
SERVOSTAR® CD

Installation Manual

**SERVOSTAR® CD Product Series
Installation and Setup Manual
M-SU-004-H Issue 1
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Firmware Version 3.4 and earlier

Record of Manual Revisions

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Safety Instructions

Only qualified personnel are permitted to transport, assembly, commission, and maintenance this equipment. Properly qualified personnel are persons who are familiar with the transport, assembly, installation, commissioning and operation of motors, and who have the appropriate qualifications for their jobs. The qualified personnel must know and observe the following standards and regulations:

IEC 364 resp. CENELEC HD 384 or DIN VDE 0100

IEC report 664 or DIN VDE 0110

National regulations for safety and accident prevention or VBG 4

- Read all available documentation before assembly and commissioning. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information on the installation requirements.
- It is vital to ensure that all system components are connected to earth ground. Electrical safety is impossible without a low-resistance earth connection.
- The SERVOSTAR® product contains electrostatically sensitive components that can be damaged by incorrect handling. Discharge yourself before touching the product. Avoid contact with high insulating materials (artificial fabrics, plastic film, etc.). Place the product on a conductive surface.
- During operation keep all covers and cabinet doors shut. Otherwise, there are deadly hazards that could possibly cause severe damage to health or the product.
- In operation, depending on the degree of enclosure protection, the product can have bare components that are live or have hot surfaces. Control and power cables can carry a high voltage even when the motor is not rotating.
- Never pull out or plug in the product while the system is live. There is a danger of electric arcing and danger to persons and contacts.
- After powering down the product, wait at least 10 minutes before touching live sections of the equipment or undoing connections (e.g. contacts, screwed connections). Capacitors can store dangerous voltages for long periods of time after power has been switched off. To be safe, measure the contact points with a meter before touching.
- The safety-alert symbols are illustrated as follows:



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.

Directives and Standards

The SERVOSTAR® CD product series have been successfully tested and evaluated to meet UL/cUL 508C for both the U.S. and Canadian markets. This standard describes the fulfillment by design of minimum requirements for electrically operated power conversion equipment, such as frequency converters and servo amplifiers, which is intended to eliminate the risk of fire, electric shock, or injury to persons, being caused by such equipment.

CE Mark Conformance

Servo drives are components; which are intended to be incorporated into electrical plant and machines for industrial use. When the servo drives are built into machines or plant, the intended operation of the drive is forbidden until it has been established that the machine or plant fulfills the requirements of the EC Directive on Machines 89/392/EEC and the EC Directive on EMC (89/336/EEC). EN 60204 and EN 292 must also be observed.

In connection with the Low Voltage Directive 73/23/EEC, the harmonized standards of the EN 50178 series are applied to the amplifiers, together with EN 60439-1, EN 60146 and EN 60204.

The manufacturer of the machine or plant is responsible for ensuring that they meet the limits; which are required by the EMC regulations. Advice on the correct installation for EMC - such as shielding, grounding, arrangement of filters, treatment of connectors and the laying out of cabling - can be found in this documentation.

Conformance with the EC Directive on EMC 89/336/EEC and the Low Voltage Directive 73/23/EEC is mandatory for the supply of servo drives within the European Community.

The servo drives have been tested by an authorized testing laboratory in a defined configuration with the system components; which are described in this documentation. Any divergence from the configuration and installation described in this documentation means that you will be responsible for the performance of new measurements to ensure that the regulatory requirements are met.

Kollmorgen's SERVOSTAR® C-Series of drives and systems have been successfully tested and evaluated to the limits and requirements of the EC Directive on EMC (89/336/EEC) and the EC Directive on Low Voltage (72/23/EEC). The product lines have been evaluated to EN50178 and EN60204 as a component of a machine and other relevant standards.

The EMC of a system can be identified in two parts: emissions and immunity. Emissions refer to the generation of EMI (electromagnetic interference) and immunity refers to the susceptibility levels of the equipment. Limits were derived from generic standards EN55081-2 and EN55082-2 for heavy industrial environment. The SERVOSTAR® C-series of drives have been tested for radiated emissions, conducted emissions, EFT, ESD, surge, conducted immunity, and radiated immunity. These tests have been done in accordance with EN55011, EN61000-4-2, ENV50140, IEC 1000-4-4, EN61000-4-5, and ENV50141.



The installation of the equipment is critical in designing for system and machine electromagnetic compatibility (EMC). The user must apply the installation recommendations in (See Section 3. 3 Installation Practices on page 3-4 and 3.5 CE Filtering Techniques on page 3-13) this manual when mounting and installing the drive system for CE conformance.

Section 1

General Information

1.1 HOW TO USE THIS PACKAGE

This Product Support Package (PSP) is designed to provide the user with a complete set of support tools for easy installation and setup, feature understanding, and application implementation of a SERVOSTAR® CD drive system. It is divided into two parts: Installation and Setup manual and a CD-ROM that includes the drive's software package, software reference guides, application notes, and sales publications in a .pdf format.

1.1.1 Installation and Setup Manual

This manual is designed to lead you through the proper installation and setup of a SERVOSTAR® CD servo system. It was developed with the assumption that there is a fundamental understanding of basic electronics, computers, mechanics, and proper safety practices. However, you do not have to be an expert in motion control to install and operate the drive system. It is recommended that you read the entire manual completely before installation and operation is attempted.

The layout of material in this manual is designed to guide you through the following process:

- Product description and features (Section 2)
- System hardware installation (Section 3)
- System startup through a host communicator (Section 4)
- Basic theory including the system's various modes of operation (Section 5)
- System troubleshooting and customer support (Section 6)

1.1.2 CD-ROM Contents

The CD-ROM contains the software interface package. Product feature content is also provided for the user desiring to obtain a more comprehensive understanding of the SERVOSTAR® drive. Adobe's Acrobat Reader is necessary to read and print these documents. The reader is provided for easy installation (If you have a version earlier than 3.01, it is recommended that you reinstall this reader for graphic clarity).

The material on the CD-ROM provides the following information about this product:

- Application notes providing comprehensive feature and application explanation.
- MotionLink® software package
- Software Reference: VarCom Reference Guide (Variable/Command Set)

1.2 WARRANTY INFORMATION

All products covered in this manual are warranted to be free of defects in material and workmanship and to conform to the specifications stated either in this document or a product catalog description. All Kollmorgen brushless motors and electronics are warranty for a period of 24 months from the time of installation or 30 months from time of shipment, whichever ever comes first. There are no other warranties, expressed or implied (including the warranty of merchantability and fitness for a particular purpose, which extends beyond this warranty. Kollmorgen warrants that the products covered in the manual are free from patent infringement when used for normal purposes.

1.3 USE AS DIRECTED

The following guidelines describe the restrictions for proper use of the SERVOSTAR® CD system:

- These amplifiers are components which are built into electrical equipment or machines and can only be commissioned as integral components of such equipment.
- The servo amplifiers are to be used only on earthed three-phase industrial mains supply networks (TN-system, TT-system with earthed neutral point).
- The servo amplifiers must not be operated on power supply networks without an earth or with an asymmetrical earth.
- If the servo amplifiers are used in residential areas, or in business or commercial premises, then additional filter measures must be implemented by the user.
- The servo amplifiers are only intended to drive specific brushless synchronous servomotors from Kollmorgen, with closed-loop control of torque, speed, and/or position. The rated voltage of the motors must be at least as high as the DC-link voltage of the servo amplifier.
- The servo amplifiers may only be operated in a closed switch gear cabinet, taking into account the ambient conditions defined in the environmental specifications described in Section 2.1.3 Cx Electrical Specifications on page 2-8.
- We only guarantee the conformance of the servo amplifiers with the standards for industrial areas stated in the front of this manual if Kollmorgen delivers the components (motors, cables, amplifiers etc).

1.4 CUSTOMER SUPPORT

Kollmorgen is committed to quality customer service. Our goal is to provide the customer with information and resources as soon as they are needed. In order to serve in the most effective way, Kollmorgen offers a one-stop service center to answer all your product needs. This one number provides order status and delivery information, product information and literature, and application and field technical assistance:

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If you are unaware of your local sales representative, please contact us at the number above. Visit our web site for MotionLink[®] software upgrades, application notes, technical publications, and the most recent version of our product manuals.

1.4 LIST OF FIGURES

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1.5 ABBREVIATIONS

A/D or ADC	Analog-to-Digital Converter
AppNote	Application Note
CCW	Counter Clockwise
CMR	Common Mode Rejection
CW	Clockwise*
CR-LF	ASCII Carriage Return, Line Feed
D/A or DAC	Digital-to-Analog Converter
EMF	Electro-Motive Force
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
Hz	Hertz
I	Current
I/O	Input / Output
kHz	KiloHertz
KCSN	Kollmorgen Customer Support Network
KW	KiloWatts
LED	Light Emitting Diode
NEC	National Electrical Code
PC	Personal Computer
PSP	Product Support Package
P/N	Part Number
PWM	Pulse Width Modulation
R/D	Resolver-to-Digital
Regen	Regeneration
RMS	Root Mean Square
Rx	SERCOS Receiver Port
SERCOS	S ERIAL R eal-time C OMMUNICATION S TANDARD
Tx	SERCOS Transmit Port
UL	Underwriters Laboratories
VarCom	Variable and Command Set Reference Guide

Section 2

System Description

2.1 SERVOSTAR[®]

The SERVOSTAR[®] is a digital servo motor amplifier that meets the needs of many servo applications such as machine tooling, packaging, electronic assembly, and document handling. It has been designed to be a multifaceted amplifier capable of driving Kollmorgen's vast product basket of motors and their assorted feedback devices. The C-series (Compact Drive), that includes an integrated power supply, is available in 3 and 6 amp sizes. All are packaged in a small frame size perfect for minimizing cabinet space. This product can be commanded through analog, serial, and SERCOS (for use with SERVOSTAR[®] MC controllers only) user interfaces and has its own tailored software environment in Kollmorgen's MotionLink[®] for Windows.

2.1.1 Product Features

The SERVOSTAR[®] includes a vast array of features. Its various control techniques, interfaces, and user tools give the customer a fully compatible drive to meet most motion control applications. The following illuminates all the user features:



Bulleted words that begin in capital letters indicate formal feature names. Words that are all capitals in parenthesis indicate the software variables and commands associated with the feature. This section is designed to draw the user to the VarCom reference manual for details on these features.

Current/Torque Control

- See section 5.5 Torque Loop Operation on page 5-6 for a comprehensive discussion on the feature
- digital current loop control (Torque Mode - OPMODE 2 or 3) receiving serial (T) or analog command
- PWM sine wave commutation (PWMFRQ) providing smooth and precise low-speed control and high-speed performance
- current loop adaptive gain (MLGAINC, MLGAINP, MLGAINZ)
- system current-limiting capability (ILIM, ILIM2, IMAX, MICON, MIPEAK)
- exponential current vs. time limiter (FOLD, FOLDMODE)
- back EMF compensator (MBEMFCOMP)

Velocity Control

- See AppNotes ASU006H and ASU008H on the PSP CD-ROM for a comprehensive discussion on the features listed below.
- digital velocity loop control (Velocity Mode - OPMODE 0 or 1) receiving serial (J), analog (ANIN), or I/O triggered commands (MISPEEDx, INx, INxMODE where x is 1,2,3)
- velocity stepping and jogging capability (STEP, J)
- serial control through stored commands triggered through the Configurable I/O (INx, INxMODE where x is 1,2,3)
- automatic control loop tuning through the AutoTune feature (TUNE)
- configurable application and system speed limits (VLIM, VOSPD, VMAX)
- advanced control algorithms (COMPMODE):
 - 1) Proportional-Integral (GV, GVI)
 - 2) Pseudo-Derivative w/Feed Forward (KV, KVI, KVFR)
 - 3) Standard Pole Placement (BW, MJ, LMJR, TF)
 - 4) Extended Standard Pole Placement (BW, MJ, LMJR, TF)
- first and second-order low pass filtering capability (FILTMODE, LPFHZ1, LPFHZ2, COMPFILT)
- notch filtering capability (FILTMODE, NOTCHHZ, NOTCHBW)
- bandwidths up to 400Hz
- “on the fly” homing capability (HOMETYPE) in analog velocity mode (OPMODE 1) through either the Configurable Inputs or terminal.
- “on-the-fly” switching between velocity and current/torque control (INx, INxMODE where x is 1,2,3)

Position Control

- See AppNotes ASU007H (Position Control) and ASU002H (Pulse Control) on the PSP CD-ROM for a comprehensive discussion on the features listed below.
- serial positioning loop control (Position Mode - OPMODE 8 & PCMDMODE) receiving serial or I/O-controlled command (INx, INxMODE where x is 1,2,3)
- analog positioning loop control (Position Mode - OPMODE 8 & PCMDMODE) over a $\pm 10V$ range with scaling capability (PSCALE, GEAR, GEARI, GEARO) and I/O triggering
- incremental and absolute positioning with an “in position” indicator (MI, MA, INPOS, PEINPOS).
- simple absolute and incremental indexing with I/O triggering capability (MAPOS, MASPEED, MIDISTx and MISPEEDx where x is 0,1,2,3) through either the serial port or the hardware configurable inputs (INx, INxMODE where x is 1,2,3)
- position homing with I/O triggering capability (MH, HOMESPD, HOMESTATE, HOMETYPE) through either the serial port or the configurable inputs (INx, INxMODE where x is 1,2,3)
- Electronic Gearing (Position Mode - OPMODE 4) featuring pulse following or master encoder capability with resolution up to 3MHz through C8 connector (2.5KHz through opto-isolators in C3) (GEAR, GEARMODE, GEARI, GEARO, PEXT, PEXTOFF, VEXT, XENCRES, XENCDIR). Homing capability is provided.
- dual-loop mode (DUALFB) capable of positioning from a load feedback (C8 input, PEXTOFF, PEXT, VEXT, XENDIR) device while controlling velocity and torque from the motor feedback (C2 input)

- PID position loop tuning (GP, GPD, GPI,) with feed-forward acceleration gain input to both the velocity and current loops (GPAFR, GPAFR2), and feed-forward velocity gain input to the velocity loop (GPVFR).
- software position limits (PLIM, PMAX, PMIN, PEMAX)
- configurable integrator dynamics through travel range (GPISATOUT, GPISATIN)
- cumulative, revolution, and error position counters (PFB, HWPOS, PRD, PE)
- position indicators (INPOS, PEINPOS, PE, PEMAX, PFB, PFBOFF)

Profile Ramping Control

- Electronic Braking (STOPMODE, ISTOP). See AppNote ASU005H on the PSP CD-ROM for a comprehensive discussion on this feature.
- separate accel/decel linear ramping control in velocity and position mode (ACC, DEC, PROFMODE)
- S-curve accel/decel ramping control (PROFSCRV, PROFMODE) in the position mode (OPMODE=8)
- controlled decelerating (DECSTOP, DISSPEED, DISTIME) with acceleration feed-forward when the drive is left enabled (STOP, HOLD, CWLIM, CCWLM, LIMDIS) or becomes disabled (K, S, ACKFAULT, DIS). Also can be used in conjunction with the Electronic Braking feature.
- torque compensator for coulomb friction and weight counter-balancing (IFRIC, IGRAV)

Motor Controllability

- provides linear and rotary motor control (MOTORTYPE, MPITCH, MENCRES) with automatic unit conversion
- configurable back EMF characteristics for effective current loop controller design and command (MBEMF, MBEMFCOMP)
- Kollmorgen's patented Torque Angle control to maximize motor output power (MTANGLC, MTANGLP, MVANGLF, MVANGLH)
- motor speed and current limits (MSPEED, MICON, MIPEAK)
- thermal protection control (MFOLD, MFOLDD, MFOLDDIS, MFOLDR, MFOLDT) adaptable to any motor
- AutoConfig feature (ACONFIG, ACONFIGST, MFBDIR) automatically configures the motor's power and feedback cables. It checks, warns, and corrects for incorrect wiring of these cables.
- configurable positive motion direction (DIR)

Feedback Devices

- device zeroing mode that rotates the motor to an electrical null point (ZERO, IZERO)

Resolvers

- variety of motor/resolver pole combinations (MPOLES, MRESPOLES)
- resolver-zero offsetting (MPHASE)
- system accuracy's better than 20 arc minutes (reduced when resolver pole count is increased)
- inter-LSB interpolation between least significant bits (ILSBMODE) allows 18-bit velocity control and 16-bit positioning capability

automatic resolution configuring based on application speed requirements (RDRES, VMAX)

Encoders:

- maximum frequencies to 3 MHz before quad
- up to 10 million counts per motor electrical cycle (MENCRES)
- configures automatically (ENCINIT, ENCINITST, ENCSTART, IENCSTART)
- index pulse offsetting capability (MENCOFF)
- variety of encoder types (MENCTYPE):
 - 1) encoder with or without index
 - 2) encoder-hall effects with or without index (MHINVA, MHINVB, MHINVC, HALLS)

Sine Encoders:

- See AppNote ASU009H (Sine Encoder Feedback) on the PSP CD-ROM for a comprehensive discussion on this feature.
- 256x internal interpolation
- up to 128x Encoder Equivalent Output (SININTOUT)
- most standard encoder features mentioned above

System Communications

- serial communications port (address setting through DIP switch on top of drive).
 - 1) RS232 single and up to 31 axis MultiDrop addressing (ADDR)
 - 2) RS485 single and up to 31 axis MultiDrop addressing (ADDR)
 - 3) Data transmission (DUMP, GET, LIST, MLIST, GETMODE) baud rates of 9600 or 19200
 - 4) configurable protocol (ECHO, PROMPT, ACKMODE, GETMODE, MSG)
 - 5) interface through Kollmorgen's MotionLink[®] or a dumb terminal
 - 6) See AppNote ASU003H on Serial Communications Protocol on the PSP CD-ROM.
- differential analog input command (ANIN)
 - 1) $\pm 10\text{v}$ @ 14 bit resolution
 - 2) $\pm 10\text{v}$ @ 15 bit resolution below 4V of input for slow speed operation using the Dual Gain feature (ANDG - SE units only)
 - 2) input signal filtering (ANLPHFHZ)
 - 3) flexible analog input scaling (VSCALE, ISCALE, ANOFF, ANZERO, ANDB)
- SERCOS communications port (for use with SERVOSTAR[®] MC controllers only)
 - 1) 2msec update rate
 - 2) complete set of manufacturer's IDNs
 - 3) MotionLink[®] communication through the serial port
- Encoder Equivalent Output signal (C4 connector) eliminates the need for an additional position feedback device. The maximum frequency of this output is 3MHz for standard encoders and 1.2MHz for sine encoders.
 - 1) resolver-based systems: developed through R/D hardware circuitry for minimal phase lag, it provides a before quad resolution of up to 16384 lines (65536 quad counts) per revolution of the motor shaft (dependant on motor speed). This signal resolution is configurable (ENCOUT). Index pulse can be varied as much as one complete revolution (INDEXPOS).
 - 2) encoder-based systems: actual encoder signals are exported through this output (MENCRES) and can be scaled down by multiples of two (ENCOUTO).
 - 3) sine-encoder systems: developed through the interpolator circuit (SININTOUT) and encoded to a quadrature signal. A frequency limiter (MSINFRQ) is provided with fault protection.

MotionLink[®] Software Environment

- easy setup, commanding, and monitoring techniques
- contains an extensive database for many of Kollmorgen's motor series
- a Backup Screen that provides automatic loading of system parameters
- real-time metering of many system parameters
- PC Scope feature for profile recording and real-time motion performance measuring
- optional Terminal Mode feature for keystroke commanding and monitoring
- Status Screen indicating system operation and fault/error checking
- extensive On-line Help file (F1) designed to assist the user in MotionLink[®]'s intuitive nature
- a set of Limits folders allowing the user to manipulate the position, velocity, current, and filtering limits from one screen.
- an I/O Screen for easy manipulation of the drive's I/O, thermostat options, encoder output, and hardware position limits capabilities.
- a Feedback Device Screen that provides real-time pictorial positioning information. It also includes a Resolver Zeroing routine and an encoder initialization folder.
- a Tuning Screen designed to allow the user to adjust control loop gains quickly while visibly watching the affects on performance.
- a Control Loops Screen that provides direct manipulation of velocity and position loop gain parameters.

Monitoring and Troubleshooting Tools

- performance recording (RECDONE, RECING, RECOFF, RECORD, RECRDY, RECTRIG)
- system status checking (STAT, STATUS, STATUS2)
- control loop monitoring:
 - 1) current/torque (I, IA, IC, ICMD, IMAX, ICONT, DICONT, DIPEAK)
 - 2) speed (V, VCMD, VE)
 - 3) position (PCMD, PFB, PE, HALLS, HWPOS, INPOS, PRD, PEXT, PEINPOS)
- analog output (ANOUT) with 12-bit resolution and scaling flexibility (PSCALE) that can be configured to monitor speed, torque, current, power, velocity error, following error, and position feedback (PFB). Should be used as a monitoring tool **only**.
- dual-state digital output (O1, O1MODE, O1RST, O1TRIG) that toggles according to various absolute current, speed, and position parameter settings. Also can be used to communicate occurrences of FoldBack, motor braking, and the status of the Remote Enable hardware switch.
- Status Display (TESTLED) indicator that communicates operational and fault characteristics
- real-time reading of the 10-position DIP switch (DIP, DIPEN)
- software status switch indicator provided for Configurable Inputs INx, INxMODE (IN)

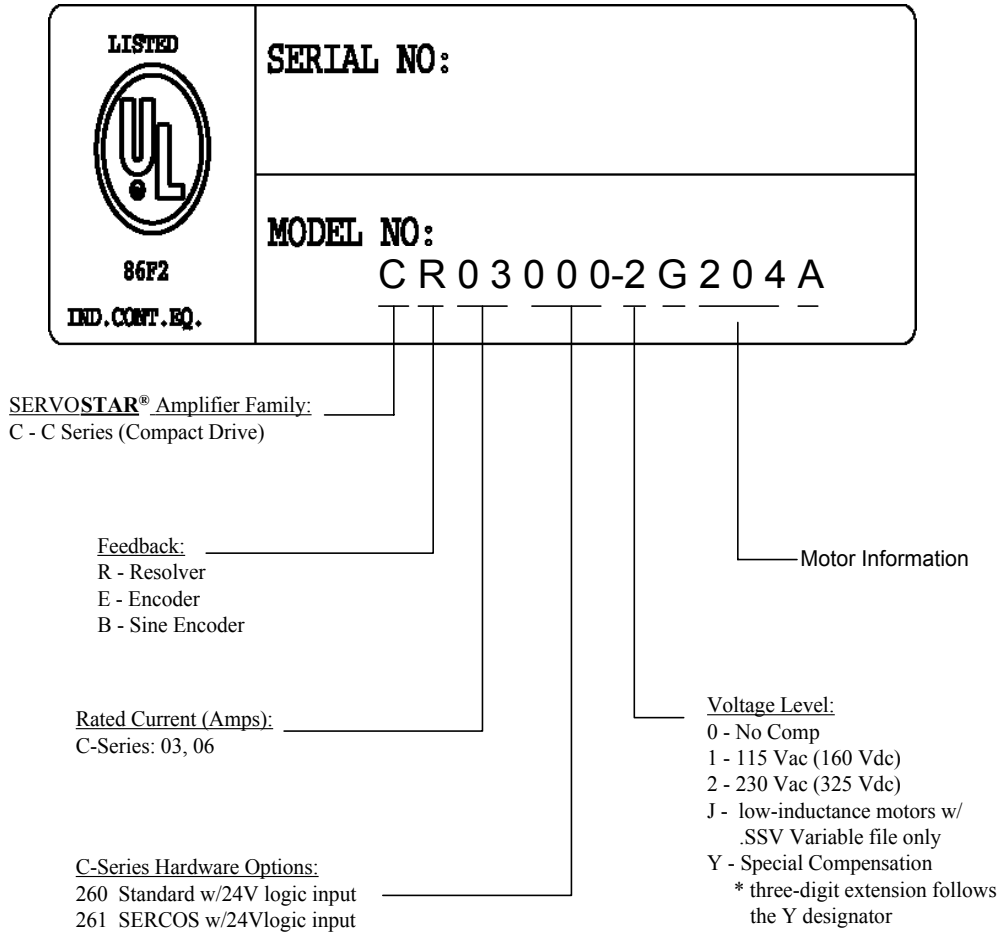
Fault and Safety Detection

- watchdog faults
- general faults (ACKFAULT, STAT, STATUS)
- configurable UnderVolts protection (UVMODE, UVTIME, UVRECOVER)
- Speed and current protection (VOSPD, VLIM, ACC, DEC, ILIM, ILIM2)
- fatal and non-fatal error coding with text explanation to the host (ERR, FLTHIST, FLTCLR) . Also includes a run-time counter (TRUN) that records the time the error occurred.
- configurable motor thermal protection that accepts various thermostat types (THERM, THERMODE, THERMTYPE, THERMTIME)
- configurable drive thermal protection through the FoldBack feature (FOLD, FOLDMODE). It sets the maximum time limit the drive can provide peak current (2:1 Sx, 3:1 Cx) to the motor.
- configurable motor thermal protection through the motor FoldBack feature (MFOLD, MFOLDD, MFOLDDIS, MFOLDR, MFOLDT). It sets the maximum time limit the drive can provide continuous current to the motor.
- hardware position limit switch detection (CCWLIM, CWLIM, LIMDIS, INx, INxMODE where x is 1,2,3)
- configurable software position limits (PLIM, PMAX, PMIN, PEMAX)
- configurable fault relay output (RELAY, RELAYMODE, DISTIME, INxMODE)
- active disable feature (ACKFAULT) that allows the user to determine how the system should react at the occurrence of a fault. The system can immediately disable, where the motor will coast to a stop, or it can be programmed to a controlled decelerated stop (DECSTOP, DISSPEED, DISTIME, STOPMODE, ISTOP).
- active enable indicator through the Status Display decimal (ACTIVE, DRIVEOK, SWEN, READY, REMOTE, DIPEN)

General

- many enabling and disabling features (K, S, STOP, REMOTE, EN, DIS)
- flash firmware memory for easy field upgrade installation
- Kollmorgen's patented "Torque Angle Control" for buried magnet motor designs (MTANGLC, MTANGLP, MTANGLF, MTANGLH - defined as speed and torque optimization through commutation angle advancing of the drive's output current waveform with respect to the motor's back EMF waveform.
- firmware and serial number information (VER, SERIALNO, MOTOR) via terminal

2.1.2 Part Number Description



2.1.3 Cx Electrical Specifications

Product Model		Cx03	Cx06
Main Input Power	Voltage (Vac _{L-L}) Nominal ±10%	110-230	
	230Vac 1 ϕ / 3 ϕ	1 / 3	
	Line Frequency	47-63	
	KVA at 230(1 ϕ) / 230(3 ϕ)	0.89 / 1.39	1.8 / 2.79
	Continuous Current (amps) at 230(1 ϕ / 3 ϕ)	3.9 / 3.5	7.7 / 7
	Peak Current (amps) for 500 msec at 230(1 ϕ /3 ϕ)	7.8 / 7	15.4 / 14
Logic Input Power	Line Fuses (amps) (FRN or equivalent)	10	20
	+24Vdc Ext. Logic Voltage (volts)	22 – 27	
SoftStart	+24Vdc Ext. Logic Current (amps sink)	1.5	
	Max. Surge Current (amps)	30	
Protection Functions	Max. Charge Time (sec)	0.25	
	Fault Contact Rating	1 A (UCB)	
	Fault Contact Closing Period (mSec)	Close = 3mS, Open = 2mS (UCB)	
Rated Main Output (Ma, Mb, Mc)	OverTemperature trip (°C)	80°C	
	Continuous Power Capability (KVA) @ 230Vac 1 ϕ /3 ϕ Line Input (45°Ambient)	0.7 / 1.1	1.4 / 2.2
	Continuous Current (Arms)	3	6
	Peak: Continuous ratio for 500mSec	3:1	3:1
	Peak Current (Arms) for 500mSec	9	18
	Peak: Continuous ratio for 2Sec	2:1	2:1
	Peak Current (Arms) for 2Sec	6	12
	PWM Frequency (kHz)	16	8
Protective Functions	PWM Motor Current Ripple (kHz)	32	16
	Form Factor (rms/avg)	≤1.01	
	UnderVoltage Trip (nominal)	90 Vdc	
	OverVoltage Trip	430 Vdc	
Environment	OverTemperature Trip	80°C	
	Internal heat dissipation (watts)	84	
	Operation temperature (°C)	5 to 45°C	
	Storage temperature (°C)	-0 to 70	
	Ambient humidity	10% to 90%	
External Regen Kits	Atmosphere	w/o no corrosive gasses or dust	
	Altitude	Derate 5% per 300m above 1000m	
	Vibration	0.5 g	

Table 2-1 SERVOSTAR[®] Cx Electrical Specifications

2.1.4 Cx Regen Information

Product Model		Cx03	Cx06
External Shunt Regulator	Peak current (amps)	20	
	Minimum resistance (ohms)	20	
	Watts	200	
Application Information	Capacitance (Farads)	0.00082	0.00164
	BUS Voltage (nominal) (Vdc)	325	
	V _{HYS} (Regen circuit turn-off) (Vdc)	370	
	V _{MAX} (Regen circuit turn-on) (Vdc)	390	
External Regen Kits	ERH-26	✓	✓

Table 2-1 SERVOSTAR[®] Cx Regen Information

*For guidance on application sizing of Regen Kits, see Applicatin Note ASU001H on the PSP CD-ROM.

2.1.5 Product Family Control Specifications

Product Model		SERVOSTAR CD Control Specifications
Current Loop	Update Rate	62.5 μ S (16kHz)
	Bandwidth	<2000Hz
Commutation Loop	Update Rate	62.5 μ S (16kHz)
	Output Waveform	Sinusoidal
Velocity Loop	Update Rate	250 μ S (4kHz)
	Bandwidth	<400Hz
	Speed Command Resolution	Serial/Analog: 12Bit (Optional 14)
	Maximum / Minimum Speed	500Hz / [Serial: 1 RPM or Analog: (1/2048) x VMAX]
	Long-term Speed Regulation	.01% (μ P clock tolerance)
Position Loop	Update Rate	500 μ S (2kHz)
I/O Connector (C3 by pinout)		
Analog Input (2,3)	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 / CMR	> 10 K ohms / 50 dB
	Long-term Drift	100 ppm (0.075%/°C)
Fault Output Relay (5,6)	Max Capacity	1 A @ 24 Vdc
Remote Enable (7,8) Configurable Inputs(7,9,10,11)	Input Frequency	2.5kHz (Opto-isolated)
	Input Voltage Range	12 to 24 V Nominal
	Min. On / Max. Off	10 V / 1 V
	Current Demand per Input	20mA
Configurable Digital Output (7,12)	Output Voltage (max.)	0 to 48 V Nominal – Bi-directional (Open Collector)
	(Min. On)	1V
	Max. Output Current	60mA
Configurable Analog Output (13,4)	Max. Output Current	1mA (1K Ω internal series resistance)
	Sensitivity / Resolution	4.9mV / 12 Bit
	Voltage Range	-10 to +10V
Encoder Equivalent Output (C4 by pinout)		
A/B/I & Complements (1,2,4,5,7,8)	Output Voltage (high level) @25°C	2.5V min @ 20mA
	Output Voltage (low level) @25°C	.5 max @ 20mA
	RS 485 Line Drive Type	DS26C31TM
Remote Encoder Input (C8 by pinout)		
A/B/I & Complements (1,2,4,5,7,8)	Input Voltage (high/low level) @25°C	5V / 0V nominal (+.2V / -.2V)
	Input Impedance	100 Ω
	RS 485 Line Receiver Type	SN75173
	See section 5.4.2.4 Position Loop on page 5-6 for features using this input	

Table 2-1 SERVOSTAR® Control Specifications

2.2 FEEDBACK DEVICES

The SERVOSTAR® can receive resolver, encoder (with or without halls), or sine encoder feedback. Kollmorgen offers a variety of motors with options for these various feedback devices. The device preference and the associated model number must be determined when the order is placed. The following provides general information on the feedback requirements of the drive:

2.2.1 Resolver

The SERVOSTAR® can use single (two poles) or multi-speed (multiple poles) 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 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.

2.2.1.1 Specifications

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

Table 2-1 Resolver Specifications

2.2.1.2 Cable Lengths

It is important to use properly shielded cable and to keep it away from other noise-radiating devices and cables. It is not recommended to run the feedback and motor cables in the same conduit. Kollmorgen has tested cable lengths up to 750ft (229m) without degradation of commutation performance. However, performance may vary depending on motor and resolver type. Tests were performed with standard Kollmorgen cable and its low-impedance, Kollmorgen GOLDLINE™ motor resolver. Please consult factory for cable and resolver impedance specifications when long cable runs above 250ft (76m) are desired. Kollmorgen recommends twisted-shielded pair for feedback cables.

2.2.1.3 Resolution and Accuracy

The SERVOSTAR® calculates motor velocity as the derivative of position (change in position over time). With its patented technique, all readings are extended to a resolution of 16-bit. For velocity feedback calculations, the drive converts the resolver input to 18-bits of resolution giving smooth motor velocity control. The digital resolution (RDRES) of the Resolver-to-Digital Converter system is determined automatically according to the application velocity limit (VLIM). The following is a summary of the SERVOSTAR®'s resolution capabilities assuming a single-speed resolver:

VLIM (RPM)	RDRES	Counts/Rev	Encoder Eqv. Output (C4)
> 6100	12	4096	4096 quad counts
1500 to 6100	14	16384	16384 quad counts
< 1500	16	65536	65536 quad counts

Table 2-1 R/D Converter Specifications

System accuracy using resolver feedback is affected by several components. The following table gives the user information on the inaccuracy that each of these components contribute to the total accuracy of a standard SERVOSTAR® system:

Components	ArcMinutes
R/D Converter	4
Resolver mechanics (rotational)	8
Resolver mounting on motor shaft	2
Inter-LSB (digital dither over the least significant bit)	5
Total (Worse-case)	19

Table 2-2 Resolver Accuracy Specifications

2.2.2 Encoder

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 that indicates changes in position. The encoder resolution of the SERVOSTAR® (and therefore the drive's encoder equivalent output) is fixed because it is a hardware characteristic of the encoder device.

The encoder interface includes three groups of wires:

1. A/B (and complements) lines: These lines make up the encoder quadrature signals. The signals are received differentially through line receivers before being passed through a wire-break detection circuit.
2. Index pulse: This narrow pulse normally appears once per revolution and indicates a known physical position of the shaft. This pulse is received differentially through a line receiver before being passed through a wire-break detection circuit. This signal is hardware capturable.
3. Hall signals: These signals provide information representing the approximate absolute location of the motor shaft. From this information, the motor can sinusoidally commutate forward until the index signal is detected - at which time true position is known. These signals are isolated by an opto-coupler and can be differential or open-collector type signals.

2.2.2.1 Specifications

Encoder Requirements	
Required Signals	Types: A, B with or without Index pulse A, B, Index with or without Hall Channels * Halls may be integral or discrete
Signal Type: A-quad-B and Marker Halls	Differential: do not connect single-ended Differential or Open Collector
System Voltage	5 Vdc
Maximum Input Frequency	3 MHz
Maximum Cable Length	System Dependent: 50ft (15m) Recommended
Maximum Line Count	10,000,000 Lines per Motor Electrical Cycle
Maximum Supply Current from SERVOSTAR®	250mA
Protection	Separate Voltage Regulator, Broken wire detector for A, B, Index, and Hall channels, Illegal Hall Code Detection

Table 2-1 Encoder Specifications

2.2.2.2 Cable Lengths

The recommended cable length when using the SERVOSTAR® to source the encoder is no longer than 50ft (15m). Long encoder cables tend to have high DC resistance that may create significant loading effects in the supply lines to the encoder. Please consider this carefully when designing the system. An option that would allow the use of longer lengths implements a separate supply located at the motor to source the encoder. Quadrature signals returned to the drive are differentially connected which normally do not constitute a problem with longer cable lengths.

2.2.2.3 Resolution and Accuracy

A SERVOSTAR® encoder-based system typically exhibits minimal inaccuracies outside of the encoder itself. To get an approximate total value the customer need only look to the specifications listed for the encoder being used.

2.2.3 Sine Encoder

The SERVOSTAR® can receive an analog (or sine) encoder feedback device to monitor the motor shaft position. As opposed to a digital encoder, which generates incremental square-wave signals, a sine encoder outputs analog differential sinusoidal signals (the SERVOSTAR® S/CD product line only supports Heidenhain sine encoders). These sine signals are quadrature decoded and passed to an interpolation circuit that breaks each 360° cycle into 256 parts before passing it to the drive's control board. Thus, the resolution seen by the drive is 256 times the fundamental sinusoidal track on the motor's encoder. The advantage of this approach is the ability to obtain much high encoder resolution while maintaining a relatively low input frequency through the cable and into the SERVOSTAR® (See *ASU009H Sine Encoders on the PSP CD-ROM for detailed information*). The encoder interface includes three groups of wires:

1. A/B (and complements) lines: These lines make up the encoder quadrature signals. The signals are received differentially at 1Vp-p amplitudes before being processed by the interpolation circuitry.
2. Index pulse: This narrow pulse normally appears once per mechanical revolution and indicates a known physical position of the shaft. This pulse is received differentially through an op amp before being squared up and sent to the control board.
3. Commutation signals: Upon power up, these signals are used to communicate coarse position information. The first three signal types give approximate position information so the drive can commutate the motor forward until

the Index pulse is found (There are situations where the index signal is not available. Course position information is used to commutate the motor indefinitely). The fourth gives absolute information bypassing the need for the Index signal. They are as follows:

- No Hall signals: If no power-up commutation signals are available. The SERVOSTAR® can excite two phases and lock the shaft in place. It then approximates position of the locked shaft and uses only the incremental signals to commutate forward until the index is found.
- Hall signals: These signals provide information representing the approximate location of the motor shaft (6 transitions per electrical cycle of the motor). From this information, the motor can six-step commutate forward until the index signal is detected - at which time true position is known and sinusoidal commutation begins. These signals are isolated by an opto-coupler and can be differential or open-collector type signals.
- C/D lines: an alternative to Hall signals are C/D lines. These lines provide a SIN/COS sinusoidal signal where one electrical cycle equals one mechanical revolution (identical to single-speed resolver feedback). Interpolation is performed on these signals: thus, absolute position is known within 256 parts of a mechanical revolution. The motor can commutate forward until the Index signal is detected.
- Endat: Sine encoders with Endat capability add another approach to communicating commutation position. Here, absolute position information is stored in the encoder and is serially communicated to the drive upon power up. The data is received synchronously by a clock signal provided by the drive. Absolute position is known immediately; therefore, an index signal is not needed.

2.2.3.1 Specifications

Sine Encoder Requirements	
Required Signals	Types: A, B with or without Index A, B, Index with discrete Hall Channels A, B, Index with C, D once per revolution A, B, Endat
Signal Level:	1Vp-p
Signal Type: A, B, Index C, D Endat (Data/Clock) Halls	Differential Differential Differential Differential or Open Collector
System Voltage	5 Vdc
Maximum Frequency	125 kHz from encoder
Maximum Cable Length	System Dependent: 50ft (15m) Recommended
Maximum Line Count per Motor Electrical Cycle	39,000 Line counts 10,000,000 Line counts after interpolation
Maximum Supply Current from SERVOSTAR® for encoders	250mA
Protection	Separate Voltage Regulator, Broken wire detector for A, B, Index, and Hall channels, Illegal Hall Code Detection, A/B signals out of range, "burst" pulse overflow
Maximum Interpolation (input)	x256 (after quad)

Table 2-1 Sine Encoder Requirements

2.2.3.2 Cable Lengths

The recommended cable length when using the SERVOSTAR® to source the encoder is no longer than 50ft (15m). Long encoder cables tend to have high DC resistance that may create significant loading affects in the supply lines to the encoder. Please consider this carefully when designing the system. An option that

would allow the use of longer lengths would be to put a separate supply at the motor to source the encoder. Except for noise susceptibility, signals returned to the drive are differentially connected which normally do not constitute a problem with longer cable lengths.

2.2.3.3 Resolution and Accuracy

Internal resolution of the system can be derived through the following calculation:

Encoder line resolution x 256 x 4 (quadrature).

System accuracy is largely dependent upon the accuracy of the encoder itself. To get an approximate total value, the customer need only look to the specifications listed for the encoder being used.

2.3 ENCODER EQUIVALENT OUTPUT

The SERVOSTAR[®] provides a motor position output to the user in the form of quadrature encoder signals eliminating the need for an additional position feedback device. The outputs are 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 minimized for device protection. 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 (EEO) signals depends on the type of motor feedback device:

2.3.1 Resolver Systems

The output signal is developed through the R/D hardware circuitry for minimal phase lag and has a maximum frequency determined by the motor speed and R/D limits (*see section 2.2.1.3 Resolution and Accuracy on page 2-10*). It provides a configurable (ENCOUT) resolution of up to 16384 lines (65536 quad counts) per revolution of the motor shaft. The placement of the index pulse (INDEXPOS) can be varied on resolver systems within 360 electrical degrees of the feedback signal. For single-speed resolvers, this means the user can vary the position of this signal over one mechanical revolution. For multi-speed resolvers, the mechanical position variation is determined by the pole-pair count of the resolver (e.g. three-speed resolver gives mechanical variation of the pulse within 1/3 of a revolution).

2.3.2 Encoder Systems

The output signal is the actual encoder feedback signal that is pre-configured (MENCRES) in the drive's motor parameters. It can be scaled down by multiples of two (ENCOUTO: 1, 2, 4, 8, 16) and has a maximum frequency limit of 3MHz.

2.3.3 Sine-encoder Systems

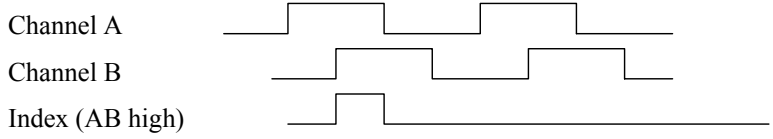
This output signal is developed for a resolution that is determined by a divisor (SININTOUT: 128, 64, 32, 16, 8, 4, 2, 1) of the actual sine-encoder line resolution (MENCRES). It is then encoded to a quadrature signal before being exported out of the drive. The maximum frequency limit is 1.2MHz. A frequency limiter (MSINFRQ) is provided with burst frequency fault protection.

2.3.4 EEO Phasing

The EEO signals are not phased the same for resolver and encoder systems. The following demonstrates these phasing relationships:

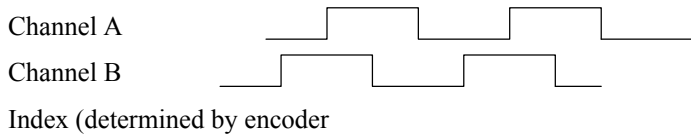
2.3.4.1 Resolver Systems

A-Leads-B convention for clockwise rotation:



2.3.4.2 Encoder and Sine-encoder Systems

B-Leads-A convention for clockwise rotation



Section 3

Hardware Installation

3.1 UNPACKING AND INSPECTION



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. 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.

3.2 MOUNTING

For proper ventilation the SERVOSTAR® CD units should be mounted vertically and spaced approximately 0.5in (12.7mm) apart. These products are designed for mounting in an electrical enclosure to protect them from physical and environmental damage.

3.2.1 SERVOSTAR® Cx Hardware Specifications

Amplifier Model		Cx03	Cx06
Unit Weight	lbs / Kgs	3.56 / 1.61	4.9 / 2.22
Mounting Hardware	English (Metric)	10-32 (M4)	
	Applied Torque	20lb-in (2.26Nm)	
Connection Hardware	Line Screw Size/Torque	M3.5 / 12lb-in (1.35Nm)	
	BUS Screw Size/Torque		
	Motor Screw Size/Torque		
	Ground Screw Size/Torque		
Wire Size (AWG#)	Control Logic (AWG/ mm ²)	28 – 16 / 0.5 – 1.5	
	Motor Line (AWG/ mm ²)	14 / 2.5	
	Main Input (AWG/ mm ²)	14 / 2.5	12 / 4
	Configurable I/O wire gauge	22-18 AWG (0.5-.1mm ²) Ferrules recommended: 18 AWG Type H1 - 0/14 Weidmuller 4630.0 or equivalent 20 AWG Type H0 - 75/14 Weidmuller 4629.0 or equivalent	
	Spade Terminals	16/14 AWG (1.5mm ²): Hollingsworth XSS0954S OR SS20947SF or equivalent 12/10 AWG (4-6mm ²): Hollingsworth XSS20836 OR SS20832F or equivalent	
	Ring Terminals	8 AWG (10mm ²): Hollingsworth R3027BF or equivalent 6 AWG (16mm ²): Hollingsworth R4001BF or equivalent 4 AWG (25mm ²): Hollingsworth R5100BF or equivalent 2 AWG (35mm ²): Hollingsworth R7998BFN or equivalent	
	Clearance Distance	Side-to-Side	.5in (12.7mm)
Top/Bottom		2.5in (63.5mm)	
Mating Connector Hardware	CK100 Kit	Includes: C1, C2, C4, C7 (plus 2ft / 0.69m of stranded bus ribbon), C8	
	C3	Kollmorgen #: A-93899-013 Vendor Info: Weidmuller BL3.5/13 Cat.No. 161574	
	C5	Kollmorgen #: A-81014-004 Vendor Info: PCD ELFP04110	
	Connector Screw Torque	2.25 lb-in (0.25Nm)	
	24V Logic (optional)	(PCD ELFP02210 or equivalent)	

Table 3-1 SERVOSTAR® Cx Hardware Specifications

3.2.2.2 Cx unit

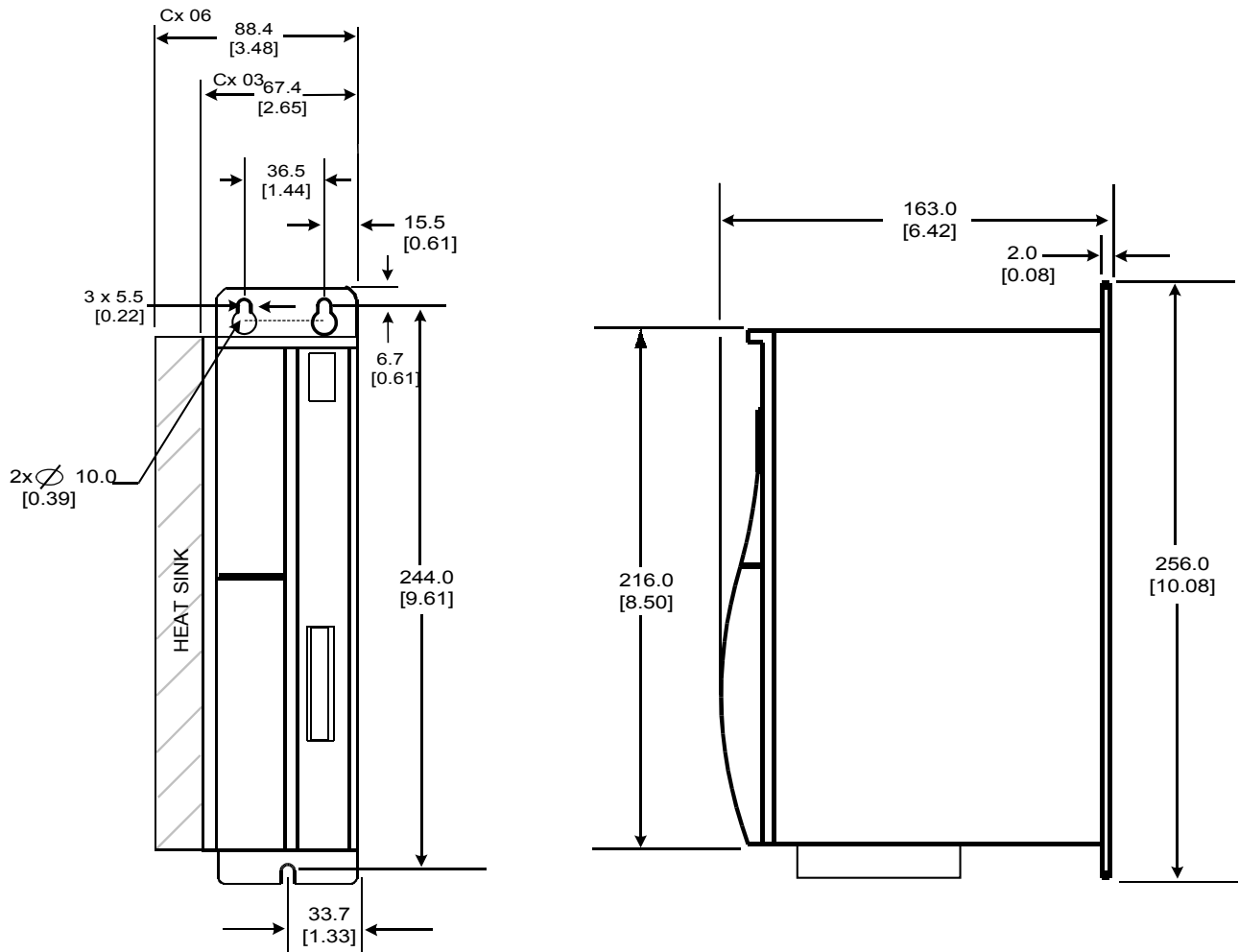


Figure 3-1 Cx Outline Dimension (MSU031D)

3. 3 INSTALLATION PRACTICES

The environment that any electronic control system ‘lives’ in can effect its operation. Kollmorgen recommends that the SERVOSTAR[®] system be operated and stored under the environmental conditions stated in the product specification tables (*see 2.1.3 Cx Electrical Specifications on page 2-8*). The system may be operated in higher temperature ambient conditions with a derating applied. Please check with the factory for derating information.

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

3.3.1 Enclosure

The Kollmorgen SERVOSTAR[®] series of electronic system components are designed for panel assemble. This panel assemble should then be mounted in a metallic enclosure. Enclosures are supplied by the manufacturers of the final product and must meet the environmental IP rating of the end product. To ensure proper grounding (and to optimize EMC), the enclosure should have continuous ground continuity maintained between all metal panels. This ground continuity is intended to be both a safety ground and a high frequency ground. The units should be mounted on a back plane, which is installed into the enclosure. Ideally, the back plane should be an unpainted metallic surface to optimize electrical bonding of the frame and provide the lowest possible impedance path to earth ground. These enclosures also provide added safety.

3.3.2 Wiring Practices

Particular care should be used when layout of an enclosure is designed. Efforts to separate power wires from small signal wires should be taken. The following guidelines highlight some important wiring practices to implement:

- Control and signal cables must be separated from power and motor cables. Distance of 20cm (8in) will be sufficient in most cases.
- Control and signal cables must be shielded to reduce the effects of radiated interference.
- Where control cables must cross power or motor cables, they should be done with an angle of 90 degrees if possible. This will reduce the field coupling effect.

3.3.3 Grounding

System grounding is essential for proper performance of the drive system. A ground bus bar may be used as a single point ground for the system. Safety grounding should be provided to all pieces of the system from a “star point”. In addition to the safety grounding, a high frequency ground must be provided that connects the back panel to the enclosure, and ultimately to earth ground. The objective is to provide an extremely low impedance path between the filters, drives, power supplies, and earth ground. This high frequency ground can be accomplished with the use of a flat braid or copper bus bar. It is important not to rely on a standard wire for the high frequency ground. In general, a wire has an inductance of 8nH/in regardless of diameter. At higher frequencies, this unwanted inductance between grounds equates to limited filter performance. When connecting high frequency grounds, use the shortest braid possible.

3.3.4 Bonding

The proper bonding of shielded cables is *imperative* for minimizing noise emissions and increasing immunity levels of the drive system. Its effect is to reduce the impedance between the cable shield and the back panel. Kollmorgen recommends that all shielded cables be bonded to the back panel.

Power input wiring does not require shielding (screening) if the power is fed to the cabinet (enclosure) via metallized conduit. If the metallized conduit is used with proper high frequency grounds, bonding technology, and recommended wire routing, then power input wire shielding will have no affect. In the event that metallized conduit is not implemented into the system, shielded cable will be required on the power input wires and proper bonding technologies should be implemented.

The motor and feedback cables should have the shield exposed as close to the drive as possible. This exposed shield can be bonded to the back panel using one of the two suggested methods below:

3.3.4.1 Non-insulated Cable Clamp

The following figures shows how cable bonding can be implemented using non-insulated metallic cable clamps. The first figure demonstrates clamping to the back panel in the vicinity of the drive. The second shows a technique for bonding a terminal strip (for best results, it is recommended not to break the shielding of the cable).

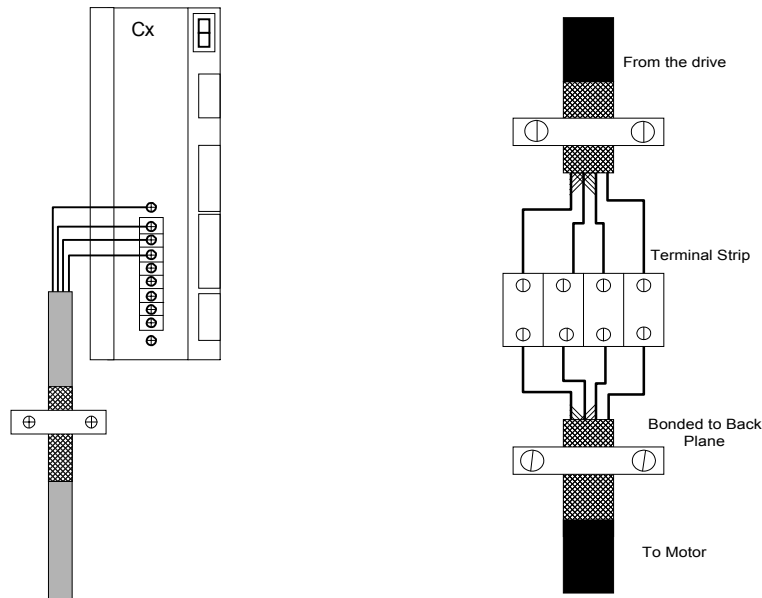


Figure 3-1 Cx Drive Clamp (MSU033D), Terminal Clamp (MSU016D)

3.3.4.2 Alternative Bonding Methods

Another option is to use cable bonding clamps offered by Phoenix Contact (and others). When using the Phoenix Contact parts, make sure that a low impedance (high frequency) ground is connected from the ground bus bar to the back panel. This can be done with a flat braid or a copper bus bar. The SK parts from Phoenix (SK8, SK14, & SK20) slide onto the bus bar. The cable (with exposed shield) is inserted through the SK piece and the thumbscrew on top of the SK piece is used to tighten the connection between the cable shield and the bus bar.

Phoenix Contact Part #	Description	Cable Diameter Range
3025163 Type SK8	Shielded terminal block - for placing the shield on bus bars.	SK8 up to 8mm or 0.315 inches
3025176 Type SK14	Shielded terminal block - for placing the shield on bus bars.	SK14 8mm to 14mm or 0.551 inches
3025189 Type SK20	Shielded terminal block - for placing the shield on bus bars.	SK20 14mm to 20mm or 0.787 inches
0404428 Type AB/SS	Support for bus bar. 2 needed to mount ground bus.	N/A
0402174 Type NLS-CU 3/10	Bus bar material - 10mm x 3mm copper at varying lengths.	N/A

Figure 3-6 and 3-7 represent a side and top view of the SK device that clamps down on the shield of the cable. The use of the Phoenix SK device is an excellent method for providing a low impedance path between cable shield and the back panel.

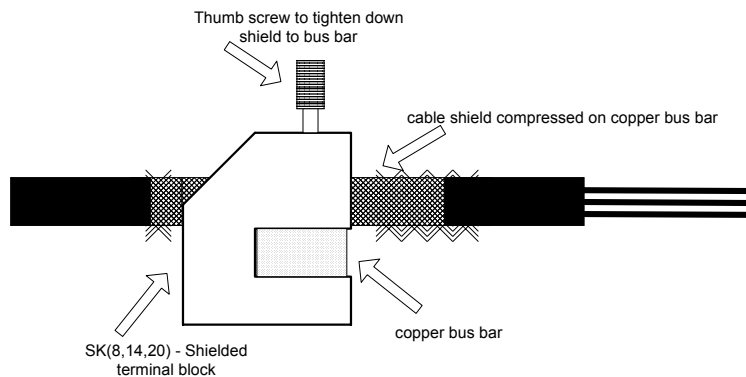


Figure 3-1 Phoenix Contact - Side View (MSU017D)

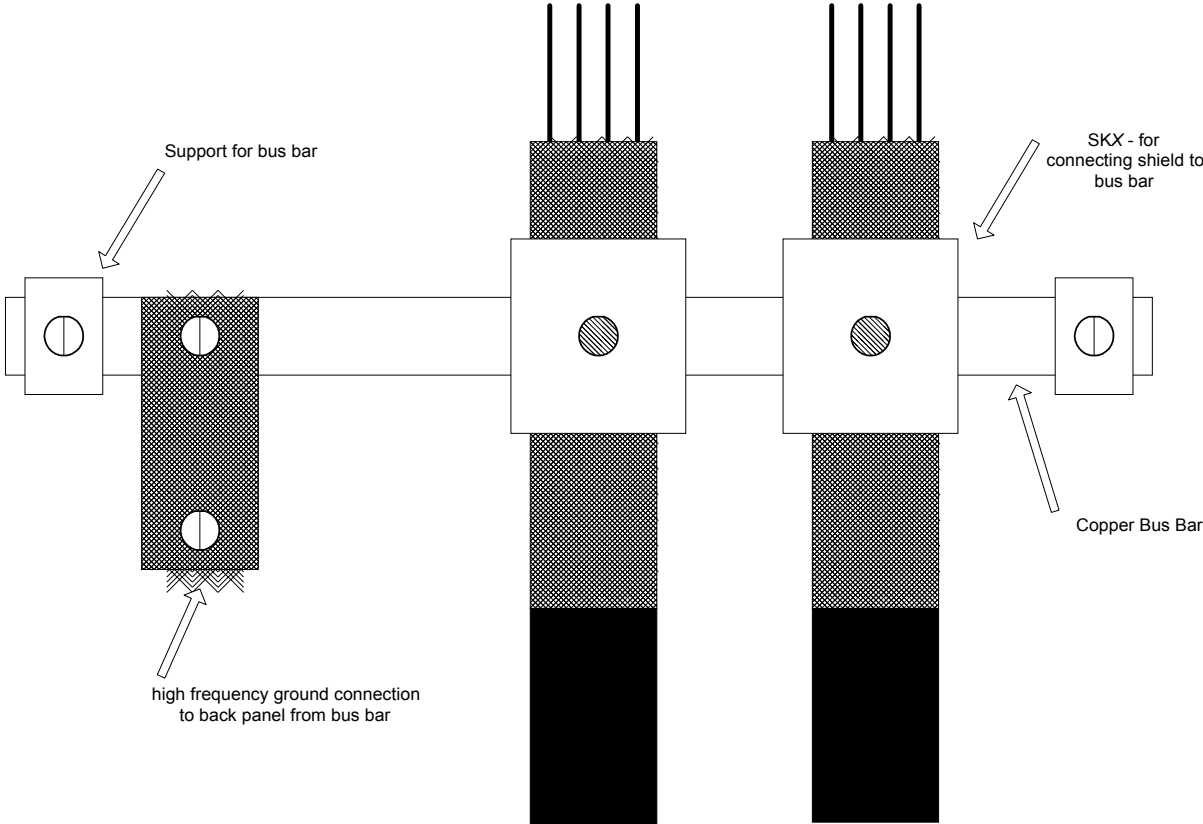
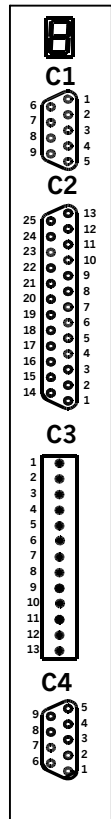


Figure 3-2 Phoenix Contact - Top View (MSU018D)

3.4 SYSTEM INTERCONNECT

3.4.1 Front Connectors



C1: Communications Connector	
Pin	Function
1	Shield
2	REC (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)

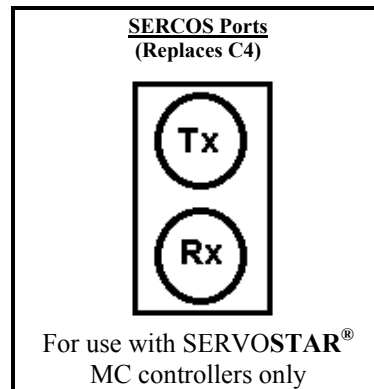
C2: Feedback Connector			
Pin	Resolver	Encoder	Sine Encoder*
1	Sine High	A	A
2	Sine Low	/A	/A
3	Shield	Shield	Shield
4	Cosine High	B	B
5	Cosine Low	/B	/B
6	Shield	Shield	Shield
7		E5V Return	E5V Return
8		E5V Return	E5V Return
9		H1B	H1B (/C) (/Data)
10		H2B	H2B (/D) (/Clock)
11		H3B	H3B
12	Shield	Shield	Shield
13	Thermostat High	Thermostat High	Thermostat High
14	Shield	Shield	Shield
15	Ref. High Out	Index	Index
16	Ref. Low Out	/Index	/Index
17	Shield	Shield	Shield
18		E5V Supply	E5V Supply
19		E5V Supply	E5V Supply
20		E5V Supply	E5V Supply
21	Shield	Shield	Shield
22		H1A	H1A (C) (Data)
23		H2A	H2A (D) (Clock)
24		H3A	H3A
25	Thermostat Low	Thermostat Low	Thermostat Low

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	Configurable Input(See IN1 variable)
10	Configurable Input (See IN2 variable)
11	Configurable Input (See IN3 variable)
12	Configurable Output (See O1 variable)
13	*Configurable Output (See ANOUT variable)

* Reference to Pin 4: DC Common

Figure 3-1 Front View (MSU001D)

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



3.4.2 Top Connectors

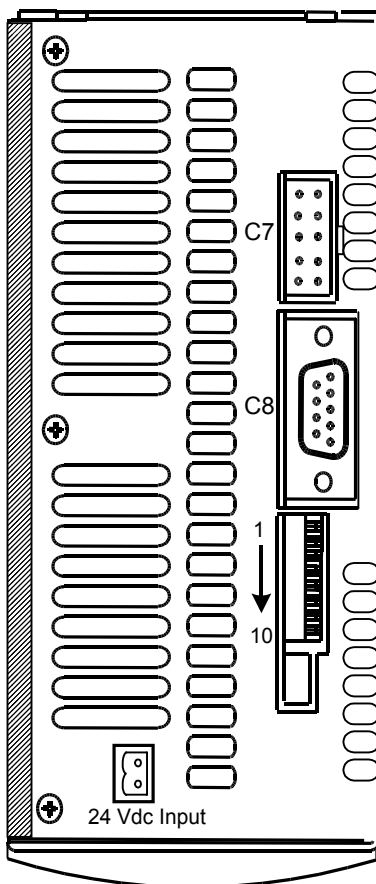
C7: MultiDrop Communications

Type: 10 Pin (0.1" x 0.1") Female Ribbon Cable. Connector and cable are included in the optional CK100 kit.

This connector functions only when using the RS232 interface. It will NOT function using RS485.

C8: Remote Encoder Input	
Pin	Function
1	A Input + (High)
2	A Input - (Low)
3	DC Common
4	B Input + (High)
5	B Input - (Low)
6	Shield Connection
7	Reserved
8	Index +
9	Index -

See section 5.4.2.4 Position Loop on page 5-6 for features using this input



Notes for DIP switch:

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 (7,8) control the motor operation and are monitored in real-time. This switch provides the following functions:

- MultiDrop Address Select: Switches 1 through 5 set the drive's address. A drive having address 0 powers up in the addressed state. If these five switches are set to anything but 0, the drive will assume an address code indicated by the switch settings (See **Address Switch Settings** on page 4-3 for additional information)
- Baud Rate: Switch 6 sets the Serial/SERCOS baud rate to either 9600/2M (switch off) or 19200/4M (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 its 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 so the receiver is not overdriven when using short cables. Long cables require more power.
- Factory Reserved: Must be set to 0.

Note: Setting the switch to "1" means "Closed" or "On".

Figure 3-1 Top View (MSU032D)

Configuration Switch		
Switch #	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/SERCOS Baud Rate	0 = 9600 (2M) 1 = 19200 (4M)
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

3.4.3 System Diagram

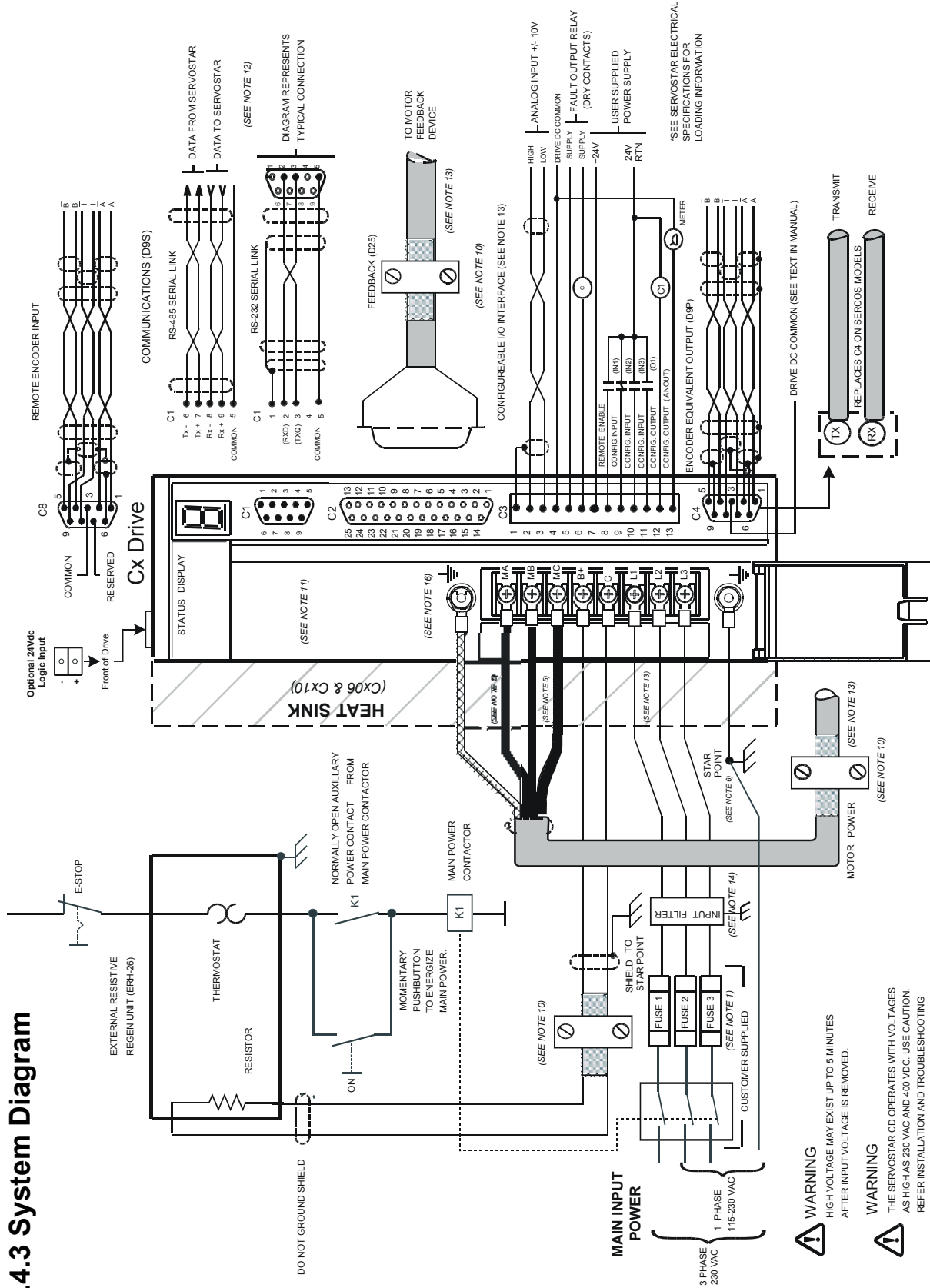


Figure 3-2 Cx System Wiring Diagram (MSU011D)

Figure 3-7 System Wiring Diagram notes:

Note 1: FUSE 2 and contactor may not be required if input power line is neutral. Also see Note 9.

Note 2: Allow 30 seconds after turning power off before reapplying power

Note 5: All AC Line wires should be twisted pair

Note 6: The ground of the drive and motor best minimizes ground currents and noise when connected in a “star point” configuration

Note 9: See 2.1.3 Cx Electrical Specifications on page 2-8 for recommended line input fusing.

REFFORMATVERBINDENSEITENREFNote 10: Cables should be properly bonded to the backpanel and implemented as close to the drive side of the cable as possible for effective grounding. If bonding is installed, the shield on the cable end need not be connected to the “star point” configuration. Only connect the shield on one end of the cable; preferably on the drive side. See section 3.3 Installation Practices on page 3-4 for detailed information.

Note 11: Units must be installed in an enclosure that meet the environmental IP rating of the end product (ventilation or cooling may be necessary to prevent enclosure ambient from exceeding 45°C).

Note 12: Do not connect unused pins on C1 connector. Some manufacturers’ cables connecting all pins may give unpredictable operation.

Note 13: See 3.2.1 SERVOSTAR® Cx Hardware Specifications on page 3-2 for wire gauge and ferrule sizes.

Note 14: See 3.5 CE Filtering Techniques on page 3-13 for further information.

Note 16: See 3.2.1 SERVOSTAR® Cx Hardware Specifications on page 3-2 for spade and ring terminal sizes.

3.4.4 System Feedback

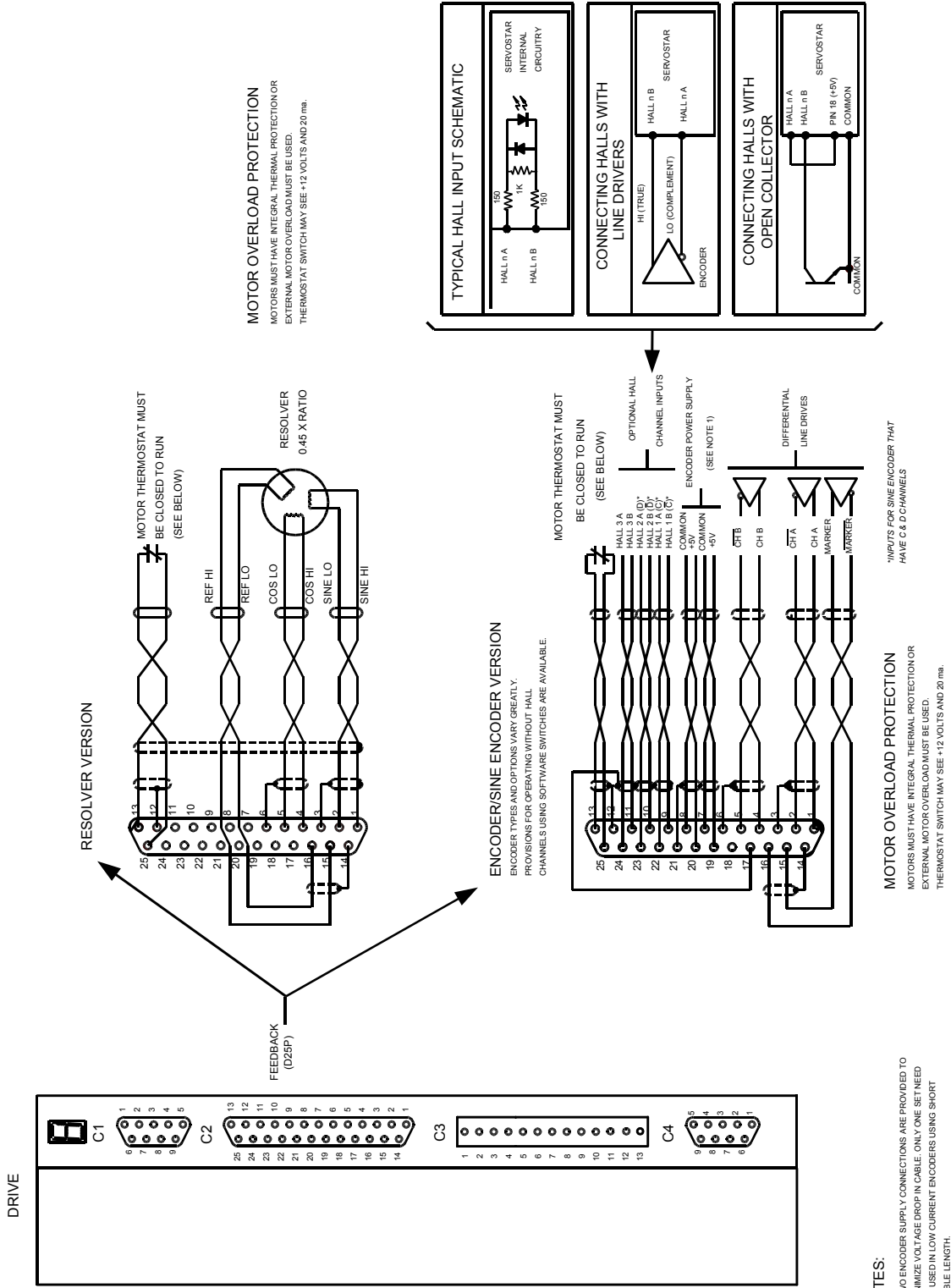


Figure 3-1 Feedback Wiring Diagram (MSU010D)

3.5 CE FILTERING TECHNIQUES

The SERVOSTAR[®] CD system meets the CE Mark standards stated in the front of this manual. It is imperative for the user to apply proper bonding and grounding techniques, described earlier in this section, when incorporating EMC noise filtering components for the purpose of meeting this standard.

Noise currents often occur in two types. The first is conducted emissions that are passed through ground loops. The quality of the system grounding scheme will inversely determine the noise amplitudes in the lines. These conducted emissions are of a common-mode nature from line to neutral (or ground). The second is radiated high-frequency emissions that are usually capacitively coupled from line-to-line; therefore, they are differential in nature.

To properly mount the filters, the enclosure should have an unpainted metallic surface. This will allow for more surface area to be in contact with the filter housing and provide a lower impedance path between this housing and the back plane. The back panel should in turn have a high frequency ground strap connection to the enclosure frame and/or earth ground.

3.5.1 Input Power Filtering

The Kollmorgen SERVOSTAR[®] C-series drive system requires EMI filtering of the input power leads to meet the conducted emission requirements for the industrial environment. This filtering will block conducted-type emissions from exiting onto the power lines and/or provide a barrier for EMI that might be present on the power lines.

Care must be taken to adequately size the system. The type of filter must be based on the voltage and current rating of the system and whether the incoming line is single or three-phase. One input line filter may be used for multi-axis control applications. These filters should be mounted as close to the incoming power as possible so noise is not capacitively coupled into other signal leads and cables. Similarly, care should be taken when routing wires from the load side of the filter to the drive input. These lines may be noisy and should be separated from other sensitive cabling to avoid unwanted coupling of noise. When these lines must pass other lines (whether I/O or power) they should cross perpendicularly. Also, route the ac input lines physically close to the back panel. This will create a capacitive coupled path for noise to route back to the ground plane as opposed to being radiated from the cabinet. Several manufacturers of these filters are listed below. They should be able to recommend the best filter design for most typical motor control applications. Kollmorgen has also provided specific filters recommendations that will adequately attenuate the conducted noise to levels below the CE limits. The implementation of the EMI filter should be done in accordance with the following guidelines:

- Filter should be mounted on the same panel as the drive.
- Filter should be mounted as close as possible to incoming cabinet power.
- Filter should be mounted as close as possible to drive. If separation exceeds 30 cm (1 ft), flat cable (braid) may be used for the high frequency connection between filter and BUS Module.
- When mounting the filter to the panel, remove any paint or material covering. Use an unpainted metallic back panel if possible (low impedance between all system components).
- Filters are provided with an earth connection. All ground connections should be tied to ground.
- Filters can produce high leakage currents. ***Filters must be earthed before connecting the supply!***
- Filters should not be touched for a period of 10 seconds after removal of the supply (potential capacitive charges).

ServoStar Drive	Recommended EMI Line Filter	Kollmorgen Part #
CD03 three phase	Schaffner FN258-30/07	A-96776-003
CD06 three phase	Schaffner FN258-30/07	A-96776-003
CD10 three phase	Schaffner FN258-30/07	A-96776-003
CD03 single phase	Filter Concepts SF7	n/a
CD06 single phase	Filter Concepts SF15	n/a

Table 3-1 Recommended Line Filters

3.5.2 Motor Line Filtering

Motor filtering may not be necessary for CE compliance of SERVOSTAR® systems; however, this additional filtering may increase the reliability of the system. Poor non-metallic enclosure surfaces and lengthy, unbonded (or unshielded) motor cables that couple noise line-to-line (differential) and line to ground (common mode) are just some of the factors that may lead to the necessity of motor lead filtering.

Motor lead noise may be either common-mode or differential. The common-mode conducted currents occur between each motor lead and ground (line-to-neutral). Differential radiated currents will exist from one motor lead to another (line-to-line). The filtering of the lines feeding the motor will provide additional attenuation of noise currents that may enter surrounding cables and equipment I/O ports that are in close proximity.

Differential mode currents commonly occur with lengthy motor cables. As the cable length increases, so does its capacitance and its ability to couple noise from line-to-line. While every final system is different and every application of the product may cause a slightly different emission profile, it may become necessary to use differential mode chokes to provide additional noise attenuation to minimize the radiated emissions. The use of a ferrite core (placed at the drive end) on each motor lead, as shown in the diagram below, can attenuate differential mode noise and lower frequency (30-60 MHz) broadband emissions to within specifications. Kollmorgen recommends a Fair-Rite P/N 263665702 (or equivalent) ferrite core. The user should wrap each motor lead through the core several times as shown in the figure below:



Never wrap a ground lead through a core.

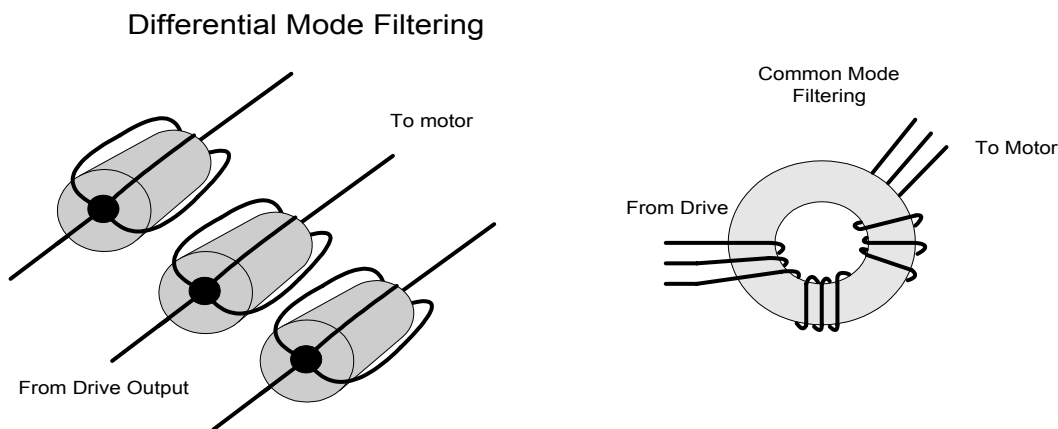


Figure 3-1 Ferrite Core Wrapping (MSU019D)

Common mode currents commonly occur from noise spikes created by the PWM switching frequency of the drive. The use of a ferrite or iron-powder core toroid (See Figure 3-1) will place common mode impedance in the line between the motor and the drive. The use of a common mode choke on the motor leads may increase signal integrity of encoder outputs and associated I/O signals. The following is a list of toroidal and ferrite cores that can be used to make common mode chokes:

Manufacturer	Manufacturer's Part #	Size		
Micrometals	T400-26D	OD 4in (102mm)	ID 2.25in (57.2mm)	HT 1.3in (33mm)
Micrometals	ST102-267	OD 1.025 in (26mm)	ID .6 in (15.2mm)	HT .475 in (12.1mm)
Micrometals	ST150-275B	OD 1.52 in (38.6mm)	ID .835 in (21.2mm)	HT .825 in (21mm)
Micrometals	ST200-275B	OD 2.01 in (51.1mm)	ID 1.24 in (31.5mm)	HT 1.025 in (26mm)
Magnetics	77930-A7	OD 1.09 in (27.7mm)	ID .555in (14.1mm)	HT .472in (11.99mm)
Fair-Rite	2643803802	OD 2.4in (61mm)	ID 1.4in (35.55mm)	HT .5in (12.7mm)

Table 3-1 Toroidal Core Recommendations

Manufacturer	Manufacturer's Part #	Kollmorgen Part #	Description
Schaffner	RD7137-36-0m5	A-96843-005	500 μ H 3 phase common mode choke. 36 amps continuous.
Schaffner	RD8137-64-0m5	A-96843-010	500 μ H 3 phase common mode choke. 64 amps continuous.

Table 3-2 Pre-wound Common-Mode Chokes

3.5.3 I/O Filtering

I/O filtering, while not a necessity for CE compliance, may be desired depending on system installation, application, and integration with other equipment. It may be necessary to place ferrite cores on I/O lines to avoid unwanted signals entering and disturbing the drive system or other associated equipment. The following chart lists some ferrite parts that may be used for I/O filtering and noise attenuation. These parts are ideal for providing an in-line common mode impedance for I/O lines (Fair-Rite Products Corporation also has a varied selection, which can suit most any application).

Manufacturer	Manufacturer's Part #	Kollmorgen Part #	Description
Ferrishield	SS33B2032	A-96770-003	Clamp on core
Ferrishield	SS33B2036	A-96769-005	Clamp on core
Ferrishield	FA28B2480	A-96771-003	Clamp on core - flat cable clamp
Ferrishield	SA28B4340	A-96772-009	Clamp on core - flat cable clamp
* Fair-Rite	2643167251	n/a	n/a

Table 3-1 I/O Filter Recommendations

The following figure illustrates the use of multiple turns through a clamp-on core. The more turns created, the more impedance is added to the line. Avoid putting the shield in a clamp-on core. It is undesirable to place an impedance in-line with the shield. The use of ribbon cable may be common in many cabinets. Some ferrite clamps are designed just for ribbon cable use as shown below.

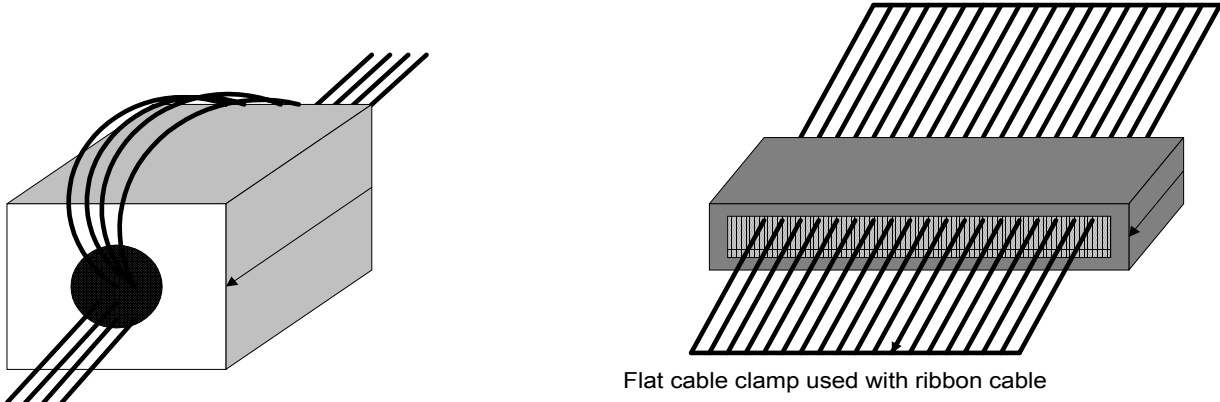


Figure 3-1 I/O Filtering Techniques (MSU020D)

3.5.4 Filter and Bonding System Diagram

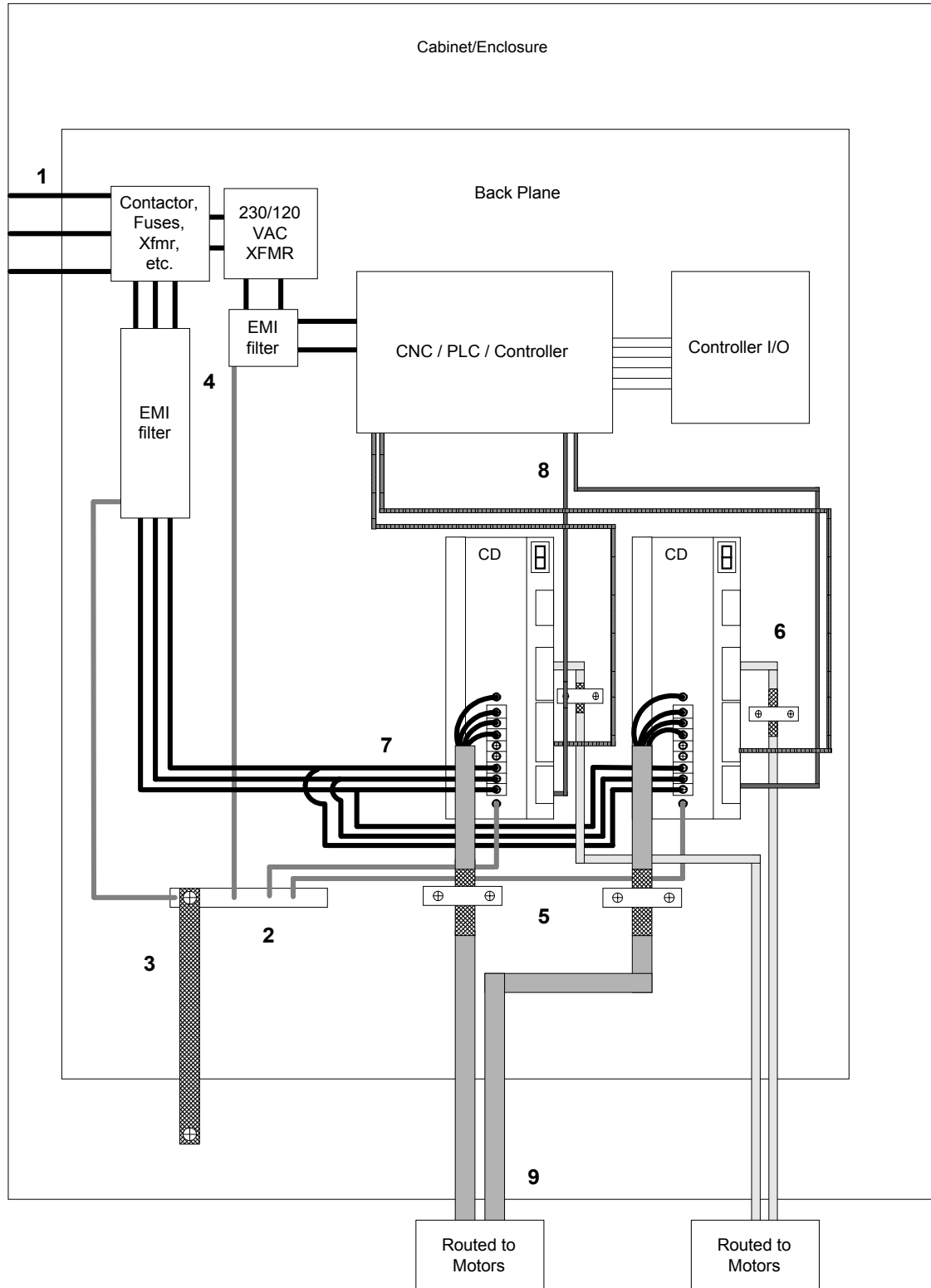


Figure 3-1 Filter/Bonding System Diagram (MSU034D)

Filter/Bonding System Diagram Notes:

1. Input power - Enters enclosure from metal conduit.
2. Single point ground. A bus bar (ground bus) is an excellent way to achieve this.
3. High frequency ground between conductive back panel and enclosure. Also, a high frequency ground is required between the enclosure and earth ground.
4. EMI filter grounding. Safety grounds must be provided on the filters. Potentials can exist even when the power is off because of the capacitors internal to the filters.
5. Bonding of motor cables. The use of armored (screened) motor cables that are bonded as close to the drive as possible are essential for CE compliance and strongly recommended to better the overall performance and reliability of the system.
6. Feedback cable bonding is required for CE compliance. As with the motor cables, the feedback cables should be bonded to the back panel. This bonding will do two things. First it will cut down radiation from the drive. This radiation may be in the form of high frequency energy resulting from internal processor clocks. The second thing this bonding effort does is provide immunity for the drive. Since the feedback device is located internal to the motor it is going to pick up some noise currents and transmit them along the feedback cable. The bonding will direct the currents from the shield of the feedback cable to back panel ground. This will reduce the amount of noise entering the drive.
7. AC power lines that must be routed past other lines (such as motor cables or I/O lines) should cross at a 90 degree angle. This will minimize the coupling effect. Additionally, the power lines should be routed as close to the back panel as possible. Any noise currents on the lines may then be capacitively coupled to the ground plane and not to other lines.
8. Control (I/O) signals should be kept separate from all power and motor cables if possible. Keep control wiring as short as possible and use screened wire. Bonding is also recommended but not required for CE compliance. Separation distance of 20cm (8 in) should be sufficient in most cases. Where control cables must cross power cables, they should cross with an angle of 90 degrees.
9. Motor cables and feedback cables exiting the cabinet going to the motor should be separated as much as possible. Ideally, the use of separate conduits will provide good isolation which can limit coupling of noise from motor to feedback cables.

3.5.5 Recommended Manufacturers' List

Schaffner Elektronik AG
Nordstrasse 11
CH-4708 Luterbach
Switzerland
Phone: 065 802 626
Fax: 065 802 641

North America
Schaffner EMC Inc.
9-B Fadem Road
Springfield, NJ 07081
Phone: 201 379-7778
Fax: 201 379-1151

Corcom

World Headquarters
844 E. Rockland Road
Livertyville, IL 60048
Phone: 708 680-7400
Fax: 708 680-8169

East Coast Sales Office
17 Sarah's Way
Fairhaven, MA 02719
Phone: 508 992-4495
Fax: 508 992-3798

West Coast Sales Office
6700 Fallbrook Ave. Suite 160
West Hills, CA 91307
Phone 818 226-4306
Fax 818 704-1757

Filter Concepts Inc.

2624 South Rouselle Street
Santa Ana, CA 92707 USA
Phone: 714 545-7003 Fax: 714 545-4607

FerriShield Interference Control Components

Empire State Building
350 Fifth Ave., Suite 7505
New York, NY 10118-7591
Phone: 212 268-4020 Fax: 212 268-4023

Fair-Rite Products Corp.

P.O. Box J
One Commercial Row
Wallkill, NY 12589
Phone: 914 895-2055 Fax: 914 8985-2629
E-Mail ferrites@fair-rite.com

Micrometals, Iron Powder Cores

5615 E. La Palma
Anaheim, CA 92807
Phone: 800 356-5977 Fax: 714 970-0400 Worldwide: 714 970-9400

Magnetics

P.O. Box 391
Butler, PA 16003-0391
Phone: 412 282-8282 (800 245-3984) Fax: 412 282-6955

Phoenix Contact Inc.

P.O. Box 4100
Harrisburg, PA 17111-0100
Phone 800 888-7388
Fax 717 948-3475

Section 4

System Startup

4.1 SYSTEM COMMUNICATION

The user can communicate with the SERVOSTAR[®] through either the serial port or on a SERCOS fiber-optic ring (for use with SERVOSTAR[®] MC controllers only). The serial port can transmit data at baud rates of 9600 or 19200 (DIP switch 6) in either RS232 or RS485 configurations. Multiple drives can be addressed simultaneously when daisy chained as described later in this section.

The SERVOSTAR[®] comes with its own software interface called MotionLink[®]. MotionLink[®] is a Windows 95-based program designed to effectively assist the user in setting up and controlling the drive's operation. It is highly intuitive in nature and contains an extensive context-sensitive on-line Help (F1) tool. The on-line Help describes how to use the program in detail and serves as a valuable reference for the drive's variable and command set, setup process, and troubleshooting techniques. This software package can be downloaded from the PSP CD-ROM accompanying this manual. Also provided on this CD-ROM is the VarCom Reference Guide detailing the complete variable and command set. This guide is a great added resource to MotionLink[®] when using the package in the Terminal mode of operation.

Since the software is designed to guide the customer through the operation process of the drive, the MotionLink[®] discussion in this section will cover only general steps of use. A "dumb terminal" can also be used to communicate to the drive. The user will find this method of communication very awkward until a certain level of familiarity with the drive's operation is achieved. MotionLink[®] also provides a terminal emulation feature that contains many useful editing tools for this type of communication.

4.1.1. Computer Requirements

MotionLink[®] requires an IBM-PC or compatible computer with the following features:

- IBM-PC, XT, AT, 386, 486, PS/2, or compatible computer.
- 512 K RAM.
- Windows 95
- CD-ROM player
- Standard Video Adapter (CGA, MDA, EGA, MCGA, and VGA).
- Serial Port (for communication link with SERVOSTAR[®]). The serial communications port may be COM1, COM2, COM3, or COM4. COM1 is the normal configuration:

COM1: Address 3F8h, Interrupt Request #4

COM2: Address 2F8h, Interrupt Request #3

COM3: Address 3E8h, Interrupt Request #4

COM4: Address 2E8h, Interrupt Request #3

4.1.2 Drive Communication

The SERVOSTAR[®] has the flexibility to be addressed and controlled from a single-line or a daisy-chain (MultiDrop) configuration in RS-232-A and RS485. The first five switches of the 10-position DIP located on the top of the drive sets the binary address number for that particular drive (*See Section 3.4.2 Top Connectors of the drive on page 3-8 for switch description and Section 4.1.2.3 Setting Drive Address on page 4-3 for drive addressing*). Switch 6 of the DIP determines the serial communication baud rate for either 9600 BPS or 19200 BPS.



The SERVOSTAR[®] cannot be configured for RS-232-A and RS-485 at the same time. Damage could occur to the drive.

4.1.2.1 RS-232-A Connection

The drive can be configured for a RS-232-A single-ended connection through the C1 connector by wiring the 9-pin mating connector (*See Section 3.4.1 Front Connectors on page 3-8 or the System Wiring diagram on page 3-11 for pinout connections*). To configure for multiple units, the drives must be daisy-chained across the C7 connectors of each drive in that chain. When communicating to a single-line unit the drive's DIP switch must be set for a binary 0 address. When communicating to multiple units, the DIP switch can be set for any binary equivalent number from 1 to 31 (see table below), as desired by the user. The user can also communicate with any or all (called Global Addressing) drives within the daisy chain configuration from any one RS-232-A port on that chain.

4.1.2.2 RS-485 Connection

The drive can also be configured for RS-485 differential connection through the same C1 connector. The user need only wire the 9-pin mating connector for RS-485 (*See Section 3.4.1 Front Connectors on page 3-8 or the System Wiring diagram on page 3-11 for pinout connections*). No software or hardware changes are necessary. Setting the drive's DIP address is identical to that described for the RS-232. When addressing multiple units the drives must be daisy-chained across C1. The user cannot daisy chain across the C7 connector in RS-485 configuration. Termination hardware is provided internal to the drive for those applications where noise becomes a problem and/or the host connection is single-ended. Contact the factory for instructions on how to set the drive's hardware for proper termination.

4.1.2.3 Setting Drive Address

The following table shows the MultiDrop DIP switch address settings (Note: OFF = 0)

Drive Address	Switch 5	Switch 4	Switch3	Switch 2	Switch 1
* 0 (single unit addressing only)	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
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

Table 4-1 Address Switch Settings



When the switch setting is set for binary 0, the drive assumes a single-line serial configuration.

4.1.3 Sending/Retrieving System Data

The following chart describes the flow of data between the PC and the SERVOSTAR[®]. When logic power is applied to the drive, it loads the variable parameters stored in EEPROM into the dynamic RAM for fast and easy access. The user can read (and write) these variable parameters to (and from) the PC by one of several methods described in the INITIAL STARTUP section below.

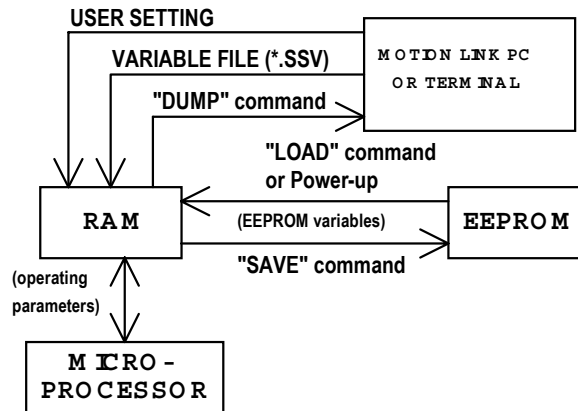


Figure 4-1 Memory Flow Diagram (MSU029D)

The PC transmits serial data to the drive and stores it in dynamic RAM. However, any variable data that is changed from the PC will be lost when logic power is lost if it is not saved into non-volatile EEPROM. Each variable listed in the VarCom Reference Guide indicates whether it can be saved to the EEPROM.

For the user who configures the same system on similar applications, the variables can be saved on disk in an .SSV file for convenient downloading into other drives (*See Section 4.2 Initial Startup*).

4.1.4 MotionLink[®] Installation

4.1.4.1 Installing on PC

- Insert the SERVOSTAR[®] PSP CD-ROM to load MotionLink[®] for Windows
- The CD-ROM should autorun. If not, select Start | Run (or browse your CD-ROM drive)
- Type "D:autorun.exe" and hit the Enter key (this assumes your CD player has a D: letter designation).
- Select a product and follow the instructions on the screen.

4.1.4.2 Running the Program

- Go to your Start/Programs listing and select SERVOSTAR[®] MotionLink[®] from the menu (or click on the SERVOSTAR[®] MotionLink[®] icon if loaded on the desktop).

4.2 INITIAL STARTUP



Review and be familiar with this section completely before applying power to the system.

Most drives are shipped from the factory already configured for a particular motor. The user can verify this by applying logic power and monitoring the Status Display. A factory-configured drive will go through a power-up sequence flashing all segments of the display before settling out to a number indicating the mode of operation. If the drive is not configured with a particular motor, the display will flash a minus sign “-“ indicating that the user must enter drive, motor, and application variable parameters. The remainder of this section will describe the process of setting up a non-configured drive.



Caution must be taken when applying power to the drive. It is factory configured to enable upon application of power. Verify that the hardware Remote Enable (REMOTE) enable switch is disabled

4.2.1 Using MotionLink[®]

MotionLink[®] gives the user three methods to configure the drive. The first uses the SERVOSTAR[®] Startup screen and is the easiest and most highly recommended approach. Its main purpose is for initial startups. The second approach allows the user to more indirectly perform the same configuration as the first using the Main MotionLink[®] screen. This method is most convenient when corrections to an existing configuration is needed. The third method uses the Terminal Mode screen to directly set (or monitor) values for the same variables and commands that the other two methods configure through a more friendly user interface. The user can gain a more thorough understanding of the SERVOSTAR[®] drive, MotionLink[®], and its variable and command set by using the context-sensitive Help (F1) provided in MotionLink[®].

4.2.1.1 SERVOSTAR[®] Startup Screen

This screen appears the first time (and any time after should the user choice not to deselect it) MotionLink[®] is run on a PC. It is designed to guide the user through a step-by-step approach to configure a drive. Click the “START” button on the first user screen and walk through the complete sequence of buttons provided to set the drive, motor, and application (Opmode, Tune, Backup, Go) variable parameters .



Should the user de-activate this screen, it can be reactivated by going to the Main MotionLink[®] screen, pulling down the Configuration menu, and selecting the New Drive (123) option.



Figure 4-1 Startup Screen (MSU012D)

- **Setting Drive Variable Parameters:** Click the Drive button. This screen allows the user to select a BUS value that corresponds to the incoming line voltage. This selection actually determines the setting of the variable VBUS. Also included is a real-time monitoring of the DIP switch on top of the drive so the user can verify the proper setting for the drive address, baud rate, and various other parameters. Click Exit to return to the SERVOSTAR® Startup screen.
- **Setting Motor Variable Parameters:** Click the Motor button. This screen allows the user to access the MotionLink® motor database. Select a motor family and then a model within that family. Information will appear in the blank parameter fields on the right. Click on the “To Drive” button beneath the fields to send the variable parameters to the drive. Click “Exit” to return to the SERVOSTAR® Startup screen.



NOTE

For the user that has a configured drive, a “From Drive” button is provided to retrieve the motor data already in the drive. Retrieving this data will not erase it from the drive.



NOTE

If the motor cannot be found in the database, click on the User Define tab. Contact the Kollmorgen Customer Support Network for detailed instructions (See Customer Support page 6-7).

- **Customizing to Application:** Click the “Opmode” button in the SERVOSTAR® Startup screen to select the mode of loop control desired; position, velocity, or torque (See Section 5.2 Operational Modes on page 5-2 for detailed explanation). Click Exit to return to the SERVOSTAR® Startup screen.

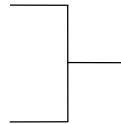
- Click on the Tune button in the SERVOSTAR® Startup screen to set the system bandwidth, the type of loop control, and the filtering necessary for the application (*see section 5.5 Torque Loop Operation on page 5-6, AppNote ASU006H, and AppNote ASU008H for further explanation*).



Caution should be used when executing the AutoTune feature. Some applications are not capable of handling the vibration caused as the shaft senses its load. If this is in question, manually tune the drive. Also, when the load inertia is very large and the selected bandwidth is high, this feature may fail to perform.

- Setup Completion: Click EXIT to go to the Main MotionLink® screen.

- Saving Variables Parameters to EEPROM
- Saving Variables Parameters to .SSV file
- Restoring Factory Variable Parameters
- Restoring Custom Variable Parameters



For explanation on these functions, refer to the Main MotionLink® Screen below.

4.2.1.2 Main MotionLink[®] Screen

This screen appears when the user exits out of the SERVOSTAR[®] Startup screen. All the screens mentioned in the method above can be accessed from this screen and should be used to make corrections in the current system configuration.

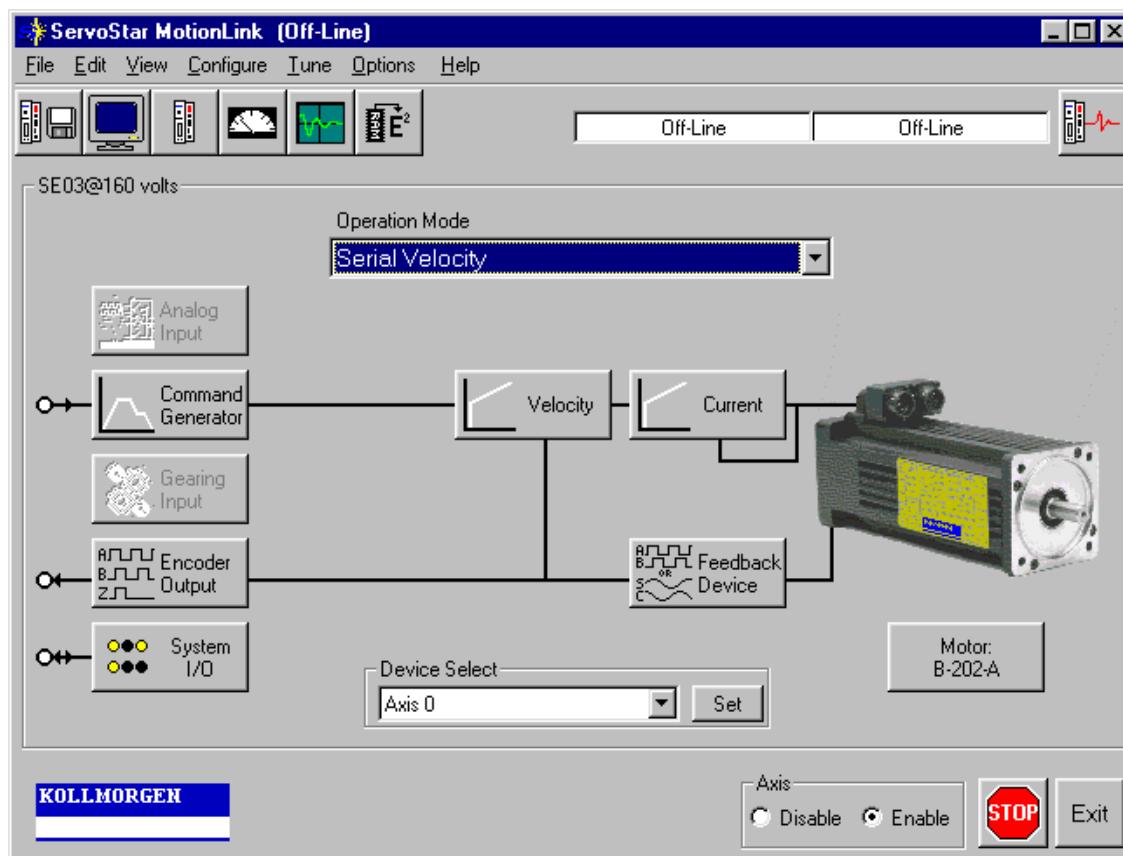


Figure 4-1 Main MotionLink[®] Screen (MSU013D)

- **Setting Drive Variable Parameters:** From the Configure menu, click the Drive option. The same screen appears as described in the SERVOSTAR[®] Startup screen section. Click Exit to return to Main MotionLink[®] Screen.
- **Setting Motor Variable Parameters:** selecting the Motor option under the Configure menu, the user can obtain the same parameter screen found in the SERVOSTAR[®] Startup screen. Click Exit to return to Main MotionLink[®] Screen.
- **Customizing to Application:** By dropping down the Operational Mode listing, the user can select the mode of loop control desired (position, velocity, torque). Clicking the “Tune” button, the user can select the system bandwidth, the type of loop control, and the filtering necessary for the application. These are the same parameter screens found in the SERVOSTAR[®] Startup screen. Click Exit to return to Main MotionLink[®] Screen.
- **Saving Variable Parameters to EEPROM:** At the top of this screen, the user can click the button labeled “RAM/E²” to save the modified variables from RAM to EEPROM.
- **Saving Variable Parameters to .SSV file:** Occasionally, the user may desire to backup the variable parameters from one drive for use in another. To do this, the user must pull down the Edit menu and

select Backup Variables, request the information from the drive (“Receive” button) into the editor, and save (“Save” button) the contents in a .SSV format to a specified disk location.

- Restoring Factory Variable Parameters: To restore the original factory variable parameters, pull down the Configure menu, select Motor, and select the motor family and motor model. Click the “To Drive” button to send the variable parameters to RAM and the “RAM/E² SAVE” button to save to EEPROM.
- Restoring Custom Variable Parameters: This process assumes that the user saved the custom variable parameters to a .SSV file, as described above. To restore the custom parameters, pull down the Edit menu, select Backup Variables, and click on “Open”. Highlight the custom .SSV file to import variable parameters into editor. Click “Xmit” to send variable parameters to drive.

4.2.1.3 Terminal Mode

Use the MotionLink[®] Terminal Mode (or any other “dumb” host) to directly monitor or modify the variable set and command the drive. This approach should only be taken when a PC with a Windows 95 operating system is not available and/or the user is well-versed with the SERVOSTAR[®] variable/command set.

The VarCom Reference Guide contains the complete variable and command set. Each variable/command must be referenced for its syntax and parameter definition. The variables/commands are grouped by function for use by terminal users.

- Clear EEPROM: If a “-“ does not appear and the user wishes to enter a new set of variable parameters, type CLREEPROM at the terminal prompt to clear the EEPROM memory.
- Setting Drive Variable Parameters: At the prompt, enter a value for VBUS. Other drive parameters are determined automatically.
- Setting Motor Variable Parameters: Locate the motor parameter group of variables in the VarCom Reference Guide. At the prompt, enter values for the variable parameters listed in this group by typing the name of the variable, space, and the numerical value.
- Customizing to Application:
Locate the following variable groups in the VarCom Reference Guide:
 - Analog Input-Related
 - Current Parameters
 - Velocity Parameters
 - Position Parameters
 - Loop Compensation and Gains Parameters
 - Motion Control Parameters

At the prompt, enter values for the variable parameters listed in these groups by typing the name of the variable, space, and the numerical value. The user is strongly encouraged to develop a full understanding of these variables before finalizing the configuration.

- Saving Variable Parameters to EEPROM: At the prompt, type SAVE. This will save the variable parameters stored in the RAM to the EEPROM. All of the variables listed in the VarCom Reference Guide indicate whether its contents can be saved to EEPROM.
- Saving Variable Parameters to .SSV file: At the prompt, type DUMP. The DUMP command causes the drive to output variables and their contents to the serial port in the format of a variable file (this includes the trailing CONFIG command). This variable file format is an ASCII file consisting of a series of variable assignment statements. The resulting transmission of data from the drive can then be saved with an .SSV extension.
- Restoring Factory Variable Parameters:
If the user has not saved any changes stored in RAM to EEPROM, then type LOAD at the prompt and the original parameters will be loaded from the EEPROM into RAM.

If changes have already been previously saved, contact the factory to obtain a set of motor variable parameters for the motor specified in the model number. At the prompt, re-enter all the motor variable parameters. Type the CONFIG command followed by the RSTVAR command.

- Restoring Custom Variable Parameters: At the prompt, type RSTVAR. Transmit to the drive the custom variable .SSV file. The contents of this file should have the CONFIG command as its last statement. The drive will execute this command and configure itself to the parameters that were just transmitted. Follow this by a SAVE command to store the contents into EEPROM.

4.2.2 MultiDrop Communication

When the user runs MotionLink[®], the opening communication screen displays a “Scan For Drives” button. Selecting this forces the software to scan for any active drives (and the address location) on the chain. Any addresses detected will then be listed in the Device Select drop-down menu at the bottom of the Main MotionLink[®] screen. The user need only highlight the desired drive to begin communications.

To communicate with individual drives in a daisy chain from a terminal, the user must type at the prompt:

```
“ \ x ” <cr> where x ∈ {0..9, A..V, *, \}
```

corresponding to the DIP address setting of that desired drive. For example, to communicate to drive #8 (DIP setting: 01000) the user would have to type at the prompt, “\ 8” <cr>.

To globally address all drives on the chain the user must type at the prompt:

```
“ \ * ” <cr>
```

When globally addressing the drives, no character echo to the terminal occurs.

4.2.3 Power-Up Sequence

Upon powering up, the SERVOSTAR[®] performs a series of self-tests. If the Status Display illuminates a solid number, then no errors were found and the EEPROM has loaded its variable parameters (or loaded with default values in case of invalid EEPROM data) into RAM. The Remote Enable switch on the I/O connector (C3) may now be energized, thus enabling the servo loops.

4.2.4 Enabling the System

The drive enable logic is based on the following variable switches and flags:

ACTIVE: This is the overall readiness flag indicating the enable/disable state of the drive. If high (1), the drive is enabled and power is being applied to motor. The following equation must hold true for ACTIVE to go high:

$$\text{ACTIVE} = (\text{READY}) \text{ AND } (\text{REMOTE}) \text{ AND } (\text{DIPEN})$$

where READY = (DRIVEOK) AND (SWEN)

READY: flag that indicates the drive is free of faults and ready to hardware enable

DRIVEOK: switch indicates the status of the drive faults.

SWEN: switch indicates the status of the software enable (EN or DIS).

REMOTE: switch indicates the status of the hardware Remote Enable line on the C3 connector.

DIPEN: switch indicates the state of the DIP enable/disable switch (#8)

Ready Flag		
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

Active Flag			
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)

If the drive will not enable, the user can check the state of the switches and flags by clicking the “Status” button in the upper right-hand corner of the Main MotionLink[®] screen. If using a terminal, the user can query the drive for the value stored in the STATUS variable (*refer to Varcom Reference Guide on the PSP CD-ROM for explanation on STATUS parameters*). The Status Display will indicate an enabled drive when the decimal point is illuminated solid.

Section 5

System Operation

5.1 STATUS DISPLAY

The SERVOSTAR[®] has a seven-segment indicator, called a Status Display that indicates four types of states: Power-up, Steady State, Flashing State, and Momentary State. The decimal point directly relates to the global drive enable.

Status Display	
DRIVE STATE	DISPLAY APPEARANCE
Power-up	Momentarily illuminates all display segments (forming an 8) and the decimal point.
Steady State (No Faults)	Displays the operational mode (OPMODE) of the drive (0-8).
Flashing State	Used to indicate an abnormal operating state: If the position hold feature is active, the OPMODE number will flash at a 1 Hz rate. If a fault was detected, a flashing code will be displayed to identify the fault. Some codes consist of a sequence of two or more digits (see Troubleshooting section). In general, these faults will cause a latched disable (sometimes controllable through software switches). To clear fault, toggle remote enable (except for OverCurrent). If the encoder initialization function (ENCSTART) is active, the OPMODE number will flash at a 3 Hz rate.
Momentary Fault	Displays a character momentarily for 500 ms before returning to the steady state. The timer is resettable. C = Communications Error F = Drive is in FoldBack mode

Table 5-1 Status Display States

Status Display Decimal Point	
DECIMAL POINT STATE	DRIVE STATUS
Steady OFF	No power to the motor
Steady ON	Drive enabled, power to the motor
Flashing	Drive enabled, power to the motor, but a motor safety feature has been disabled (for example, LIMDIS = 1).

Table 5-2 Status Display Decimal Point

5.2 OPERATIONAL MODES

The SERVOSTAR[®] has the ability to assume different modes of operation. It is factory configured in OPMODE 1 (Analog Velocity Controller) but may be reconfigured by the user. Not all commands and variables are active or meaningful in every OPMODE.

1. Serial Velocity Controller (OPMODE = 0): the SERVOSTAR[®] is configured as a velocity-loop controller and is controlled by issuing a velocity command (J: jog command, or STEP: step command) to the drive via the serial port.
2. Analog Velocity Controller (OPMODE = 1): the SERVOSTAR[®] is configured as a velocity-loop controller and is controlled through either a +/- 10V analog input signal or jog (J) commands stored in the Configurable I/O. The commanded velocity is proportional to the input voltage.
3. Serial Torque (Current) Controller (OPMODE = 2): the SERVOSTAR[®] is configured 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): the SERVOSTAR[®] is configured as a torque-loop controller and is controlled via a +/- 10V analog input signal. The commanded current is proportional to the input voltage.
5. Gearing Position Controller (OPMODE = 4): the SERVOSTAR[®] is configured as a positioning controller that can operate in one of three settings (Encoder Follower, Pulse/Direction, Up/Down Counter). The setting used is determined by the GEARMODE variable.
6. Position Controller (OPMODE = 8): the SERVOSTAR[®] is configured as a serial or an analog positioning controller, depending on the value of PCMDMODE, that can receive simple absolute, incremental, indexing, homing, and analog commands.
7. SERCOS Controller (OPMODE = 5): the SERVOSTAR[®] must be ordered from the factory as a SERCOS unit to establish communications in this OPMODE. The drive is shipped with Connector C4 as the Transmit/Receive port (no longer the Encoder Equivalent Output).



SERCOS operation is only compatible with the SERVOSTAR[®] MC controller. Contact the Kollmorgen Customer Support Network for more information.

5.3 SYSTEM I/O

This section discusses the I/O features of the C3 connector (except for the Thermostat input on C2). For detailed explanation on the electrical specifications of these features, *see section 2.1.5 Product Family Control Specifications on page 2-9* For further explanation on how to use these features, refer to the VarCom Reference Guide located on the PSP CD-ROM.

5.3.1 Analog Input (ANIN)

The position, velocity, or torque loop can receive its command from an analog voltage source and is selectable through the OPMODE variable. The analog input to the SERVOSTAR[®] is differential; meaning that the signals received at the two inputs are subtracted from each other to create a ‘difference’, which is then used to command 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 input also has a low pass filter (ANLPHZ) to prevent high frequency noise from entering the system.

The input voltage from the differential receiver is applied to a precise 14-bit Analog-to-Digital (A/D) conversion system. The A/D conversion system is read by the microprocessor every 500 μ S for the position loop modes, every 250 μ S for the velocity loop mode, and every 62.5 μ S for the torque (current) loop mode of operation. Encoder-based

units come with the additional benefit of a Dual Gain (ANDG) input. When enabled, the system uses two 14-bit A/D inputs to read the user-supplied analog signal. One input is a direct reading of the +/- 10V signal, while the other incorporates a 2x gain term. When the input voltage is less than 4V, the 2x channel is used to determine the user's input voltage; thus, extending the resolution to a 15-bit equivalent. Above 4V, the system uses the straight 14-bit conversion. Special software algorithms are used to minimize cross-over distortion and add .25V of hysteresis.

Analog systems often require scaling and offset bias. The SERVOSTAR[®] adds an analog offset (ANOFF) variable to this reading, performs an analog deadband (ANDB) adjustment, and scales it through the either the position loop input scaling (GEARI, GEARO), velocity loop input scaling (VSCALE), or torque loop input scaling (ISCALE) before passing the data to the selected control loop. The analog input (ANIN) variable indicates the analog reading after the offset (ANOFF) and the deadband (ANDB) adjustments, but before the loop scaling. The ANIN variable range is +/- 22500 counts (or mV).

The SERVOSTAR[®] 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 32mSec period and update ANOFF accordingly to cancel out analog input offset. This command also incorporates an internal offset mechanism that has finer resolution than ANOFF is capable of providing.

5.3.2 Remote Enable Input (REMOTE)

The opto-isolated Remote Enable input (REMOTE) provides a hardware drive enable switch. This 12-24 VDC input will disable or enable the power stage output to the motor. The signal must be customer supplied in order to get the drive to enable (in combination with other parameters; ACTIVE) and operate. Tapping the signal off the logic supply (C5) is not recommended. The toggling of this switch will also initiate an attempt to recover from a fault condition. It can also be used to trigger various position homing features (HOMETYPE).

5.3.3 Configurable Inputs (IN1, IN2, IN3)

These 12-24 VDC inputs are defined by the INxMODE variable. Placing the appropriate value in INxMODE (*See VarCom Reference Guide on the PSP CD-ROM for detailed explanation*) will set up the inputs to be used for such features as CC/CCW hardware position limits, Electronic Gearing, serial and analog position triggering for incremental moves and homing, fault output relay configuration, MotionLink[®] scope triggering, and more. When set for the CC/CCW hardware position 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 opto-isolated and considered "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 hardware position limits causes the SERVOSTAR[®] to enter the HOLD mode. These inputs can also be inverted (ININVx, where x = 1,2,3).



The default settings of these inputs are for the hardware position limits. The Status Display may flash an 'L' upon power-up indicating that a travel limit has been tripped. If these position limits are not in use, set LIMDIS=1.

5.3.4 Configurable Outputs (ANOUT, O1)

The ±10V, 12-bit analog output (ANOUT) is to be used as a monitoring tool **only**. The setting of this variable will allow the user to meter various feedback quantities such as velocity, current, horse power, position feedback and following error, and more. This pin must be referenced to DC Common (pin 4).

The digital output (O1, O1MODE) can be toggled in an On/Off state to indicate various drive, motor, and variable conditions. These include: absolute speed and current levels, FoldBack conditions, motor braking, motion complete and zero speed conditions, position overshoot flagging, programmable limit switch detection, and an enable (ACTIVE) flag. Condition, reset, and triggering levels are established through O1MODE, O1RST, O1TRIG.

5.3.5 Fault Output Relay (RELAY, RELAYMODE)

The SERVOSTAR[®] provides a drive ready / drive up output in the form of a relay (RELAY) output. The relay (RELAY) output is controlled by the SERVOSTAR[®]'s microprocessor. There is a software switch (RELAYMODE) that configures the relay (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.
3. If RELAYMODE = 2, the relay will open during a fault when the drive is disabled.



The user can program this fault output to open on any system fault by triggering the Configurable Inputs (INxMODE, INx)

5.3.6 Motor Thermostat Input (THERM, THERMODE)

The SERVOSTAR[®] provides a motor thermostat input on the C2 connector that can be configured for different types of thermal protections (THERMTYPE); as well as, manipulation of how the drive responds to a motor thermal condition (THERM, THERMODE, THERMTIME). Kollmorgen GOLDLINE[™] motors and cables connect the thermostat through the feedback cable. The input to the SERVOSTAR[®] should be electrically closed through the thermostat for proper operation. The drive will normally flash an 'H' in the Status Display when this input is electrically opened.



If a motor thermal device is not used, then THERMODE must be set to 3 to disable the feature; thus, turning the 'H' status display indicator off.

5.4 CONTROL LOOPS

This section describes the servo control loops, their characteristics, and how to configure them (*for additional information and a more detailed discussion of the control loops, see AppNote ASU006H*).

5.4.1 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 flash memory firmware that controls the core processor and gives the SERVOSTAR[®] its operating characteristics is saved in EPROM. The version number of the firmware can be read using the VER command. When calling Kollmorgen for technical support, be sure to have the firmware version number readily available. The most recent version of firmware is available for purchase and is easily field upgradable through a PC. It can be obtained by contacting a Kollmorgen sales representative or by contacting the Kollmorgen Customer Support Network (*see Customer Support on page 6-7*).

5.4.2 Servo Loop Description

The SERVOSTAR[®] provides high performance motor control by controlling up to four distinct closed loop systems within the DSP: the current, commutation, velocity, and position loops. Figure 5-1 depicts the control loops graphically.

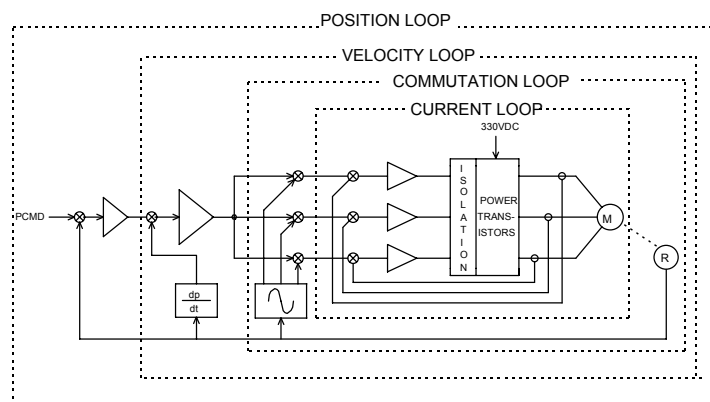


Figure 5-1 Control Loop Structure (MSU028D)

5.4.2.1 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 (see Section 5.5 Torque Loop Operation on page 5-6). The function of the current loop is to regulate motor current as directed by a current command signal. The current command signal from the microprocessor can either come from a direct user input (OPMODE's 2/3) or from the output of the velocity loop. There are actually three current loops, one for each motor phase. Each current loop receives its own command input from the commutation loop.

The SERVOSTAR[®] uses a fully digital, pole placement current loop with high bandwidth and a current loop sampling rate of 16 kHz (62.5 μ S). All coefficients of the current loop are digitally calculated inside the drive for a given set of 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 providing the highest efficiency possible. The PWM center frequency can be 8 or 16 kHz according to the drive size (See Section 2.1.3 Cx Electrical Specifications on page 2-8 for specific details).

5.4.2.2 Commutation Loop

This loop converts a single-phase current command signal into a three-phase, 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 its motors. The waveform generator is part of the microprocessor and is updated at a 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 (MOTORBEMF) characteristics of the motor. This is why resolver (or encoder) alignment to the motor is critical.

5.4.2.3 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 signals to calculate actual motor velocity (see AppNote ASU008H on the PSP CD-ROM for a comprehensive feature discussion). The command for the velocity loop can come from a direct user input (OPMODE'S 0/1) 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 SERVOSTAR[®] offers four velocity compensators (methods of regulating velocity) and are selectable through the COMPMODE variable. The four are as follows: Proportional-Integral (PI), Pseudo-Derivative-Feedback with Feed-Forward (PDFF), Standard Pole Placement, and Extended Standard Pole Placement (*see AppNote ASU006H on the PSP CD-ROM*)

5.4.2.4 Position Loop

The final control configuration is the position loop. The purpose of this loop is to maintain motor shaft position. Like the previous loops, the position loop is fully digital and uses resolver, encoder, and sine encoder feedback signals to determine actual motor position. The drive can also accept a position signal from an external feedback device (e.g. load encoder). It samples at a rate of 2 kHz and can be configured for three different modes of operation:

OPMODE 4: This mode of operation sets the SERVOSTAR[®] up to run as a pulse (or master encoder) follower by using the Electronic Gearing feature. The pulse input can either be applied through the Configurable Inputs on the C3 connector (up to 2.5KHz max - opto-isolated) or through the Remote Encoder Input on the C8 connector (up to 3MHz) on top of the drive (*see AppNote ASU002H on the PSP CD-ROM for a comprehensive discussion on this feature*).

OPMODE 8: This mode of operation configures the SERVOSTAR[®] as a simple positioning controller (*See AppNote ASU007H on the PSP CD-ROM for a comprehensive discussion on this feature*). Once in this mode, position commands can be given through the serial port, through the Configurable I/O, or through the analog input (determined by the PCMDMODE variable). The position loop has been enhanced to a full PID controller with acceleration and velocity feed-forward gains. Two integral gain variables have been added to limit the action of the integral term during selected parts of the profile. This helps to minimize overshoot and settling problems.

Using a serial command (PCMDMODE=0), the SERVOSTAR[®] can execute simple absolute, incremental (or indexing), and homing motion profiles either by direct commands through the serial port (MI, MA, MH) or by pre-configuring a profile in memory to be used in conjunction with the Configurable I/O (MASPEED, MISPEED0-3, MAPOS, O1, O1MODE, INx, INxMODE).

Using an analog command (PCMDMODE=1), the SERVOSTAR[®] can scale the analog input (GEARI, GEARO) to establish a wide range of relationships between an analog input adjustment and a corresponding shaft movement. Homing types (HOMETYPE) are available that home to a particular analog input level (and position count), triggering either through the Configurable Inputs or the Remote Enable.

In this mode of operation, the drive can also accept an external load feedback signal through the C8 connector (DUALFB=1). This helps eliminate the positional inaccuracies, due to gear backlash and poor coupling, by positioning according to the load's position (not the motor shaft's position).

The SERVOSTAR[®] also operates in the position mode when the drive is in the hold position state (HOLD = 1).

5.5 TORQUE LOOP OPERATION

Most applications use the SERVOSTAR[®] in the torque mode configuration. For this reason, the torque loop operation is explained in this hardcopy manual of this SERVOSTAR[®]'s PSP. The design of the control loops was discussed in the previous section. 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 and their locations in MotionLink[®] are presented graphically in the following discussions to help disclose meanings and relationships.

5.5.1 Serial Torque

The SERVOSTAR® can be operated as a serial torque-controlled amplifier (OPMODE 2). It receives a serial command (T) via a host to a command generator, which in turn creates a current command (ICMD). The current (or torque) command is checked against peak (IMAX, ILIM) and continuous (FoldBack features, ICONT) current clamp limits. Sinusoidal commutation modulation is added to the command and then fed to the three phase current loop regulator, which calculates a current error. This error is then fed through a digital pole-placement compensation algorithm. The output of the compensator is converted to a PWM signal and fed to the power transistor bridge. The power bridge uses the high voltage DC BUS Module (typical 325 VDC bus) to supply the required current to the motor windings. The actual motor current is updated and the process begins again. The following is a graphical representation of the serial torque loop operation (*refer to the VarCom Reference Guide located on the CD-ROM for detailed explanation on all variables and commands*):

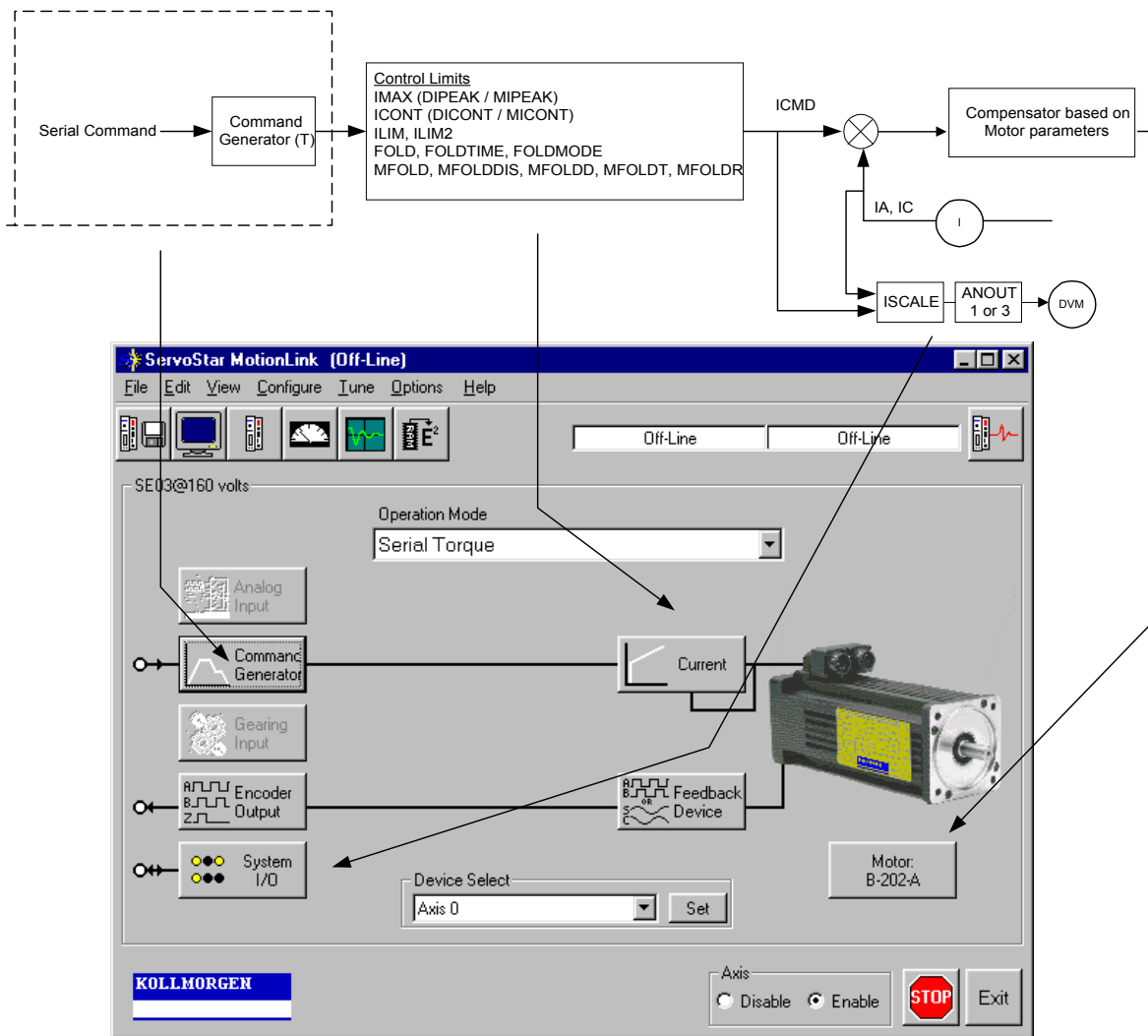


Figure 5-1 Serial Torque Mode w/MotionLink® (MSU024D)

5.5.2 Analog Torque

The SERVOSTAR® is most often configured to operate as an analog torque loop controller (OPMODE 3). In this case, the current loop receives its input from the analog-to-digital (A/D) conversion system. After conversion, the input command signal is processed through an algorithm which adjust the signal (ANOFF, ANDB, ANZERO), filters it (ANLPHZ) and then scales it (ISCALE), before developing the current command (ICMD). The current (or torque) command is then checked against peak (IMAX, ILIM) and continuous (FoldBack features, ICONT) current clamp limits. Sinusoidal commutation modulation is added to the command and then fed to the three phase current loop regulator, which calculates a current error. This error is then fed through a digital pole-placement compensation algorithm. The output of the compensator is converted to a PWM signal and fed to the power transistor bridge. The power bridge uses the high voltage DC BUS Module (typical 325 VDC bus) to supply the required current to the motor windings. The actual motor current is updated and the process begins again.

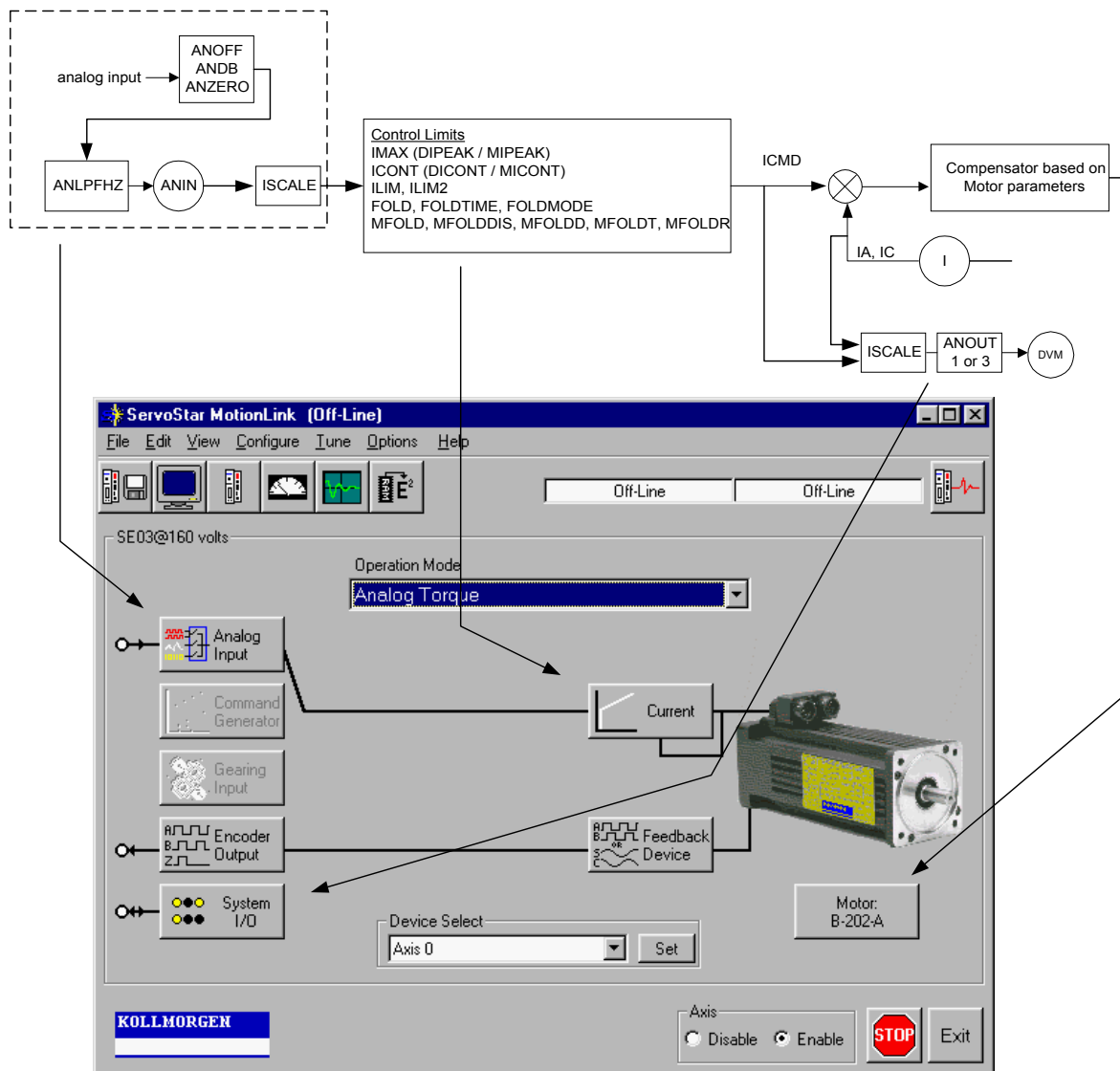


Figure 5-1 Analog Torque Mode w/MotionLink® (MSU025D)

5.5.3 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) of the current signal 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.

5.6 FOLDBACK

The SERVOSTAR[®] offers two types of FoldBack protection for both the motor and the drive. The drive's microprocessor monitors the current feedback signal and develops an RMS value of this signal for the purpose of providing the user a value that represents the current in the motor. The system is similar to an "I-squared-T accumulator."

5.6.1 Drive FoldBack

This FoldBack algorithm monitors current feedback and, if the feedback exceeds the continuous current rating of the drive/motor combination (ICONT), will decrease the system's current to the ICONT level. For example, under a step command input condition, the FoldBack algorithm will allow maximum peak current (IMAX) output from the drive for 0.5 seconds. After this period, the drive enters "FoldBack mode" (FOLD = 1) and begins an exponentially FoldBack to the system's continuous current. It will take approximately six seconds for the exponential decay to drop from the system's peak current to its continuous level.



For drive currents that exceed ICONT, but are below IMAX, the system period before FoldBack occurs is extended beyond two seconds. Two seconds is the shortest time period that will elapse before the drive enters FoldBack and only occurs when maximum peak current (IMAX) is drawn.



This FoldBack feature is designed to protect the drive electronics, not the motor. The Configurable Output, O1, (pin 12) can be configured to indicate a drive FoldBack condition.

5.6.2 Motor FoldBack

This FoldBack algorithm is designed to provide motor protection in cases where the drive's continuous current rating is above the motor's continuous rating. This combination is often desired in applications where maximum peak motor torques are required. However, the possibility exist that the drive could source current on a continuous basis indefinitely to the motor and would force it beyond its thermal capability. Unlike the drive FoldBack, the user has complete configurability over this feature (MFOLD, MFOLDD, MFOLDDIS, MFOLDR, MFOLDT).

Section 6

SERVOSTAR® Helps

6.1 TECHNICAL INFORMATION

Technical papers and publications about the SERVOSTAR® and its associated applications complete the information package necessary for the user to become well versed with the product. These notes have been prepared by Kollmorgen's engineering and technical resource staff. The PSP CD-ROM contains technical content stored in an electronic .PDF format. The user must have Adobe's Acrobat Reader (also available on the ROM) installed on their computer to view and print these documents. This package is available on the CD-ROM. The most recent versions of all the material contained in this PSP (manual and CD-ROM) can be downloaded from Kollmorgen's Web site (*see Customer Support on page 6-7*).

6.2 TROUBLESHOOTING TOOLS

The SERVOSTAR®'s MotionLink® package comes with a comprehensive monitoring and troubleshooting help set. For troubleshooting the drive, it provides a Status screen (click on "Status" button in the upper right-hand corner of Main MotionLink® screen) allowing the user to check the drive enable switches, the Status Display LED, fault status with complete error history, and mode settings for several of the drive's protection features. If using the terminal mode, the user can simply check the contents stored in the STATUS, FLTHIST, and ERR variables.

An additional help provided by MotionLink® is the I/O screen (click on "I/O" button on the side of the Main MotionLink® screen) which gives the user the ability to check the status of the hardware position limit switches, the motor thermostat, and the encoder equivalent output. It also allows the user to set up the I/O on the C3 connector for a variety of troubleshooting and monitoring approaches.

For monitoring system performance, MotionLink® comes with a variety of monitoring tools. The customer can monitor a variety of variables from the Monitor screen (click "Monitor" button at the top of the Main MotionLink® screen) and compare up to three variables against themselves all at one time. The Tune and Record screen allows the user to evaluate the system's actual performance against a predefined command profile. Also from this screen, the performance can be varied by adjusting the gains until optimum following is achieved.

6.3 ERROR CODES

In most cases, the SERVOSTAR® communicates error codes with a text message via the serial port to the host. Some error codes are also transmitted to the Status Display. The same message is saved in the EEPROM under an error history log (FLTHIST, ERR) so that nothing is lost when power is removed. Not all errors reflect a message back to the host. In these cases, the no-message errors communicate to the Status Display only.

The response of the SERVOSTAR® to an error depends on the error's severity. There are three levels of severity: 1) warnings, simply called errors, are not considered faults and do not disable operation, 2) non-fatal errors, or simply faults, that disable the drive and indicate a fault status, and 3) fatal errors, or fatal faults, that disable almost all drive functions (including communications).



The drive will automatically disabled at the occurrence of a fault. Executing a drive disable command (DIS or K) followed by the EN command, or toggling the Remote Enable line (REMOTE) will reset the fault latch, and if the fault condition is no longer present, will re-enable the system.

6.3.1 FATAL FAULT ERROR CODES

Err #	Status Display	Fault Message	Possible Cause
1	t	Power stage OverTemp	overload, fan malfunction, power stage failure
2	o	OverVoltage	excessive decel rate*
3	P	OverCurrent	power stage surge current*
4.0	r0	External feedback fault	Feedback signal through C8 not correctly detected
4.1	r1	Resolver line break	break in resolver feedback detected
4.2	r2	RDC error	fault in resolver-to-digital converted detected
4.3	r3	Sine Encoder init fail	sine encoder card has not initialized properly
4.4	r4	A/B line break	break in encoder A/B input lines detected
4.5	r5	Index line break	break in encoder index line
4.6	r6	Illegal halls	illegal hall combination detected
4.7	r7	C/D line break	break in sine encoder C/D line detected
4.8	r8	A/B out of range	sine encoder A/B level out of range
4.9	r9	Burst pulse overflow	sine encoder fault
5	u	Under voltage	bus voltage is too low
6	H	Motor over temperature	motor overload caused overheating
7.1	A1	Positive analog supply fail	Failure in +12V supply
7.2	A2	Negative analog supply fail	Failure in -12V supply
8	J	OverSpeed	velocity \geq VOSPD
8.1	J1	OverSpeed	Velocity \geq 1.8 x VLIM
9	E	EEPROM failure	Faulty EEPROM
10	e	EEPROM checksum fail	EEPROM checksum invalid on power up*
12	F	Foldback	System in FoldBack mode
14.1	d5	Positive over travel fault	PFB exceeded PMAX with PLIM=1
14.2	d6	Negative over travel fault	PFB exceeded PMIN with PLIM=1
15.1	d1	Numeric position deviation	Internal fault
15.2	d2	Excessive position deviation	PE > PEMAX
16	c	Communication interface	A communications fault has occurred

*These faults can only be cleared by cycling power

6.3.2 NON-FATAL ERROR CODES

Err #	Error Message	Possible Cause
0	No Error	no error was recorded
20	Unknown Command	Undefined command
21	Unknown Variable	undefined variable name
22	Checksum error	error on comm. message checksum (ACKMODE 2)

23	Drive Active	drive needs to be inactive for the requested command or variable
24	Drive Inactive	drive needs to be active for the requested command or variable
25	Value out of range	variable value out of range
26	Negative Number	variable must be ≥ 0
27	Not in proper Opmode	not in correct Opmode for specified command
28	Syntax Error	communication message syntax error
33	Tune Failed	auto tuning failed
34	Bad Bandwidth	AutoTuning BW is out of range
35	Bad Stability	bad stability
36	Not programmable	variable is read-only
37.01	Current loop design failed	CONFIG failed due to current loop design failure
37.02	MENCRES out of range	CONFIG failed due to MENCRES
37.03	MENCOFF out of range	CONFIG failed due to MENCOFF
37.04	MSPEED out of range	CONFIG failed due to MSPEED
37.05	MBEMF out of range	CONFIG failed due to MBEMF
37.06	MJ out of range	CONFIG failed due to MJ
37.07	ACC out of range	CONFIG failed due to ACC
37.08	DEC out of range	CONFIG failed due to DEC
37.09	DECSTOP out of range	CONFIG failed due to DECSTOP
37.10	VLIM out of range	CONFIG failed due to VLIM
37.11	VOSPD out of range	CONFIG failed due to VOSPD
37.12	VSCALE out of range	CONFIG failed due to VSCALE
37.13	O1TRIG out of range	CONFIG failed due to O1TRIG
37.14	O1RST out of range	CONFIG failed due to O1RST
37.15	DISSPEED out of range	CONFIG failed due to DISSPEED
37.16	MENCTYPE out of range	CONFIG failed due to MENCTYPE
38	Communication error	Error at physical comm. layer
39	Not in proper COMPMODE	The REFRESH command was given with COMPMODE $\neq 3$
40	EXT velocity param warning	D, H, R parameters for COMP-MODE 3 do not have the proper relationship to each other.
41	Vel loop design failed	The velocity loop can't be con-figured with given parameters
42	Invalid EEPROM	The EEPROM test failed
43	Recording active	The requested command cannot be executed because it conflicts with a recording in progress
44	Rec data not available	No data are available for the GET command
45	EEPROM is empty	Data cannot be loaded because the EEPROM is empty
46	Argument must be binary	Variable argument must be a power of 2
47	Burnin is active	The requested function cannot be executed during Burnin (a factory function)
48	Burnin is not active	Burnin (factory function) cannot be stopped if it is not active
49	Conflicts with ENCOUT	The requested value for VLIM conflicts with ENCOUT.
50	Conflicts with VLIM	The requested value for ENCOUT conflicts with VLIM.
51	Not available	The requested variable value is not available; refer to the description of the variable in section 1 to determine why.
52	Drive is in Hold mode	Motion was requested with the drive in Hold mode
53	Limit Switch Hold	Drive is in Hold mode due to limit switch being tripped
54	Command Into Limit	Requested motion is in direction of tripped limit switch
55	Drive is in Zero Mode	Motion requested while in Zero mode
56	Motor is Jogging	Tune cmd cannot be executed because motor is jogging
57	Argument not divisible by 20	Argument must be a multiple of 20 to be accepted
58	Encoder Initialization Process Active	A command cannot be executed because it has been requested while the encoder initialization process is active

60	Tune failed-no rotation	Tune cmd failed because motor could not rotate
62,66 70,74	Tune failed-current sat	Tune cmd failed because the current loop saturated
63,67 71,75	Tune failed-no vel design	Tune cmd failed because the vel loop could not be designed
76	Disable During Tune	Tune cmd failed because drive was disabled while tuning
77	Hold During Tune	Tune cmd failed because drive entered Hold mode while tuning
78	Low Velocity Limits	Tune cmd failed because VLIM is too low
79	Use Lower Bandwidth	Tune cmd requires a lower bandwidth in order to execute
80	Drive in Dual Feedback mode	Command cannot be accepted because dual feedback is active
81	Drive is in Gear mode	Command cannot be accepted because drive is in gear mode
82	Functionality is occupied	Selected INxMODE function is already assigned to another INxMODE
83	Warning: A/B Line not routed	Selected GEARMODE requires A/B inputs to be routed using INxMODE 5 and 6.
84	Warning: Limit sw not routed	Limit switches must be routed using INxMODE 1 and 2.
85	Move is pending	The last ordered move command has not been completed yet.
90	Incorrect password	The password entered by the user was incorrect
91	Password protected	The command or variable requested by the user is password protected and intended for factory use only
92	Capture during homing	A position capture occurred during homing
93	Homing during capture	A homing request was made during position capture
94	Capture process not done	The requested command can't be processed due to pos capture not being complete
95	Capture process not active	The requested command can't be processed due to pos capture not being active
96	Capture process not enabled	Position capture cannot be executed
97	ENCSTART while ACONFIG	
999	SERCOS test failure	

6.3.3 NO MESSAGE FAULTS

Fault Description	Fatal	Non-Fatal	Flashing Status Display	Steady Status Display
Watchdog (DSP)	X		≡	
Watchdog (HPC)	X			≡
No Compensation	X		-1	
Invalid Velocity Control	X		-2	
Encoder not Initialized on attempt to enable	X		-3	
Encoder Initialization failure	X		-4	
AutoConfig failure	X		-5	
Hardware CW limit switch open		X	L 1	
Hardware CCW limit switch open		X	L 2	
Hardware CW and CCW limit switches open		X	L 3	
Software CW limit switch is tripped (PFB>PMAX & PLIM=2)		X	L 4	
Software CCW limit switch is tripped (PFB<PMIN & PLIM=2)		X	L 5	
Positive and negative analog supply fail	X		A 3	
RAM failure (during init)	X			I
EPROM checksum (during init)	X			c
Altera load failure (during init)			E101	

Altera DPRAM failure (during init)			E102	
DSP load fail (during init)			E103	
DSP alive failure (during init)			E104	
Test LED			8	
Indexed position with zero velocity			b	

6.4 FAULT MONITORING SYSTEM

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 Status Display, enunciated over the serial port, and in most conditions causes a drive disable. Many faults can be reset by toggling the hardware remote enable (REMOTE input).

The following provides a list of some of the more frequent faults the drive may detect in the unit hardware and operating system.

- **Motor OverTemperature:** 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 when an 'H' appears in the status display, and the fault relay contacts (RELAY) are open.
- **Hardware Position Limit Inputs:** The IN1, IN2, IN3 Inputs are constantly monitored. If the variables INxMODE set these inputs for CW/CCW hardware position 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 hardware position 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' illuminated in the status display. If both CW and CCW position limit inputs have detected an open-circuit condition, the SERVOSTAR® enters into Hold position state (HOLD = 1).
- **Drive OverTemperature:** 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 OverCurrent (FoldBack):** 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 OverVoltage:** an over-voltage condition shuts down the drive and displays a lower-case 'o' in the status display. This fault will occur mostly during regen operation where the BUS is raised to higher values than that produced by the power supply.
- **Bus UnderVoltage:** an under-voltage condition shuts down the drive and displays an 'u' in the status display. This fault normally occurs when the incoming line voltage drops out or a fault occurs in the power supply.
- **PowerStage Fault (OverCurrent):** Hardware circuitry monitors load short-circuit, transistor failure, and instantaneous OverCurrent. In general, a power stage fault cannot 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.

- **OverSpeed fault:** Software continuously monitors the actual (feedback) speed. If the motor speed exceeds the VOSPD limit, a 'J' will be displayed and the drive will be disabled. This normally occurs when there is an improperly tuned system and the load overshoots its commanded speed.
- **No compensator:** In case the SERVOSTAR® cannot 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. This display normally indicates that the drive does not have a compensation file loaded.
- **Memory reliability:** During the initialization process upon power up, the run time, 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.

- **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. This normally indicates serious problems. Please contact the factory for support.

6.5 FIRMWARE UPGRADES

From time to time, Kollmorgen adds features to its products that expand their overall capabilities. Features added to the SERVOSTAR® can be easily implemented at the customer's site. This is accomplished by downloading new firmware via the drive's serial port directly from a host computer.

The customer ordering a firmware upgrade receives a file labeled "UPGRADE.EXE". Click on this file and a Windows program will prompt the user to choose an unzipping method, baud rate, and communications port. If the baud rate and communications port selection is incorrect or the drive is set up for MultiDrop communications, then a DOS screen will pop up indicating an error has occurred. Simply close the window and select another baud rate and/or communications port.

To obtain the latest firmware version or receive additional help, contact the Kollmorgen Customer Support Network.

6.6 CUSTOMER SUPPORT

Kollmorgen is committed to quality customer service. Our goal is to provide the customer with information and resources as soon as they are needed. In order to serve in the most effective way, Kollmorgen offers a one-stop service center to answer all our customer's product needs. This one number provides order status and delivery information, product information and literature, and application and field technical assistance:

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If you are unaware of your local sales representative, please contact us at the number above. Visit our web site for MotionLink® software upgrades, technical articles, and the most recent version of our product manuals.

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