, bus caps, and soft-start circuitry (to limit inrush currents). The main dc bus section is designed to operate from either 115 VAC single-phase or 230 VAC (line to line) three-phase input mains. A green LED indicates when there is voltage on the bus caps.

The logic power section consists of a universal input SMPS for generating the required ±15 VDC and +7.5 VDC Logic Power for one or two SERVOSTAR amplifiers. The SMPS input is connected to the L_A and L_B main dc bus input terminals.

1.6.3 Power Supply PA14xx and PA28xx

These modular power supplies have two sections, a main dc bus, and logic power.

The main dc bus section is designed to operate from 115 VAC for the PA14xx or 230 VAC three-phase for the PA28xx. Features of these power supplies include:

- A green LED to indicate when there is voltage on the bus caps.
- Relay output to indicate the power is energized and operating.
- Soft-start circuitry (to limit inrush currents).
- Internal/External Regen (shunt regulator) with a yellow LED indicator.

The power supply has a 40W rated internal resistor, for light duty applications. For heavier duty applications, a jumper on the front terminal block is removed and an external resistor is connected.

The relay output is a normally open contact which closes upon application of power to the power supply and after soft-start is completed. The contacts will open if the internal Regen resistor or main heatsink becomes too hot, or if there is improper power supply output.

The logic power section consists of a 115 VAC (PA14xx) or a 230 VAC (PA28xx) input SMPS for generating the required ±15 VDC and +7.5 VDC Logic Power. The PA14xx can drive up to two SERVOSTAR amplifiers. The PA28xx can drive up to four SERVOSTAR amplifiers. The Regen resistor is fuse protected.

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1.6.4 Power Supply PA50xx / PA75xx / PA85xx

The PA50xx, PA75xx, and PA85xx Power Supply units are identical except that the 75 amp and 85 amp units have higher power components and more capacitive filtering. None of these units have internal regeneration but each has the electronics internal and requires an external resistor.

The main dc bus section is designed to operate from 230 VAC (line to line) three-phase input mains. Features of these power supplies include:

- A green LED to indicate when there is voltage on the bus caps.
- Relay output to indicate the power is energized and operating.
- Soft-start circuitry (to limit inrush currents).
- External Regen (shunt regulator) with a yellow LED indicator.
- A red fault LED indicator showing the softstart has not closed.

The relay output is a normally open contact which closes upon application of power to the power supply and after soft-start is completed. The contacts will open if the internal Regen resistor or main heatsink becomes too hot, or if there is improper power supply output. The logic power section consists of a 230V input SMPS for generating the required $\pm$15 VDC and +7.5 VDC Logic Power for up to four SERVOSTAR amplifiers. Up to 4 amplifiers may be powered by this logic supply.

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1.6.5 Power Supply Specifications

Table 1-2. SERVOSTAR *Power Supply Specifications*

	Power Supply Model	PA08	PA28	PA50	PA75	PA85
Main Input Power	Voltage (Vac) (L-L) Nominal ± 10%	110-240	208-240	208-240	208-240	208-240
	115Vac 1ϕ / 3ϕ	1/3	n\a	n\a	n\a	n\a
	230Vac 1ϕ / 3ϕ	1/3	1/3	3	3	3
	Frequency	47-63	47-63	47-63	47-63	47-63
	KVA @115(1ϕ) / 230(1ϕ) / 230(3ϕ)	.92 /1.8/3.2	6.4/11.2	20	30	34
	Rated current (amps) @ 115(1ϕ) / 230(1ϕ) / 230(3ϕ)	8/8/8	14 / 28	50	75	85
	Max. current (amps) for 2sec / 50msec 115(1ϕ) / 230(1ϕ) / 230(3ϕ)	12/16 12/16 16/24	n/a 21/28 56/84	75 / 100	115 / 150	130 / 170
Main Output Power	DC BUS Voltage (Nominal)	140/310	310	310	310	310
	kW @ 115(1ϕ) / 230(1ϕ) / 230(3ϕ)	.67/1.3/2.48	2.4/8.7	15.5	23.3	26.4
Logic Input Power	Voltage (Vac) Nominal ± 10%	110-240	208-240	208-240	208-240	208-240
	Current (amps Max.)	1	1	1	1	1
	Frequency	47-63	47-63	47-63	47-63	47-63
Logic Output Power	Logic Voltage (Vdc)	7.25 - 8.5				
	Logic Current (amps)	2.2	4.4	4.4	4.4	4.4
	15V Voltage (+/- Vdc)	14.25 - 16				
	15V Current (amps)	0.75	2.4	2.4	2.4	2.4
Protective Functions	OVERTEMP trip (°C)	n/a	90	90	90	90
	UNDERVOLTS trip (on power-up) @ 115(1ϕ) / 230(1ϕ) / 230(3ϕ)	70	125	125	125	125
	UNDERVOLTS trip (normal) @ 115(1ϕ) / 230(1ϕ) / 230(3ϕ)	50	112	35	35	35
Regen Operation	Regen trip voltage (on) (Vdc nom.)	390	390	390	390	390
	Regen off voltage (Vdc nom.)	375	375	375	375	375
Internal Shunt Regulator	Peak current (amps)	n/a	32	n/a	n/a	n/a
	Resistance (ohms)	n/a	12.5	n/a	n/a	n/a
	Watts	n/a	40	n/a	n/a	n/a
External Shunt Regulator	Peak current (amps)	n/a	45	100	200	200
	Minimum resistance (ohms)	n/a	8.8	4.5	2.2	2.2
	Watts	n/a	400	1000	2000	2000
Soft Start	Surge current (max. amps)	30	50	40	40	40
	Charge time (max. sec)	0.75	0.25	0.5	0.75	0.85
Environment	Internal heat dissipation (watts)	45 w	130 w	200 w	275 w	TBD
	Operation temperature (°C)	5 to 45				
	Storage temperature (°C)	-0 to 70				
	Ambient humidity	10% to 90%				
	Atmosphere	With no Corrosive gasses or dust				
	Altitude	3300 feet max. without derate				
	Vibration	0.5 g				
Package	Weight lb (kg) (Typical)	4.74 (2.16)	8.18 (3.72)	14.32 (6.51)	14.52 (6.6)	15 (6.8)
	Height in (mm) (Max)	10.39 (264)	10.39 (264)	16 (406.4)	16 (406.4)	16 (406.4)
	Width in (mm) (Max)	2.5 (63.5)	4.9 (124.4)	5.7 (144.6)	5.7 (144.6)	5.7 (144.6)
	Depth in (mm) (Max)	7.95 (202)	7.95 (202)	11.2 (284)	11.2 (284)	11.2 (284)

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Table 1-2. SERVOSTAR *Power Supply Specifications (Cont.)*

	Power Supply Model	PA14	PA-LM
Main Input Power	Voltage (Vac) (L-L) Nominal ± 10%	110-120	
	115 Vac 1ϕ / 3ϕ	1/3	
	230 Vac 1ϕ / 3ϕ	n/a	
	Frequency	47-63	
	Input KVA @ 115 (1ϕ) / 115 (3ϕ)	1.6 / 2.8	
	Rated current (amps) @ 115 (1ϕ) / 115 (3ϕ)	7/14	
	Max. current (amps) for 2sec / 50msec @ 115 (1ϕ) / 115 (3ϕ)	21/ 28 28/ 42	
Main Output Power	DC BUS Voltage (Nominal)	140	
	kW @ 115 (1ϕ) / 115 (3ϕ)	1.1/ 2.1	
Logic Input Power	Voltage (Vac) Nominal ± 10%	110-120	115-^40
	Current (amps Max.)	1	1
	Frequency	47-63	47-63
Logic Output Power	Logic Voltage (Vdc)	7.25 - 8.5	
	Logic Current (amps)	2.2	2.2
	15V Voltage (+/- Vdc)	14.25 - 16	
	15V Current (amps)	.8	.8
Protective Functions	OVERTEMP trip (°C)	90	
	UNDERVOLTS trip (on power-up) @ 115(1ϕ) / 115 (3ϕ)	70	
	UNDERVOLTS trip (normal) @ 115(1ϕ) / 115 (3ϕ)	50	
Regen Operation	Regen trip voltage (on) (Vdc nom.)	200	
	Regen off voltage (Vdc nom.)	190	
Internal Shunt Regulator	Peak current (amps)	30	
	Resistance (ohms)	7.5	
	Watts	40	
External Shunt Regulator	Peak current (amps)	40	
	Minimum resistance (ohms)	4.25	
	Watts	300	
Soft Start	Surge current (max. amps)	20	12
	Charge time (max. sec)	0.25	0.03
Environment	Internal heat dissipation (watts)	70 w	7
	Operation temperature (°C)	5 to 45	
	Storage temperature (°C)	0 to 70	
	Ambient humidity	10% to 90%	
	Atmosphere	With no Corrosive gasses or dust	
	Altitude	3300 feet max. without derate	
	Vibration	0.5 g	
Package	Weight lb (kg) (Typical)	8.18 (3.72)	2.5 (1.32)
	Height in (mm) (Max)	10.39 (264)	6.25 (158.8)
	Width in (mm) (Max)	4.9 (124.4)	2.25 (56.9)
	Depth in (mm) (Max)	7.95 (202)	7.3 (185.4)

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1.7 SYSTEM ACCURACY SPECIFICATION

The following information is a guide to use on resolver-based systems to determine system accuracy:

4 arc-min converter
8 arc-min resolver
2 arc-min mounting
5 arc-min LSB (12-bit) (Worst case)

Total: 19 arc-min (Worst case)

Encoder-based systems can be calculated using the same method using no converter accuracy specification.

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SECTION 2

INSTALLATION

2.1 INTRODUCTION

The information in this Section discusses the installation of the SERVO**STAR** System. This Section provides information for all SERVO**STAR** Systems.

2.2 SAFETY INFORMATION

The safety-alert symbols are illustrated as follows:



Safety-Alert Symbols

When these symbols are seen in this manual, be alert to the potential for personal injury. Follow the recommended precautions and safe operating practices included with the alert symbols.

Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. The purpose of this section is to alert users to possible safety hazards associated with this equipment and the precautions that need to be taken to reduce the risk of personal injury and damage to the equipment.

Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

"**Warning**" alerts users to potential danger or harm. Failure to follow warning notices could result in personal injury or death.

"**Caution**" directs attention to general precautions, which if not followed, could result in personal injury and/or equipment damage.

"**Note**" highlights information critical to the users understanding or use of these products.

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2.3 UNPACKING AND INSPECTION



CAUTION

Electronic components in this amplifier are design hardened to reduce static sensitivity. However, proper procedures should be used when handling.

Upon receipt of the equipment, inspect components to ensure that no damage has occurred in shipment. If damage is detected, notify the carrier immediately.



NOTE

Check all shipping material for connector kits, manuals, diskettes, and other small pieces of equipment.

Remove all packing material and equipment from the shipping container. Be aware that some connector kits and other equipment pieces may be quite small and can be accidentally discarded if care is not observed when unpacking the equipment. Do not dispose of shipping materials until the packing list has been checked.

2.4 INSTALLATION REQUIREMENTS

Attention to proper installation and field wiring are of prime importance to insure long-term trouble-free operation. Users should familiarize themselves with and follow installation and wiring instructions. In addition, some localities and industries may require applicable electrical and safety codes, laws, and standards.

The environment that any electronic control system 'lives' in can effect its operation. Industrial Drives recommends that the SERVO**STAR** and Power Supply be operated and stored under the following conditions. The components may be operated in higher temperature ambient conditions with derating. Please check with the factory for derating information.

Operating Temperature: 0° C to 45° C
Storage Temperature: -20° C to 70° C
Humidity: 10% to 90% (Non-Condensing)
Shock: 0.5 g

It is expected that the SERVO**STAR** (and associated components) will be mounted in an electrical enclosure cabinet (or other suitable enclosure) to protect them from physical and environmental damage and provide added safety.

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2.5 MOUNTING SYSTEMS

The SERVO**STAR**(s) and Power Supply units should be mounted vertically. The Power Supply unit may be mounted on either side of the SERVO**STAR**(s). A 20 millimeter (0.8 inch) space should be left between units for additional convection cooling but is not an absolute requirement. In systems using more than two SERVO**STAR**s per Power Supply, divide the drives to the left and the right of the Power Supply. Drawings in the following pages give the mounting dimensions and hole patterns for mounting these devices. These products are designed to be mounted in an electrical enclosure. Whenever possible, the use of an unpainted (Galvanized) panel is recommended to allow optimal electrical bonding of the frame. The SERVO**STAR** and Power Supply units are mounted to the grounded electrical panel using four M4 or 10-32 (or similar) screws each. The use of lock washers is recommended.

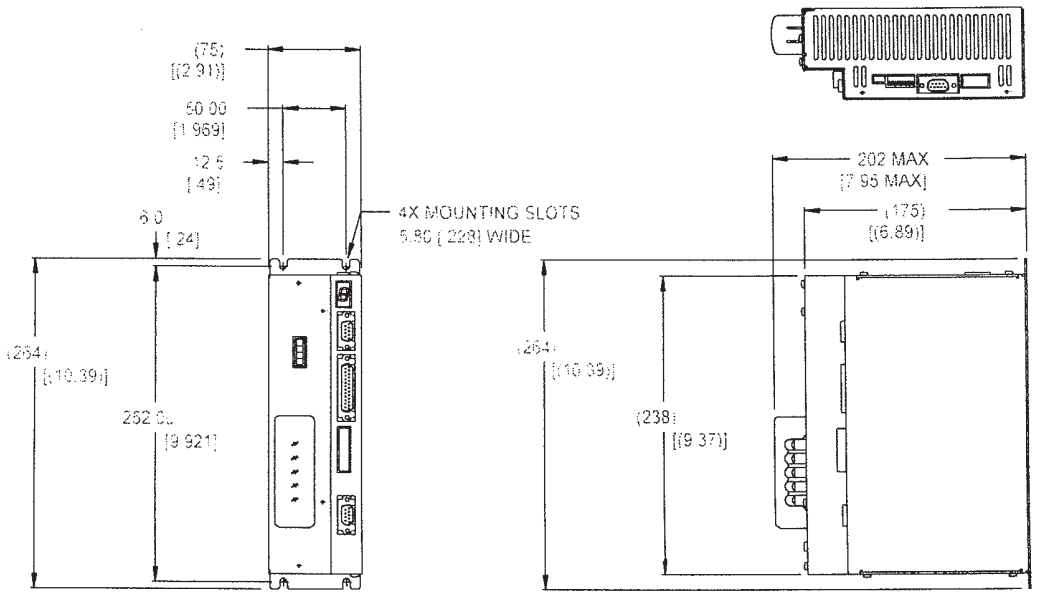


***Figure 2-1.** SERVOSTAR Sx03xxx and Sx06xxx Amp Amplifier Outline and Dimension Drawing*

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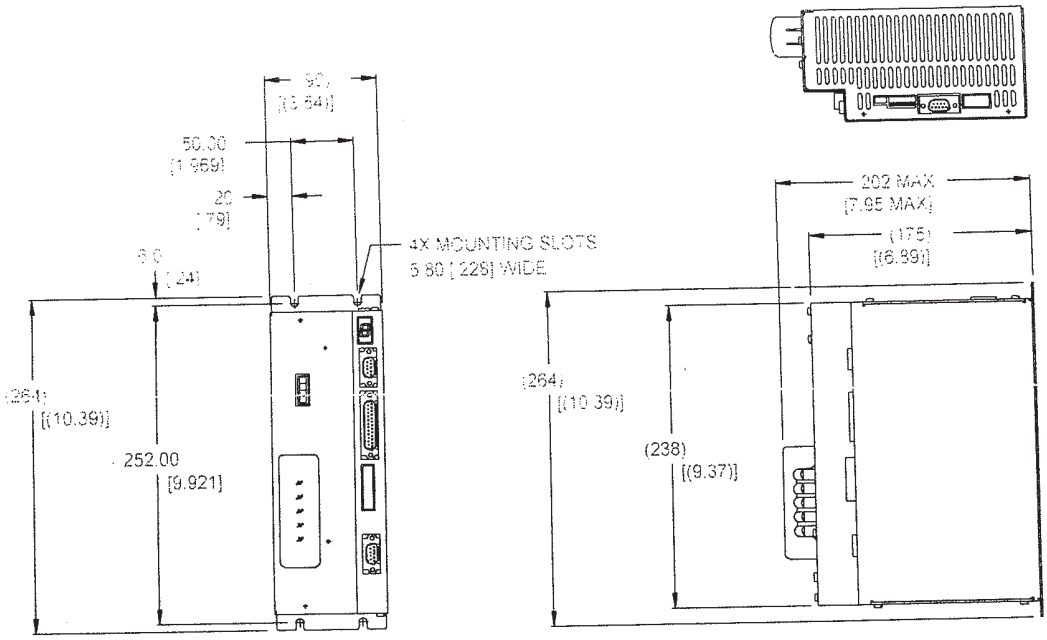


Figure 2-2. SERVOSTAR Sx10xxx Amp Amplifier Outline and Dimension Drawing

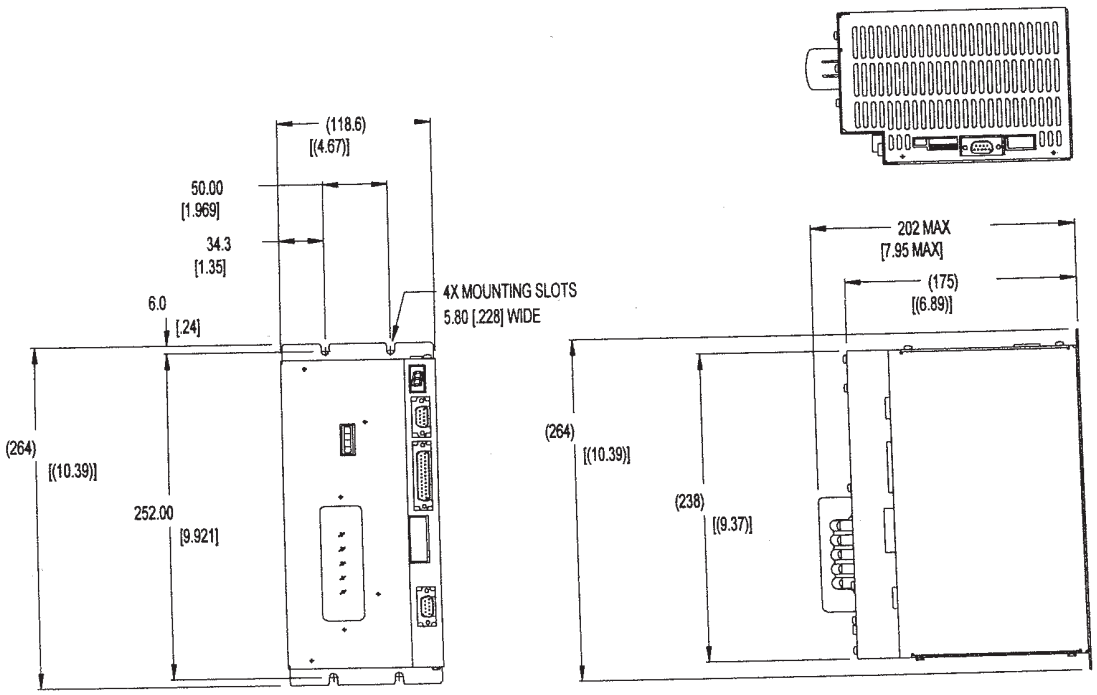


Figure 2-3. SERVOSTAR Sx20xxx Amp Amplifier Outline and Dimension Drawing

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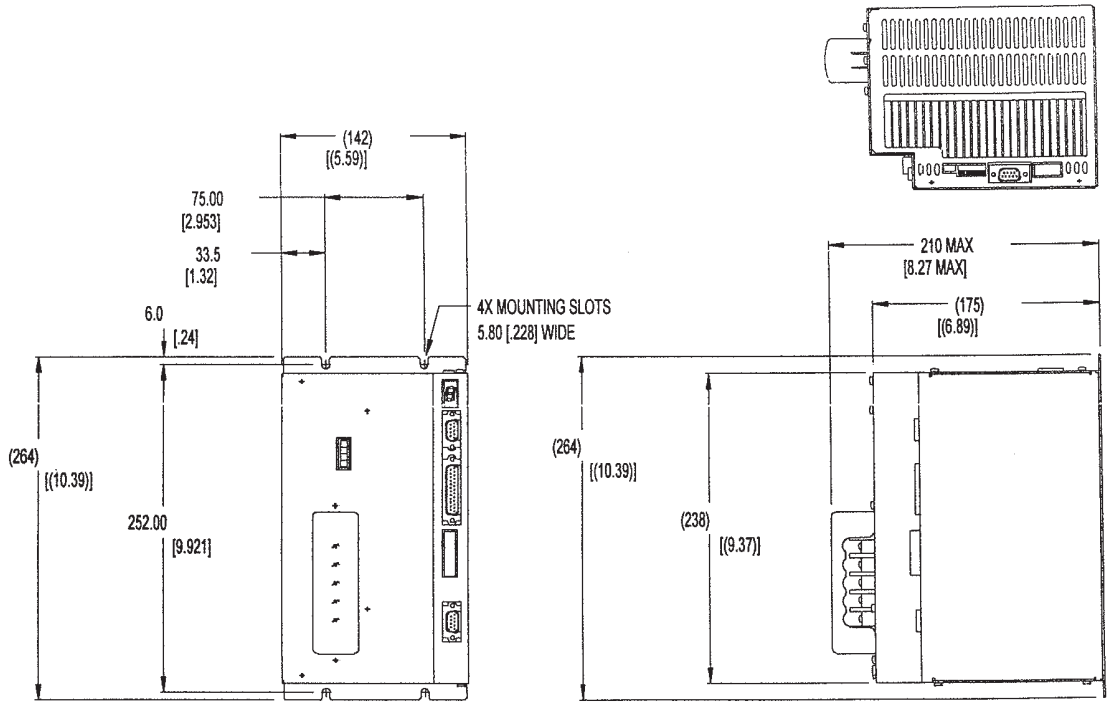


***Figure 2-4.** SERVOSTAR Sx30xxx Amp Drive Outline and Dimension Drawing*

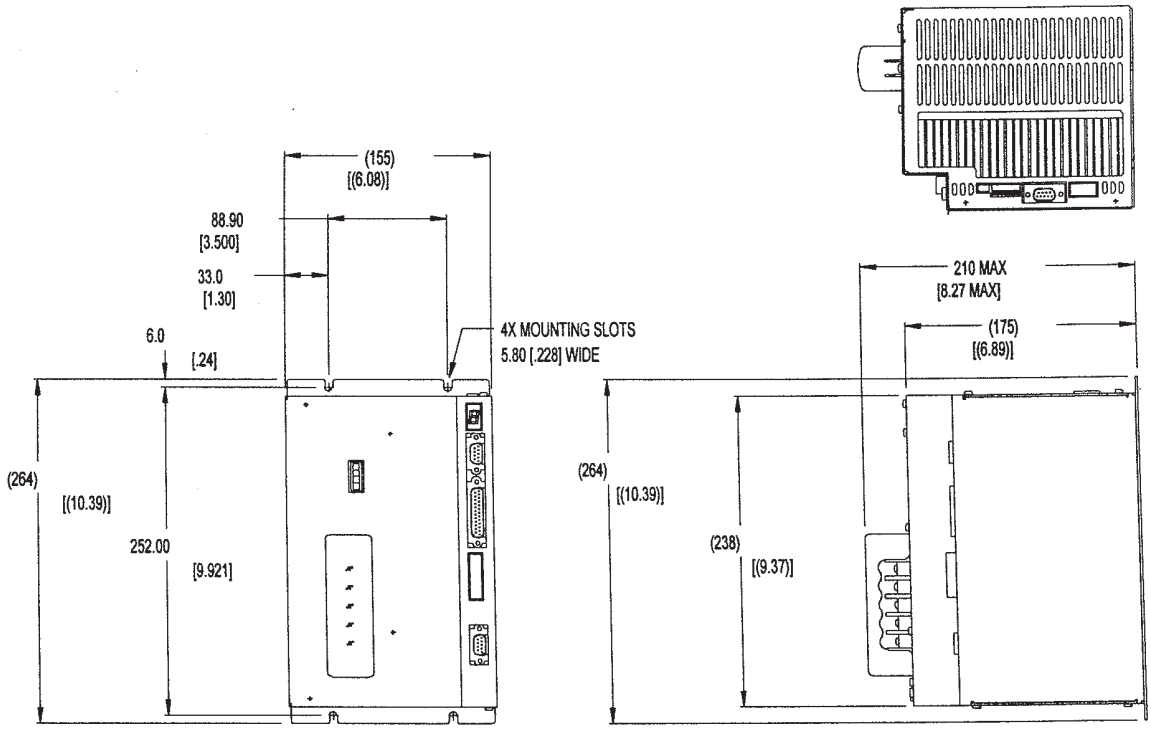


***Figure 2-5.** SERVOSTAR Sx55xxx Amp Drive Outline and Dimension Drawing*

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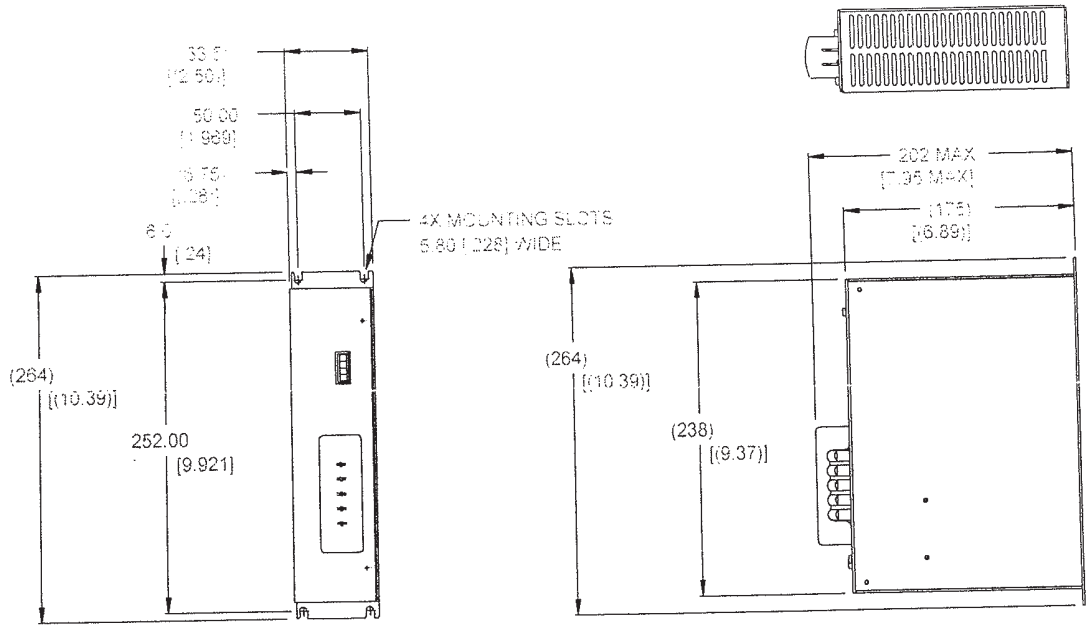


***Figure 2-6.** SERVOSTAR PA08xx Amp Power Supply Outline and Dimension Drawing*

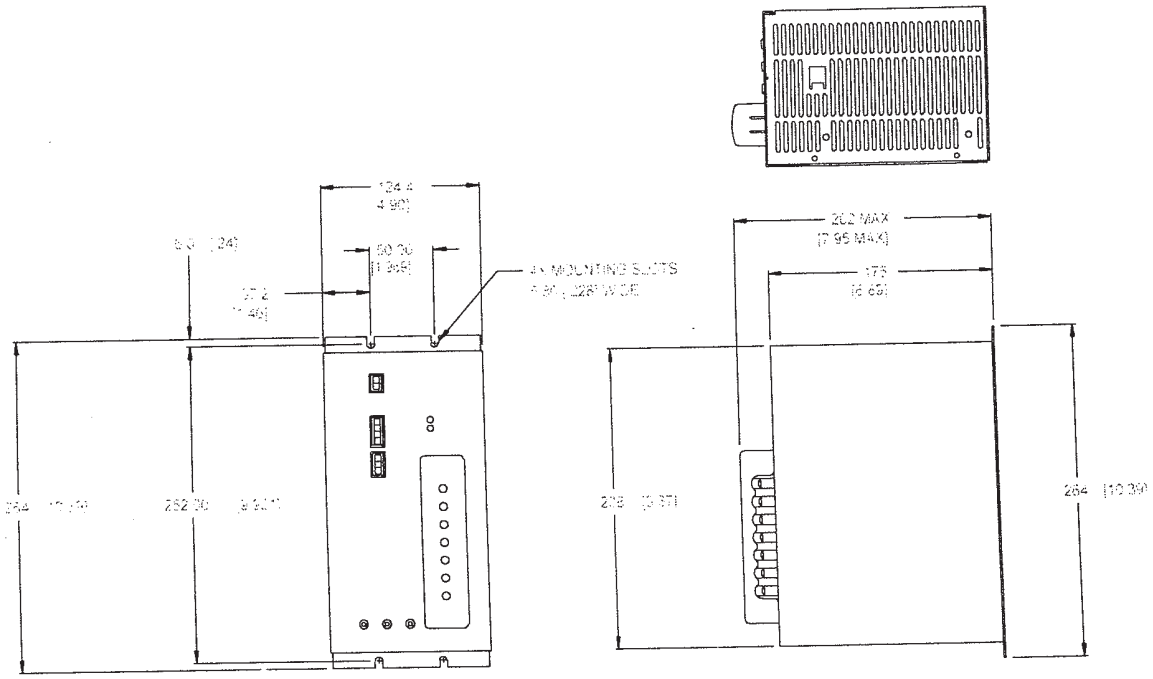


***Figure 2-7.** SERVOSTAR PA28xx Amp Power Supply Outline and Dimension Drawing*

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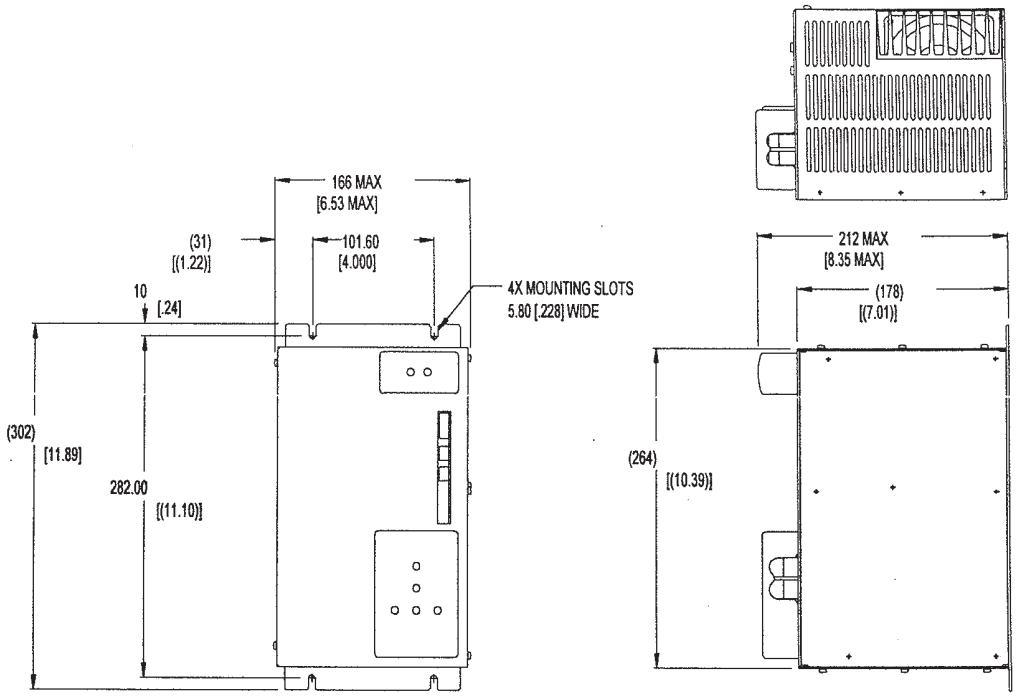
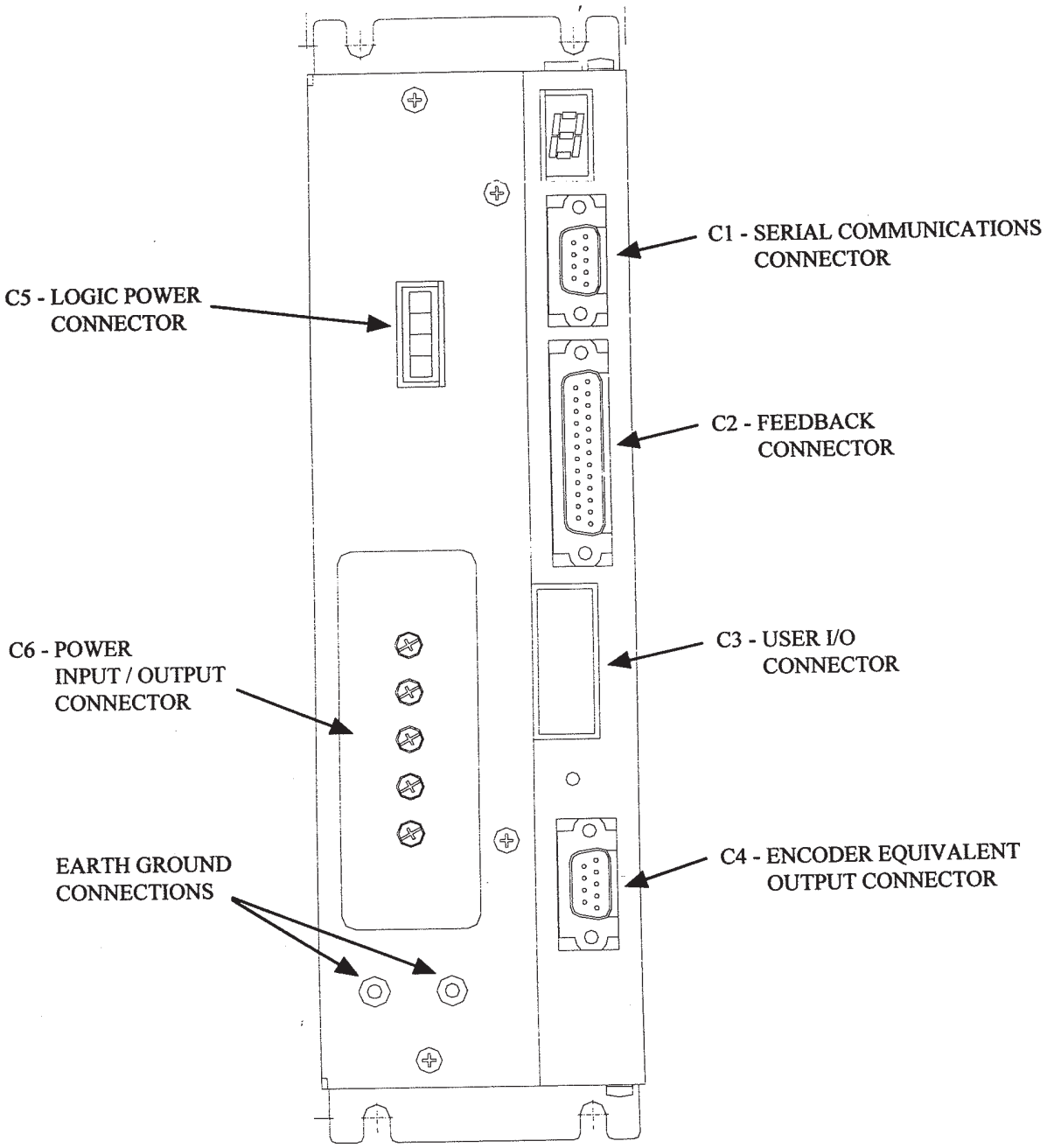


Figure 2-8. *SERVOSTAR* ***PA50xx, PA75xx, and PA85xx Amp Power Supply Outline and Dimension Drawing***

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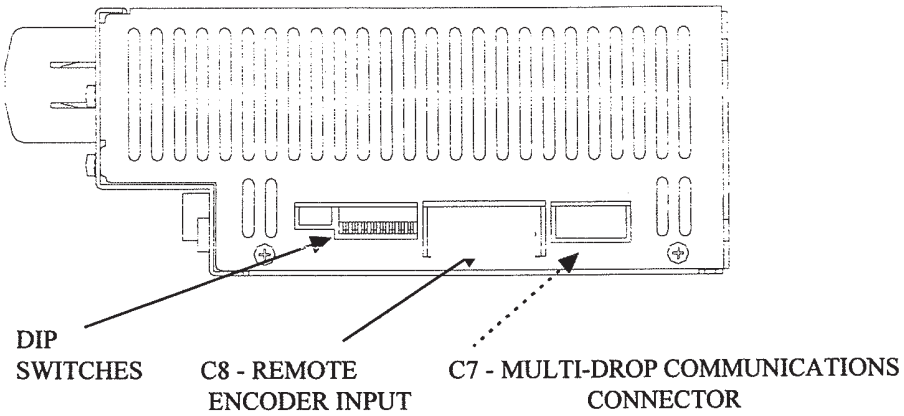
2.6 LOCATION OF CONNECTORS

2.6.1 Front Panel Connectors



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2.6.2 Top Panel Connectors



2.7 SERVOSTAR CONNECTOR PINOUTS

2.7.1 Connector C1, SERVOSTAR - Serial Communications

Connector type: 9 Pin D, male.

C1: Serial Communications Connector	
Pin	**Function**
1	Shield
2	RECV (RXD) (RS232)
3	XMIT (TXD) (RS232)
4	Reserved DO NOT CONNECT
5	Common
6	TxD+ (RS485)
7	TxD- (RS485)
8	RxD+ (RS485)
9	RxD- (RS485)

Notes:
1.) RS232 -OR- RS485 may be used, Not both.
2.) Purchased cables connecting pins other than desired may have ill effects.

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2.7.2 Connector C2, SERVOSTAR - Feedback

Connector type: 25 Pin D, female.


NOTE

This connector is used for resolver and encoder feedback models. The pins have different function assignments in each product.

C2: Feedback Connector		
Pin	Resolver Based Board Assignment	Encoder Based Board Assignment
1	Sine High	A
2	Sine Low	/A
3	Shield	Shield
4	Cosine High	B
5	Cosine Low	/B
6	Shield	Shield
7		E5V Return
8		E5V Return
9		Hall 1 B
10		Hall 2 B
11		Hall 3 B
12	Shield	Shield
13	Thermostat High	Thermostat High
14	Shield	Shield
15	Ref. High Out	Index
16	Ref. Low Out	/Index
17	Shield	Shield
18		E5V Supply
19		E5V Supply
20		E5V Supply
21	Shield	Shield
22		Hall 1 A
23		Hall 2 A
24		Hall 3 A
25	Thermostat Low	Thermostat Low

Resolver Signal Cross Reference Table		
Drive Name	Resolver Name	Resolver Wire Color (Typical)
Sine High	S3	Black
Sine Low	S1	Red
Cosine High	S2	Yellow
Cosine Low	S4	Blue
Ref. High Out	R2	Yel/Wht
Ref. Low Out	R1	Red/Wht

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2.7.3 Connector C3, SERVOSTAR - User I/O

Connector Type: 10 Pin 3.5 mm Weidmuller: Mate supplied.



NOTE

Connector is numbered top-to-bottom.

C3: User I/O Connector	
Pin	**Function**
1	Analog Signal Shield
2	Analog Differential Input + (High)
3	Analog Differential Input - (Low)
4	DC Common
5	Fault Output Relay Contact
6	Fault Output Relay Contact
7	+24V Input (Common Rail for return pins 8,9,10,11)
8	Remote Enable Input
9	Digital Input (Refer to explanation of IN1 variable)
10	Digital Input (Refer to explanation of IN2 variable)
11	Digital Input (Refer to explanation of IN3 variable)
12	Digital Output (Refer to explanation of O1 variable)
13	*Analog Output (Refer to explanation of ANOUT variable)

* Referenced to Pin 4: DC Common

2.7.4 Connector C4, SERVOSTAR - Encoder Equivalent Output

Connector type: 9 Pin D, female.

C4: Encoder Equivalent Output Connector	
Pin	**Function**
1	Encoder Channel A Output + (High)
2	Encoder Channel A Output - (Low)
3	DC Common
4	Encoder Channel B Output + (High)
5	Encoder Channel B Output - (Low)
6	Shield Connection
7	Encoder Marker (or Index) Channel Output + (High)
8	Encoder Marker (or Index) Channel Output - (Low)
9	Shield Connection

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2.7.5 Connector C5, SERVOSTAR - Logic Power

Connector Type: 4 Pin (Mate Supplied)

C5: Logic Power Connector	
Pin	**Function**
1	+ 15 Vdc Unregulated Supply Input
2	- 15 Vdc Unregulated Supply Input
3	DC Common
4	+ 8 Vdc Unregulated Supply Input

2.7.6 Connector C6, SERVOSTAR - Power Connector

Connector Type: 5 Screw Terminals.

C6: Power Connector	
Terminal	**Function**
1 = BUS +	Bus Voltage Input +
2 = BUS -	Bus Voltage Input -
3 = Ma	Motor Output Phase A
4 = Mb	Motor Output Phase B
5 = Mc	Motor Output Phase C

2.7.7 Connector C7, SERVOSTAR - Multidrop Communications

Connector type: 10 Pin 0.1" x 0.1" Ribbon Cable Connector, Female.

NOTE

Pinout on this connector is proprietary.

Note: This feature functions only when using the RS232 interface. It will NOT function using RS485.

2.7.8 Connector C8, SERVOSTAR - Remote Encoder Input Channel

Connector type: 9 Pin D, male.

C8: Remote Encoder Input Connector		
Pin	**Function**	
1	Encoder Channel A Input + (High)	
2	Encoder Channel A Input - (Low)	
3	DC Common	
4	Encoder Channel B Input + (High)	
5	Encoder Channel B Input - (Low)	
6	Shield Connection	
7	Reserved	
8	Index +	*(not available with this issue)
9	Index -	*(not available with this issue)

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2.7.9 COMMON RS-232 SERIAL DEVICE PINOUTS

*COMMON RS-232 SERIAL DEVICE PINOUTS							
IBM PC		IBM AT		TERMINAL		DEP01	
DB-25 male		DB-9 male		DB-25 female		DB-25 female	
1	SHIELD	1	SHIELD	1	SHIELD	1	SHIELD
2	TXD	2	RXD	2	TXD	2	TXD
3	RXD	3	TXD	3	RXD	3	RXD
7	COMMON	5	COMMON	7	COMMON	7	COMMON

2.7.10 E1 EARTH GROUND

A solid low impedance connection to this product is a must.



NOTE

All shields tie to this net. One or more screw holes for mounting the board is also connected to this net.

2.8 POWER SUPPLY CONNECTOR PINOUTS

2.8.1 Power Connector

Connector Type: 5 Screw Terminals or 7 Screw Terminals (PA28xx only)

Power Connector	
Terminal	Function
BUS +	Bus Voltage Output +
BUS -	Bus Voltage Output -
LA	Main Bus Input Phase A
LB	Main Bus Input Phase B
LC	Main Bus Input Phase C
R	External Regen Resistor R Terminal (PA28xx only; see note)
C	External Regen Resistor C Terminal (PA28xx only; see note)



NOTE

On the PA28xx, if an external regen resistor is not used, the R and C terminals must be jumpered together. If an external regen resistor is used, the jumper between the R and C terminals must be removed, and the resistor is connected across BUS+ and C.

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2.8.2 Connector C6, Power Supply - DC Bus Status

(Not present on the PA08xx)

This connector provides a fault contact output that indicates the status of the DC Bus output.(BUS+ and BUS-). The contacts close when the DC Bus outputs are ready and available for use. Under faulted conditions, or when the DC Bus outputs are not available, these contacts will open. Attempting to enable the SERVOSTAR drive before this DC Bus Status output becomes active may cause erratic operation.

Connector Type: 2-pin

C6: DC Bus Status Connector	
Pin	**Function**
1	DC Bus OK
2	DC Bus OK

2.8.3 Connector C7, Power Supply - Logic Power Output

Connector Type: 4-pin

C7: Logic Power Output Connector	
Pin	**Function**
1	+ 15 Vdc Unregulated Supply Output
2	- 15 Vdc Unregulated Supply Output
3	DC Common
4	+ 8 Vdc Unregulated Supply Output

2.8.4 Connector C8, Power Supply - Logic Input Voltage (PA28/55/75 only)

Connector Type: 3-pin

C8: Logic Input Voltage Connector	
Pin	**Function**
1	AC Logic Power In
2	Not Used
3	AC Logic Power In



WARNING

Input power range is 180-260 VAC.

2.9 USER CONFIGURATION SWITCHES

The 10 position DIP switch is provided for drive configuration. The first 6 switches control communications parameters and are read only at power up. Any changes in these settings will require cycling the power. The other two switch functions control the motor operation and are monitored in real-time. This switch provides the following functions:

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- Multi-axis Address Select: Switches 1 through 5 set the drive's address. A drive having address 0 powers up in the addressed state. If these four switches are set to anything but 0, the drive will assume an address code indicated by the switch settings. Refer to section 4.3.9 for additional information.
- Baud Rate: Switch 6 sets the baud rate to either 9600 (switch off) or 19200 (switch on).
- Position Hold: Activating switch 7 causes the drive to enter a position hold mode. The condition is enunciated to the user by a flashing status display. The display maintains it's current OPMODE code. If the drive is running during a HOLD command detection, the motor will ramp to a stop at the DECSTOP rate.
- Enable: Switch 8 is an input to the drive enable circuitry and can be used to force the drive to a disabled state.
- SERCOS Power Level: Functions only on SERCOS interface products. If switch 9 is set to 0, the SERCOS transmitter uses a low power setting as to not overdrive the receiver when using short cables. Long cables require more power.
- Factory Reserved: Must be set to 0.

Note: Setting the switch to '0' is also 'Closed' or 'On'.



NOTE

Note that the decimal point on the status display is used to indicate an enabled state.



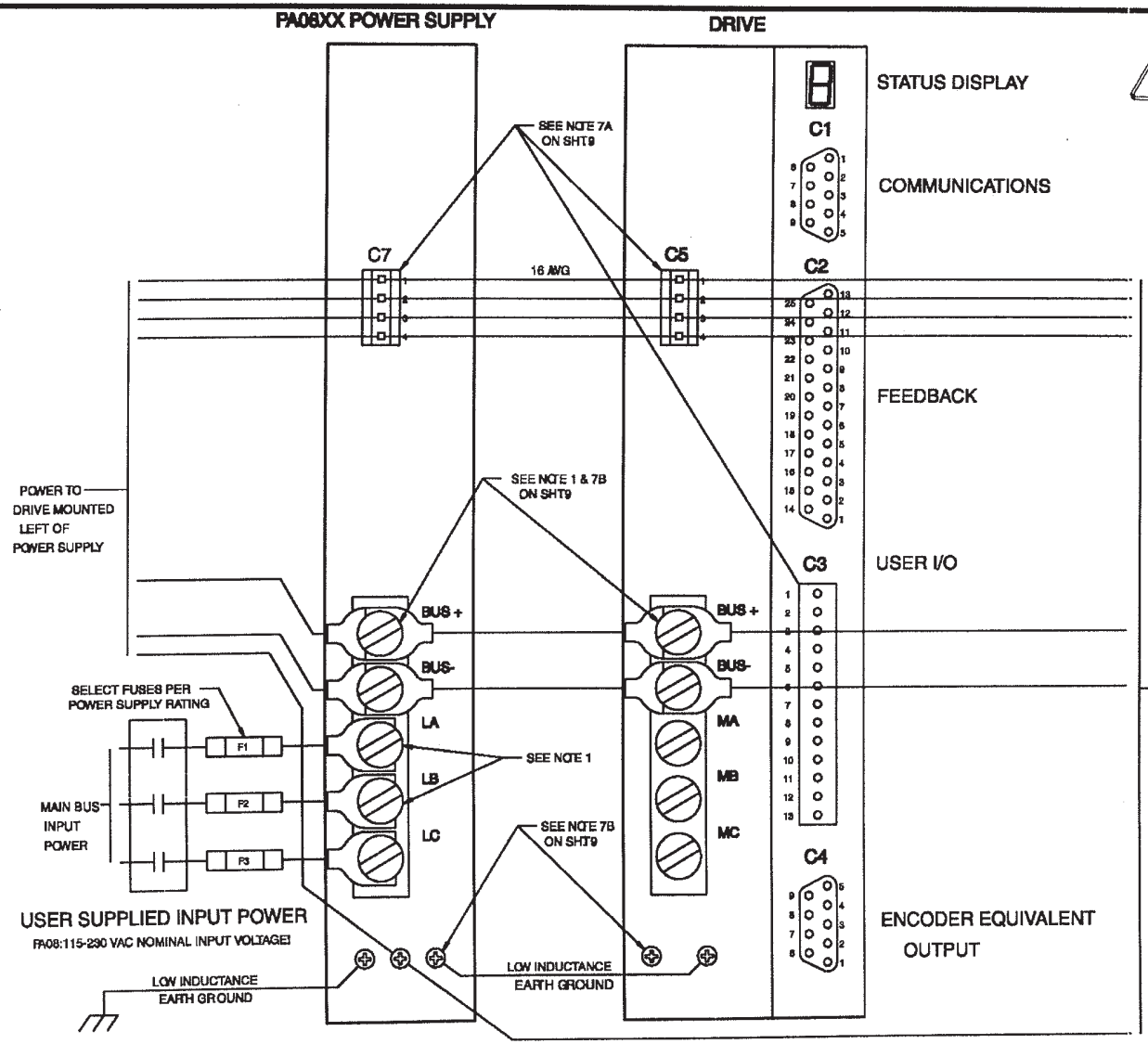
NOTE

Switch is located on top of board, near the front. Default settings refer to the state of the switches as shipped from the factory, assumed to be OFF (0).

Configuration Switch		
Switch Number	**Function**	**Settings**
1	Multidrop Addressing	Bit 0 of Multidrop Address (LSB)
2		Bit 1 of Multidrop Address
3		Bit 2 of Multidrop Address
4		Bit 3 of Multidrop Address
5		Bit 4 of Multidrop Address (MSB)
6	Serial Port Baud Rate	0 = 9600 1 = 19200
7	HOLD Mode Switch	0 = Hold Mode Inactive 1 = Hold Mode Active
8	Drive Enable / Disable	0 = Drive Enable 1 = Drive Disable
9	SERCOS Transmit Power	0 = Low Power 1 = High Power
10	Factory Reserved	Must Be set to 0

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WARNING:

READ ALL NOTES, MANUAL TEXT, WARNINGS, AND CAUTIONS

The SERVOSTAR Product line is modular in construction. There are several power supply units and many other wiring options. Some of the information may not be pertainent to all applications

C5, C7 CONNECTIONS

PIN	POWER SUPPLY	DRIVE
1	+15VDC SUPPLY	+15VDC INPUT
2	-15VDC SUPPLY	-15VDC INPUT
3	DC COMMON	DC COMMON
4	+8VDC SUPPLY	+8VDC INPUT

NOTES:

-1 FOR SINGLE PHASE OPERATION, INPUT POWER MUST BE WIRED TO "LA" AND "LB" OR LOGIC SUPPLY WILL NOT FUNCTION.

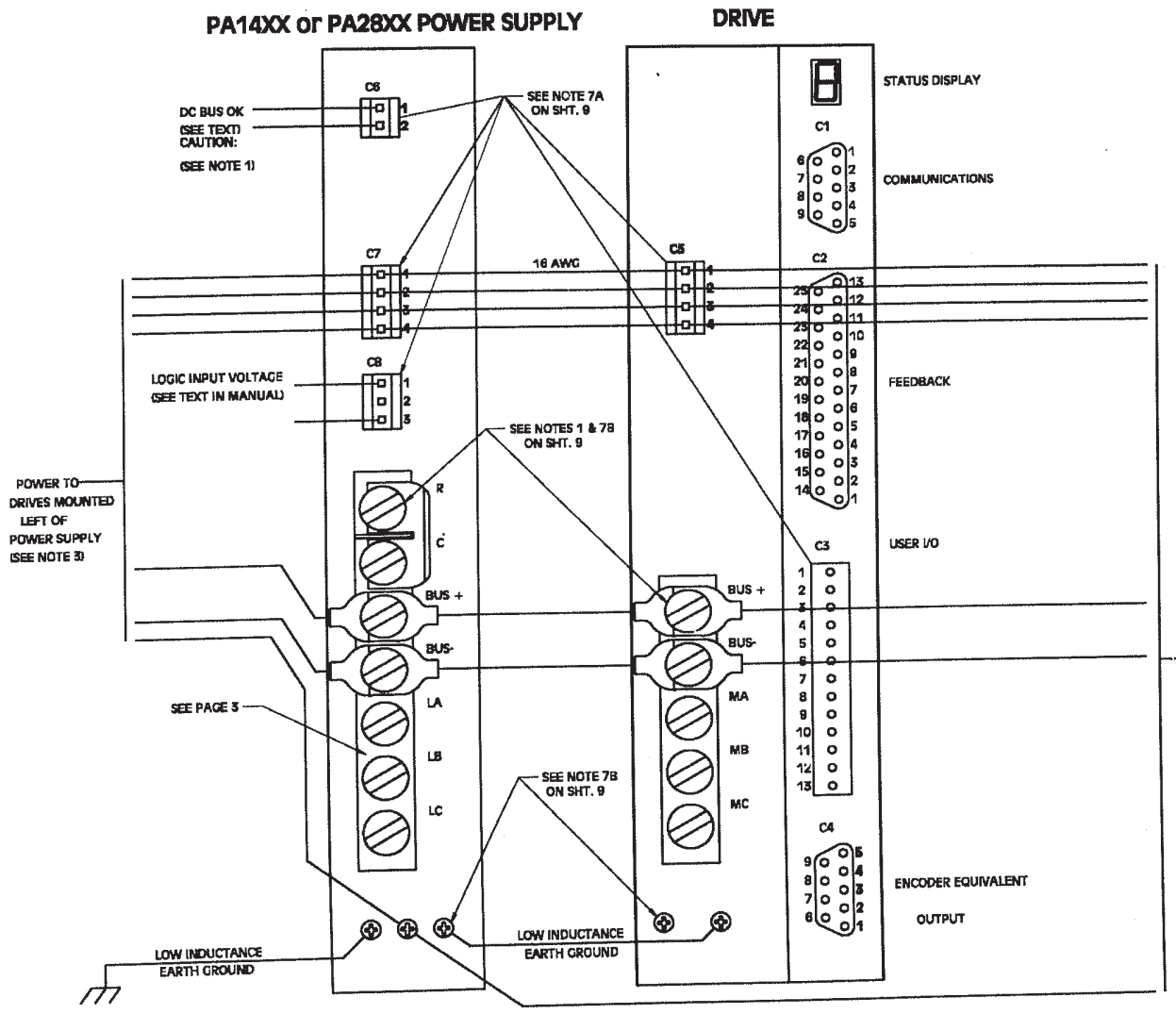
WARNING:

THE SERVOSTAR SYSTEM OPERATES WITH VOLTAGES AS HIGH AS 230 VAC AND 400 VDC. USE CAUTION AND REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL. TERMINAL COVERS AFTER SERVICING.

WARNING:

HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER POWER HAS BEEN REMOVED!

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C6
CONNECTIONS

PIN	FUNCTION	NOTES
1	DC BUS OK	SEE INSTALLATION INSTRUCTIONS IN TEXT
2	DC BUS OK	

C5, C7
CONNECTIONS
(SEE NOTE 2)

PIN	POWER SUPPLY	DRIVE
1	+15 VDC SUPPLY	+15 VDC INPUT
2	-15 VDC SUPPLY	-15 VDC INPUT
3	DC COMMON	DC COMMON
4	+8 VDC SUPPLY	+8 VDC INPUT

C8
CONNECTIONS

PIN	FUNCTION	NOTES
1	AC LOGIC POWER IN	SEE INSTALLATION INSTRUCTIONS IN TEXT
2	NOT USED	
3	AC LOGIC POWER IN	

TO OTHER DRIVES
MOUNTED RIGHT
OF POWER SUPPLY
(SEE NOTE 3)

NOTES:

-1 **CAUTION:** ATTEMPTING TO ENABLE DRIVE BEFORE THIS BUS OK BECOMES ACTIVE MAY CAUSE POWER SUPPLY TO NOT BECOME ACTIVE.

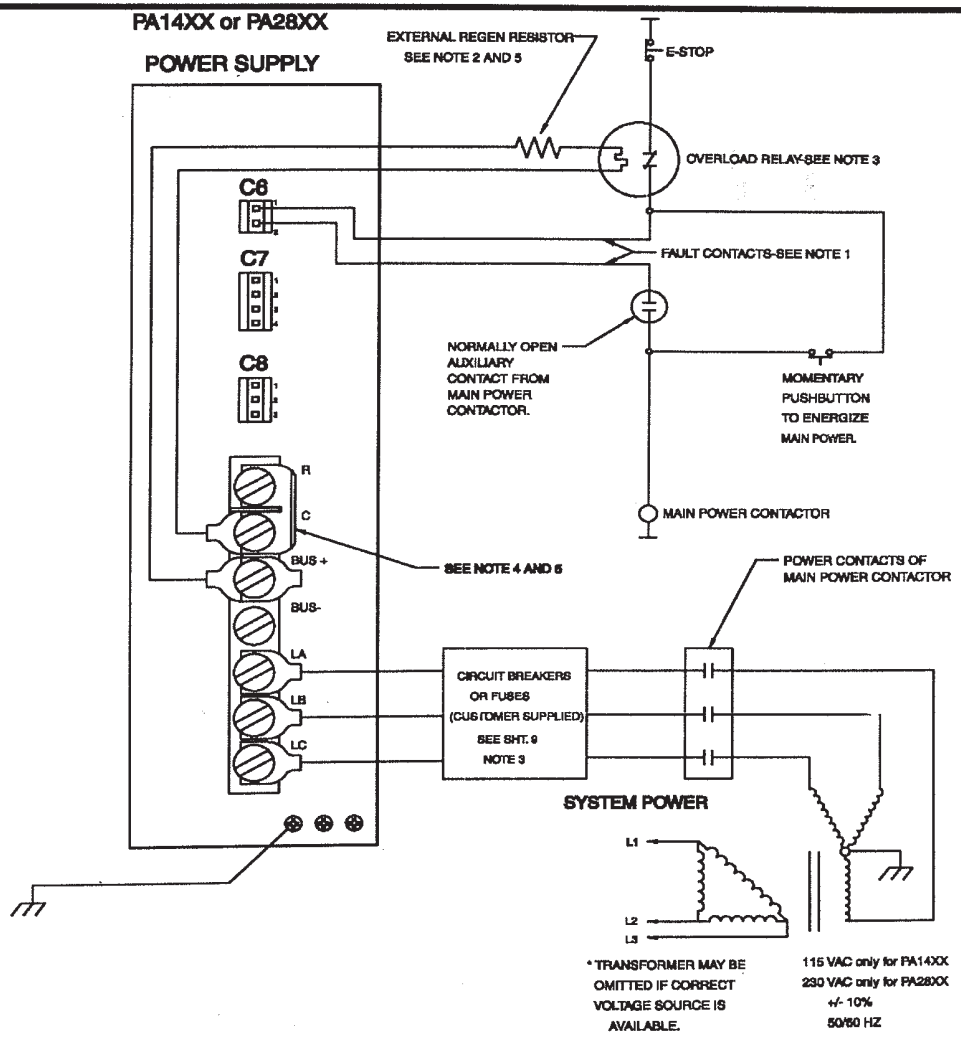
-2 CAUTION: LOW VOLTAGE DC ONLY.

-3 UP TO 4 DRIVES MAY BE MOUNTED TO EITHER SIDE OF POWER SUPPLY (SEE MANUAL) (SEE NOTE 5, SHEET 9).

WARNING:
THE SERVO STAR SYSTEM OPERATES WITH VOLTAGES AS HIGH AS 230 VAC AND 400 VDC. USE CAUTION AND REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL ONLY! ALWAYS REPLACE TERMINAL COVERS AFTER SERVICING.

WARNING:
HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER POWER HAS BEEN REMOVED!

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NOTES:

-1 CAUTION: THE PA14 AND PA28 FAULT CONTACTS (RATED 115 VAC 1 AMP)MUST BE WIRED IN SERIES WITH THE OVERLOAD RELAY AS SHOWN IN DRAWING AT LEFT. THIS CONTACT IS NORMALLY OPEN AND WILL CLOSE WITHIN 250 MSEC. AFTER APPLICATION OF CONTROL AND MAIN POWER. THIS CONTACT OPENS IN FAULT CONDITIONS.

-2 CAUTION: RESISTOR IS CONNECTED TO HIGH VOLTAGE; ENSURE SUFFICENT ELECTRICAL CLEARANCE WHEN MOUNTING. RESISTOR MAY BECOME VERY HOT DURING OPERATION. DO NOT MOUNT NEAR MATERIALS THAT ARE FLAMMABLE OR DAMAGED BY HEAT. VENTILATION MAY BE REQUIRED.
SEE WIRING DRAWING FOR SPECIFIC REGEN RESISTOR KIT. EACH KIT HAS DIFFERENT SERIES/PARALLEL RESISTOR CONNECTIONS TO OBTAIN SPECIFIC RESISTANCE AND POWER RATING.

-3 A THERMAL OVERLOAD RELAY IS SUPPLIED IN THE REGN RESISTOR KIT. THE THERMAL OVERLOAD RELAY, INCLUDED IN THE KIT, WAS SIZED FOR YOUR RESISTANCE AND POWER RATING. THE OUTPUT CONTACTS OF THE RELAY MUST BE WIRED TO DROP POWER TO THE MAIN POWER CONTACTOR IN A FAULT CONDITION, AS SHOWN AT LEFT.
DO NOT WIRE CONTROL POWER THROUGH THE MAIN POWER CONTACTOR. CONTROL POWER SHOULD NOT BE REMOVED IF PA28 FAULT CONTACTS OPEN AS THIS DEFEATS FAULT LEDS.

-4 WHEN USING INTERNAL 40 W REGEN, LEAVE JUMPER INSTALLED BETWEEN ULT TERMINAL "R" AND "C".

-5 WHEN USING EXTERNAL REGEN RESISTOR JUMPER ON TERMINALS "R" AND "C" MUST BE REMOVED.

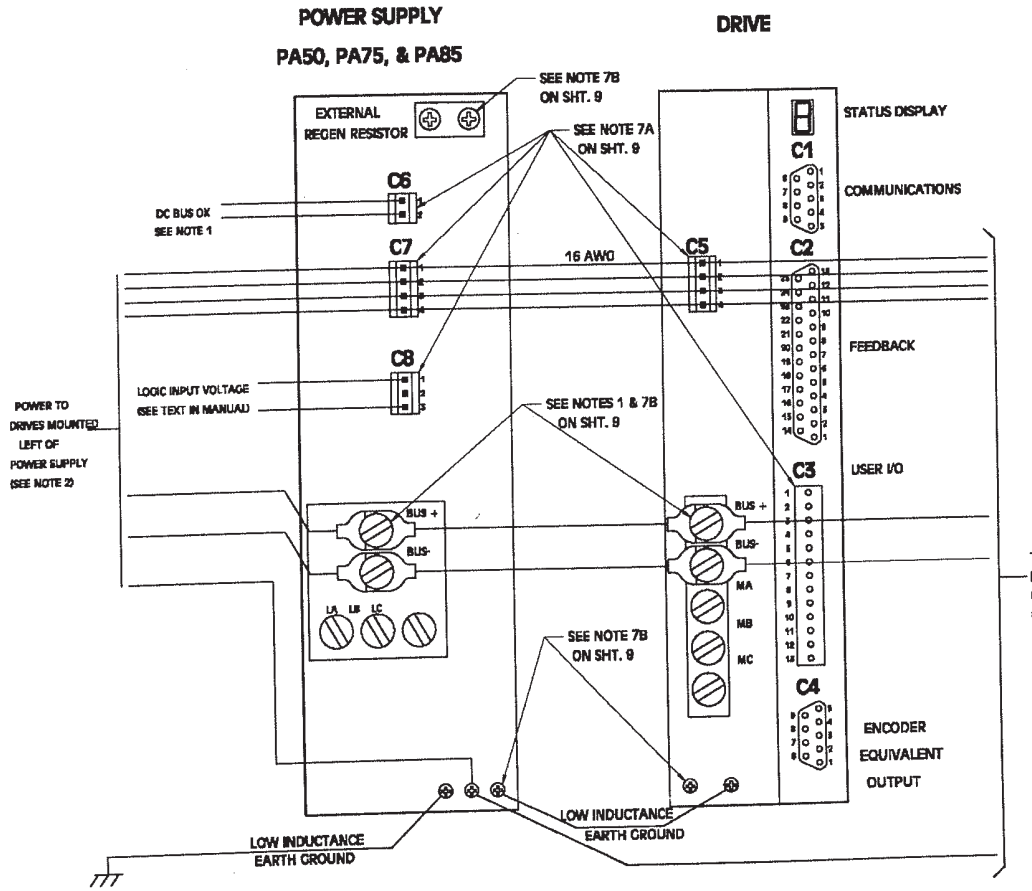
WARNING:

THE SERVO STAR SYSTEM OPERATES WITH VOLTAGES AS HIGH AS 230 VAC AND 400 VDC. USE CAUTION AND REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL ONLY! ALWAYS REPLACE TERMINAL COVERS AFTER SERVICING.

WARNING:

HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER POWER HAS BEEN REMOVED!

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C6 CONNECTIONS

PIN	FUNCTION	NOTES
1	DC BUS OK	SEE INSTALLATION INSTRUCTIONS IN TEXT
2	DC BUS OK	

C5, C7 CONNECTIONS

PIN	POWER SUPPLY	DRIVE
1	+15 VDC SUPPLY	+15 VDC INPUT
2	-15 VDC SUPPLY	-15 VDC INPUT
3	DC COMMON	DC COMMON
4	+8 VDC SUPPLY	+8 VDC INPUT

C8 CONNECTIONS

PIN	FUNCTION	NOTES
1	AC LOGIC POWER IN	SEE INSTALLATION INSTRUCTIONS IN TEXT
2	NOT USED	
3	AC LOGIC POWER IN	

NOTES:

-1 CAUTION: ATTEMPTING TO ENABLE DRIVE BEFORE THIS BUS OK BECOMES ACTIVE MAY CAUSE POWER SUPPLY TO NOT BECOME ACTIVE.

-2 UP TO 4 DRIVES TOTAL MAY BE MOUNTED TO EITHER SIDE OF POWER SUPPLY (SEE MANUAL) (SEE NOTE 5, SHEET 9).

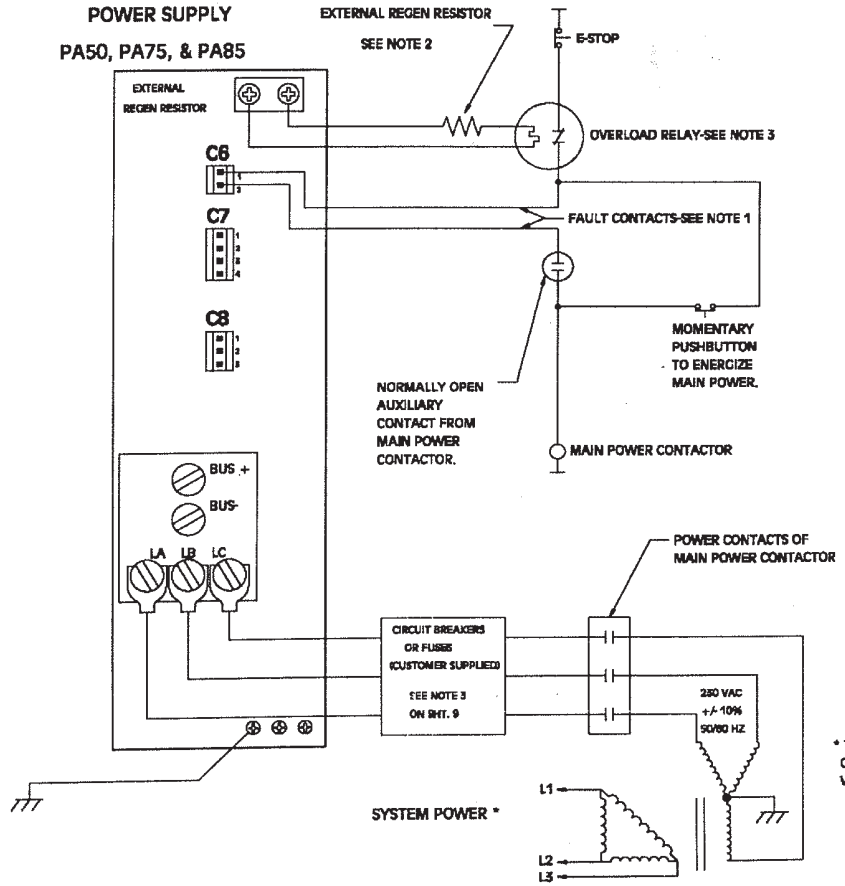
WARNING:

THE SERVO STAR SYSTEM OPERATES WITH VOLTAGES AS HIGH AS 230 VAC AND 400 VDC. USE CAUTION AND REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL ONLY! ALWAYS REPLACE TERMINAL COVERS AFTER SERVICING.

WARNING:

HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER POWER HAS BEEN REMOVED!

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* TRANSFORMER MAY BE OMITTED IF CORRECT VOLTAGE SOURCE IS AVAILABLE.

NOTES:

1- CAUTION: THE PA50, PA75 and PA85 FAULT CONTACTS (RATED 115 VAC 1 AMP) MUST BE WIRED IN SERIES WITH THE OVERLOAD RELAY AS SHOWN IN DRAWING AT LEFT. THIS CONTACT IS NORMALLY OPEN AND WILL CLOSE WITHIN 250 MSEC. AFTER APPLICATION OF CONTROL AND MAIN POWER. THIS CONTACT OPENS IN FAULT CONDITIONS.

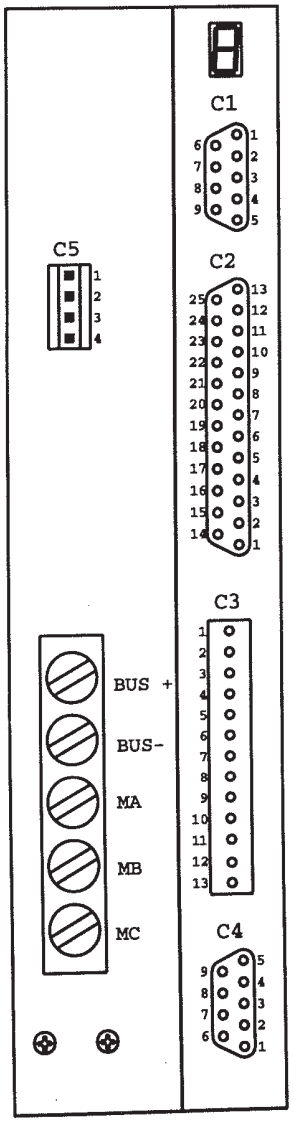
-2 CAUTION: RESISTOR IS CONNECTED TO HIGH VOLTAGE, ENSURE SUFFICENT ELECTRICAL CLEARANCE WHEN MOUNTING. RESISTOR MAY BECOME VERY HOT DURING OPERATION. DO NOT MOUNT NEAR MATERIALS THAT ARE FLAMMABLE OR DAMAGED BY HEAT. VENTILATION MAY BE REQUIRED.
SEE WIRING DRAWING FOR SPECIFIC REGEN RESISTOR KIT. EACH KIT HAS DIFFERENT SERIES/PARALLEL RESISTOR CONNECTIONS TO OBTAIN SPECIFIC RESISTANCE AND POWER RATING.

-3 A THERMAL OVERLOAD RELAY IS SUPPLIED IN THE REGN RESISTOR KIT. THE THERMAL OVERLOAD RELAY, INCLUDED IN THE KIT, WAS SIZED FOR YOUR RESTANCE AND POWER RATING. THE OUTPUT CONTACTS OF THE RELAY MUST BE WIRED TO DROP POWER TO THE MAIN POWER CONTACTOR IN A FAULT CONDITION, AS SHOWN AT LEFT.
DO NOT WIRE CONTROL POWER THROUGH THE MAIN POWER CONTACTOR. CONTROL POWER SHOULD NOT BE REMOVED IF PA50, PA75, OR PA85 FAULT CONTACTS OPEN AS THIS DEFEATS FAULT LEDS.

WARNING:
THE SERVO STAR SYSTEM OPERATES WITH VOLTAGES AS HIGH AS 230 VAC AND 400 VDC. USE CAUTION AND REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL ONLY! ALWAYS REPLACE TERMINAL COVERS AFTER SERVICING.

WARNING:
HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER POWER HAS BEEN REMOVED!

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STATUS DISPLAY

COMMUNICATIONS

FEEDBACK (D25P)

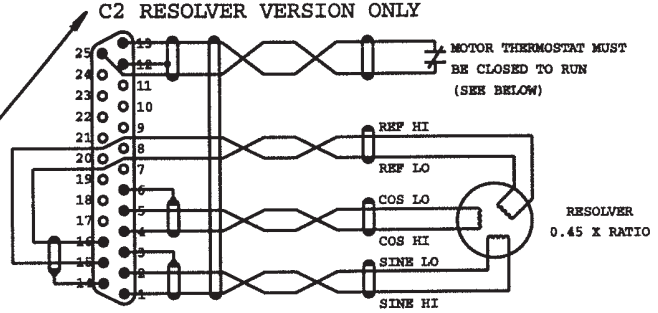
USER I/O

ENCODER EQUIVALENT OUTPUT

ENCLOSURE

DRIVE AND POWER SUPPLY MUST BE INSTALLED IN AN ENCLOSURE (VENTILATION MAY BE NECESSARY TO PREVENT ENCLOSURE AMBIENT FROM EXCEEDING 45 DEGREE C).

C2 RESOLVER VERSION ONLY

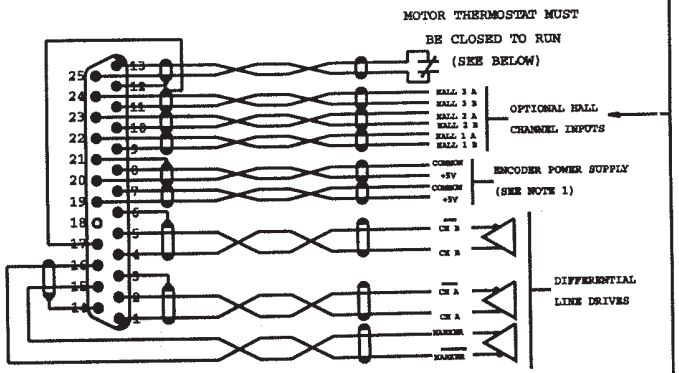


RESOLVER SIGNALS

REFERENCE: 7 KHZ, 4.25 VAC RMS
FEEDBACK: 2 VAC RMS

C2 ENCODER VERSION ONLY

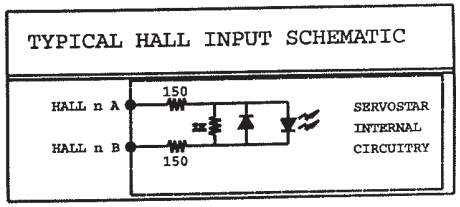
ENCODER TYPES AND OPTIONS VARY GREATLY.
PROVISIONS FOR OPERATING WITHOUT HALL CHANNELS USING SOFTWARE SWITCHES ARE AVAILABLE.



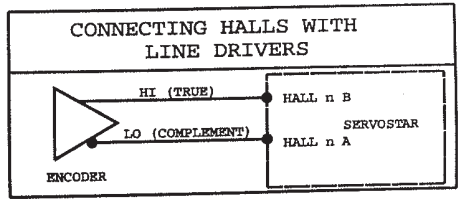
TYPICAL GOLDLINE MOTOR CONNECTOR PIN OUT

SIGNAL NAME	MOTOR PIN
SINE HI	A
SINE LO	B
COS HI	D
COS LO	C
REF HI	F
REF LO	E
THERM	T
THERM	U

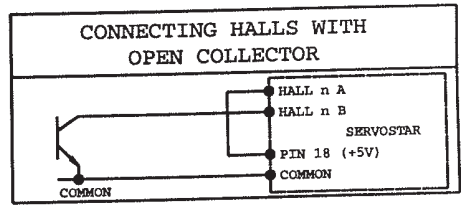
TYPICAL HALL INPUT SCHEMATIC



CONNECTING HALLS WITH LINE DRIVERS



CONNECTING HALLS WITH OPEN COLLECTOR



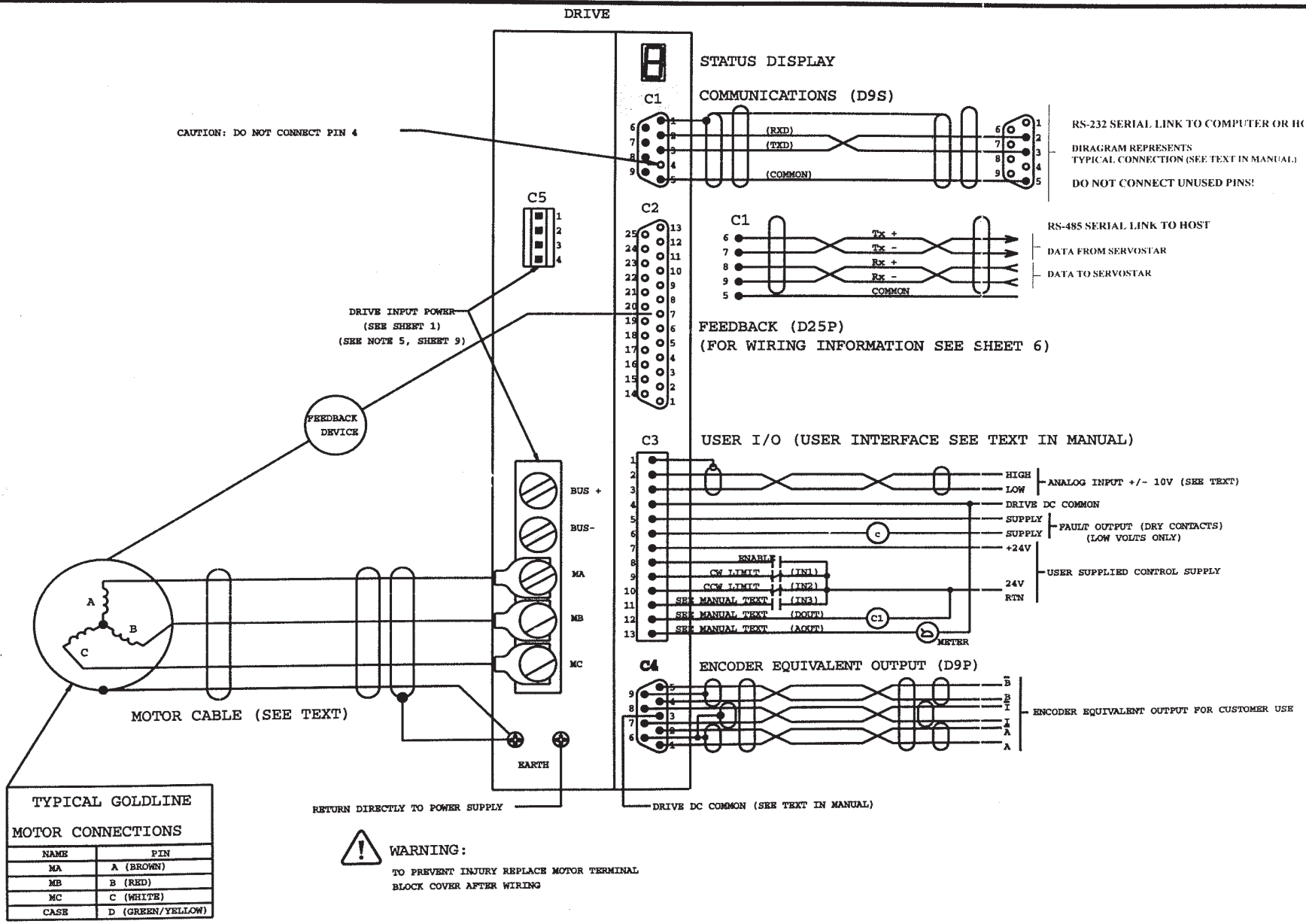
MOTOR OVERLOAD PROTECTION

MOTORS MUST HAVE INTEGRAL THERMAL PROTECTION OR EXTERNAL MOTOR OVERLOAD MUST BE USED.
THERMOSTAT SWITCH MAY SEE +12 VOLTS AND 20 ma.

NOTES:

-1 TWO ENCODER SUPPLY CONNECTIONS ARE PROVIDED TO MINIMIZE VOLTAGE DROP IN CABLE. ONLY ONE SET NEED BE USED IN LOW CURRENT ENCODERS USING SHORT CABLE LENGTH.

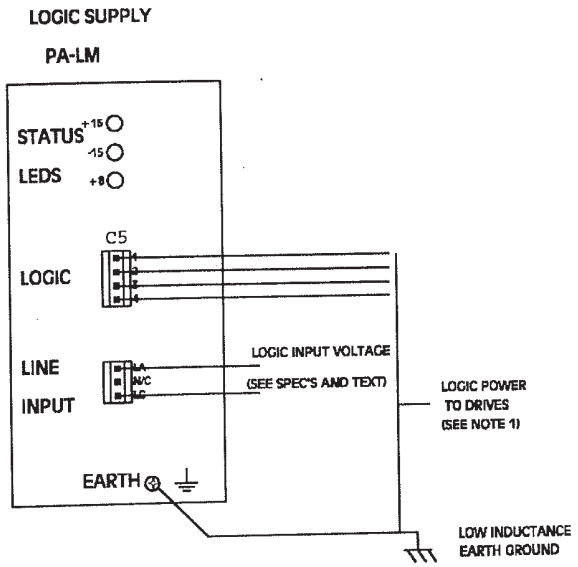
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TYPICAL GOLDLINE MOTOR CONNECTIONS

NAME	PIN
MA	A (BROWN)
MB	B (RED)
MC	C (WHITE)
CASE	D (GREEN/YELLOW)

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C5
CONNECTIONS



PIN	POWER SUPPLY	DRIVE
1	+15 VDC SUPPLY	+15 VDC INPUT
2	-15 VDC SUPPLY	-15 VDC INPUT
3	DC COMMON	DC COMMON
4	+8 VDC SUPPLY	+8 VDC INPUT

LINE INPUT
CONNECTIONS



PIN	FUNCTION	NOTES
1	AC LOGIC POWER IN	SEE INSTALLATION INSTRUCTIONS IN TEXT
2	NOT USED	
3	AC LOGIC POWER IN	

NOTES:

CAUTION:

-1 UP TO 2 DRIVES TOTAL MAY BE MOUNTED TO EITHER SIDE OF POWER SUPPLY (SEE MANUAL) (SEE NOTE 5, SHEET 9).

WARNING:

THE SERVOSTAR SYSTEM OPERATES WITH VOLTAGES AS HIGH AS 230 VAC AND 400 VDC. USE CAUTION AND REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL ONLY! ALWAYS REPLACE TERMINAL COVERS AFTER SERVICING.

WARNING:

HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER POWER HAS BEEN REMOVED!

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1. WARNING: ALWAYS REPLACE TERMINAL COVERS AFTER SERVICE OR INSTALLATION!

2. DRIVE AND POWER SUPPLY MUST BE INSTALLED IN AN ENCLOSURE (VENTILATION OR COOLING MAY BE NECESSARY TO PREVENT ENCLOSURE AMBIENT FROM EXCEEDING 45°C).

3. WIRE SIZES, BREAKERS AND FUSES FOR SERVOSTAR.

   PA08 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 8 AMPS RMS. FUSE FOR 10 AMPS (FRN-10 OR EQUIVALENT).

   PA14 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 14 AMPS RMS. FUSE FOR 20 AMPS (FRN-20 OR EQUIVALENT).

   PA28 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 28 AMPS RMS. FUSE FOR 35 AMPS (FRN-35 OR EQUIVALENT).

   PA50 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 50 AMPS RMS. FUSE FOR 60 AMPS (FRN-60 OR EQUIVALENT).

   PA75 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 75 AMPS RMS. FUSE FOR 80 AMPS (FRN-80 OR EQUIVALENT).

   PA85 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 85 AMPS RMS. FUSE FOR 100 AMPS (FRN-100 OR EQUIVALENT).

   THE ACTUAL APPLICATION MAY REQUIRE LESS CURRENT, USE 600V VAC INSULATED WIRE AND REFER TO LOCAL ELECTRICAL CODES FOR PROPERWIRE SIZE FOR THE CURRENTS LISTED ABOVE. FUSES FOR MAIN POWER SHOULD BE A UL RATEDTIME DELAY TYPE, SUCH AS, BUSS FRN-RSERIES. CONTROLS CIRCUITS SHALL BE PROVIDED WITH APPROPRIATEOVER-CURRENT PROTECTION.

   THE POWER BUS BETWEEN POWER SUPPLIES (PA08, PA14, PA28, PA50, PA75, AND PA85) AND DRIVES SHOULD USE THE FOLLOWING MINIMUM WIREGUAGE WITH 600 VAC INSULATION. USE ONLY COPPER WIRE. WIRE SIZE MAY BE DETERMINED FROM TABLE 310-16 OF THE NEC 60° OR 75° COLUMN.

   RECOMMENDED WIRE GUAGE POWER SUPPLIES

   PA08, 14 AWG OR LARGER WIRE

   PA14, 14 AWG OR LARGER WIRE

   PA28, 10 AWG OR LARGER WIRE

   PA50, 6 AWG OR LARGER WIRE

   PA75, 4 AWG OR LARGER WIRE

   PA85, 1 AWG OR LARGER WIRE

   RECOMMENDED WIRE GUAGE DRIVES

   SX03, 14 AWG OR LARGER WIRE

   SX06, 14 AWG OR LARGER WIRE

   SX10, 14 AWG OR LARGER WIRE

   SX20, 10 AWG OR LARGER WIRE

   SX30, 10 AWG OR LARGER WIRE

   SX55, 6 AWG OR LARGER WIRE

   RECOMMENDED SPADE TERMINALS
   16/14 AWG HOLLINGSWORTH XSS20954S OR SS20947SF
   12/10 AWG HOLLINGSWORTH XSS20836 OR SS20832F

   RECOMMENDED RING TERMINALS
   8 AWG HOLLINGSWORTH R3027BF
   6 AWG HOLLINGSWORTH R4001BF
   4 AWG HOLINGSWORTH R5100BF

4. ALL AC LINES SHOULD BE TWISTED CABLES.

5. THE TOTAL NUMBER OF AXES ALLOWED PER POWER SUPPLY DEPENDS ON THE APPLICATION AND THE COMBINATION OF DRIVES REQUIRED POWER.
   PA-LM A MAXIMUM OF 2 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO NOT EXCEED LOGIC SUPPLY CAPACITY!
   PA08: A MAXIMUM OF 2 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO NOT EXCEED LOGIC SUPPLY CAPACITY!
   PA14: A MAXIMUM OF 4 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO NOT EXCEED LOGIC SUPPLY CAPACITY!
   PA28: A MAXIMUM OF 4 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO NOT EXCEED LOGIC SUPPLY CAPACITY!
   PA50: A MAXIMUM OF 4 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO NOT EXCEED LOGIC SUPPLY CAPACITY!
   PA75: A MAXIMUM OF 4 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO NOT EXCEED LOGIC SUPPLY CAPACITY!
   PA85: A MAXIMUM OF 4 DRIVES (SEE SPECIFICATIONS OF POWER SUPPLY AND REQUIREMENTS OF DRIVE) DO N

6. ALL SIGNAL AND CONTROL WIRES TO BE 22-18 AWG WIRE. FERRULES ARE RECOMMENDED TO IMPROVE CONNECTIONS.
   20 AWG TYPE HO, 75/14 NO. 4629.0 FROM WEIDUMULLER
   18 AWG TUPE H1, 0/14 NO. 4630.0 FROM WEIDMULLER

7. RECOMMENDED TORQUES ARE
   A) CONTROL SIGNALS 2.25 IN-LB
   B) SX03, SX06, SX10, SX20, PA08, PA14, AND PA28
      MAX TORQUE 12 IN-LB: MOTOR, BUS CONNECTION AMD GROUND STUD
   C) SX30, SX55, PA50, PA75, AND PA85
      MAX TORQUE 20 IN-LB: MOTOR, BUS CONNECTION AND GROUND STUD

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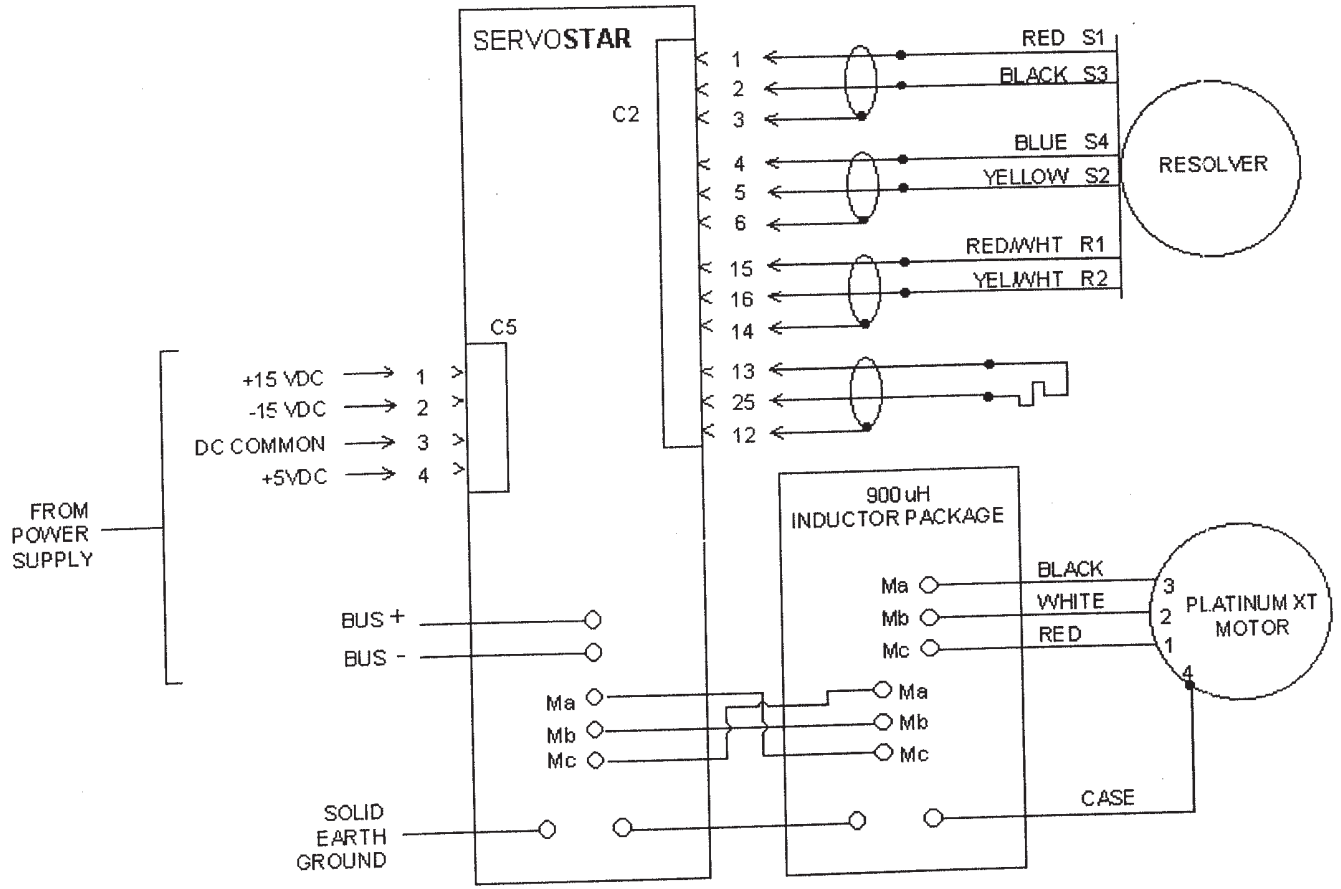


Figure 2-9. Typical Platinum XT Wiring Diagram - Resolver Based

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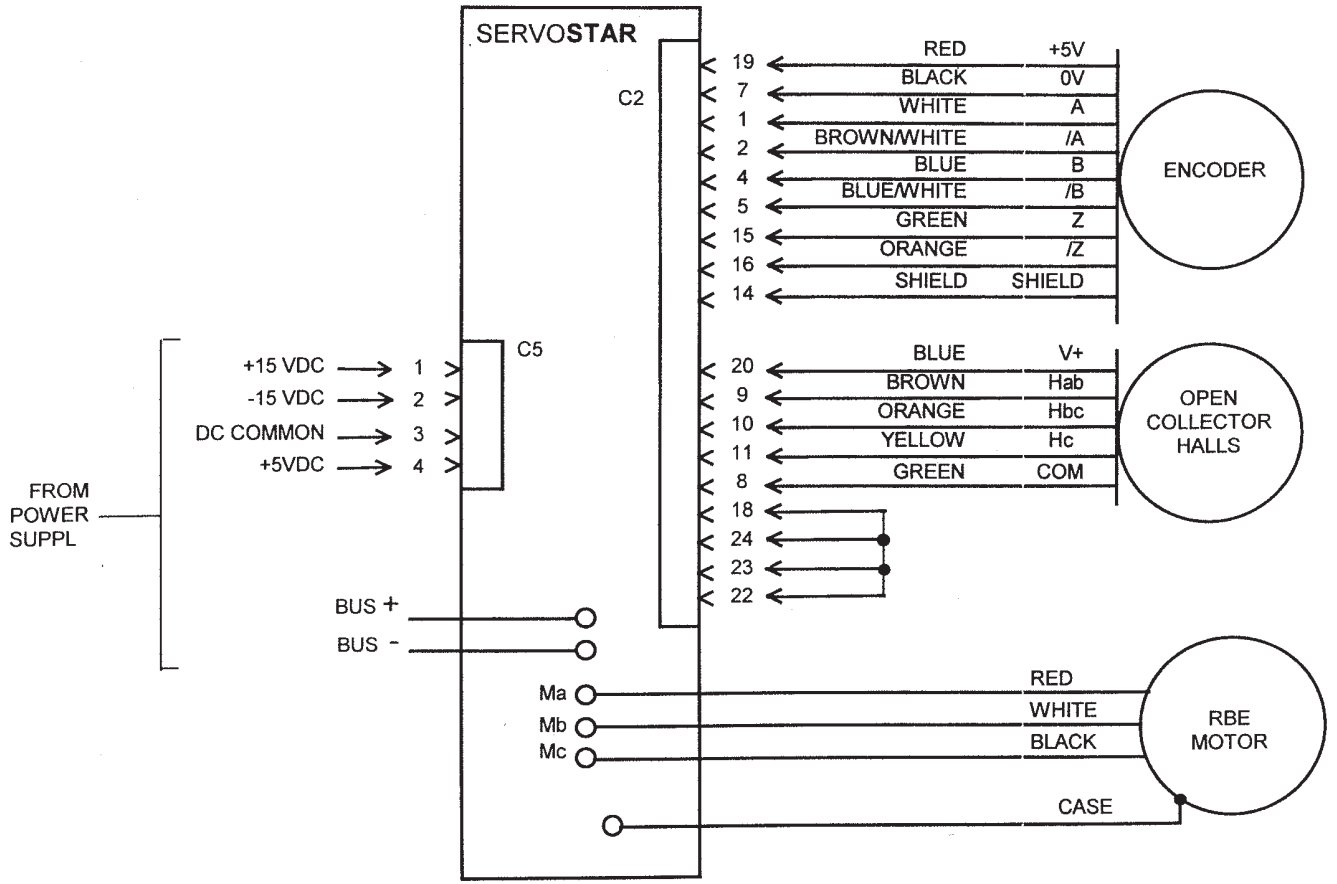


Figure 2-10. Typical RBE Motor Wiring Diagram

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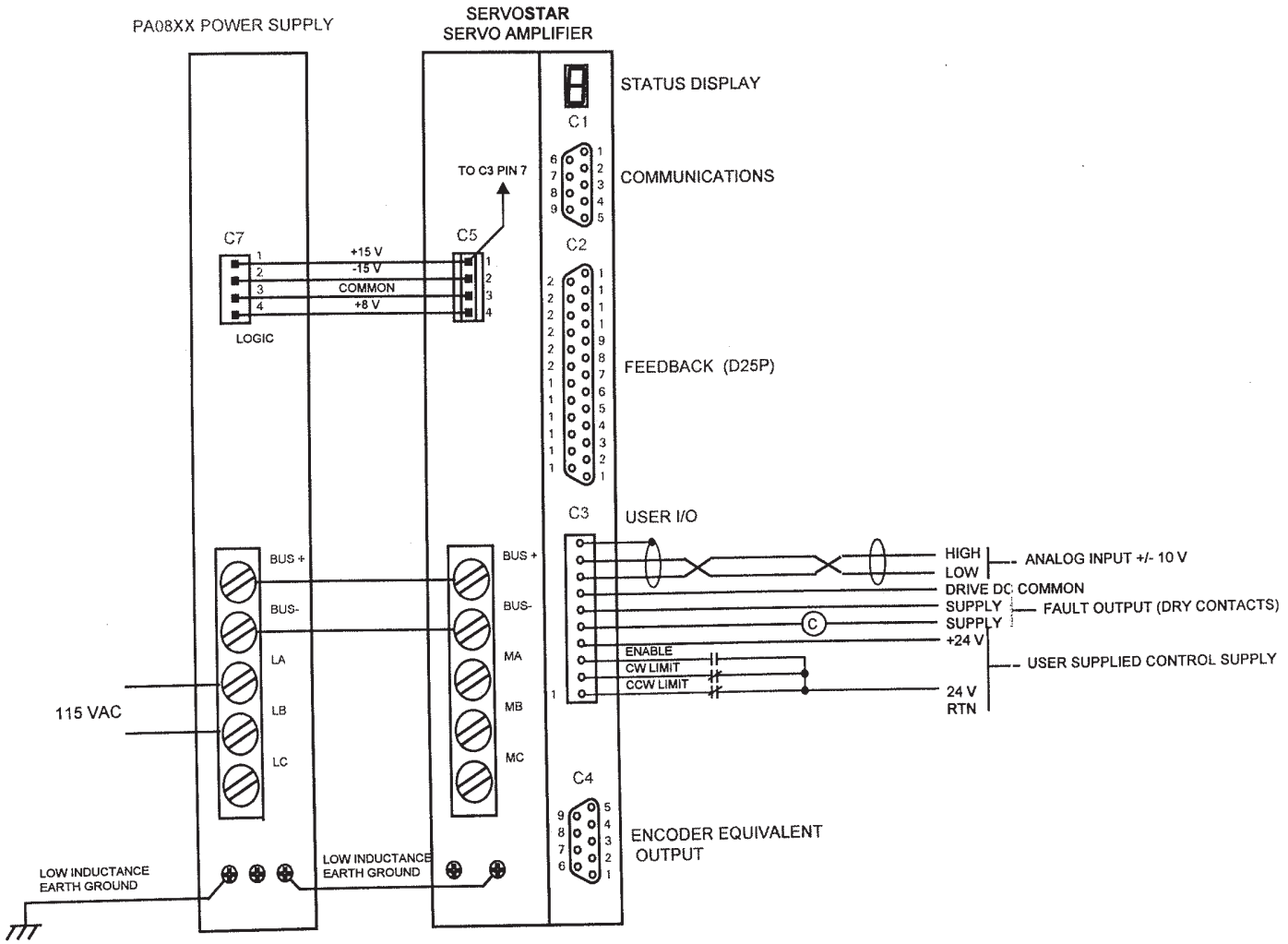


Figure 2-11. SERVOSTAR / SilverLine Motor (Hall Effect Connections) - Sheet 1 of 2

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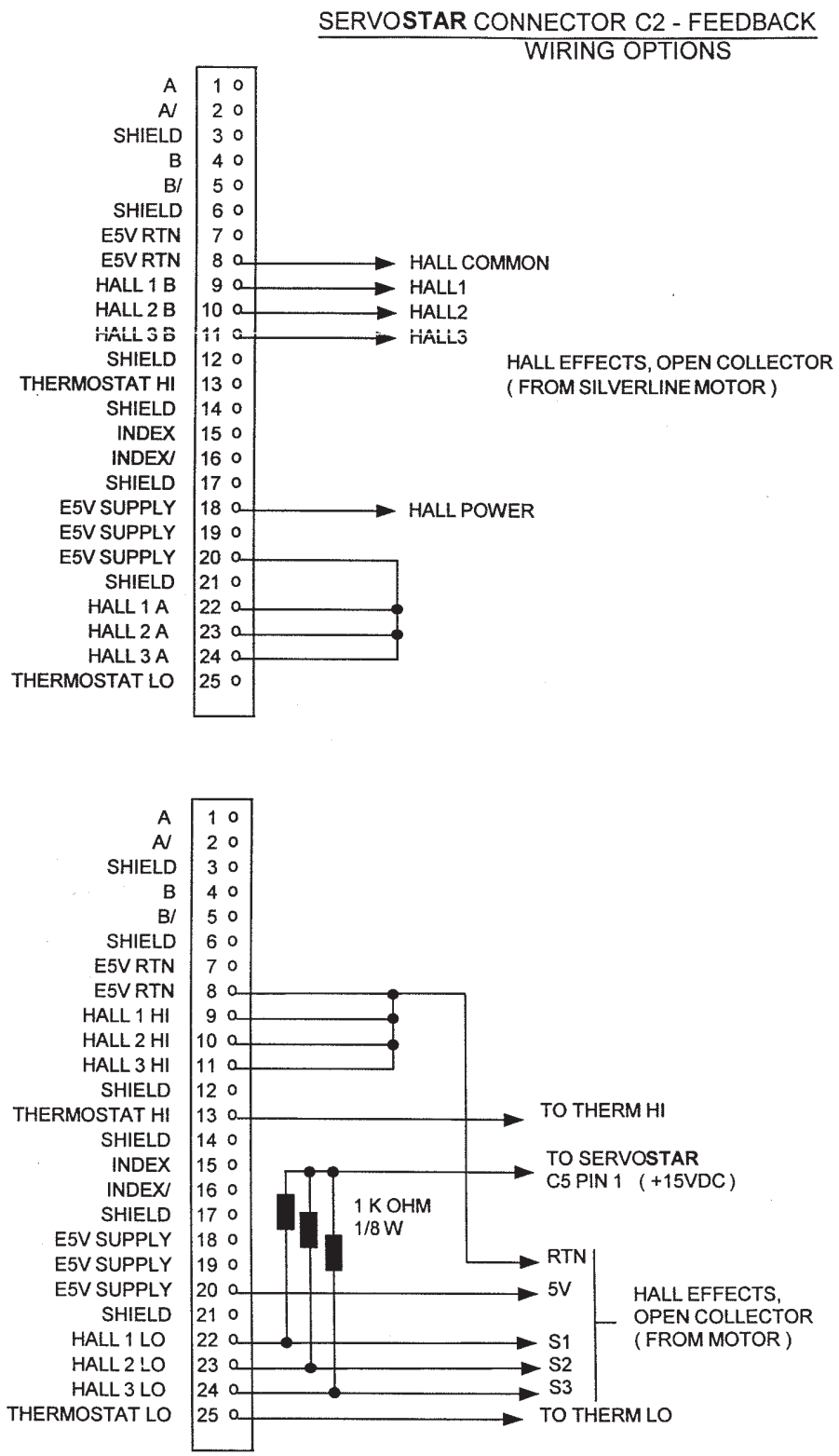


Figure 2-11. SERVOSTAR / SilverLine Motor (Hall Effect Connections) - Sheet 2 of 2

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SECTION 3

SYSTEM START UP

3.1 SETTING UP A DRIVE

This section describes how to set up a SERVOSTAR drive. REVIEW THIS SECTION COMPLETELY, and familiarize yourself with the information contained here.

3.2 SETTING UP A DRIVE FOR THE FIRST TIME

Once a SERVOSTAR amplifier and motor combination is installed and connected, the flowchart on the next page guides you in setting up the drive and motor combination for its application. The following sections provide more information about the blocks in the flowchart.

(1) Is the Drive Already Configured with Motor Parameters?

If your drive's LED display shows a flashing minus sign (-) when you power up the drive, then the drive is not configured with motor data. Most drives that are shipped from the factory are already configured with motor data, and if they are, the LED display will show something other than the flashing minus sign. If you see the flashing minus sign, then before you can continue, the first thing you have to do is enter important drive and motor data into your drive. The flowchart indicates what steps to take, and those steps are described below.

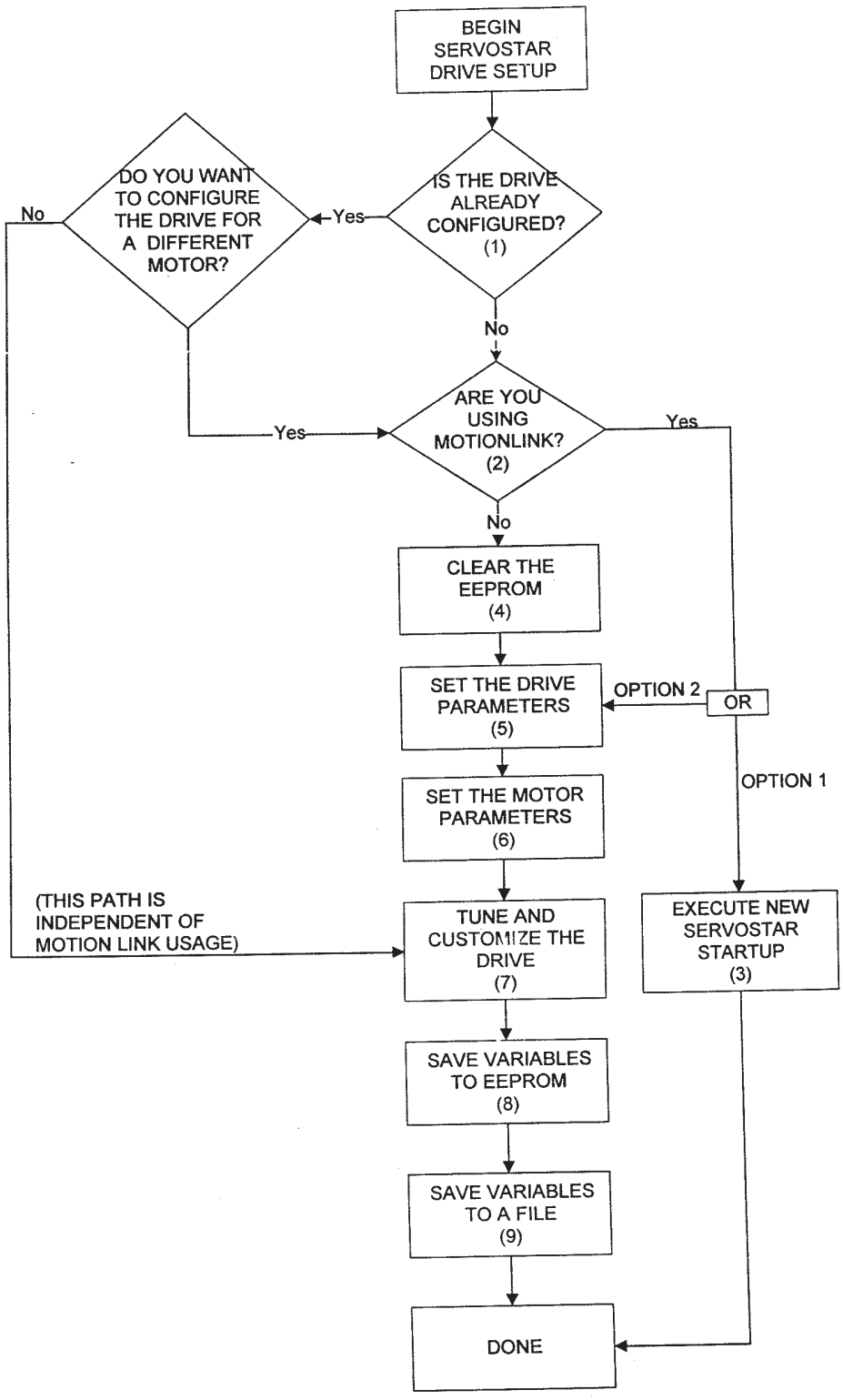
(2) Are you Using MotionLink?

If you're using MotionLink to configure your drive (which is *highly* recommended), you have two choices: you can execute steps 5-9 of the flowchart manually, using MotionLink's screens and controls, or you can use the "New SERVOSTAR Startup" function in MotionLink (recommend), which will walk you through steps 5-9 of the drive setup process automatically. **Refer to Section 8 for more information on the MotionLink software package.**

(3) Executing MotionLink's New SERVOSTAR Startup Function

For brand new drives that aren't configured, or when an existing drive needs to be reconfigured for a new motor or a new application, using the ***New SERVOSTAR Startup*** function in MotionLink is the easiest method. On the SERVOSTAR MotionLink Main Display Screen, pull down the Configure Menu and select the "New Drive (123)" menu item. From there, MotionLink will walk you through the steps necessary to configure a drive.

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DRIVE SETUP FLOWCHART
(numbers correlate to numbered paragraphs in section 3.2)

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(4) Clear the EEPROM

This step is necessary only if you're using a terminal. At the terminal, type CLREEPROM. This will clear the drive's EEPROM memory, and the drive display will show a flashing minus sign.

(5) Setting Drive Parameters

Using MotionLink: access the Bus Voltage Configuration Screen and select or enter the correct bus voltage.

Using a terminal: enter VBUS from the terminal screen.

Explanation: VBUS is the only drive parameter that needs to be entered. Other drive parameters are determined automatically: DICONT and the feedback type are read from the SERVOSTAR control board, and DIPEAK is calculated from DICONT.

(6) Setting Motor Parameters

Using MotionLink: access the Motor Database tab on the Motor Configuration Screen. Select a motor from MotionLink's predefined motor data bases. When you select a motor from the data base, the motor parameters are called up automatically, and they can then be transferred to the drive. If your motor is not in MotionLink's database, you can use the User Defined tab on the Motor Configuration Screen to enter your own parameters manually and transfer them to the drive. See Appendix D (Field Setup - Motor Parameters) for more details.

Using a terminal: assign values to the variables listed in the following table, and then type a CONFIG command, followed by a RSTVAR command. The CONFIG command will configure the current and velocity loops based on motor and drive data, and the RSTVAR command will set all variables to their default values.

MOTOR PARAMETERS REQUIRED FOR DRIVE CONFIGURATION			
MOTOR	MENCOFF	MLGAINZ	MRESPOLES
MIPEAK	MENCTYPE	MLMAX	MTANGLC
MICONT	MJ	MLMIN	MTANGLP
MSPEED	MKT	MPHASE	MVANGLF
MBEMF	MKTI	MPOLES	MVANGLH
MENCRES	MLGAINP	MRES	MBEMFCOMP

(7) Tuning and Customizing the Drive for its Application

Using MotionLink: to tune the control loop gains, access MotionLink's Tune Screen and use it to set the gains. To set the values of general system variables, MotionLink provides a variety of pages and screens that manipulate variable settings and execute commands using graphical controls (refer to the Limits Screen and Other Settings Screen).

Using a terminal: each control loop gain value and each system variable can be set individually from a terminal.

Explanation: to optimize the performance of a drive/motor combination for the application, it is necessary to set the variables that control the drive's performance. There are two processes in this step: tuning the control loop gains and setting general system variables.

The control loop gains and parameters are listed in the Loop Compensation and Gains table in section 6.

In addition to the control loop gains and parameters, there are other system variables and switches that affect system performance. Listings of these variables and switches are found in the following tables in section 6:

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(1) Analog Input-Related; (2) Current Parameters; (3) Velocity Parameters; (4) Loop Compensation and Gains; and (5) Motion Control Parameters. The user is advised to learn about the variables listed in those tables and to experiment with how different configurations alter system performance. Section 6 is a valuable reference that describes all commands and variables.

(8) Saving System Variables to EEPROM

Using MotionLink: click the SAVE button in the lower left-hand corner of the Tune Screen.

Using a terminal: execute a SAVE command.

Explanation: during setup and operation, any changes that are made to variables are stored in dynamic system RAM and will be lost if the drive is powered down. If this occurs, the variables will revert back to their EEPROM or default values when the drive is powered up again.

Many of the SERVOSTAR variables, however, can be saved to system EEPROM, and they will not be lost when the drive is powered down and back up. The variables that can be saved in this fashion are listed in a table below and are denoted "EEPROM: yes" in the descriptions in section 6.

Therefore, the operator can make changes to system variables, execute a SAVE command, and any changes that have been made will be saved permanently, as long as the variable is an EEPROM variable. Once an operator has correctly configured a SERVOSTAR for its application, all variables can be saved, and none of the configuration information will be lost.

VARIABLES STORED IN EEPROM			
NOTE: The settings of these variables are stored in EEPROM whenever the SAVE command is executed. The values in EEPROM are loaded into the system upon power-up and whenever the LOAD command is executed. Refer to the SAVE, LOAD, and RSTVAR commands for more information.			
ACC	GV	MJ	MBEMFCOMP
ACKMODE	GVI	MKT	OPMODE
ACTFAULT	H	MKTI	PROFMODE
ANDB	ICONT	MLGAINP	PROMPT
ANOFF	ILIM	MLGAINZ	R
AVGTIME	IMAX	MLMAX	RDRES
BW	ISCALE	MLMIN	RELAYMODE
COMPMODE	IZERO	MOTOR	THERMODE
D	KV	MPHASE	TRUN
DEC	KVFR	MPOLES	UNITS
DECSTOP	KVI	MRES	UVRECOVER
DICONT	LIMDIS	MRESPOLES	VBUS
DIPEAK	LMJR	MSG	VLIM
DIR	MBEMF	MSPEED	VMAX
ECHO	MENCOFF	MTANGLC	VOSPD
ENCOUT	MENCRES	MTANGLP	VSCALE
FOLDMODE	MICONT	MVANGLF	
GETMODE	MIPEAK	MVANGLH	

(9) Saving System Variable Files

Using MotionLink: access the Backup Screen. Click the Receive button to receive variables from the drive, and click the Save button to save the variables to disk.

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Using a terminal: execute a DUMP command and save the resulting transmission from the drive into a variable file (*.SSV file name).

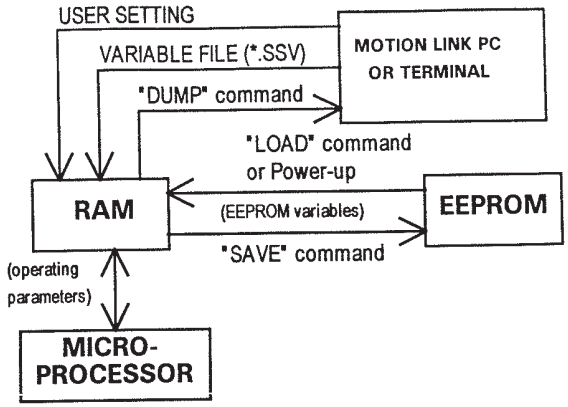
Explanation: the SERVOSTAR makes use of a Variable File (*.SSV file name in DOS), which can be used to read and write system variables to and from disk. A variable file is an ASCII file consisting of a series of variable assignment statements. The last line of a variable file is a CONFIG command.

When a variable file is transmitted to the drive over a serial port, it is interpreted by the drive as a series of variable assignments, the same as if an operator had typed the statements in from a terminal. The final line of the variable file, CONFIG, is processed as a CONFIG command, and the drive will configure itself using the variable values that were just transmitted from the file.

A DUMP command causes the drive to output variables and their values to the serial port, in the format of a variable file (including the trailing CONFIG command). This enables the user to quickly save a system configuration by executing a DUMP command and saving the resulting serial port transmission to a *.SSV file. That file can later be loaded back into the drive to restore the saved configuration, or the file can be copied and modified for use in other applications.

VARIABLE FILE (*.SSV) FORMAT		
NOTE: This table lists the variables that comprise a variable file, including a CONFIG command at the end. The DUMP command will output the variables listed here, along with their current settings, followed by a CONFIG.		
1 MOTOR	25 IZERO	49 GVI
2 MIPEAK	26 VLIM	50 H
3 MICONT	27 VOSPD	51 KV
4 MSPEED	28 VSCALE	52 KVI
5 MBEMF	29 ACC	53 KVFR
6 MENCRES	30 ACKMODE	54 LIMDIS
7 MENCOFF	31 ACTFAULT	55 LMJR
8 MJ	32 ANDB	56 MSG
9 MKT	33 ANOFF	57 MTANGLC
10 MKTI	34 AVGTIME	58 MTANGLP
11 MLGAINP	35 BW	59 MVANGLF
12 MLGAINZ	36 COMPMODE	60 MVANGLH
13 MLMAX	37 D	61 OPMODE
14 MLMIN	38 DEC	62 PROFMODE
15 MPHASE	39 DECSTOP	63 PROMPT
16 MPOLES	40 DIR	64 PWMFRQ*
17 MRES	41 ECHO	65 R
18 MRESPOLES	42 ENCOUT	66 RELAYMODE
19 VBUS	43 FOLDD*	67 THERMODE
20 DIPEAK	44 FOLDMODE	68 UNITS
21 DICONT	45 FOLDR*	69 UVRECOVER
22 ILIM	46 FOLDT*	CONFIG
23 ICONT	47 GETMODE	
24 ISCALE	48 GV	
*These are factory-use variables that are transmitted during a DUMP command. These variables don't need to be defined as part of a user's variable file, but if they are, their values **should not** be changed from those transmitted during a DUMP.		

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As described above, variable files can be received from the drive using the DUMP command in terminal mode, or by using the RECEIVE function in the Backup Screen in Motion Link. Variable files can be transmitted to the drive using a terminal or using the XMIT function in the Motion Link Backup Screen.

3.3 RESTORING FACTORY SETTINGS

Using MotionLink: access the Motor Configuration Screen. Using the Motor Database or User Database tab, select the motor data for which the drive was originally configured. Click the TO DRIVE button and then click the SAVE button.

Using a terminal:

1. Type CLREEPROM.
2. Re-enter the values that were stored in the drive and motor parameters when the drive was shipped from the factory (see items 3 and 4 in section 3.2). If the values of the drive and motor parameters when it was shipped from the factory are unknown or the data has been lost, contact Kollmorgen Motion Technologies Group for assistance.
3. Type a CONFIG command, followed by a RSTVAR. This configures control loops and resets many variables to default values, based on motor and drive parameters (see 3.8 for more on RSTVAR).
4. Type a SAVE command to save the variables to EEPROM.

3.4 RESTORING A CUSTOM CONFIGURATION

This sequence is executed if the user has changed variables and saved them to EEPROM since the original system parameters were entered (when the drive was first set up). The operator executes this sequence if he wishes to return to the drive to its original configuration for the application.

Using MotionLink: access the Backup Screen. Click the OPEN button and open the variable file that was saved as part of the procedure in section 3.2 (Setting up a Drive for the First Time). Send the variables to the drive by clicking the XMIT button. Lastly, save the variables to EEPROM in the drive by clicking the SAVE to EEPROM button located on either the Tune Screen, the Bus Voltage Configuration Screen, or the Motor Configuration Screen.

Using a terminal:

1. Execute a RSTVAR command.
2. Transmit to the drive the Variable File that was saved as part of the procedure in section 3.2 (Setting up a Drive for the First Time)
3. Execute a SAVE command to save the values to EEPROM.

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3.5 CHANGING A DRIVE CONFIGURATION

After setting up a drive (section 3.2), the user may wish to change the system settings to investigate performance with different system settings. In this case, this procedure is used.

Using MotionLink: utilize the various screens in the program (primarily the Tune Screen, Limits Screen, and Other Settings Screen) to change operating parameters and optimize the performance of the drive. Save variables to EEPROM in the drive by clicking the SAVE to EEPROM button located on either the Tune Screen, the Bus Voltage Configuration Screen, or the Motor Configuration Screen. Backup the drive configuration to a new computer file using the Backup Screen.

Using a terminal:

1. Set system gain values and general variables to values that optimize the performance of the drive for its application.
2. Execute a SAVE to save all EEPROM variables.
3. Execute a DUMP command and save the resulting transmission to a new variable file (DOS extension *.SSV).

3.6 DRIVE ENABLE LOGIC

The drive enable logic is based on the following switches and flags: ACTIVE, READY, DRIVEOK, SWEN, REMOTE, and DIPEN.

The overall readiness indicator of the drive is the ACTIVE flag. If the ACTIVE flag is equal to 1, then the drive is powered up and ready to accept commands.

The following logic equations control the drive enable status.

ACTIVE = (READY) AND (REMOTE) AND (DIPEN)
where READY = (DRIVEOK) AND (SWEN)

3.7 SETTING CURRENT AND VELOCITY LIMITS

CURRENT LIMIT VARIABLES	
VARIABLE	**DESCRIPTION AND CHARACTERISTICS**
DIPEAK	drive peak current rating, read-only, equal to (DICONT x 2)
MIPEAK	motor peak rating, read/write, read from motor file
DICONT	drive continuous current rating, read from jumpers (standard drive, read-only) or entered by user (non-standard drive, read/write)
MICONT	motor continuous current rating, read/write, read from motor data file
IMAX	max system current, read-only, minimum of DIPEAK and MIPEAK
ICONT	system continuous rating, read/write, defaults to minimum of DICONT and MICONT; $0 \leq$ ICONT $\leq$ IMAX; used by foldback algorithm
ILIM	user/application limit, read/write, defaults to IMAX, $0 \leq$ ILIM $\leq$ IMAX; limits the T command and the current loop output
IZERO	zero mode phase current, read/write, defaults to 25% of MICONT

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VELOCITY LIMIT VARIABLES	
VARIABLE	**DESCRIPTION AND CHARACTERISTICS**
MSPEED	max motor velocity, read/write, read from motor data file
VMAX	max system velocity, read-only, calculated from hardware-dependent parameters (MSPEED, VBUS, MBEMF, MENCRES), VMAX ≤ 12,000
VOSPD	overspeed trip limit, read/write, defaults to (VMAX*1.2), 100 ≤ VOSPD ≤ (VMAX*1.2)
VLIM	user/application limit, read/write, defaults to VMAX; 100 ≤ VLIM ≤ VMAX; limits the J command and the velocity loop output

3.8 GENERAL CONFIGURATION INFORMATION

DEFAULT VALUES ASSIGNED BY THE RSTVAR COMMAND		
ACC = 399,987	FOLDMODE = 0	LMJR=0
ACKMODE = 0	FOLDR=12000	MPHASE = 0
ACTFAULT = 0	FOLDT=2500	MSG = 1
ANDB = 0	GETMODE = 0	OPMODE = 1
ANOFF = 0	GV = 500	PROFMODE = 0
AVGTIME = 0	GVI = 20	PROMPT = 1
BW = 20	H = all 0's	R = all 0's
COMPMODE = 2	ILIM=IMAX	RELAYMODE = 0
D = all 0's	ISCALE = 1250	THERMODE = 0
DEC = 399,987	IZERO = 25	UNITS=0
DECSTOP = 5000	KV = 1000	UVRECOVER = 0
DIR = 1	KVI = 1000	VLIM=VMAX
ECHO = 1	KVFR = 0	VOSPD=1.2*VLIM
ENCOUT = 1024	LIMDIS = 0	VSCALE=1.25*VLIM
FOLDD=2000		

After setting the values shown in the preceding table, the system will also set the value of ICONT according to the rules governing its default value.

POWER-UP STATE OF THE SERVOSTAR SWITCHES		
OFF (= 0)		
FOLD	RECDONE	RECRDY
HOLD	RECING	ZERO
ON (= 1)		
SWEN		
REMEMBERED		
ACTFAULT	ECHO	RELAYMODE
ACTIVE	LIMDIS	REMOTE
CCWLIM	MSG	THERM
CWLIM	PROFMODE	UNITS
DIPEN	PROMPT	UVRECOVER
DIR	READY	
DRIVEOK	RELAY	
NOTE: The "REMEMBERED" switches include switches whose settings are loaded from EEPROM or are determined by hardware, by other switch settings, etc. The true default value of switches listed in the REMEMBERED section can be found in section 6.		

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3.9 SERIAL COMMUNICATIONS PROTOCOL

3.9.1 How to Control the Drive

The user issues commands to and sets variables for the SERVOSTAR via a serial port. The other end of the serial port is hooked up to a PC running Motion Link for Windows software, a PC running a user's custom program, or a dumb terminal. Any of those three setups allows the user to utilize the PC or terminal to issue commands to the SERVOSTAR or to read and change variables in the SERVOSTAR.

The dumb terminal method is the most basic method of controlling the SERVOSTAR. The most sophisticated way of controlling the SERVOSTAR is using Motion Link for Windows, which provides a robust set of control menus, function buttons, graphical displays, and dialog boxes. When using Motion Link, the PC responds to the user commands in the Motion Link program by transmitting the appropriate commands and variables over the serial port to the drive.

This section gives examples of the communications protocol between the SERVOSTAR and the terminal or PC. For simplicity's sake, this section assumes that a dumb terminal is being used to control the drive. In the following protocol definitions, special control codes are used. They are defined according to the table.

CONTROL CODE DEFINITIONS				
Name	**Symbol**	**Control**	**Hex**	**Decimal**
Bell	<Bell>	^G	07h	7
Line Feed	<Lf>	^J	0Ah	10
Carriage Return	<Cr>	^M	0Dh	13
Space	<Sp>	--	20h	32
Ack Message	<Ack>	^F	06h	6
Nak Message	<Nak>	^U	15h	21

Serial protocol is defined using the following protocol box format. The example in the table shows an enable (EN) command being issued to the Drive, with ECHO=1 and PROMPT=1. In this example, the Terminal transmits EN, the Drive echoes the EN, the Terminal transmits a carriage return, and the Drive responds with a carriage return, line feed, and the three-character prompt.

# Bytes	1	1	1	1	1	5
T->D	E		N		<Cr>	
D->T		E		N		<Cr> <Lf> -->

T->D = Terminal-to-Drive transmission
D->T = Drive-to-Terminal transmission

3.9.2 Drive-to-Terminal Communications

There are five items that the Drive will transmit to the Terminal:
1) echoes of characters entered from the terminal (see ECHO);
2) a prompt (see PROMPT);
3) <Ack>/<Nak> messages (see ACKMODE = 1)
4) variable values; and
5) error messages.

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3.9.3 Terminal-to-Drive Communications

There are two items that the Terminal will transmit to the Drive:
1) commands
2) variables

3.9.4 Flags Affecting Comm Protocol

There are four flags that affect the communications between the Drive and the Terminal. Refer to the descriptions of these flags in section 6 for more information. The flags are: ACKMODE, ECHO, MSG, and PROMPT.

3.9.5 Issuing a Command to the Drive

EXAMPLE 1: command the drive to jog at a speed of 100 RPM with ECHO=1, PROMPT=1, and ACKMODE=0. Non-multidrop mode.

COMMAND: J 100

# Bytes	1	1	1	1	1	1	1	1	1	1	1	5
T->D	J		<Sp>		1		0		0		<Cr>	
D->T		J		<Sp>		1		0		0		<Cr> <Lf> -->

EXAMPLE 2: command the drive to jog at 1000 RPM with ECHO=1, PROMPT=1, and ACKMODE=0. Multidrop mode, address = 8. Note the transmission of a backslash-8 at the beginning and the different prompt returned by the Drive. Also note that the backslash-8 is not echoed by the Drive.

COMMAND: \8J 1000

# Bytes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
T->D	\	8	J		<Sp>		1		0		0		0		<Cr>	
D->T				J		<Sp>		1		0		0		0		<Cr> <Lf> 8->

3.9.6 Requesting a Variable Value

EXAMPLE 3: request the value of PRD (which in this example is equal to 2057). ECHO=1, PROMPT=0, and ACKMODE=0. Non-multidrop mode.

COMMAND: PRD

# Bytes	1	1	1	1	1	1	1	2	4	2
T->D	P		R		D		<Cr>			
D->T		P		R		D		<Cr> <Lf>	2057	<Cr> <Lf>

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EXAMPLE 4: request the value of PRD (which in this example is equal to 12244). ECHO=0, PROMPT=1, and ACKMODE=1. Multidrop mode, address = 7.

COMMAND: \7PRD

# Bytes	1	1	1	1	1	1	2	5	5	5
T->D	\	7	P	R	D	<Cr>				
D->T							<Cr> <Lf>	<Ack>	12244	<Cr> <Lf> 7->

3.9.7 Setting a Variable Value

EXAMPLE 5: set KV = 50. ECHO=0, PROMPT=0, and ACKMODE=1. Non-multidrop mode.

COMMAND: KV 50

# Bytes	1	1	1	1	1	1	7
T->D	K	V	<Sp>	5	0	<Cr>	
D->T							<Cr> <Lf> <Ack>

EXAMPLE 6: set DEC = 800. ECHO=1, PROMPT=1, and ACKMODE=0. Multidrop mode, address = 3.

COMMAND: \3DEC 800

# Bytes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
T->D	\	3	D		E		C		<Sp>		8		0		0		<Cr>	
D->T				D		E		C		<Sp>		8		0		0		<Cr> <Lf> 3->

3.9.8 Error Messages

When the SERVOSTAR detects an error, the drive will output an error message over the serial port. There are two types of error messages, each of which results in the same type of transmission from the drive to the terminal:

1) command errors - these occur when an incorrect command is entered from the Terminal.
2) system errors - these occur when a system operational error is detected, such as an overtemperature detection.

Example 7: operator accidentally enters "JX 100" instead of "J 100." This is an example of a command error. ACKMODE=1, PROMPT = 1, no multi-drop.

# Bytes	1	1	1	5	3	1	2	1	15	1	1	3
T->D												
D->T	<Cr>	<Lf>	<Bell>	<Nak>	ERR	<Sp>	20	<Sp>	Unknown command	<Cr>	<Lf>	-->

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SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

The material presented in this section is designed to build a basic understanding of the SERVOSTAR System and its operation. This foundation of knowledge will allow a user to continue on to the more detailed information presented in other sections and become proficient at integrating the SERVOSTAR into a machine control system.

As with any microprocessor-based product, the operational properties are often governed by three characteristics: the hardware platform, the operating firmware, and the user's configuration. It is therefore necessary to make some references to system variables which have not yet been introduced by this manual. System commands and variables are typed in ALL CAPS in this section and described in detail in Section 6.

This section is presented in the following major subsections. In the context of this section, a "system" is a SERVOSTAR drive. The associated power supply and motor are discussed where appropriate.

1. System Display and LED's - a description of how the drive and power supply present information to the operator.
2. System I/O - a description of I/O between the drive and external components.
3. System Operation - basic information on powering up the drive, enabling it, and controlling it.
4. System Monitoring and Fault Detection - how the drive detects faults and protects itself and the motor.
5. Servo Loop Description - information on the servo loops, how they operate, and how to tune them.

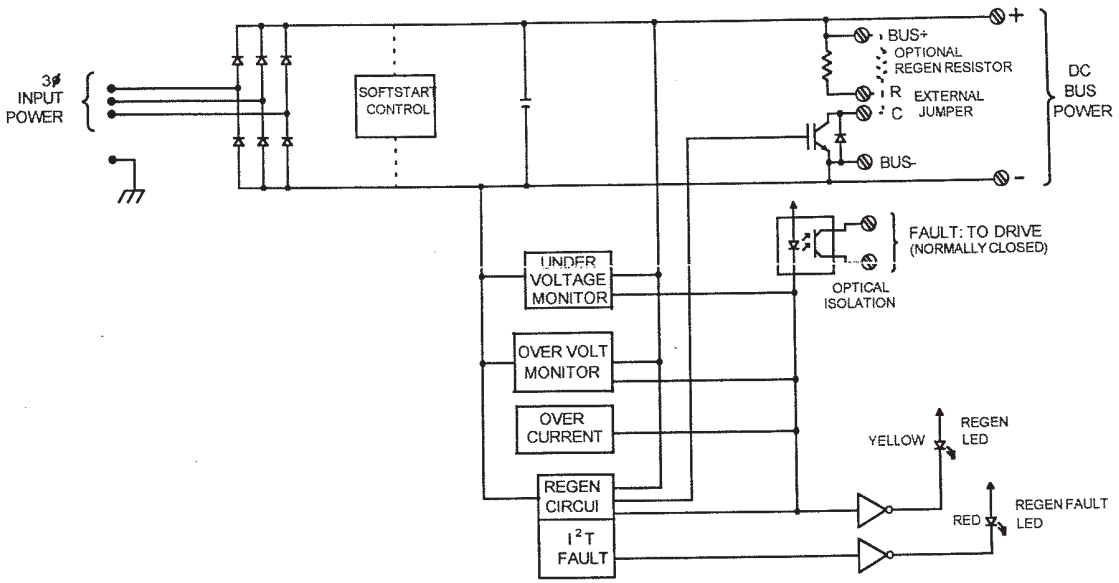
4.2 SYSTEM DISPLAY AND LED'S

4.2.1 Drive Status Display and Power Supply LED's

A red, seven-segment LED Status Display on the front of the SERVOSTAR drive indicates important system status information. The Status Display normally indicates the mode of operation (OPMODE) the drive is in, and in the event of a fault, the Status Display will flash an error code.

The decimal point in the Status Display is also used for status indication. It indicates the state of the 'global' drive enable (ACTIVE). If the Remote Enable hardware input (REMOTE) is active, the DIP switch enable (DIPEN) is active, the software enable (SWEN) is active, and no faults are present (DRIVEOK) the microprocessor will enable the power stage. This condition is indicated by an illuminated decimal point. If any of the above conditions prevent the drive from enabling, the decimal point will remain off. A flashing decimal point is used to indicate that the drive is enabled but some safety feature has been disabled (for example, LIMDIS has been set to 1, which disables the travel limit switch inputs). See section 4.4.2 for more information on enabling the drive.

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TYPICAL INTEGRAL POWER SUPPLY

Figure 4-1. The SERVOSTAR Power Supply Simplified Schematic Diagram

The SERVOSTAR power supplies also have status LED's which indicate their operational status. There are four SERVOSTAR power supply models, and they each have status LED's as detailed in the following table:

Table 4-1. SERVOSTAR Power Supply LED's

LED COLOR AND MEANING	PA08 POWER SUPPLY	PA14 and PA28 POWER SUPPLIES	PA50 POWER SUPPLY	PA75 and PA85 POWER SUPPLIES
Green - DC BUS	√	√	√	√
Yellow - REGEN		√	√	√
Red - REGEN FAULT			√	√

Under normal static conditions, the green DC BUS LED is the only LED that will be illuminated, indicating that bus power is present. The yellow REGEN LED may flash during aggressive decelerations, indicating that the drive's regen circuitry is active. The red REGEN FAULT LED coming on will also log an over-voltage fault, indicating that too much power is being pumped back into the drive.

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4.3 SYSTEM I/O (INPUT/OUTPUT)

4.3.1 Analog Input

The velocity loop (or torque loop) described later in this section can receive its input from an analog voltage source. The analog input to the SERVO**STAR** is differential, meaning that the signals received at the two inputs are subtracted from each other to create a 'difference' which is then used by the rest of the system. This type of input has a high degree of noise immunity and, in many cases, will allow for ground isolation between systems. This analog front-end also has a low pass filter to prevent high frequency noise from entering the system.

The input voltage from the differential receiver is applied to a precise 12-bit or 14-bit Analog-to-Digital (A/D) conversion system

The A/D conversion system is read by the microprocessor every 250µS for velocity loop analog input, or every 62.5µS for torque (current) loop analog input. Since analog systems often require scaling and offset bias, the SERVO**STAR** adds the ANOFF (Analog Offset) variable to this reading, performs an ANDB (Analog Dead Band) adjustment, and scales it with VSCALE (velocity loop input scaling) or ISCALE (torque loop input scaling) before passing the data to the velocity or torque loops. The ANIN (Analog Input) variable indicates the analog reading after the offset (ANOFF) and the deadband (ANDB) adjustments, but before the scaling (VSCALE or ISCALE). The ANIN variable range is +/- 10000 milliVolts (If UNITS=0) and it can be scaled to +/- 16,383 (If UNITS=1) for an input voltage of +/- 10 Volts.

The SERVO**STAR** also offers an automatic analog input zeroing function. Invoking the ANZERO command while the drive is enabled or disabled will sample motor velocity over a 32 millisecond period and update ANOFF accordingly to cancel out analog input offset. This command also incorporates an internal offset mechanism which has finer resolution than ANOFF is capable of providing.

4.3.2 Remote Enable Input (REMOTE)

The Remote Enable input (REMOTE) provides a hardware drive enable switch. The REMOTE (12-24 VDC) input will disable or enable the power stage output to the motor. This signal must be asserted in order to get the drive to enable and operate. The assertion of this signal will also initiate an attempt to recover from a fault condition.

4.3.3 Digital Inputs (IN1, IN2, IN3)

These (12-24 VDC) inputs are defined by the INxMODE variable. Placing the appropriate value in INxMODE will set up the inputs to be used for such features as CC/CCW End Travel Limits, Gearing (refer to Application Note A-SU-002-H for information on Gearing), and positional Holding. When set for the CC/CCW End Travel Limits, the inputs prevent any further motor travel in their respective direction but do not disable the drive or prevent motion in the opposite direction. Note that if acceleration control is in place (PROFMODE = 1) the motor will ramp to a stop after the opening of the End Travel Limit. These inputs are "active enable", meaning current must flow through these signals to allow the system to operate. This provides a 'dead-man' safety feature. Energizing both the CW and CCW travel limits causes the SERVO**STAR** to enter the HOLD mode.

All inputs are current limited and will operate with 10 to 30 VDC applied. Current is a non-linear function of voltage and can be expected to be between 10 and 30 milliamps.

4.3.4 Analog and Digital Outputs (ANOUT, O1)

The analog output is to be used as a monitoring tool only. Setting of variable O1 will allow the user to meter various feedback quantities such as velocity, current, power, following error (See ANOUT for details of features). This pin must be referenced to DC Common (pin 4).

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The digital output can be turned on to indicate various drive, motor, and variable conditions. These conditions can be configured with respect to a variety of trigger and reset levels. It can also indicate a foldback and position overshoot (See O1, O1MODE, O1RST, O1TRIG for further explanation).

4.3.5 Drive Ready / Drive Up Output (RELAY)

The SERVOSTAR provides a drive ready / drive up output in the form of a RELAY output. The RELAY output is controlled by the SERVOSTAR's microprocessor. There is a software switch (RELAYMODE) that configures the RELAY output to act as a 'Drive Ready' or 'Drive Up' indicator:

1. If (RELAYMODE = 0), the relay is closed when the drive is error free and ready to run. This is a 'Drive Ready' configuration.

2. If (RELAYMODE = 1), the relay will be closed only when the drive is enabled. This is a 'Drive Up' configuration.

4.3.6 Motor Thermostat Input (THERM)

The SERVOSTAR provides an input designed to accept the Motor Thermostat Input (THERM). Kollmorgen Industrial Drives Gold Line motors and cables connect the thermostat using the feedback cable. The input to the SERVOSTAR should be electrically closed through the thermostat for proper operation. The SERVOSTAR will normally flash an 'H' in the status display when this input is neither disabled nor closed. There is a software switch (THERMODE) that determines the operation of the drive when the Motor Thermostat Input opens:

1. If (THERMODE=0), Disable drive immediately, open Fault relay (RELAY) immediately.

2. If (THERMODE=1), Disable drive after 2 minutes, open Fault relay (RELAY) immediately.

3. If (THERMODE=2), Do not disable drive, open Fault relay (RELAY) immediately.

4. If (THERMODE=3), Ignore thermostat input.

4.3.7 Resolver Interface

The SERVOSTAR can use a resolver or encoder as a feedback device. The Encoder interface will be discussed later.

The SERVOSTAR uses resolver feedback to monitor the motor shaft position. A resolver can be thought of as a transformer whose output is unique for any given shaft position (an absolute position feedback). The transformer is driven with a 7 kHz 4.25 VAC (RMS) sinewave reference signal. Two AC signals are returned from the resolver into the Sine and Cosine inputs. All three of these sinewave signals are low-level and susceptible to noise. It is important to use properly shielded cable and keep the cable away from noise radiating devices and cables.

The SERVOSTAR calculates motor velocity as the derivative of position (change in position). The digital resolution (RDRES) of the Resolver-to-Digital Converter (RDC) system is determined automatically according to the application limit velocity (VLIM). For VLIM of 1500 RPM and below, RDRES is 16 bits, providing resolution of 1 part in 65536 per revolution. For VLIM between 1500 RPM and 6100 RPM, RDRES is 14 bits, providing resolution of 1 part in 16384 per revolution. For VLIM above 6100 RPM, RDRES is 12 bits, providing resolution of 1 part in 4096 per revolution. The SERVOSTAR uses a patented technique to extend all readings to 16-bit, and for velocity feedback calculations, the SERVOSTAR converts the resolver input to 18-bit resolution, for smooth motor velocity control.

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4.3.8 Encoder Interface

The SERVOSTAR can use encoder feedback to monitor the motor shaft position. As opposed to a resolver, which is an absolute position feedback device, the encoder is an incremental device, indicating changes in position. The encoder resolution is fixed, and it is a hardware characteristic of the device.

The encoder interface includes three groups of wires:

1. A and B lines are the encoder quadrature signals. Those signals are differential, received through line receivers, and wires break detection circuit.
2. Index signal. A narrow pulse that appears in a known position of the shaft. This signal is differential too, received through line receivers, and wire break detection circuit. This signal is hardware capturable.
3. Hall signals. Hall signals are three inputs that provide six steps of absolute position, for start-up commutation, until the index signal is detected. Those signals are isolated by an opto-coupler and can be differential or open-collector type signals.

For added safety, the encoder receives its 5-volt supply from the SERVOSTAR from a different DC-to-DC converter than the logic 5-volts supply.

4.3.9 Encoder Equivalent Output

The SERVOSTAR provides a motor position output to the user in the form of quadrature encoder signals. The outputs are driven using differential line drivers. There is an associated dc common output (C4: pin 3) which can connect to the user's port to keep common mode noise and voltage spikes down to protect the devices. Because there are normally differences of potential between the user's controller and the drive, connection is recommended (If ground loops occur, disconnect and retest).

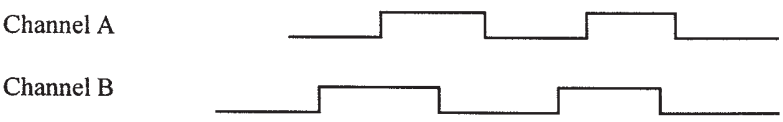
The source of the encoder equivalent output signals depends on the type of motor feedback device. For encoder-based motors, the encoder equivalent output signals are the same as the encoder inputs from the motor, thus, the resolution is fixed. For resolver-based motors, the encoder equivalent output signals are created from the motor resolver signal using hardware for minimum phase lag. In this case, the output resolution (ENCOUT) is user selectable: 512, 1024, 2048, 4096 lines per revolution (2048 and 4096 are available only if RDRES is 14 or 16 bits).

Please note that the encoder equivalent output signals are not phased the same for resolver and encoder systems.
Encoder Equivalent Output Signals

Resolver Based Systems: (A-Leads-B convention for clockwise rotation)



Encoder Based Systems: (B-Leads-A convention for clockwise rotation)



4.3.10 Serial Communications and Multidrop Communications

The SERVOSTAR has an RS-232 serial communications port for communicating with a PC (using the MotionLink program) or with any "dumb" terminal. This port allows the user (or host computer) to issue commands, set and

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monitor variables, monitor operations, modify configuration, and troubleshoot the system via an RS-232 physical interface (connector C1). Section 6 contains detailed descriptions of the commands and variables that can be issued to the drive over the serial connection, and Section 8 contains an introduction to MotionLink, the proprietary Kollmorgen Windows©-based PC program that communicates with a SERVO**STAR** drive.

The ServoStar also supports RS485 serial communications for multidrop mode. The user simply wires the serial communications to the appropriate terminals on the connector.

Both 9600 bps and 19200 bps baud rates are available. The user can select the desired baud rate by setting switch number 6 in the DIP switch. All DIP switch settings are read by the microprocessor once upon power-up, in the initialization process, so any change in the DIP switch settings requires that power be cycled in order to be sensed. Refer to Section 2.9 for additional DIP switch information, including its location.

Multiple SERVO**STAR** drives, up to 31, can be set up to communicate with a single host computer. In this scenario, the host computer or terminal is connected to one drive, called the primary drive, via connector C1. The remaining drives are connected to the primary drive by "daisy-chaining" a ribbon-cable from the 10-pin ribbon cable connector on the top of the primary drive to the ribbon cable connectors on top of the secondary drives. In this fashion, the ribbon cable connectors on the top of all the drives are connected in parallel. This feature is only available when the RS232 hardware is used. It is not supported when choosing the RS485 interface. RS485 can be mutidrop by using the classical methods of this hardware interface.

Each drive in a multiple-drive setup must have a unique address from 0 to 9 or A through V (A-V corresponds to address 10 through 32). The address for a drive is determined by setting DIP switches 1 to 5 with a binary code (5 bits offer 32 possible addresses). Once the drive addresses in a multi-drive setup are configured using the DIP switches, the operator can communicate with a unique drive by typing a backslash character, followed by the drive address, before entering the command.

For example, to issue an EN command to drive #5 in multi-drive setup, the operator would actually transmit "\5" then "EN" to the drive. To issue a DIS command to drive #12 in multi-drive setup, the operator would actually transmit "\C" then "DIS" to the drive (the C corresponds to a numerical value of 12). Refer to the following table for DIP switch settings that correspond to multidrop addresses.

Table 4-2. SERVOSTAR Multi-Drive DIP Switch Settings

Multi-drive DIP Switch Settings (Note: OFF = 0)					
Drive Address	**Switch 5**	**Switch 4**	**Switch3**	**Switch 2**	**Switch 1**
0 (no multdrop)	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
A	0	1	0	1	0
B	0	1	0	1	1
C	0	1	1	0	0

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D	0	1	1	0	1
E	0	1	1	1	0
F	0	1	1	1	1
G	1	0	0	0	0
H	1	0	0	0	1
I	1	0	0	1	0
J	1	0	0	1	1
K	1	0	1	0	0
L	1	0	1	0	1
M	1	0	1	1	0
N	1	0	1	1	1
O	1	1	0	0	0
P	1	1	0	0	1
Q	1	1	0	1	0
R	1	1	0	1	1
S	1	1	1	0	0
T	1	1	1	0	1
U	1	1	1	1	0
V	1	1	1	1	1

4.4 SYSTEM OPERATION

4.4.1 Power Up Sequence

Upon power-up, the SERVO**STAR** performs a series of self-tests. After finding no errors, working RAM is loaded with saved variables from the EEPROM non-volatile memory (or loaded with default values in case of invalid EEPROM data). The Remote Enable input may now be energized, enabling the servo loops.

Failure to design a valid compensator (for example, in the case of motor parameters not being initialized in the drive) results in a '-' in the status display. If the bus voltage is not present on power-up, a 'U' (Under Voltage Fault) may appear in the display.

4.4.2 Enabling the Drive

The enable circuit, which can be controlled by both hardware and software, has two states - enabled and disabled. In order for the drive to become enabled (ACTIVE = 1), there must be no faults (DRIVEOK = 1), the software enable must be active (SWEN = 1), the enable DIP switch must be active (DIPEN = 1), and the hardware Remote Enable must be active (REMOTE = 1). See the descriptions of the DRIVEOK, SWEN, READY, DIPEN, and REMOTE switch variables for more information.

The software enable flag (SWEN) can be enabled using the EN command and can be disabled using the DIS (or K) command. The software enable (SWEN) initializes on power-up to the enabled state, allowing a hardware enable (using the Remote Enable input) without explicitly commanding a software enable. Fault resetting and re-enabling action is initiated by using the EN command or by the rising edge of the hardware enable line (REMOTE). The software enable and disable are generally used for debug purposes (i.e., disabling the drive and investigating its condition to determine the cause of a fault or incorrect operation).

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The Remote Enable Input (REMOTE) also has a direct connection to the Power Stage and must be active to allow power to the motor.

Enable status is displayed in the 7 segment display's decimal point as described earlier in section 4.2.1.

The following two tables show the relationship between the various hardware and software enable switches and indicators. Note that the READY flag is the general indicator of whether or not the drive is "ready" to be enabled. (READY is determined using DRIVEOK and SWEN). Once READY = 1, enabling the two hardware enables (REMOTE and DIPEN) will cause the drive to enter the enabled state (ACTIVE = 1).

Table 4-3a. Drive Ready Switch

DRIVEOK (fault status)	SWEN (software enable)	READY (drive ready)
0 (fault exists)	0 (disable)	0
0 (fault exists)	1 (enable)	0
1 (no faults)	0 (disable)	0
1 (no faults)	1 (enable)	1

Table 4-3b. Drive Active Switch

READY (drive ready)	REMOTE (hardware enable)	DIPEN (DIP switch enable)	ACTIVE (power to the motor)
0	X	X	0 (no)
X	0	X	0 (no)
X	X	0	0 (no)
1	1	1	1 (yes)

4.4.3 Operational Modes

The SERVOSTAR offers four operational modes (OPMODE's):

1. Serial Velocity Controller (OPMODE = 0): in this mode, the SERVOSTAR acts as a velocity-loop controller and is controlled by issuing a velocity command (using the Jog, or J, command) to the drive via the serial port.

2. Analog Velocity Controller (OPMODE = 1): in this mode, the SERVOSTAR acts as a velocity-loop controller and is controlled via a +/- 10V analog input signal (discussed in section 4.3.1). The commanded velocity is proportional to the input voltage.

3. Serial Torque (Current) Controller (OPMODE = 2): in this mode, the SERVOSTAR acts as a torque-loop controller and is controlled by issuing a current command (using the T command) to the drive via the serial port.

4. Analog Torque (Current) Controller (OPMODE = 3): in this mode, the SERVOSTAR acts as a torque-loop controller and is controlled via a +/- 10V analog input signal (discussed in section 4.3.1). The commanded current is proportional to the input voltage.

5. Gearing Position Controller (OPMODE = 4): in this mode the SERVOSTAR acts as a positioning controller that can operate in one of three settings (Encoder Follower, Pulse/Direction, Up/Down). The setting used is determined by the GEARMODE variable.

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4.4.4 Configuring and Operating the Drive

The SERVOSTAR drive provides a rich set of commands and variables that provide the user with a multitude of ways to configure and control the drive. Section 3 (System Start-up) contains detailed instructions on how to configure a drive, and Section 6 (Serial Commands and Variables) contains detailed information on the commands and variables that are used to control the drive.

4.4.5 Drive Configuration Data Management

The SERVOSTAR's configuration data is stored in non-volatile memory (EEPROM). Upon completion of the power-up tests, the stored variables are copied from the EEPROM to working RAM. This load procedure can be forced at any time by the user with the LOAD command. As the user changes the SERVOSTAR configuration through the serial port, only the variables in working RAM are changed. The user may write the new configuration to EEPROM using the SAVE command.

Once a SERVOSTAR is configured by the user for exact performance, the settings can be archived to diskette, using the DUMP command, or by accessing the Backup Screen in MotionLink. The DUMP command dumps all the variables and their values from the EEPROM, in ASCII format, to the serial port. To configure another drive with the same configuration, simply transmit the archived data file to the drive. Issuing a SAVE command is recommended after downloading a data file to a drive.

To restore the initial configuration of the drive:

1. Issue a CLREEPROM command. This clears the EEPROM of all data that has been saved to it. Clearing the EEPROM causes the drive to enter the "no-comp" state, characterized by a flashing "-" on the LED display. The drive will remain disabled in this case.
2. Set the value of VBUS (from a dumb terminal or using MotionLink's Drive Configuration screen). Download motor parameters from a data sheet or from a prepared file (using the Motor Configuration Screen in MotionLink). This sets all motor-dependent variables.
3. Issue the CONFIG command. Upon receiving this command, the SERVOSTAR tries to design current and velocity loop compensators. If the design terminates successfully, the drive is no longer in "no-comp" state, and the minus sign on the LED display will disappear.
4. Issue a RSTVAR command. This will set all non-motor variables to their factory default settings and will calculate values of some variables that are dependent upon motor variables.
5. Issue a SAVE command to save the configuration to EEPROM.

4.5 SYSTEM MONITORING AND FAULT DETECTION

4.5.1 Fault Monitor

The SERVOSTAR's microprocessor is constantly monitoring the status of many different components. In general, the philosophy of the SERVOSTAR is to latch all fault conditions so the user can readily determine the source of the problem. When a fault is detected, it is logged in the internal error log, indicated in the LED Status Display, enunciated over the serial port, and in most conditions causes a drive disable. Many faults can be reset by toggling the hardware drive enable (REMOTE input).

The following, is a list of faults detected by the drive hardware and operating system. Faults and fault displays are described in more detail in Section 7, Troubleshooting.

- **Motor Over-Temperature:** The Motor's External Thermostat input is monitored for an open circuit condition. The user can define (using THERMODE) what happens under this fault condition. The worst case event is a power stage disable with an 'H' placed in the status display, and the fault relay contacts (RELAY) are open.

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- **End Travel Limit Inputs:** The IN1, IN2, IN3 Inputs are constantly monitored. If the variables INxMODE set these inputs for CW/CCW limits then they are monitored for an open-circuit condition. Although not necessarily an error condition, motor operation can be affected by these inputs. The SERVOSTAR can ignore the End Travel Limits if the user sets LIMDIS = 1. The worst case event is that further motion in the given direction is not allowed with an 'L' placed in the status display. If both CW and CCW End Travel Limit Inputs have detected an open-circuit condition, the SERVOSTAR enters into Hold position state (HOLD = 1).

- **Drive Over-Temperature:** The internal heatsink temperature is monitored for an unsafe condition. This condition causes a 't' to be displayed and disables the drive. The drive will eventually cool enough to allow reset of this condition.

- **RMS Over-Current (Foldback):** As described in section 4.5.2 below, the Foldback detection system can 'clamp' the available output current. This is not a true fault condition, but may cause undesired performance, due to the command current being limited below what is required to achieve the desired performance. This condition is indicated with a flashing 'F' in the status display and can be detected by monitoring the FOLD switch variable.

- **Bus Over-voltage:** As described in the Regeneration Circuit section below, an over-voltage condition shuts down the drive and displays a lower-case 'o' in the status display.

- **Bus Under-Voltage:** As described in the Regeneration Circuit section below, an under-voltage condition shuts down the drive and displays an 'u' in the status display.

- **Power Stage Fault (over current):** Hardware circuitry monitors load short-circuit, transistor failure, and instantaneous over-current. In general, a power stage fault can not be reset by toggling the Remote Enable, but only by power cycling. This condition is indicated by a flashing 'P' in the status display.

- **Feedback Loss:** Hardware is used to detect a wire-break condition in encoder based systems, or the presence of the Sine and Cosine resolver feedback signals in resolver based systems. Either of these signals not being present will cause the SERVOSTAR to disable and display an 'r' in the status display.

- **Low-voltage power supply faults:** Out of tolerance values on the +/- 12 VDC analog supplies will cause an 'A' to be displayed, and cause the drive disable.

- **Over speed fault:** Software monitors continuously the actual (feedback) speed. If the motor speed exceeds the VOSPD limit, a 'J' will be displayed, and the drive will be disabled.

- **No compensator:** In case the SERVOSTAR can not design a compensator, such as after a RSTVAR command, CLREEPROM, or any change in the motor or drive parameters, a flashing minus sign (-) will be displayed, and will cause the drive to disable.

- **Memory reliability:**
  Upon power-up, during the initialization process, both the run time and variables memory (RAM - Random Access Memory) and the program memory (EPROM - Electrically Programmable Read Only Memory) are tested.

  If a RAM fault is detected, an 'I' will be displayed, and cause the drive to halt. If an EPROM fault is detected, a 'c' will be displayed, and cause the drive to halt.

  The user configuration non-volatile memory (EEPROM - Electrically Erasable Programmable Read Only Memory) is also checked for integrity upon power-up. Any discrepancy in this data is noted with an 'e' in the status display. After power-up is successfully completed, any subsequent fault in the operation of the EEPROM is noted with an 'E' in the status display.

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- **WatchDogs:** In addition, the SERVOSTAR incorporates a watchdog system to maintain software operation integrity. Failure of the watchdog mechanism will display three bars on the status display, and cause the drive to halt.

4.5.2 Current Foldback

The SERVOSTAR microprocessor monitors the current feedback signal and accumulates an RMS value designed to monitor safe drive operating conditions. The system is similar to an "I-squared-T" accumulator.

The current foldback algorithm monitors current feedback and, if the feedback exceeds the continuous current rating of the drive/motor combination (ICONT), the foldback algorithm will decrease system current to the ICONT level. For example, under a step command input condition, the foldback algorithm will allow peak current (IMAX) output from the drive for two seconds. After two seconds, the drive enters "Foldback mode" (FOLD = 1) and begins an exponential 'Foldback' of the output current, which over a period of six seconds will reduce the output current to the continuous drive rating (ICONT).

For drive currents that exceed ICONT but are not as high as IMAX, it will take longer than two seconds for foldback to occur. Two seconds is the shortest time period that will elapse before the drive enters foldback.

Note that the foldback feature is designed to protect the drive electronics, not the motor. The digital output (pin 12) can be configured to indicate a drive foldback condition.

4.5.3 Regeneration Circuit

The regeneration circuit within the PA Power Supply Units (Except PA08) includes circuitry which monitors the main DC bus. During quick decelerations, the motor will operate as a DC generator and pump energy back into the bus, causing the bus voltage to rise. The regeneration circuit limits excessive voltage rise during the deceleration periods by dumping the excess energy into an internal regeneration resistor load. Provisions for extra regen capacity are made through external connections designed for a larger external regeneration resistor. The regeneration circuit turns on when the bus is above 390 VDC. This circuit is also used to quickly discharge the DC bus when power to the drive is removed. This feature is referred to as Dynamic Bus Discharge. A yellow LED is provided to indicate that the regen circuit is active.

An electronic RMS power limiter circuit monitors the use of the regen circuit when only the internal regen resistor is used. A red REGEN FAULT LED illuminates if this circuit detects excessive use of the regen circuitry.

The bus monitors also provide protection. A low input voltage is dangerous to the power stage, if left running. If the bus voltage is low, an under-voltage fault is signaled to the microprocessor and prevents drive operation with a latched fault. Likewise an excessive voltage condition can be dangerous to the entire power stage and is detected and latched with an over-voltage condition.

4.6 SERVO LOOP DESCRIPTION

This section describes the servo loops, their characteristics, and how to configure them. For additional information and a more detailed discussion of the servo loops, refer to Section 9, Velocity Controllers.

4.6.1 Core Processors

A 40 MHz embedded Controller and a 40 MHz DSP controller are the heart of the SERVOSTAR. They use its internal operating system to monitor inputs, adjust outputs, communicate serially, maintain servo control, and monitor faults. The firmware that controls the core processor and gives the SERVOSTAR its operating

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characteristics is saved in EPROM. The version number for this firmware can be read using the VER command. When calling Kollmorgen for technical support, be sure to have the firmware version number readily available.

4.6.2 Servo Loop Description

The SERVOSTAR provides high performance motor control by closing up to four distinct closed loop systems within the DSP: the current, commutation, velocity, and position loops. Figure 4-2 depicts the control loops graphically.

Current Loop: the innermost control loop is the current loop. Since current and torque are proportional in a Permanent Magnet (PM) motor, the current loop is often referred to as the "torque loop." The function of the current loop is to regulate motor current as directed by a current command signal. The current loop command signal comes from the microprocessor and may be the output of the velocity loop, or, if operating as a torque controller (OPMODES 2 & 3) directly from the user commanded torque (digital command T or analog input). There are actually three current loops, one for each motor phase. Each current loop receives its own command input from the commutation loop (see below).

The SERVOSTAR uses a fully digital pole placement current loop with high bandwidth and a current loop sampling rate of 16 kHz (62.5 microsecond period). All coefficients of the current loop are digitally calculated inside the drive for given motor and drive characteristics. The current loop also includes adaptive gain terms to compensate for some non-linear effects.

The current loop incorporates electrical isolation for protection from the high-voltage bus. These current loops also convert the output voltage to a Pulse Width Modulated (PWM) signal for highest efficiency. The PWM center frequency can be 8 kHz or 16 kHz according to the drive size. The PWM default center frequency is 16 kHz for SERVOSTAR units up to 10 Amps, and 8 kHz for units with power ratings of 20 Amps and above.

Commutation Loop: the next basic loop is the commutation loop, which converts a single-phase current command signal into a three-phase, motor-position-modulated sine wave input to the current loops. The SERVOSTAR has a patented sinusoidal wave form generator which uses a technique called Torque Angle Advance to get top performance out of motors. The waveform generator is part of the microprocessor and is updated at an 16 kHz rate. This provides hi-fidelity sinewave commutation at both low and high velocities. The sinewave output must be aligned to the back-emf (BEMF) characteristics of the motor. This is why resolver (or encoder) alignment to the motor is critical.

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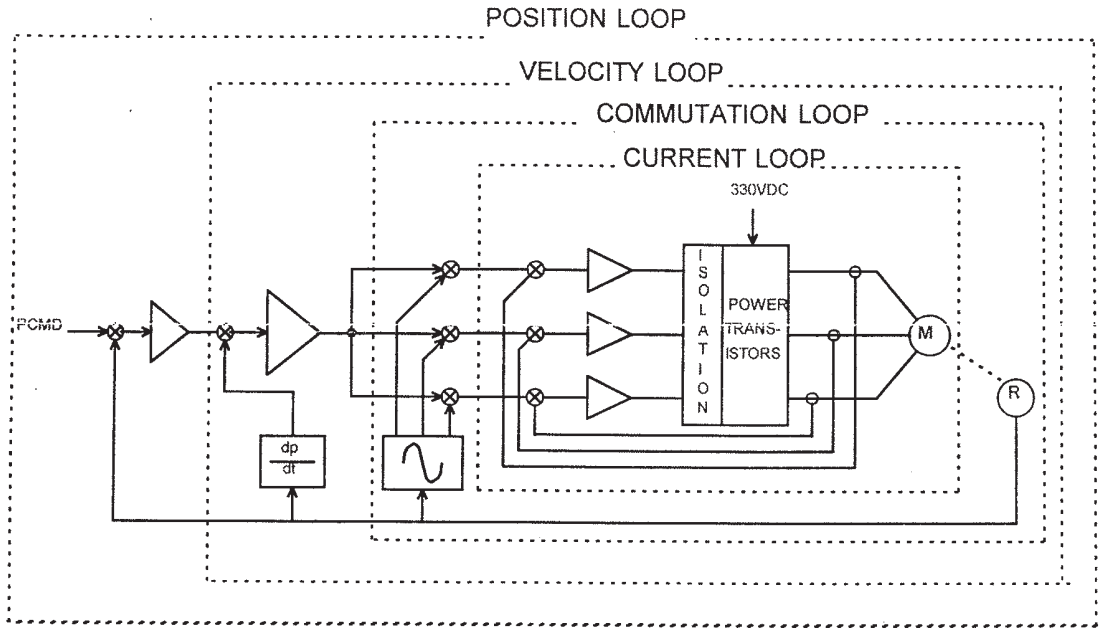


Figure 4-2. SERVOSTAR Servo Loop Block Diagram

Velocity Loop: the next loop in the servo loop system is the velocity loop. The purpose of the velocity loop is to regulate motor speed. Like the current and the commutation loops, the velocity loop is fully digital and uses the resolver or the encoder feedback to calculate actual motor velocity.

The command for the velocity loop can come from a direct user input (digital command J or analog input), or can be the output of the position loop. The velocity loop is a digital sampling system operating at 4 kHz.

The difference between actual and desired velocity is filtered through a compensator algorithm and fed to the commutation loop. The velocity compensator, or method of regulating velocity, is chosen by the user to be one of four compensators, using the variable COMPMODE. The available compensators (COMPMODE 0, 1, 2, and 3) are Proportional-Integral (PI), Pseudo-Derivative-Feedback with Feed-Forward (PDFF), Standard Pole Placement, and Advanced Pole Placement. Section 4.6.5 describes the operational characteristics of each COMPMODE, how to select the proper COMPMODE, and how to tune for each COMPMODE.

Position Loop: the final control loop is the position loop. The purpose of this loop is to maintain motor position. It is present only when the drive is in a hold position state (HOLD = 1) or in OPMODE 4. Like the previous loops, the position loop is fully digital and uses the resolver or the encoder to determine actual motor position. The position error is fed through a proportional gain block (designed automatically) algorithm to the velocity loop regulator. The position loop is a digital sampling system operating at 2 kHz.

4.6.3 Servo Loop Operation

The design of the control loops has been discussed individually in section 4.6.2. Now the operation as a system is presented. The SERVOSTAR has many internal variables that can be used to examine and dictate system operation. Many of these variables are presented parenthetically in the following discussion to help disclose meanings and relationships.

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The SERVOSTAR is most often configured to operate as an analog velocity loop controller (OPMODE 1). In this case, the velocity loop (described above) receives its input from the analog-to-digital (A/D) conversion system. The input command signal (ANIN) is then processed through an algorithm which scales the signal (ANOFF, ANDB, VSCALE) and turns it into a velocity command (VCMD). The actual present velocity (V) is subtracted from the commanded velocity, creating a velocity error (VE). The velocity error is then fed through a digital compensation algorithm (determined by the COMPMODE). The output of the compensator is the desired torque (ICMD).

The torque command is checked against peak (IMAX, ILIM), and continuous (foldback) current clamp (ICONT) limits. Sinusoidal commutation modulation is added to the command before it is outputted to the three phase current loop regulator, which calculates a current error. The current error is then fed through a digital pole-placement compensation algorithm. The output of the compensator is converted to a pulse width modulated (PWM) signal and fed to the power transistor bridge. The power bridge uses the high voltage DC power supply (typical 325 VDC bus) to supply the required current to the motor windings. Actual motor current (equivalent current) (I), velocity (V), and position (PRD) are updated and the process begins again.

4.6.4 Current Sampling

The current loop receives corrective feedback from the current sampling circuitry. The current sensors use closed-loop hall sampling techniques in all units.

The current sample is used by the current loops to regulate the current in each of the three motor phases. Two phases (A and C) current signals are sampled by the microprocessor at a 16kHz rate. The momentary A phase current and C phase current can be monitored by examining the IA and IC variables, respectively. The microprocessor calculates the equivalent absolute current, which can be monitored as I. This value can be averaged for 2, 4, 8, 16, 32, or 64 samples.

4.6.5 Tuning the Velocity Controller

To tune the drive for operation in OPMODE 0 or 1 (velocity controller), you must first select the proper velocity compensator algorithm (COMPMODE), and then tune the drive. There are two ways to tune the velocity controller: automatically, using the TUNE command, or manually, by adjusting the gain parameters for the selected COMPMODE.

Selecting the Velocity Compensator (COMPMODE):

Table 4-4 briefly presents the four types of compensators (COMPMODE's) available and the advantages and drawbacks of each.

1. Proportional-Integral (PI), COMPMODE = 0: the PI compensator is best suited for applications requiring a quick response to a command input (high acceleration), such as a master-slave application, but it may cause overshoot when responding to commands and may not settle accurately to the proper velocity. The parameters associated with the PI compensator are GV and GVI. Changing GV affects the drive's ability to match the command velocity, while changing GVI affects the response time and tendency to overshoot.

2. Pseudo-Derivative-Feedback with Feed-Forward (PDFF), COMPMODE = 1: this compensator will exhibit the best performance in applications requiring good speed regulation in response to changing load conditions. The PDFF compensator will generally match the commanded acceleration very well, but its steady-state error may be greater than that of a PI compensator. The parameters associated with the PDFF compensator are KV, KVI, and KVFR. KV affects the command-matching ability of the drive. KVI affects the response time to a changing command, while KVFR will also change the response time to a changing command, but it may cause overshoot and oscillation of the response.

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Table 4-4. COMPMODE Characteristics

COMPMODE	CONTROLLER TYPE	ADVANTAGES	DISADVANTAGES
0	PI (Proportional-Integral)	High steady-state command following accuracy	May overshoot
1	PDFF (Pseudo-Derivative Feedback with Feed-Forward)	Excellent command-following capabilities for changing load conditions	May not be able to achieve accurate steady-state command following
2	Standard Pole Placement	Easy to tune; excellent response time and command following capabilities	Doesn't offer flexible tuning options for shaping drive response
3	Advanced Pole-Placement	Good for applications with complex and changing moments of inertia	Complicated to tune
4	Standard Pole Placement (extended performance)	Easy to tune; excellent response time and command following capabilities	Susceptible to noise in feedback device or poor feedback resolution

3. Standard Pole-Placement, COMPMODE = 2: this compensator is the easiest to tune and exhibits the best overall performance, with good response time and command-following capability. The parameters associated with the Standard Pole-Placement compensator are LMJR and BW. LMJR sets the ratio between the load inertia and the motor inertia (MJ), while BW sets the bandwidth of the velocity loop. Setting LMJR too high will cause the drive response to overshoot and oscillate, while setting LMJR too low will cause the drive response to be sluggish. Either situation may cause the drive to be unstable. The higher the bandwidth BW, the sharper the response time of the drive, and the more accurately it will follow a command. Higher bandwidths are also more likely to make the system become unstable, so the bandwidth that makes the proper tradeoff between performance and stability must be selected carefully.

4. Advanced Pole-Placement, COMPMODE = 3: this compensator is used for loads with complex and dynamic moments of inertia. The parameters associated with the advanced Pole-Placement compensator are three vectors (R, D, and H) that are designed outside the drive, based on a characterization of the load being controlled by the drive. The R, D, and H parameters must be factory-set.

5. Standard Pole Placement (Extended Performance), COMPMODE = 4: this pole placement compensator gives extended performance to that in COMPMODE 2. The algorithm allows bandwidths as high as 400Hz (as compared to 200Hz in COMPMODE 2). This mode allows for faster response but faster responses tend to be more susceptible to noise.

Tuning the Drive Automatically (TUNE Command): the TUNE command is issued to the drive via the serial port and tunes the drive by performing closed-loop velocity steps, capturing the system dynamics, and setting tuning constants accordingly. The TUNE command performs the velocity steps in COMPMODE 2 and sets gain parameters for COMPMODE's 0, 1, and 2 based on the system dynamics. The TUNE command is described in detail in Section 6.

Tuning the Drive Manually: the operator can tune the drive manually by setting the gain parameters for the selected COMPMODE and examining system response as those parameters are set to different values. Table 4-5 correlates the COMPMODE to the relevant tuning and gain parameters (loop variables). See the text above that describes each COMPMODE in order to learn how each loop variable affects performance.

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Table 4-5. COMPMODE Options and Related Loop Variables

COMPMODE	CONTROLLER TYPE	LOOP VARIABLES
0	PI (Proportional-Integral)	GV, GVI
1	PDFF (Pseudo-Derivative Feedback with Feed-Forward)	KV, KVI, KVFR, COMPFILT
2	Standard Pole Placement	BW, MJ, LMJR, TF
3	Advanced Pole-Placement	D, H, R
4	Standard Pole Placement (extended performance)	BW, MJ, LMJR, TF

The easiest way to tune the drive manually is to tune it in COMPMODE 2, using MotionLink's Tune Screen, or a terminal. The pole-placement design uses, in addition to the motor parameters (particularly MJ), the desired bandwidth BW, and the inertia of the load, LMJR.

The inertia of the load is actually entered as a load-to-motor inertia ratio. The characteristics of the drive response can be examined to help set the value of LMJR. One of the pole-placement controller qualities is that it responds with an overshoot to a velocity step command if the load inertia value LMJR is less than the actual load inertia. If the load inertia value is greater than the actual load inertia, there might be an undershoot in the step response or even oscillations, and the controller might become unstable. Therefore, the way to tune LMJR is to set its value, examine the drive step response for overshoot or undershoot, adjust the value of LMJR, and examine the response again. To complete the tuning of the drive, continue to adjust LMJR until the desired response is achieved with your target bandwidth BW.

A well-tuned controller is one that the response to step command has no overshoots on one hand, and no undershoots or oscillations on the other hand.

To use the Tune Screen in MotionLink to tune the drive, access MotionLink's on-line help by going to the Tune Screen and pressing the F1 key on the computer keyboard. This will call up context-sensitive help that will explain how to use the Tune Screen.

To tune the drive using a terminal, the tune process is:

1. Set the operation mode to serial velocity, using 'OPMODE=0'.
2. Set the velocity compensator to standard pole-placement, using 'COMPMODE=2'.
3. Enable the drive, using 'EN'.
4. Set the desired bandwidth, using the 'BW' variable. It is recommended to start with a low bandwidth (10 Hz).
5. Set the load inertia ratio to zero, using 'LMJR=0'. The load inertia value is expressed in units of rotor inertia (0, 0.01 ('LMJR=1'), to 100 ('LMJR=10000')). At this point the step response should have the maximum overshoot.
6. Activate the recording mechanism to record the velocity command, the current command, and the actual (feedback) velocity, using 'RECORD 1 1024 "VCMD "ICMD "V'.
7. Jog the motor in constant low speed, using 'J *value1*' command.
8. Activate the recording trigger, using 'RECTRIG "VCMD *value2* 20 1'. *Value2* should be greater than *value1* in the previous stage.
9. Jog the motor to higher value than specified in the 'RECTRIG' command. This is actually the step command. The higher the step the better the results. The step velocity should not be below 300 RPM.
10. The recording takes about half a second. After this period of time, the user may reduce the motor speed.
11. Verify that the recording process terminated, using 'RECDONE' command. RECDONE will be equal to 1 if the recording process terminated successfully.

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12. Dump the recorded data to the serial port, using 'GET' command. Capture the resulting transmission from the drive in a computer file or terminal screen.
13. Analyze the results. It is recommended to use an electronic spread sheet.

    If the current command saturated (reached absolute values of 'ILIM') during the process, reduce the step command velocity or reduce the bandwidth, and return to step 6.

    Inspect the feedback velocity. If there is an undershoot or oscillations, reduce 'LMJR' to the mean value of the present 'LMJR' and the last 'LMJR' where an overshoot exists, and return to stage 6. If there is an overshoot, increase 'LMJR' by 100 and return to stage 6.
14. Repeat this process until the overshoot goes below a value of 2 percent of the step command velocity.

As described above, this process can be done automatically, using the TUNE command. After successful termination of the TUNE command, the SERVOSTAR designs equivalent PI and PDFF controllers. The output of the tune process is a good estimation of the load inertia LMJR. Once a successful TUNE command is executed, the user can manually increase the bandwidth, or modify the PI or PDFF controller parameters.

Issuing a SAVE command is needed to store all the new values in the non-volatile memory (EEPROM).

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SECTION 5

SERIAL COMMUNICATIONS

5.1 INTRODUCTION

The serial communication link enables the digital drives to be controlled using ASCII-coded messages, transmitted over a serial asynchronous multi-drop link. The drive language includes messages to command and interrogate the drive, as well to set and query variables and parameters. Thus, from the point of view of the messages on the bus, there is no distinction between commands, variables and parameters.

The serial communication specification applies in general to both communication software implemented in the digital drive and to the software implemented in the host computer that is used to control the drive. Specific cases where differences exist will be noted.

5.2 COMMUNICATIONS PROTOCOL

Serial communications is very important to the SERVO**STAR** product line. Motion Link and customers with a higher level controller rely heavily upon it. The SERVO**STAR** supports both a simple dumb-terminal interface and a higher level interface. Software and hardware switches are used to determine exactly how the drive will communicate.

The SERVO**STAR** is capable of processing about 1 character each 500 uS. It can be configured for 9600 baud or 19.2 kBaud by setting a user configuration switch. The operating system will obey backspaces and reset upon receipt of an ESC character. Software switches are provided for:

- Echo: character-by-character
- Prompt: -->
- ACK / NAK Mode
- Checksum error detection
- Unsolicited message suppression

There is no power-up message, as on other Kollmorgen products, rather the VER command returns a message similar to:

Kollmorgen Motion Technologies
SERVO**STAR** :Encoder Version
XX Amp Continuous 2xXX Amp Peak Rating
Firmware Version:
Runtime = XX:XX:XX

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Communication is always interactive. When the SERVOSTAR is ready to receive command (and PROMPT =1), it generates the prompt "-->". In general, the SERVOSTAR responds to the user commands.

The user can enter a specific "command" to control and configure the SERVOSTAR, or monitor its operational status. In addition to commands, "variables" can be set or read. Each of the software variables can be in one of two categories:

a. Read Only Variables - monitoring only. These variables are set or calculated by the program.

b. Read/Write Variables - these variables can be set or monitored. Since certain variables are very critical to the system operation, the firmware provides protection so that a variable is not written at a "poor" time.

All variable names followed by <CR> are considered query commands, and prompted with its present values. To set the control variable, you have to enter the variable name followed by optional white spaces (blanks, tap, "=" etc.) and values. The term "switch variable" refers to variables which select one function out of two or more choices.

The SERVOSTAR maintains two copies of all variables. One set of variables in EEPROM (nonvolatile storage) is copied into RAM at the time of initialization or "LOAD" command, and used. When a variable is changed, only the content of RAM is affected. To change variables permanently (variables in EEPROM), you have to issue "SAVE" command.

5.2.1 Physical Layer

The communications link between the drives and a host computer will be full duplex, using either RS-232 daisy-chain, or 4-wire RS-485 connections. When using RS-232, the signaling lines (CTS, RTS, etc.) will not be used.

Data will be transmitted asynchronously, using 8 data bits, no parity, and 1 stop bit.

Data rate will transmitted at either 9600 or 19200 bps. The rate will be set according to the state of one of the DIP switches, which the drive will read on power up.

5.2.2 Data Link Layer

The functions included at the Data Link Layer level are Addressing, Flow Control, Error Control, and Active Echoing. The following paragraphs describe these functions.

5.2.2.1 Addressing

Drives are addressed using addressing commands that are part of the set of commands recognized by the drive. Addressing one drive will automatically deaddress all the other drives on the network. A special addressing command will be used to address all the drives simultaneously, to be used by the host to broadcast commands to all the drives. In this case the drives will remain addressed until a regular addressing command is sent, at which point the addressed drive will remain addressed, and all the other drives will be deaddressed.

The address of the drive is set using switches 1 to 5 of the DIP switch. Address 0 is reserved for a single drive system. A drive having this address will power up in the addressed state, and will accept commands from the host without the host having to first address it.

The backslash character (\) is defined as the addressing command, and it has the form:

$$\backslash x \qquad \textit{where } x \in \{0..9, A..V, *, \backslash\}$$

The '*' argument to the backslash command is used to globally address the drives. The '\' argument is used to globally deaddress the drives.

5.2.2.2 Flow Control / Prompt Function

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When the prompt function is enabled, the drive will return a prompt to the host after it has finished processing the last command received from the host. The format of this prompt for a drive whose address is 0 is:

-->

and for a drive whose address is A, where A ∈ {1..9, A..V}:

A->

The receipt of the prompt will indicate to the host that the drive is ready to receive further commands.

5.2.2.3 Error Control

Different levels of error control are needed for different systems. The SERVOSTAR provides three levels of safety, with the specific level being selected by the user using a specific command. In addition, and irrespective of the safety level chosen, active echoing may be enabled.

Error control is specified for message transfer from the host to the drive only, for two reasons. First, message transfer from the drive to the host is far less critical than that from the host to the drive. Second, all the drives listen to data transmitted by the host. If the host were to echo binary data transmitted from a drive, the data may be such that its pattern is the same as an address command. This would then result in a drive being addressed erroneously.

Safety Level 1

At this level, no error control is provided. The host receives no feedback regarding the validity of the commands it sends to the drive.

Safety Level 2

At the second level, drives respond to messages sent by the host with ACK or NAK ASCII characters. ACK indicates positive acknowledgment of the message and NAK indicates that the message was invalid. The message could be invalid either due to invalid parameters, or because the message is not understood by the drive. (The user can interrogate the status word to indicate the exact cause of the negative acknowledgment.)

Safety Level 3

The highest level of error control uses ACK/NAK message acknowledgment, with the addition of a Block Check Character (BCC) appended to the message. This BCC is implemented as a single character checksum, which is transmitted using an ASCII-HEX format as two bytes. The message validity checking performed by the receiving station will include checking the validity of the BCC, such that a negative acknowledgment (NAK) by the receiving station may be due to an invalid command, invalid parameters, or invalid checksum. The status word will indicate which of the events caused the negative acknowledgment.

5.2.2.4 Active Echoing

When active echoing is enabled, the drive re-transmits each character it receives, and thus the host can check (with a certain level of reliability) that the data it transmits is being received correctly. An exception to this rule is when the drives are globally addressed using the * address. Since the commands are being sent to all the drives simultaneously, active echoing is disabled by the drive as long as global addressing is in effect.

When an error is detected using this mechanism, the message being transmitted will be aborted, and the host will indicate to the user that an echo error was detected. The message is aborted using the method described in the Message Processing section below.

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Echoing will be enabled in the drive by a dedicated command (ECHO), and the drive will begin echoing only from the next command it receives from the host. When the host sends a command to disable echoing, the command will take effect only from the next command the host sends.

An exception to echoing is the addressing command, i.e. the backslash. Neither the backslash nor the address specification following it will be echoed by the drive, even if echoing is enabled in the drive.

5.3 MESSAGE PROCESSING

5.3.1 Message Processing Rules

1. The drive will begin processing a message when it detects the <CR> message termination character. It will be not be able to process more than one message simultaneously.

2. The ACK/NAK response will be sent (if this mode is selected) after the message has been parsed and its executability has been determined. The response indicates whether the message can be executed or not.

5.3.2 Aborting Message Transmission

The host will be able to abort a message being transmitted to the drive at any point during the transmission by sending an ESCAPE character (ASCII 1BH) to the drive. When active echoing is enabled, the ESC would not be echoed by the drive. Message transmission from the drive to the host cannot be aborted by the host.

5.4 GENERAL MESSAGE STRUCTURE

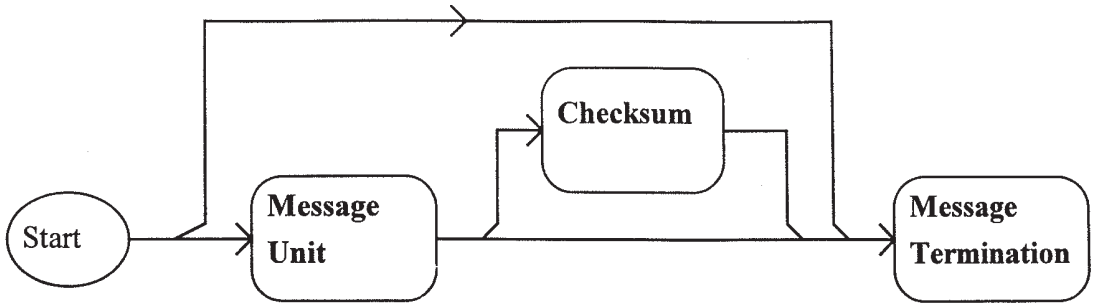
The general message structure defines the way ASCII coded messages sent across the drive network are structured. Messages sent from the host can be used to send commands, to set variables, or to request information from the drive. The messages sent by the drive to the host will contain the response to requests for information from the host.

Messages are, in general, composed of three specific functional elements, and these are the Header, the Parameters, and the Termination. The message header defines the context of the parameters that follow it. Messages sent from the host to the drives will always have headers. Information sent from the drive to the host will generally not include a header, although in specific cases it will.

5.4.1 Message Structure

The term **message unit** to refers to a block of information being transmitted on the communications medium. In general, messages units are composed of a mnemonic and one or more optional parameters. The SERVOSTAR will be able to receive only a single message unit in a program message. The basic message structure may be described by the following diagram. The 'Start' indication has no symbolic significance: it is only used here to emphasize the start of the message.

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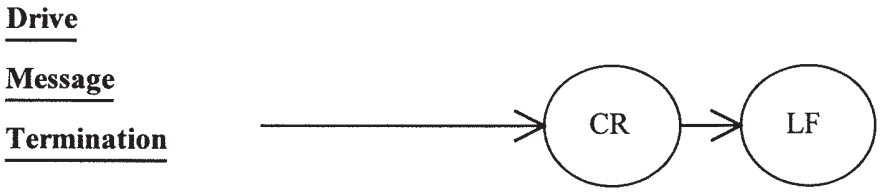


This diagram shows that the drive will also accept (and ignore) a message termination sent without any additional information, and that the checksum is optional: it is used when Safety Level 3 is selected.

5.4.2 Message Termination

The message termination is used to indicate the end of the message to the receiving station. Messages transmitted by the host will be terminated by the Carriage Return (CR) character (ASCII 0DH), while messages transmitted by the drive will be terminated by the Carriage Return / Line Feed (CR/LF) combination (ASCII 0DH / 0AH).

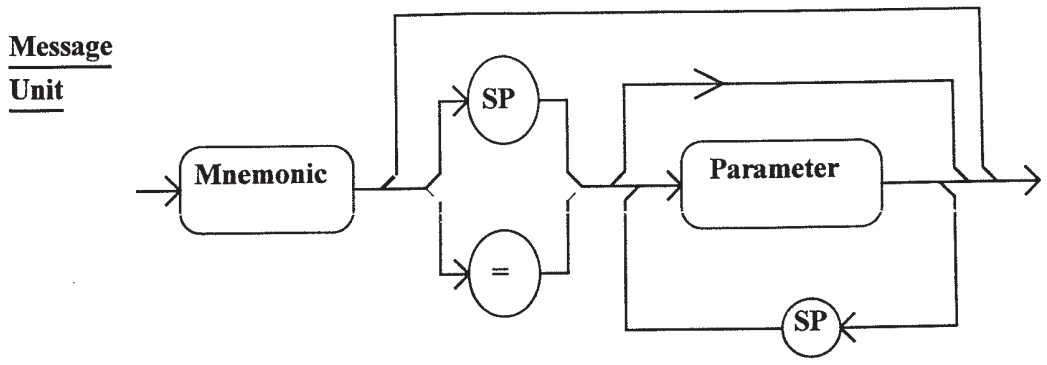




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5.4.3 Message Unit Structure

The message unit structure is described by the following diagram:



Reading the diagram from left to right, it shows that a message unit is composed of a mnemonic with optional parameters. When using parameters, they are separated from the mnemonic by either a space or the assignment operator. When using more than one parameters, they are separated by spaces.

5.4.4 Parameter Representation

Different message units may require parameters represented differently from others. Some parameters may be best represented as numeric data, while others may need to be represented as character data (a string). We define four parameter types.

1. Decimal numeric data. This data type is suitable for sending decimal integers. The digits are ASCII coded.

2. ASCII-HEX numeric data. This data type is useful for sending data in a format that will require less processing overhead on the part of the receiving station. This format is differentiated from decimal numeric data by a **#H** prefix. The characters of the parameter may be any hexadecimal characters, i.e. 0 through 9 and A through F. Example: ACC H64 corresponds to ACC 100.

3. String data. The string will be prefixed by inverted commas (").

4. Binary data. This data type is used only for uploading recorded data, and then only if the user requests the data to arrive in binary format. In binary format, all the data are transmitted **without** the comma separator between each value.

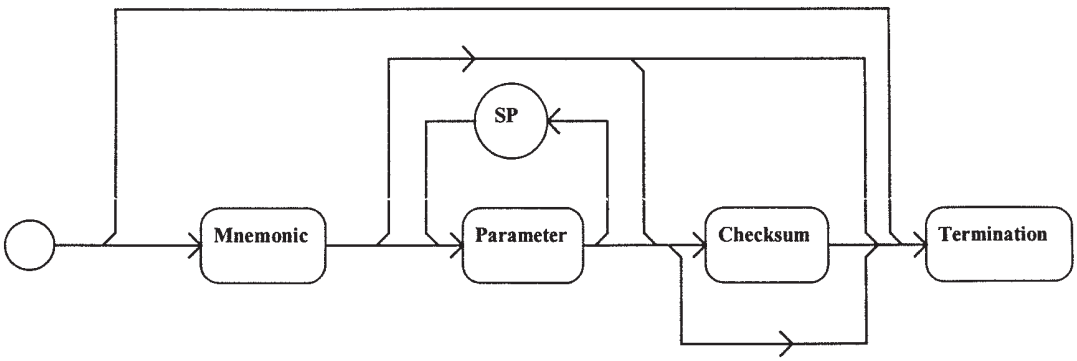
5.4.5 Checksum Structure

The checksum will be used by the **host** when Safety Level 3 is selected. It is calculated as the modulo-256 sum of all the characters comprising the program message, excluding the message termination. The resulting byte will be translated to two ASCII-HEX bytes for transmission, since binary data transfer from the host is not allowed. This is done by separating the upper and lower nibbles of the checksum character, and then adding 30H to each before transmission. For example, if the checksum calculation yields 9CH, the checksum is transmitted as the bytes 39H first and then 3CH.

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5.4.6 Summary

The general message structure may be summarized by the following diagram. Note that the checksum block is used only when Safety Level 3 is selected.



5.5 THE ASYNCHRONOUS ERROR MESSAGE

When the Asynchronous Error Message function is enabled, and an error or fault has occurred, the drive will transmit a brief error message to the host when it receives a message from the host. This error message will have the following format:

<CTRL-G>ERR xx <Error message string><CR><LF>

where **<CTRL-G>** indicates the BELL character (ASCII 07H).

This error message will only be transmitted after the <CR> message termination has been detected by the drive. If echoing is enabled, the characters in the message will all be echoed prior to the error message being transmitted. The drive will still accept the incoming message, and will try to execute it.

Note that the most recent error/fault recorded by the drive is stored in a variable that is NOT of the read-and-clear type. That is, reading the error does not clear it. The drive must thus detect a new error/fault before transmitting the error message, and not only the existence of the error/fault.

The Asynchronous Error Message mode is enabled and disabled using the MSG command.

5.6 RECORDED DATA TRANSFER FORMAT

Recorded data may be transmitted by the drive to the host in either an ASCII, ASCII-HEX or Binary format, as defined using the GETMODE command. This command will specify the format using a parameter having one of the following values:

- 0: ASCII format
- 1: ASCII-HEX
- 2: Binary

In all cases, the recorded data will be preceded by an ASCII header having the following format:

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"SERVOSTAR RECORDING"<CR><LF>
<Number of sample sets>,<time increment><CR><LF>
"<Variable 1 name>","<Variable 2 name>","<Variable 3 name>"<CR><LF>
where:

- <Number of sample sets> ∈ [1..1024], according to the length of the recording
- <Time Increment> ∈ [1, 2....], according to the time between recording of variables, each time increment is 0.5 millisecond.
- <Variable 2 name> is only relevant if two or more variables were recorded
- <Variable 3> is only relevant if three variables were recorded

The recorded data follows this header. The prompt is returned once all the data have been transmitted.

5.6.1 ASCII Format

The data are arranged as rows containing <Number of elements> columns of ASCII data. The data are separated by commas, and each row is terminated by <CR><LF>. The number of rows corresponds to <Number of samples>.

$<X_1>,<Y_1>,<Z_1><CR><LF>$
$<X_2>,<Y_2>,<Z_2><CR><LF>$
$<X_3>,<Y_3>,<Z_3><CR><LF>$
.
.
.
$<X_n>,<Y_n>,<Z_n><CR><LF>$

5.6.2 ASCII-HEX Format

The data are arranged as rows containing <Number of elements> columns of ASCII-HEX data. The data are not separated, and each row is terminated by <CR><LF>. The number of rows corresponds to <Number of samples>. Each data point is comprised of 4 bytes, representing a 16 bit value.

$<X_1><Y_1><Z_1><CR><LF>$
$<X_2><Y_2><Z_2><CR><LF>$
$<X_3><Y_3><Z_3><CR><LF>$
.
.
.
$<X_n><Y_n><Z_n><CR><LF>$

5.6.3 Binary Format

The binary data are transmitted in the same order as for ASCII and ASCII-HEX data, but in binary format and without <CR><LF> separators. The transmission will be terminated by a <CR><LF> suffix.

$<X_1><Y_1><Z_1><X_2><Y_2><Z_2><X_3><Y_3><Z_3>...<X_n><Y_n><Z_n><CR><LF>$

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SECTION 6

SERIAL COMMANDS AND VARIABLES

6.1 INTRODUCTION

The SERVOSTAR is a user configurable device with extensive serial communications capability. The information in this section explains how to use the serial communications capability and the commands available. A communications program is supplied with the SERVOSTAR and is called MotionLink. A discussion on MotionLink can be found in Section 8. The use of MotionLink is a convenience, not a requirement to be able to communicate with the SERVOSTAR as any device capable of meeting the ASCII protocol can be used. This section uses the word HOST to indicate the device communicating to the SERVOSTAR, be it a computer, terminal, or PLC.

This release of the ServoStar firmware has advancements that under development and may have more variables than what is mentioned here but are not fully supported at this time.

6.2 SERIAL PROTOCOL

The SERVOSTAR and the terminal must use the same format for serial data. RS-232-C and RS-485 describe hardware only. There are other specifications left up to the user: full- or half-duplex, the number of bits per character, whether or not parity is used, the number of stop bits, and the baud rate. Full-duplex means both the terminal and the SERVOSTAR can send and receive at the same time. Half-duplex means only one system can talk at a time. Bits per character refers to the number of actual data bits sent at one time. The parity is a bit sent for error detection. The number of start and stop bits sets a minimum delay between characters. The baud rate is the rate at which bits are transmitted and received.

The SERVOSTAR requirements are:

Full-duplex
8 bits per character
No parity
1 Start bit
1 Stop bit
Supported Baud rates:
9600, or 19200.

Most terminals and computers will allow setting these options with little difficulty.

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6.3 MODES OF OPERATION

The SERVOSTAR has the ability to assume different modes of operation. It is factory configured in OPMODE 1 (Analog Velocity Loop Controller) but may be reconfigured by the user. Not all commands and variables are active nor meaningful in every OPMODE. Table 6-1 lists and defines the available operational modes.

Table 6-1. OPMODE DEFINITION

OPMODE	Name	Function
0	Serial Velocity Mode	The SERVOSTAR is configured as a velocity loop controller. Velocity is controlled by the serial jog (J) command and step (STEP) command.
1	Analog Velocity Mode	The SERVOSTAR is configured as a velocity loop controller. Velocity is controlled by the analog input channel.
2	Serial Torque Mode	The SERVOSTAR is configured as a torque loop controller. Torque is controlled by the serial torque (T) command.
3	Analog Torque Mode	The SERVOSTAR is configured as a torque loop controller. Torque is controlled by the analog input channel.
4	Gearing Position Mode	The SERVOSTAR is confiqured as a position loop controller. Position is controlled as an Encoder Follower, Pulse/Direction, or Up/Down counter

6.4 SERVOSTAR COMMAND SET

A command is a transmission to the SERVOSTAR which causes it to do something. In general, all communications are commands. The display and assignment commands are the most common and yet some of the least obvious. The SERVOSTAR allows a great amount of flexibility by using a very simple command set. The following command set is executed as indicated by sending the indicated ASCII string to the serial port followed by the CR-LF terminator.

Serial commands are received by the SERVOSTAR anytime after self-tests are completed. The drive does not process a command until the end-of-line-terminator (CR). The commands are sent to the serial port in a 'dumb-terminal' fashion meaning that each message is sent in ASCII code as though one were typing it on a keyboard.

The SERVOSTAR responds to all commands, unless otherwise suppressed by the PROMPT switch variable, with a minimum of a prompt. The drive prompt is two minus signs followed by a greater-than sign: -->. It also responds to power-up and fault conditions with a message unless otherwise suppressed using the MSG switch variable.

The SERVOSTAR 'echoes' (retransmits) all received messages character-by-character unless suppressed by the ECHO switch variable. This feature can be used by the host to check for valid data reception.

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6.4.1 SERVOSTAR COMMANDS

See section 6.4.3 for complete descriptions of the following commands.

SERVOSTAR COMMANDS			
NAME	DESCRIPTION	UNITS	RANGE
ANZERO	Zero the Analog Input	n/a	n/a
CLREEPROM	Clear the EEPROM	n/a	n/a
CONFIG	Configure the Drive	n/a	n/a
DIS	Disable the Drive	n/a	n/a
DUMP	Dump the Variables to the Serial Port	n/a	n/a
EN	Enable the Drive	n/a	n/a
ENCINIT	Initialize the Encoder	n/a	n/a
ENCSTART	Initialize the Encoder	n/a	n/a
ERR	Display the Last Error	n/a	n/a
FLTCLR	Clear the Fault Buffer	n/a	n/a
FLTHIST	Display Last 10 Faults	n/a	n/a
GET	Get Recorded Data	n/a	1-100
J <vel>	Jog (Rotate) the Motor at Velocity <vel> (OPMODE 0)	RPM	+/-VLIM
K	Kill (Disable) the Drive	n/a	n/a
LIST	Dump Commands and Variables to Serial Port	n/a	n/a
LOAD	Load EEPROM Variables	n/a	n/a
MLIST	Display Motor Variables	n/a	n/a
RECOFF	Turn Recording Off	n/a	n/a
RECORD	Record Data	n/a	n/a
REFRESH	Copy Pole-Placement Variables from Buffer to Control Loop	n/a	n/a
RSTVAR	Reset Variables	n/a	n/a
S	Stop Motion	n/a	n/a
SAVE	Save EEPROM Variables	n/a	n/a
STEP	Record Step Command	n/a	n/a
STOP	Stop Motor Motion	n/a	n/a
T <current>	Torque / Current Cmd (OPMODE 2)	% of DIPEAK * 0.1	10 -ILIM
TESTLED	Test the LED	n/a	n/a
TUNE <bw> <dir><vel>	Tune the Drive With bandwidth <bw>, direction <dir>, and velocity <vel>	Hz, n/a, RPM	10-100 0-2 350-0.7vlim

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6.4.2 Command Convention

Commands are described in the following format:

COMMAND NAME Command Definition . . . . . .
Command Description . . . . . .

Firmware Versions: tells what firmware versions the command is implemented in. To check your drive's firmware version, use th VER command.
Syntax: gives the exact syntax of the command. Any optional or required parameters are also listed. If parameters are used with the command, the units and ranges of those parameters are given.
OPMODES: .....indicates in which operational modes (opmodes) the command can be used.
Drive Status: .....indicates the drive state in which the command can be used. Enabled, Disabled, or Enabled / Disabled = either state.

6.4.3 Explanation of Commands

ANZERO Analog Zero:
This command causes the drive to zero the analog offset. A sample of the motor analog input command is averaged over 64 samples, and the value of ANOFF is set to zero out the analog input command. This command may need to be executed more than once to achieve zero offset, and ANOFF will probably be modified. Not available while recording.

Firmware Versions: All
Syntax: .....ANZERO
OPMODES: .....All
Drive Status: .....Enabled / Disabled

CLREEPROM Clear EEPROM :
This command clears the non-volatile memory (EEPROM) in the drive. The drive null's the EEPROM and assumes a no-comp state. A complete drive configuration procedure then has to be initiated before resuming drive operation. This command is the only method of resetting the run time clock.

Firmware Versions: All
Syntax: .....CLREEPROM
OPMODES: .....All
Drive Status: .....Disabled

CONFIG Configure Setup:
This command configures the current control loops after motor data has been entered. Executing this command tells the drive that all motor data parameters have been entered and that it is time for the drive to configure its control loops using the motor data.

When certain drive or motor variables are entered, they will cause the drive to enter a non-compensated (no-comp) state. The LED display will flash a minus sign. In this case, a CONFIG command is required. This also occurs when CLREEPROM is executed.

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PARAMETERS THAT REQUIRE A "CONFIG" COMMAND WHEN CHANGED		
When these parameters are changed, they will cause the drive to enter a "no comp" state, characterized by a flashing minus sign on the LED display. When the drive is in this state, a CONFIG command must be executed before resuming operation.		
MBEMF	MLGAINP	MRESPOLES (resolver only)
MICONT	MLGAINZ	VBUS
MIPEAK	MPOLES	**CLREEPROM**
MKT	MENCRES (encoder only)	
MKTI	MENCTYPE (encoder only)	
MLMIN	MSPEED	

Firmware Version: All
Syntax: .....CONFIG
OPMODES: ..... All
Drive Status: ..... Disabled

DIS

Disable:
This command disables the drive. Software servo loops are halted and power is disconnected from the motor. The function is immediate, and the motor may coast.

Firmware Versions: All
Syntax: .....DIS
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

DUMP

Dump Variables:
This command transmits all variables and their settings to the serial port terminal. This command actually outputs the EEPROM contents of the drive to the serial port, where the variables can then be reviewed or saved to a variable file (*.SSV). The last line of a dump is a CONFIG command.

Firmware Versions: All
Syntax: .....DUMP
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

EN

Enable:
This command initiates a software enable of the drive. This command first attempts to reset any existing fault conditions, then sets SWEN to 1. If READY, REMOTE, and DIPEN are equal to one, then the drive becomes ACTIVE. Checking the value of ACTIVE will inform the user whether or not an EN command successfully enabled the drive.

Firmware Versions: All
Syntax: .....EN
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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ENCINIT

Encoder Initialization:
This command triggers the encoder initialization process for type 0-2 encoders (see MENCTYPE). The initialization process requires rotating the motor until the encoder index is found, whereupon the drive will set the value of MENCOFF.

If the drive is enabled and in Opmode 0, the jog command can be used to rotate the motor. When the encoder index is encountered, the drive will set the value of MENCOFF. In this case, the status of the ENCINIT function is observed using the switch variable ENCINITST.

Firmware Versions: All
Syntax: .....ENCINIT
OPMODES: .....All
Drive Status: .....Disabled

ENCSTART

Encoder Start
This command triggers the encoder initialization process for encoder types 1-4 (see MENCTYPE). In the initialization process, the ServoStar rotates the motor to a known electrical position by placing IENCSTART current from the motor B terminal to the motor C terminal. If the encoder index is encountered (for type 1 and 2 encoders), the process terminates immediately. The ENCSTART process is initiated by doing the following:

1. With the drive disabled, type the command "ENCSTART".
2. Enable the drive. The current will be placed on the motor terminals and the initialization process will be completed after the drive enable occurs.

Enable is inhibited until this command is executed (for encoder types 1 and 3). The Status Display will flash the current OPMODE at 3 Hz as a visual indicator that the encoder is not initialized yet.

Firmware Versions: All
Syntax: .....ENCSTART
OPMODES: .....All
Drive Status: .....Disabled

ERR

Recall Error:
This command displays the last error detected by the SERVOSTAR. A numeric code and a short explanatory string are output to the serial port (if MSG = 1). The error buffer is cleared when the drive undergoes a transition from disabled (dis) to enabled (en).

Firmware Versions: All
Syntax: .....ERR
OPMODES: .....All
Drive Status: .....Enabled / Disabled

FLTCLR

Fault History Buffer Clear:
This command clears the fault history buffer, which contains up to 10 faults.

Firmware Versions: All
Syntax: .....FLTCLR
OPMODES: .....All
Drive Status: .....Enabled / Disabled

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FLTHIST

Recall Error Buffer:
This command will cause the drive to transmit the fault history buffer to the serial port. The most recent fault is sent first. Up to 10 fault messages will be output by the drive, with each fault message followed by a CR-LF. A time stamp in the format of hours:minutes is displayed along with each fault, indicating the time at which the fault occurred (refer to TRUN for more time stamp information).

Firmware Versions: All
Syntax: .....FLTHIST
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

GET

Get Recorded Data:
This command causes all recorded variables to be transmitted to the serial port for use with PC Scope. The data format is defined by the variable GETMODE. See also RECORD.

Firmware Versions: All
Syntax: .....GET
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

J

This variable sets the continuous jog speed and initiates motion at that speed if the motor is currently enabled (see EN and REMOTE) in OPMODE 0. J is set to 0 whenever the drive is disabled or enabled, or the operational mode is changed to prevent the motor from moving when enabled. The J command has an optional parameter of 'for-time', in milliseconds. Not available when the drive is in Hold mode.

Firmware Versions: all
Command Syntax: J [speed] {time}
speed (required) = -VLIM to +VLIM in RPM (rotary) or mm/sec (linear)
time (optional) = 0 to 32767 in milliseconds
Opmodes: 0
Drive Status: ..... en

K

Kill:
This command is the same as the disable command (DIS) and provides a one-key hot-button. The drive is disabled and the motor may coast when this command is issued.

Firmware Versions: All
Syntax: .....K
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

LIST

List:
This command dumps a list of valid commands and variables to the serial port. Only the names of variables are transmitted, not values. Note that some factory variables and commands, not intended for use by the user, may be printed. **Do not** use commands and variables that are not described in this section.

Firmware Versions: All
Syntax: .....LIST
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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LOAD

Load RAM:
This command loads all variables saved in the EEPROM into system RAM. This command is automatically executed upon power-up.

Firmware Versions: All
Syntax: .....LOAD
OPMODES: .....All
Drive Status: .....Disabled

MLIST

Motor List:
This command dumps all motor variables and their values to the serial port.

Firmware Versions: All
Syntax: .....MLIST
OPMODES: .....All
Drive Status: .....Enabled / Disabled

RECOFF

Record Off:
This command is used to cancel/reset a recording process that has been armed but has not triggered.

State before RECOFF: RECRDY=1, RECING=0, RECDONE=0.
State after RECOFF: RECRDY=0, RECING=0, RECDONE=0.

Firmware Versions: All
Syntax: .....RECOFF
OPMODES: .....All
Drive Status: .....Enabled / Disabled

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RECORD

Record Variables:
This command captures real-time variables to memory for retrieval / display using the GET command or the Motion Link PC Scope function. RECORD must be set up before the RECTRIG command is used. Note that variables that are recorded using this method are NOT averaged using AVGTIME.

Three 1024-byte buffers are available for use by the RECORD command. This command defines the time period between each consecutive recorded data point and the variable names (up to three) being recorded. A parameter defines the number of recorded data points for each variable (up to 1024). Once they are recorded, variables are retrieved with the GET command. See also RECTRIG, RECDONE, RECING, RECOFF, and RECRDY Switch Variables.

Firmware Versions: All
Syntax: .....RECORD [sample time] [num points] [VAR1] {VAR2} {VAR3}
Range/Units: ..... sample time = 1 to 10,000 (*0.5 milliseconds)
num points = 1 to 1024
VARn = a system variable, by ASCII (text) name

Example: RECORD 10 100 "VCMD "V "PRD
(record 100 points for VCMD, V, AND PRD every 5 milliseconds)

Note: system variables to be recorded must be from the following list, and their names must be preceded by a double-quote ("): IA, IC, I, ICMD, PRD, V, VCMD.

OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

REFRESH

Refresh Pole Placement Parameters:
This command is used when tuning the drive for COMPMODE 3. With the Advanced Pole Placement algorithm utilized in the SERVO**STAR**, the interaction of the variables is too dramatic to allow variables to be changed one by one. Therefore, as pole placement algorithm vector variables (D, H, and R) are entered, the new values are buffered without changing the actual values used by the control loops.

Once all desired new values have been entered, the operator enters a REFRESH command, and all vector variables are written to the control loops simultaneously.

Firmware Versions: All
Syntax: .....REFRESH
OPMODES: 0, 1
Drive Status: ..... Enabled / Disabled

RSTVAR

Reset Variables:
This command sets all variables, switch variables, and switch mode variables to their factory default settings. These settings are stated within this document under the variable DEFAULT category. The default values of variables loaded from a motor data file (DOS file name *.MTR) cannot be predicted and are denoted "motor data" in the DEFAULT category. A complete system reset requires the RSTVAR, Entry of Motor Data Sheet Parameters, a CONFIG command, desired modifications from default parameters required for the application, and a SAVE command. The described reset procedure is performed every time a CONFIG file is copied to a Drive RAM, since the file includes the necessary commands, in addition to the variables.

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DEFAULT VALUES ASSIGNED BY THE "RSTVAR" COMMAND			
ACC = 399,987	ECHO = 1	ILIM=IMAX	OPMODE = 1
ACKMODE = 0	ENCOUT = 1024	ISCALE = 1250	PROFMODE = 0
ACTFAULT = 0	FILTMODE=0	IZERO = 25	PROMPT = 1
ANDB = 0	FOLDD=2000	KV = 1000	R = all 0's
ANOFF = 0	FOLDMODE = 0	KVI = 1000	RELAYMODE = 0
AVGTIME = 0	FOLDR=12000	KVFR = 0	TF=100
BW = 20	FOLDT=2500	LIMDIS = 0	THERMODE = 0
COMPMODE = 2	GETMODE = 0	LMJR=0	UNITS=0
D = all 0's	GV = 500	LPFHZ1 = 500	UVRECOVER = 0
DEC = 399,987	GVI = 20	LPFHZ2 = 500	VLIM=VMAX
DECSTOP = 5000	H = all 0's	MPHASE = 0	VOSPD=1.2*VLIM
DIR = 1	IENCSTART=25	MSG = 1	VSCALE=1.25*VLIM

After setting the values shown in the table, the system will also set the value of ICONT according to the rules governing its default value.

Firmware Versions: All
Syntax: .....RSTVAR
OPMODES: .....All
Drive Status: .....Disabled

S

Active Disable:
This command will stop motor motion in all OPMODES. Deceleration ramp control is always used, using the rate specified by DECSTOP. The drive is disabled 10 ms after the profile generator reaches 0 speed. This command is a one-key hot button, similar to the K command, but with an active stop function controlled by the drive (no coasting of the motor will occur, as is possible with the K command).

Firmware Versions: All
Syntax: .....S
OPMODES: .....All
Drive Status: .....Enabled / Disabled

SAVE

Save Variables:
This command copies all system configuration variables from working RAM to non-volatile memory (EEPROM). This command must be executed to retain setting changes during power cycling. The SAVE command takes about 2 seconds to execute.

Firmware Versions: All
Syntax: .....SAVE (prohibited while in Zero Mode)
OPMODES: .....All
Drive Status: .....Enabled / Disabled

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STEP

This command generates a step or square wave velocity command. This command is intended to be used to record the drive response after the RECTRIG has been set up to define the trigger as occurring after the next command. This command takes 2, 3, or 4 parameters.

When 2 parameters are used, the drive is issued a STEP command with a specified duration ("duration1") and velocity ("velocity1").

When 3 parameters are used, the command becomes a repeating square wave which includes a zero velocity cycle whose duration is specified by the third parameter ("duration2").
When 4 parameters are used, the square wave command will run for the time specified by "duration1" at the speed specified by "velocity1," then will run for the time specified by "duration2" at the speed specified by "velocity2." This motion then repeats.

The user can terminate the command by entering S, K, DIS, or a Jog (J) command. This command is prohibited while in Hold mode.

Firmware Versions: all

Command Syntax:
STEP [duration1] [velocity1] {<duration2> <velocity2>}

Units/Range: ..... durationN = milliseconds (0 to 32767)
velocityN = rotary: RPM (-VLIM to +VLIM)
linear: mm/sec (-VLIM to +VLIM)

Opmodes: 0
Drive Status:..... en

STOP

Stop:
This command will stop motion in OPMODE 0 (J and STEP commands) or 2 (T command). Unlike the S command, the drive is not disabled using the STOP command. Deceleration ramp control is used in OPMODE 0, if PROFMODE is set to 1. The deceleration rate is stored in the variable DEC. If this command is invoked in opmode 1 or 3, it is ignored.

Firmware Versions: All
Syntax: .....STOP
OPMODES: 0, 2
Drive Status: .....Enabled

T

Torque Command:
This command is used to set commanded current in OPMODE 2 (Serial Torque Mode). This command is subject to current limits, clamps, and digital filtering, and it is set to zero whenever the drive is enabled or disabled. The range of this value is -1000 to 1000, but the value entered by the user cannot exceed ILIM. An S, STOP, DIS, or K command, or change of operating mode, zeros the value of T.

Firmware Versions: All
Syntax: .....T [current] (where -1000 ≤ current ≤ 1000)
Range: .....-ILIM to +ILIM
Units: .....% of DIPEAK*0.1
OPMODES: 2
Drive Status: .....Enabled

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TESTLED

Status LED Test Mode
This command is used to put the drive into a Status LED test mode. In this test mode, all of the segments of the LED will illuminate for approximately half a second and then return to normal.

Firmware Versions: All
Syntax: .....TESTLED
OPMODES: .....All
Drive Status: .....Enabled

TUNE

This command tunes the system for the given drive and load conditions. Velocity steps are performed in closed loop while maintaining position and velocity constraints in order to capture the system dynamics and set tuning constants accordingly.

Motor rotations are performed in OPMODE 0, with a bandwidth of 10 Hz. Successful termination of this command will set the value of LMJR (COMPMODE = 2 or 4) and will change the control variables of the PI (COMPMODE = 0) and PDFF (COMPMODE = 1) controllers accordingly. Successful termination of this command may change BW, LMJR, GP, GV, GVI, KV, KVI, KVFR, FILTMODE, and TF.

The command may take a few seconds to execute. This command may not always be successful, in which case the tuning variables must be set manually. Unsuccessful termination may result due to current saturation, a motor that cannot rotate, or an unsuccessful controller design. For successful termination, it is required that VLIM is greater than or equal to 500 RPM, and VMAX is greater than or equal to 1160 RPM.

This command takes three optional parameters: bandwidth, direction, and speed. Bandwidth can range from 10 to 100 Hz (the default is the current bandwidth BW). Direction is equal to 0, 1, or 2 (0 = bi-directional rotation, which is the default, 1 = CW rotation only, 2 = CCW rotation only). Speed must be greater than 350 RPM, and its default is the minimum of 500, (0.7 * VLIM), and (0.3 * VMAX).

Recommendations: (1) use low bandwidth for tuning and increase the bandwidth (using BW), if desired, after tuning is successful; (2) execute a SAVE after the TUNE command has executed successfully in order to write new gain parameters to EEPROM; (3) the higher the TUNE speed, the more accurate the process is.

NOTE: this command not available in version 1.0.0 & 1.0.1 firmware.

Firmware Versions: all
Command Syntax: TUNE [bw] [dir] [speed]
bw = bandwidth in Hz (10 to 100)
dir = 0, 1, 2 (0=bidir, 1=CW, 2=CCW)
speed = speed used during TUNE in RPM (rotary) or
mm/sec (linear) (350 to 0.7 * VLIM)
Opmodes: all Drive Status: en/dis

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6.5 SERVOSTAR VARIABLE SET

The SERVOSTAR compliments a simple set of commands with an extensive set of variables accessible by the user. Some of the variables are used to provide status information for installation and debugging. Other variables are provided to allow the user to customize the system for the particular application. The SERVOSTAR recognizes four different types of variables:

String Variables
A string variable is a variable which may include letters or punctuation or numbers. The SERVOSTAR does not require entry of string variables but may transmit them as in the case of ERR and MOTOR commands. Most string variables transmitted by the SERVOSTAR are properly formatted to fit on a 2-line by 40-character LCD display terminal.

Variables
A variable is a number within the SERVOSTAR that has a very specific meaning. Some variables are user settable to configure the drive, such as OPMODE. Some variables are set by the SERVOSTAR and not settable, such as velocity feedback (V). Others are determined by hardware readings, such as resolver position (PRD). All variables are readable (or testable).

Switch Variables
A sub-class of variables, switch variables can only assume two states; 1 (on) or 0 (off). Some of these can be set by the user, such as the direction reverser: DIR.

Switch Mode Variables
Also a sub-class of variables, switch mode variables are like a multiple-pole rotary switch. They can assume only one-of-n values where 'n' is defined as a function. An example of the switch mode variable is the THERMODE switch. In general, switch mode variable names end with the letters 'MODE'.

Vector Variable
A sub-class of variables, vector variables are used to group multiple numbers. This reduces the total number of variables used by the SERVOSTAR



NOTE

Modifying any component in the SERVOSTAR's memory will only be in effect until power is cycled if a SAVE command is not executed.

MOTOR DATA File Reference
The value to which some variables are set depend highly upon motor and load characteristics. The following variable definition section contains references to default values. Those indicating Motor Data mean they are set to the specific motor being used. If it is a non-standard system, then the variable being referenced is writeable. Non-standard is a status defined by the code on the power stage.

Motor File

A Motor is identified by its name (MOTOR string variable). It is the Users' responsibility to define those parameters according to the relevant data sheet.

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6.5.1 VARIABLES SORTED BY TYPE

See section 6.5.3 for complete descriptions, including ranges and units.

READ/WRITE SWITCH VARIABLES		
ACTFAULT	MHINVB	PROMPT
DIR	MHINVC	RELAYMODE
ECHO	MSG	UNITS
HOLD	O1	UVRECOVER
LIMDIS	PROFMODE	ZERO
MHINVA		

READ-ONLY SWITCH VARIABLES		
ACTIVE	IN1	RECRDY
CCWLIM	IN2	RELAY
CWLIM	IN3	REMOTE
DIPEN	READY	SWEN
DRIVEOK	RECDONE	THERM
FOLD	RECING	

READ/WRITE SWITCH MODE VARIABLES		
ACKMODE	GEARMODE	MPOLES
ANOUT	GETMODE	MRESPOLES
AVGTIME	IN1MODE	O1MODE
COMPMODE	IN2MODE	OPMODE
ENCOUT	IN3MODE	STOPMODE
FILTMODE	MENCTYPE	THERMODE
FOLDMODE		

READ-ONLY SWITCH MODE VARIABLES		
DIP	HALLS	RDRES
ENCINITST	ILSBMODE	

READ/WRITE VARIABLES			
ACC	IFRIC	MBEMFCOMP	MTANGLP
ANDB	IGRAV	MENCOFF	MVANGLF
ANOFF	ILIM	MENCRES	MVANGLH
BW	ISCALE	MICONT	O1RST
DEC	ISTOP	MIPEAK	O1TRIG
DECSTOP	IZERO	MJ	PFBOFF
GEAR	KV	MLGAINP	RECTRIG
GEARI	KVFR	MLGAINZ	TF
GEARO	KVI	MLMAX	VBUS
GV	LMJR	MLMIN	VLIM
GVI	LPFHZ1	MPHASE	VOSPD
ICONT	LPFHZ2	MSPEED	VSCALE
IENCSTART	MBEMF	MTANGLC	XENCRES

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READ-ONLY VARIABLES		
ADDR	ICMD	TRUN
ANIN	IMAX	V
DICONT	PFB	VCMD
DIPEAK	PRD	VE
I	STAT	VEXT
IA	STATUS	VMAX
IC		

VECTOR VARIABLES		
VD	VH	VR

STRING VARIABLES		
MOTOR	VER	

6.5.2 Variable Convention

The operator can set variable values by typing the name of the variable followed by a value for the variable, separated by an equals sign or one or more spaces. Typing in the name of a variable without a new value causes the SERVOSTAR to output the current value of that variable to the serial port (this can be done at any time and in any drive state). All the variables range and default are in physical units. Variables are described in the following format:

VARIABLE NAME Variable Definition . . . . . .
Variable Description . . . . . .

Firmware Versions: tells what firmware versions the command is implemented in. To check your drive's firmware version, use th VER command.

Type: ..... switch variable, switch mode variable, standard variable, or vector variable. Switch variables can be toggled between two different states (0/1, on/off, etc.). Switch mode variables are state variables used to select one of more than two states (for example, opmode is a switch mode variable that selects one of four opmodes). Standard variables are set to a numerical value within a given range. Variables are classified as read-only (R) or read/write (R/W). Some variables are read-only for standard drives and read/write for non-standard drives. These variables are clearly labeled.

Units: ..... defines the units of the variable.

Range: ..... defines the range of valid values for the variable.

Default: ..... defines the default value of the variable.

EEPROM: ..... (yes or no) specifies whether or not a variable can be stored in non-volatile memory (EEPROM). If a variable is stored in EEPROM, it is "remembered" by the SERVOSTAR when the drive is powered down and back up.

OPMODES: ..... indicates in which operational modes (opmodes) the variable is used (see the description for the variable OPMODE). Most variables can be set in any opmode, but they only have an effect in the opmodes listed here.

Drive Status: ..... indicates the drive state in which the command can be used. Enabled, Disabled, or Enabled / Disabled = either state.

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6.5.3 Explanation of Variables

ACC

This sets the drive acceleration rate. This variable is only asserted when linear ramp control and velocity mode are selected (PROFMODE = 1 and OPMODE = 0 or 1).

Firmware Versions: all
Type: ..... variable (R/W)
Units: ..... rotary: RPM / sec
..... linear: mm/sec/sec
Range:..... 1 to 399,987
Default: 399,987
EEPROM: ..... yes
OPMODES:: 0, 1
Drive Status:..... en/dis

ACKMODE

Communications Safety Level:
This switch mode variable sets the communication safety level of the drive. The range of values is 0, 1, or 2.

0 = No safety procedures or error messages
1 = Drive responds with ACK or NAK after every message
2 = Same as 1 with an added Block Check Character (BCC or checksum) attached to the end of every message

Firmware Versions: All
Type: ..... Switch Mode Variable (Read / Write)
Units: ..... n/a
Range: ..... 0 - 2
Default: 0
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

ACTFAULT

This defines how to handle the DISABLE procedure when a fault occurs.
0 = disable the drive immediately
1 = follow an Active Disable procedure (similar to the "S" cmd - see also DECSTOP, DISSPEED, and DISTIME)

Note: the drive will always be disabled immediately in the event of a feedback loss fault to prevent the drive from "running away."

Firmware Versions: all
Type: ..... switch (R/W)
Units: ..... n/a
Range:..... 0, 1
Default: 0
EEPROM: ..... yes
OPMODES: ..... all
Drive Status:..... en/dis

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ACTIVE

Drive Active:
This switch variable displays if the drive is enabled and power is applied to the motor. This flag is the overall readiness indicator of the drive.
0 = drive is inactive
1 = drive is active and ready to operate

Firmware Versions: All
Type: .....Switch Variable (Read Only)
Units: .....n/a
Range: 0, 1
Default: .....n/a
EEPROM: .....No
OPMODES: .....All
Drive Status: .....Enabled / Disabled

ADDR

This variable displays the position of the drive address switches (switches 1-4 or 1-5, depending upon firmware version, of the DIP switch) located on the top of the drive.

Firmware Versions: All
Type:..... variable (R)
Units: ..... n/a
Range:..... 0 to 15 (firmware versions prior to 2.0.0)
0 to 31 (firmware versions 2.0.0 and later)
Default: ..... hardware defined
EEPROM:..... no
OPMODES: ..... all
Drive Status: .....en/dis

ANDB

This variable sets the dead band of the analog input signal. If the absolute value of the analog input signal is less than this value, then no analog command signal is generated.

Firmware Versions: all
Type: ..... variable (R/W)
Units: ..... milliVolts
Range:..... 0 to 10,000
Default:..... 0
EEPROM:..... yes
Opmodes:..... 1,3
Drive Status: ..... en/dis

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ANIN

Analog Input:
This is a read only variable which displays the analog input value after being filtered by ANOFF and ANDB. The AVGTIME variable effects the time-averaging of this variable.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... Millivolts
Range: ..... -10,000 to +10,000
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

ANLPFHZ

This variable sets a filter rate (corner frequency) for the analog input filter. This is a simple single pole filter which is always present. The filter rate will need to be adjusted as the analog input sampling rate changes for different operational modes.

Firmware Versions: 2.1.0 and later
Type: ..... variable (R/W)
Units: ..... Hz
Range: ..... 1 to 10,000
Default: 10,000
EEPROM: ..... yes
Opmodes: 1,3
Drive Status:..... en/dis

ANOFF

Analog Offset:
This variable sets the analog offset which is added to the analog input command to the drive. This is used to compensate for the analog input signal (ANIN) offset or drift.

Firmware Versions: All
Type: ..... Standard Variable (Read / Write)
Units: ..... Millivolts
Range: ..... -10,000 to +10,000
Default: 0
EEPROM: ..... Yes
OPMODES: 1, 3
Drive Status: ..... Enabled / Disabled

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ANOUT

This variable sets the source for the analog output feature at user connector C4 pin 13. The update rate on the analog output is to be as fast as practical.

Argument List:

0 - Tachometer (vel. feedback) scaled identical to VSCALE.
1 - I monitor (equivalent current) scaled identical to ISCALE.
2 - Velocity Error scaled identical to VSCALE.
3 - Torque Command Output Scaled to ISCALE.
4 - Horse Power Meter Scaled 0-10V (Absolute) for 0-130%.
5 - Position following error, scaled to PEMAX.
6 - User variable.
7 - Low-frequency triangle wave.

Firmware Versions: 2.1.0 and later
Type: switch mode (R/W)
Range: 0 to 7
Units: ..... n/a
Default: 0
*Opmode:*a ll
Drive Status: .....en/dis
EEPROM: ..... yes

AVGTIME

Averaging Time:
This switch mode variable sets the variable averaging time period. This variable is expressed as multiples of the servo update period (Ts), which is 500 microseconds. A value of 0 for AVGTIME causes requested variable values to be returned as instantaneous values. Note that AVGTIME has no effect on variables that are sampled using the Record command and MotionLink's PC Scope Screen.

Firmware Versions: All
Type: .....Switch Mode Variable (Read / Write)
Units: .....Ts (500 Microseconds)
Range: .....0, 2, 4, 8, 16, 32, or 64
Default: 0
EEPROM: .....Yes
OPMODES: .....All
Drive Status: .....Enabled / Disabled

BW

This sets the desired velocity control loop bandwidth. This variable only affects the system when using the Standard Pole-Placement controller in velocity mode (COMPMODE = 2 or 4 and OPMODE = 0 or 1). With COMPMODE=2, BW is limited to 200 Hz; with COMPMODE=4, BW can extend to 400 Hz. Note that COMPMODE=4 is only available in firmware versions 2.1.0 and later.

Firmware Versions: all
Type: ..... variable (R/W)
Units: ..... Hz
Range:.....10 to 200 (COMPMODE=2)
.....10 to 400 (COMPMODE=4)
Default: 20
EEPROM: ..... yes
OPMODES: 0,1
Drive Status: ..... en/dis

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CCWLIM

CCW Limit Input State:
This switch variable displays the state of the external counter clockwise (CCW) limit switch input (see also CWLIM).

0 = switch closed, CCW limit not reached
1 = switch open, CCW limit reached

Firmware Versions: All
Type: ..... Switch Variable (Read Only)
Units: ..... n/a
Range: 0, 1
Default: ..... Hardware Defined
EEPROM: No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

COMPFILT

This is a switch variable that enables and disables a 400 Hz low pass filter in the velocity feedback loop. The filter will automatically be disabled if COMPMODE is set equal to 4. COMPFILT will retain its value regardless of whether the COMPMODE setting is enabling and disabling the filter.

Firmware Versions: 2.1.0 and later
Type:..... switch (R/W)
Units: ..... n/a
Range: ..... 0 (OFF), 1 (ON)
Default: ..... hardware
EEPROM: ..... no
OPMODES: 0,1
Drive Status: ..... dis

COMPMODE

This sets the velocity controller type for OPMODE 0 or 1 according to the following table.

COMPMODE	Controller Type	Loop Variables
0	PI	GV, GVI
1	PDFF	KV, KVI, KVFR
2	Standard Pole Placement (low-frequency)	BW, MJ, LMJR, TF
3	Advanced Pole Placement	D, H, R
4	Standard Pole Placement (high-frequency)	BW, MJ, LMJR, TF

Note: COMPMODE 3 is not available in version 1 firmware. COMPMODE 4 is available in firmware versions 2.1.0 and later.

Firmware Versions: see Note
Type: ..... switch mode (R/W)
Units: ..... n/a
Range: ..... 0 - 4
Default: 2
EEPROM: ..... yes
OPMODES:..... 0, 1
Drive Status: ..... dis

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CWLIM

CW Limit Input State:
This switch variable displays the state of the external clockwise (CW) limit switch input (see also CCWLIM).
0 = switch closed, CW limit not reached
1 = switch open, CW limit reached

Firmware Versions: All
Type: .....Switch Variable (Read Only)
Units: .....n/a
Range: 0, 1
Default: .....Hardware Defined
EEPROM: .....No
OPMODES: .....All
Drive Status: .....Enabled / Disabled

D

D Polynomial Vector:
This is a vector of variables that sets the D (forward path) polynomial of the Advanced Pole-Placement velocity controller (COMPMODE = 3). The vector defined by this variable includes five integers that represent the polynomial coefficients and a shift parameter that scales the polynomial.
Note that if this variable is changed, a REFRESH command is required.

Firmware Versions: All
Syntax: D [vector1] [vector2] [vector3] ... [vector5] [scale]
Example: D 100 200 300 400 500 1
Ranges: vectorN = -32,768 to 32,767
scale = 0 to 15

Type: .....Vector Variable (Read / Write)
Units: .....n/a
Range: .....See Above
Default: .....0 (All Parameters)
EEPROM: .....Yes
OPMODES: 0, 1
Drive Status: .....Enabled / Disabled

DEC

This variable sets the deceleration rate of the drive. This variable only affects the drive when linear ramp control and velocity mode are selected (PROFMODE = 1 and OPMODE = 0 or 1).

Firmware Versions: all
Type: ..... variable (R/W)
Units: ..... rotary: RPM / sec
Range:..... 1 to 399,987
Default: 399,987
.....linear: mm/sec/sec
EEPROM: ..... yes
OPMODES: 0, 1
Drive Status: ..... en/dis

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DECSTOP

This variable is a deceleration that is used by drive commands that require a faster than usual stop. This DECSTOP value is used instead of DEC in the following instances: end-travel limits, HOLD, S, and a fault occurrence with ACTFAULT = 1. See also DISSPEED and DISTIME.

Firmware Versions: all
Type: variable (R/W)
Units: ..... rotary: RPM * 1000/sec
..... linear: m/sec/sec
Range: ..... 1 to 32767
Default: 5000
EEPROM: ..... yes
OPMODES:..... all
Drive Status: ..... en/dis

DICONT

Drive Continuous Current
This variable defines the continuous rated current for the drive (sinusoidal RMS). This is a hardware-defined read-only variable that is detected automatically by the SERVOSTAR.

DICONT is usually 50% of the peak current of the drive (DIPEAK). In a given application, the drive may be configured to a lower rating than DICONT by setting the value of ICONT to the desired rating.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... Amperes * 0.1
Range: ..... 30 to 1100
Default: ..... Hardware / User Defined
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

DIP

This variable displays the settings of the DIP switches located on top of the drive. This variable returns a series of 1's and 0's for each of the switches, with a comma inserted in the middle for clarity. Switch 10 is the leftmost digit, and switch 1 is the rightmost. Refer to chapter 5 for more detail on the DIP switch definitions.

Note: in firmware versions prior to V2.0.0, there were only 8 DIP switches, and no comma was printed out.

Firmware Versions: all
Type: ..... switch mode (R)
Units: ..... 1=on, 0=off
Range: ..... 00000000-11111111 (firmware versions prior to 2.0.0)
..... 00000,00000-11111,11111 (firmware 2.0.0 and later)
Default: ..... hardware defined
EEPROM: ..... no
OPMODES: ..... all
Drive Status: ..... en/dis

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DIPEAK

Drive Peak Rated Current
This variable defines the peak rated current of the drive (sinusoidal RMS). This is a hardware-defined read-only variable that will be set to a value of (DICONT * 2). DIPEAK sets the 100% reference for many other current variables.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... Amperes * 0.1
Range: ..... 60 to 2200
Default: ..... DICONT * 2
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

DIPEN

Dip Switch Enable Status:
This switch variable displays the state of the Enable Dip Switch (switch number 8 of the DIP switches on top of the drive). This variable has to be set to 1 (switch set to OFF) to allow the drive to be enabled.
0 = DIP switch disabled
1 = DIP switch enabled

Firmware Versions: All
Type: ..... Switch Variable (Read Only)
Units: ..... n/a
Range: 0, 1
Default: ..... Hardware Defined
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

DIR

Direction:
This switch variable sets the direction defined as positive rotation for the motor as seen when looking at the motor shaft end.
0 = positive motion is counter-clockwise (CCW)
1 = positive motion is clockwise (CW)

Firmware Versions: All
Type: ..... Switch Variable (Read / Write)
Units: ..... n/a
Range: 0, 1
Default: 1
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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DISSPEED

This sets the speed window for the Active Disable function. The Active Disable function ramps the motor to zero speed using DECSTOP. DISSPEED is compared to the actual motor speed, and if the speed is less than this value, the active disable timer (DISTIME) will begin timing. Once the timer times out, the drive disables. See also ACTFAULT, DECSTOP, and DISTIME.

Firmware Versions: 2.1.0 and later
Type: ..... variable (R/W)
Units: ..... rotary: RPM
..... linear: mm/sec
Range: ..... 1 to 15,000
Default: ..... 50 RPM
EEPROM: ..... yes
Opmodes: ..... all
Drive Status: ..... en/dis

DISTIME

This sets the amount of time to wait after motor speed goes below DISSPEED before the drive is disabled in the Active Disable process. Once motor speed goes below DISSPEED, the drive will wait for the time period specified by DISTIME, and will then disable the drive. See also ACTFAULT, DECSTOP, and DISTIME.

Firmware Versions: 2.1.0 and later
Type: ..... variable (R/W)
Units: ..... millisecond * 0.1
Range: ..... 1 to 65535
Default: 100
EEPROM: ..... yes
OPMODES: ..... all
Drive Status: ..... en/dis

DRIVEOK

Drive Fault Status:
This switch variable displays the status of the drive faults.
0 = faults exist
1 = no faults exist

Firmware Versions: All
Type: ..... Switch Variable (Read Only)
Units: ..... n/a
Range: 0, 1
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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ECHO

Echo Enable:
This switch variable enables/disables serial port character echo. If echo is enabled, characters received via the serial port are echoed back to the serial port and displayed on the Motion Link monitor or terminal.

0 = serial port echo disabled
1 = serial port echo enabled

Firmware Versions: All
Type: ..... Switch Variable (Read / Write)
Units: ..... n/a
Range: 0, 1
Default: 1
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

ENCINITST

Encoder Initialization Status
This switch mode variable displays the status of the encoder initialization function (see ENCINIT). This variable is reset to 0 when the user manually sets the index position (see MENCOFF).

0 = initialization process has not begun
1 = encoder initialization is in progress
2 = encoder initialization has been completed

Firmware Versions: All
Type: ..... Switch Mode Variable (Read Only)
Units: ..... n/a
Range: ..... 0 - 2
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

ENCOUT

Encoder Output:
This switch mode variable sets the resolution (number of lines) of the encoder equivalent output channel for resolver based systems only. For encoder-based systems, this variable is read-only and is set equal to MENCRES. Note that ENCOUT values of 2048 and 4096 are available only when VLIM < 6100 RPM (RDRES = 14 or 16).

Firmware Versions: All
Type: ..... Switch Mode Variable (Read / Write)
Units: ..... Lines per revolution
Range: 512, 1024, 2048, 4096
Default: 1024
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Disabled

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FILTMODE

This variable sets the velocity loop Low Pass Filter (LPF) mode.
0 = no LPF.
1 = a single first order filter. Cutoff frequency is LPFHZ1.
2 = two first order filters. Cutoff frequencies are LPFHZ1 and LPFHZ2.

The filters affect the PI, PDFF, and standard pole placement controllers (COMPMODES 0-2 and 4), and are ignored in the advanced pole placement controller (COMPMODE=3).

Firmware Versions: all
Type: ..... switch mode (R/W)
Units:..... n/a
Range: 0, 1, 2
Default:..... 0
EEPROM: ..... yes
Opmodes: ..... all
Drive Status:..... en/dis

FOLD

Foldback State:
This switch variable displays the status of the foldback circuit. When the system current level exceeds ICONT for too long, the drive enters foldback mode, FOLD changes from 0 to 1, and the drive current is limited gradually (in exponential fashion) to the value of ICONT.
0 = foldback off
1 = foldback on

Firmware Versions: All
Type: .....Switch Variable (Read Only)
Units: .....n/a
Range: 0, 1
Default: .....n/a
EEPROM: .....No
OPMODES: .....All
Drive Status: .....Enabled / Disabled

FOLDMODE

Foldback Mode:
This switch mode variable sets the course of action to be taken when the drive enters foldback mode.
0 = normal foldback from ILIM to ICONT
1 = foldback to ICONT and issue fault after 30 seconds
2 = issue fault immediately upon detection

Firmware Versions: All
Type: .....Switch Mode Variable (Read / Write)
Units: .....n/a
Range: .....0 - 2
Default: 0
EEPROM: .....Yes
OPMODES: .....All
Drive Status: .....Enabled / Disabled

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GEAR

This variable enables/disables electronic gearing. The GEAR command is an immediate command (causes immediate gearing) unless INxMODE is selected to allow hardware control. If INxMODE is selected to control this function, this serial command must be 1 and the INx input must be on to enable the gear function. The GEAR function is a velocity-lock function so any bits lost during unlock time or ramp-to-speed are lost.

Firmware Versions: 2.1.0 and later
Type: ..... switch (R/W)
Units:..... n/a
Range:..... 0 (off), 1 (on)
Default: 1
EEPROM: ..... yes
OPMODES: 4
Drive Status: ..... en/dis

GEARI

This variable specifies the number of teeth on the input "gear" for the Gearing mode.

Firmware Versions: 2.1.0 and later
Type: ..... variable (R/W)
Units:..... teeth
Range: ..... -32768 to + 32767
Default: 1
EEPROM: ..... yes
OPMODES: 4
Drive Status: ..... en/dis

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GEARMODE

This variable is a switch mode variable that specifies the operation of electronic gearing for OPMODE 4:

GEARMODE = 0 - Encoder Follower, Flex I/O (Connector C3) Inputs: The encoder input channel is decoded as a quadrature input, scaled through GEARI / GEARO, and becomes the position command for the motor. The digital I/O ("Flex I/O") inputs serve as the encoder input channel (see Note below for clarification).

GEARMODE = 1 - Pulse and Direction, Flex I/O (Connector C3) Inputs: The encoder input channel A counts positive edges and becomes the position command. The encoder input channel B level dictates if the counter will count up or down. Channel B low drives motor in CW direction. The digital I/O ("Flex I/O") inputs serve as the encoder input channel (see Note below for clarification).

GEARMODE = 2 - Up/Down Mode, Flex I/O (Connector C3) Inputs: The encoder input channel is configured as a counter to command the motor's position. Positive edges on the A channel increments the counter (motor CW) while positive edges on the encoder input channel B decrements the counter (motor CCW). The digital I/O ("Flex I/O") inputs serve as the encoder input channel (see Note below for clarification).

GEARMODE = 3 - Encoder Follower, Remote Encoder (Connector C8) Inputs: The encoder input channel is decoded as a quadrature input, scaled through GEARI / GEARO, and becomes the position command for the motor. The remote encoder ("handwheel") inputs serve as the encoder input channel (see Note below for clarification).

GEARMODE = 4 - Pulse and Direction, Remote Encoder (Connector C8) Inputs: The encoder input channel A counts positive edges and becomes the position command. The encoder input channel B level dictates if the counter will count up or down. Channel B low drives motor in CW direction. The remote encoder ("handwheel") inputs serve as the encoder input channel (see Note below for clarification).

GEARMODE = 5 - Up/Down Mode, Remote Encoder (Connector C8) Inputs: The encoder input channel is configured as a counter to command the motor's position. Positive edges on the A channel increments the counter (motor CW) while positive edges on the encoder input channel B decrements the counter (motor CCW). The remote encoder ("handwheel") inputs serve as the encoder input channel (see Note below for clarification).

Note: if GEARMODE = 0-2, encoder A/B inputs are received via the digital "Flex I/O" inputs on connector C3 (see INx and INxMODE descriptions); if GEARMODE = 3-5, encoder A/B inputs are received via the remote encoder (sometimes called "handwheel") inputs on connector C8.

Note that each of these modes are subject to: GEARI, GEARO, GEAR, and DIR.

Firmware Versions: 2.1.0 and later
Type: switch mode (R/W)
Units:..... n/a
Range: ..... 0 to 5
Default:..... 0
EEPROM: ..... yes
Opmodes: 4
Drive Status: ..... dis

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GEARO

specifies the number of teeth on the output "gear" for the Gearing mode.

Firmware Versions: 2.1.0 and later
Type: ..... variable (R/W)
Units: ..... teeth
Range: ..... 1 to 32767
Default: 1
EEPROM: ..... yes
OPMODES: 4
Drive Status: ..... en/dis

GETMODE

Data Get Mode:
This switch mode variable sets the mode of data transfer from the drive to the host when using the GET command.

0 = ASCII data transfer format
1 = ASCII-HEX data transfer format
2 = BINARY data transfer format (fastest)

Firmware Versions: All
Type: ..... Switch Mode Variable (Read / Write)
Units: ..... n/a
Range: ..... 0 - 2
Default: 0
EEPROM: ..... Yes
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

GP

This sets the proportional gain for the position loop. Executing the TUNE command successfully may change the value of this parameter.

Firmware Versions: 2.1.0 and later
Type: ..... variable (R/W)
Units: ..... rotary: 0.01 kRPM/min/rev
..... linear: 0.01 m/min/mm
Range: ..... 1 to 7000
Default: ..... calculated
EEPROM: ..... yes
OPMODES: 4
Drive Status: ..... en/dis

GV

Proportional Gain, Velocity Loop, PI:
This variable sets the proportional gain for Proportional Integral Velocity Control Loop (PI loop; COMPMODE = 0). Executing the TUNE command successfully may change the value of this parameter.

Firmware Versions: All
Type: ..... Standard Variable (Read / Write)
Units: ..... n/a
Range: ..... 0 to 32767
Default: 500
EEPROM: ..... Yes
OPMODES: 0, 1
Drive Status: ..... Enabled / Disabled

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GVI

Integral Gain, Velocity Loop, PI:
This variable sets the velocity integral gain for the Proportional Integral Velocity Control Loop (PI loop; COMPMODE = 0). Executing the TUNE command successfully may change the value of this parameter.

Firmware Versions: All
Type: ..... Standard Variable (Read / Write)
Units: ..... n/a
Range: ..... 0 to 32767
Default: 20
EEPROM: ..... Yes
OPMODES: 0, 1
Drive Status: ..... Enabled / Disabled

H

H Polynomial Vector:
This vector variable sets a vector of variables that defines the H (feedback path) polynomial of the Advanced Pole-Placement velocity controller (COMPMODE = 3). The vector defined by this variable includes four integers that represent the polynomial coefficients, and four shift parameters, one that scales each polynomial.
Note that if this variable is changed, a REFRESH command is required.

Firmware Versions: All
Syntax: H [h0] [h0shift] [h1] [h1shift]... [h3] [h3shift]
Example: H 10000 2 30000 4 50000 6 70000 8
Range : hN = -2,147,483,647 to +2,147,483,647
hNshift = 0 to 32767

Type: ..... Vector Variable (Read / Write)
Units: ..... n/a
Range: ..... See Above
Default: ..... 0 (All Parameters)
EEPROM: ..... Yes
OPMODES: 0,1
Drive Status: ..... Enabled / Disabled

HALLS

Hall Switch Values:
This switch mode variable returns the hall switch values (encoder feedback option only). The switch values are displayed as a three-bit code in the sequence C-B-A.

Firmware Versions: All
Type: ..... Switch Mode Variable (Read Only)
Units: ..... Bits
Range: ..... 000 - 111
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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HOLD

Position Hold Software Switch:
This switch variable sets a flag indicating whether or not the drive should enter the position-hold mode. When activated, the motor will decelerate to zero speed at the DECSTOP rate and switch modes to hold the motor shaft at its present position. This variable may be set either by serial communication, by asserting both limit switches (CWLIM and CCWLIM), or by setting DIP switch number 7, or during an active disable.

The Status Display will flash the current OPMODE as a visual indicator that the drive is in the HOLD mode.

Firmware Versions: All
Type: ..... Switch Variable (Read / Write)
Units: ..... n/a
Range: 0, 1
Default: 0
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

HWPOS

This variable displays the position feedback directly from the feedback hardware counter. For resolver-based systems, HWPOS will range from 0 to 65,535 per electrical revolution of the resolver (the number of electrical resolver revolutions per each mechanical revolution is calculated by dividing the number of resolver poles by 2 - see MRESPOLES). The resolution of HWPOS is based on RDRES:

RDRES = 12, resolution of HWPOS = 16
RDRES = 14, resolution of HWPOS = 4
RDRES = 16, resolution of HWPOS = 1

For encoder-based systems, HWPOS will return the encoder counter content, which is based on quadrature pulse input and will range from -2048 to 2047.

Firmware Versions: 2.0.0 and later
Type: ..... variable (R)
Units:..... counts
Range:..... 0 to 65,535 (resolver -2048 to 2047 (encoder)
Default: ..... n/a
EEPROM: ..... no
OPMODES: ..... all
Drive Status: ..... en/dis

I

Current Monitor:
This variable displays the motor current. The AVGTIME variable determines the averaging of this variable, except when recorded for graphical display by MotionLink, in which case it is not averaged.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... % of DIPEAK * 0.1
Range: ..... 0 to 2000
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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IA

Phase 'A' Current Monitor:
This variable displays the motor's A phase current. AVGTIME does not affect this variable.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... % of DIPEAK * 0.1
Range: ..... -1000 to 1000
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

IC

Phase 'C' Current Monitor:
This variable displays the motor's C phase current. AVGTIME does not affect this variable.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... % of DIPEAK * 0.1
Range: ..... -1000 to 1000
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

ICMD

Current Command:
This variable displays the Current (Torque) command to the current controller. This variable is equivalent to the Analog Input (ANIN) in OPMODE 3, to the Torque Command (T) in OPMODE 2, and to the output of the velocity controller in OPMODE 0 or 1. The AVGTIME variable affects averaging of this variable, except when recorded for graphical display by MotionLink, in which case it is not averaged.

Firmware Versions: All
Type: ..... Standard Variable (Read Only)
Units: ..... % of DIPEAK * 0.1
Range: ..... -1000 to 1000
Default: ..... n/a
EEPROM: ..... No
OPMODES: ..... All
Drive Status: ..... Enabled / Disabled

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