Danaher Motion

SERVO**STAR**® SBD Series

Installation Manual

KOLLMORGEN

giving our customers freedom of design

M-ST-009-2031

Record of Manual Revisions

ISSUE NO.	DATE	BRIEF DESCRIPTION OF REVISION
1	08/11/2000	Initial Release
2	11/23/2000	Revised Power Supply Information for PS Series
3	11/05/2001	Revised Hardware Specifications

Copyright Information

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Safety Instructions

Only qualified personnel are permitted to transport, assemble, install, and maintain 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 installation. 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 SERVO**STAR**® 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 possibility cause severe damage to health or the product.

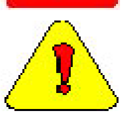
In operation, depending on the degree of enclosure protection, the product can have bare components that are live or have hot surfaces. Control and power cables can carry a high voltage even when the motor is not rotating.

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.

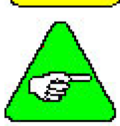
After powering down the product, wait at least 10 minutes before touching live sections of the equipment or undoing connections (e.g. contacts, screwed connections). Capacitors can store dangerous voltages for long periods of time after power has been switched off. To be safe, measure the contact points with a meter before touching.

The safety-alert symbols contained in this manual are:

"**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.

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.

Directives and Standards

The SERVO**STAR** product series has been successfully tested and evaluated to meet UL/cUL 508C for U. S. and Canadian markets. This standard outlines the minimum requirements for electrically operated power conversion equipment (frequency converters and servo amplifiers), which are intended to eliminate the risk of fire, electric shock, or injury to persons, being caused by such equipment.

Mark Conformance

Servo drives are incorporated in electrical plants and machines for industrial use. When the servo drives are built into machines or plants, the operation of the drive is prohibited until the machine or plant meets 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 met.

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 lay 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; described in this documentation. Kollmorgen is not responsible for any divergence from the configuration and installation described in this documentation and is not responsible for the performance of new measurements or ensuring that regulatory requirements are met.

Kollmorgen's SERVO**STAR** products 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 (72/73/EEC). The product lines have been evaluated to EN50178 and EN60204 as a component of a machine and other relevant standards.

The Electromagnetic Compatibility (EMC) of a system is identified in two parts: emissions and immunity. Emissions are the generation of EMI (electromagnetic interference) and immunity is the susceptibility levels of the equipment. Limits are derived from generic standards EN55081-2 and EN55082-2 for heavy industrial environment. The SERVO**STAR** series of drives and BUS modules have been tested for radiated emissions, conducted emissions, EFT, ESD, surge, conducted immunity, and radiated immunity. These tests have been in accordance with EN55011, EN61000-4-2, ENV50140, IEC 1000-4-4, EN61000-4-5, and ENV50141.

Installation of the equipment is critical in designing system and machine electro-magnetic compatibility (EMC). The user must apply the installation recommendations in this manual. See the installation section and CE Filtering Techniques information when mounting and installing the drive system for CE conformance.

General Information

This manual is designed to lead you through the proper installation and setup of a SERVO**STAR**® SBD Series servo system. It was developed with the assumption that there is a fundamental understanding of basic electronics, 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.

USE AS DIRECTED

The following guidelines describe the restrictions for proper use of the SERVO**STAR** SBD 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 single or 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 the user must implement additional filter measures.
- The servo amplifiers are only intended to drive specific brush-type servomotors from Kollmorgen, with closed-loop control of torque and velocity. 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.

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 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, which 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.

ABBREVIATIONS

AC	Alternating Current
AppNote	Application Note
CCW	Counter Clockwise*
CMR	Common Mode Rejection
CW	Clockwise*
DC	Direct Current
Diff	Differential
EMF	Electro-Motive Force
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
Ext	External
Hz	Hertz
I	Current
Info	Information
I/O	Input / Output
KHz	KiloHertz
KCSN	Kollmorgen Customer Support Network
KW	KiloWatts
LED	Light Emitting Diode
Lim	Limit
NEC	National Electrical Code
PSP	Product Support Package
P/N	Part Number
PWM	Pulse Width Modulation
Regen	Regeneration
RMS	Root Mean Square
Tach	Tachometer
UL	Underwriters Laboratories

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

System Description

The SERVO**STAR** SBD-Series is a four-quadrant analog brush-type servo motor drive amplifier that meets the needs of many servo applications such as machine tooling, packaging, electronic assembly, and document handling. The SBD-Series of drives comes in standard packages of 3, 6, 10, 20, 30, 55, and 85 amps. A wide range complementary of Power Supply Modules are also available. A CT-series (Compact Drive), that includes an integrated BUS module, is available in 3, 6 and 10 amp sizes. All are packaged in a small frame size perfect for minimizing cabinet space. This product is a velocity controller commanded through an industrial standard +/- 10V analog interface using a DC tachometer generator for velocity feedback.

PRODUCT FEATURES

The SERVO**STAR** SBD is a brush motor drive capable of controlling the motor's velocity using a tachometer generator mounted to the motor as the feedback device. The drive is designed as a modern update to Kollmorgen's SBD Series of brush drive amplifiers produced over the past 25 years. The drive is fully analog and can receive the exact comp (compensation) card that was used in existing SBD2 application. The drive is built on Kollmorgen's SERVO**STAR** S-Series platform, which uses modern technology and has a long life expectancy. The SERVO**STAR** S-Series of brush drives is modular in design meaning that it has a separate power supply module. The PS Series of power supply modules are fully compatible to the SERVO**STAR** SBD Series of products.

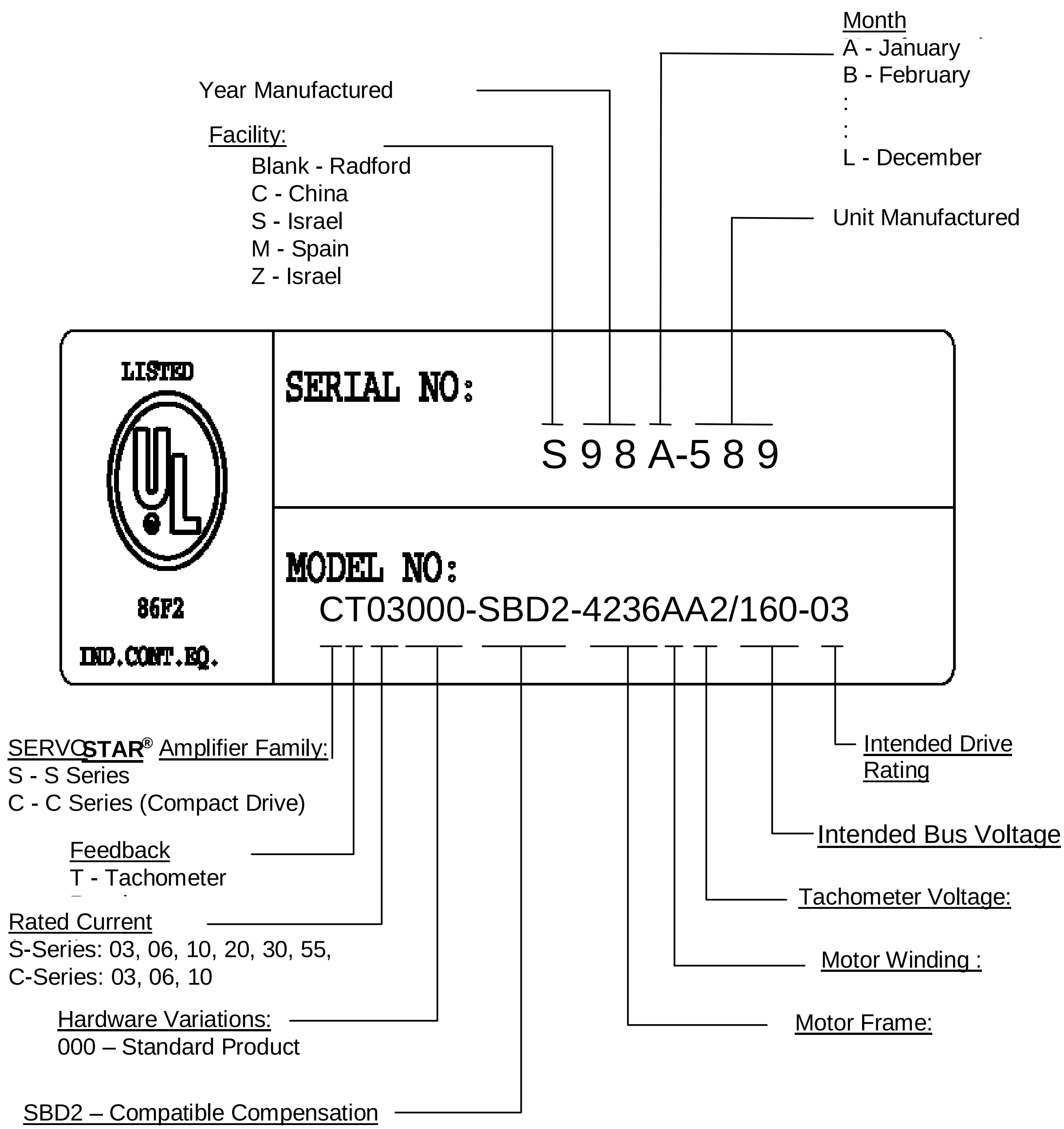
Fault and Safety Detection

Over Voltage protection
Over Current Protection (Short Circuit)
Under Voltage Lock-out (Can be disabled)
Motor Over Speed Protection
Over Temperature Protection (Drive's internal temperature)

General

Industry Standard +/- 10 Volt command signal input
External Regeneration Capability
SBD2 Compensation-Compatible Drive
Wide Range of Power Capacity
Smaller units available with integral Power Supply
Units available with Modular Power Supply

PART NUMBER DESCRIPTION



CT ELECTRICAL SPECIFICATIONS

Product Model		CT03	CT06	CT10
Main Input Power	Voltage (VAC_{L-L}) Nominal ±10%	63-230		
	Phases	1 / 3		
	Line Frequency	47-63		
	KVA @ **115 (1ϕ)**	0.44	0.89	0.89
	Continuous Current (amps) @ 115VAC	3.9	7.7	7.7
	Peak Current (amps) for 500 mSec 115VAC	11.7	23.1	23.1
	Peak Current (amps) for 2Sec 115VAC	7.8	15.4	15.4
	KVA @ **230(1ϕ)**	0.89	1.8	1.8
	Continuous Current (amps) @ 230(1ϕ)	3.9	7.7	7.7
	Peak Current (amps) for 500mSec @ 230(1ϕ)	11.7	23.1	23.1
	Peak Current (amps) for 2Sec @ 230(1ϕ)	7.8	15.4	15.4
	Line Fuses (FRN-R, LPN, or equivalent)	10	20	20
	KVA @ **230(3ϕ)**	1.4	2.8	4.6
	Continuous Current (amps) @ 230(3ϕ)	3.5	7	12
	Peak Current (amps) for 500mSec @ 230(3ϕ)	10.5	21	36
	Peak Current (amps) for 2Sec @ 230(3ϕ)	7	14	24
	Line Fuses (FRN-R, LPN, or equivalent)	10	20	25
Logic Input Power	+24VDC Ext. Logic Voltage (volts)	22 - 27		
	+24VDC Ext. Logic Current (amps sink)	1.5		
SoftStart	Max. Surge Current (amps)	30		
	Max. Charge Time (sec)	.25		
Protection Functions	Fault Contact Rating	1A		
	Fault Contact Closing Period (mSec)	Close = 3mS, Open = 2mS		
	OverTemperature trip (°C)	80°C		
Rated Main Output (Ma, Mb, Mc)	Continuous Power (KVA) @ 115VAC 1ϕ Line Input (45° Ambient)	0.35	0.7	0.7
	Continuous Power (KVA) @ 230VAC 1ϕ Line Input (45°C Ambient)	0.7	1.4	1.4
	Continuous Power (KVA) @ 230VAC 3ϕ Line Input(45° Ambient)	1.1	2.2	3.5
	Continuous Current (Adc)	3	6	10
	Peak Current (Adc) for 500mSec	9	18	20
	Peak Current (Adc) for 2Sec	6	12	20
	PWM Frequency (kHz)	10	10	10
	PWM Motor Current Ripple (kHz)	20	20	20
Protective Functions	UnderVoltage Trip (nominal)	90 VDC (Can be defeated)		
	OverVoltage Trip	430 VDC		
	OverTemperature Trip	80°C		
	Internal heat dissipation (watts – maximum))	60	80	132
Environment	Operation temperature (°C)	5 to 45°C		
	Storage temperature (°C)	-0 to 70		
	Ambient humidity	10% to 90%		
	Atmosphere	w/o no corrosive gasses or dust		
	Altitude	Derate 5% per 1000ft (300m) above 3300ft (1000m)		
	Vibration	0.5 g		

CT Regen Information

Product Model		CT03	CT06	CT10
Internal Shunt Regulator	Peak current (amps)	N / A		
	Resistance (ohms)			
	Watts			
	Fuse Rating (amps)(internal)			
External Shunt Regulator	Peak current (amps)	20		
	Minimum resistance (ohms)	20		
	Watts	200		
Application Information	Capacitance (Farads)	.00082	.00164	
	BUS Voltage (nominal) (VDC)	325		
	V_{HYS} (Regen circuit turn-off) (VDC)	370		
	V_{MAX} (Regen circuit turn-on) (VDC)	390		
Internal Regen	Resistance (Ω)	N / A		
	Power Rating (Watts)			
External Regen Kits	ERH-26	✔	✔	✔

For guidance on application sizing of Regen Kits, see Application Note, SERVOSTAR** S/C-Series Regeneration Requirements on the PSP CD-ROM, or the Kollmorgen website (www.MotionVillage.com).*

ST ELECTRICAL SPECIFICATIONS

Product Model		ST03	ST06	ST10	ST20	ST30	ST55	ST85
Main Input	BUS (VDC)	to 360			to 360			
	Rated Power @ DC (kW)	0.63-1.4	1.26-2.79	1.96-4.34	8.68	13.33	24.45	37.20
Rated Main Output (MA, MB, MC)	Continuous Power (KVA) @ 115VAC 1ϕ Line Input (45° Ambient)	0.55	1.1	1.6	n/a	n/a	n/a	n/a
	Continuous Power (KVA) @ 230VAC 1ϕ Line Input (45°C Ambient)	1.1	2.2	3.2	3.2	n/a	n/a	n/a
	Continuous Power (KVA) @ 230VAC 3ϕ Line Input(45° Ambient)	1.1	2.2	3.6	7.3	11	20	30
	Continuous Current (Adc)	3	6	10	20	30	55	85
	Peak Current (Adc) for 500mSec	6	12	20	40	60	110	170
	Peak Current (Adc) for 2Sec	6	12	20	40	60	110	170
	PWM Frequency (kHz)	10			10			
	PWM Motor Current Ripple (kHz)	20			20			
Control Input	+8VDC Supply Voltage	7.3-8.5						
	+8VDC Supply Current (amps)	0.5						
	±15VDC Supply Voltage	14.3-15.5						
	±15VDC Supply Current (amps)	.37		.38	.5	.47	.66	.87
Protective Functions	UnderVoltage Trip (on power-up) (Can be defeated)	90 VDC			255 VDC			
	UnderVoltage Trip (nominal) (Can be defeated)	90 VDC			125 VDC			
	OverVoltage Trip	430 VDC						
	OverTemperature Trip	118°C			90°C			
Environment	Internal heat dissipation in 45° ambient @ continuous current (Maximum Watts)	37 w	84 w	120 w	240 w	254 w	465 w	675 w
	Operation temperature (°C)	0 to 45°						
	Storage temperature (°C)	-20 to 70°						
	Humidity (non-condensing)	10% to 90%						
	Atmosphere	w/o corrosive gasses or dust						
	Altitude	Derate 5% per 1000ft above 3300ft						
	Vibration	0.5 g						

CONTROL SPECIFICATIONS

I/O Connector (C3 by pinout)		
Analog Input (2,3)	Maximum Voltage	13 V differential
Fault Output Relay (5,6)	Max Capacity	500mA @ 110VAC
User Controls (Enable, CW/CCW Lim, Torque Hold, Ext I Limit	Operation	Tie to common to activate circuit. DO NOT APPLY VOLTAGE.

FEEDBACK DEVICES

The SERVO**STAR** SBD is designed for use with analog tachometer feedback only. The absolute maximum voltage that the tachometer is allowed to generate and send to the control electronics is 100V.

Power Supplies

The SERVO**STAR** family includes a variety of BUS modules that convert a single-phase logic voltage and a single or three-phase AC line into the drive's DC logic power and main DC BUS.

Brush motor design makes them more sensitive to high voltage conditions than brushless motors. The PS power supply family offers a number of voltage ratings designed to shunt-regulate regenerated power to maintain safe operating voltage levels. Operating these power supplies with higher-than-designed input voltages can cause regen circuit failure.

FEATURES

- Converts single or three-phase AC main lines (or transformer outputs) into a rectified DC BUS (check BUS module Electrical Specifications table to verify specific BUS module operation). The input consists of a 3ϕ diode bridge, soft-start circuitry, and BUS capacitors. These capacitors help to minimize BUS ripple, and therefore BUS drooping, during the peak power demands of the load.
- All units have soft-start capability to gradually develop the DC BUS allowing direct line connection to minimizes the effect of "in-rush" current spikes inherent in a power-up cycle.
- An external Shunt Regulator option to dissipate regenerative energy while maintaining a safe operating voltage for the motor.
- The logic BUS module on all units consists of a switching power supply to develop the required ±15V and +8V from either the main line (use L_A and L_B) or a separate AC logic input.
- Product features are:

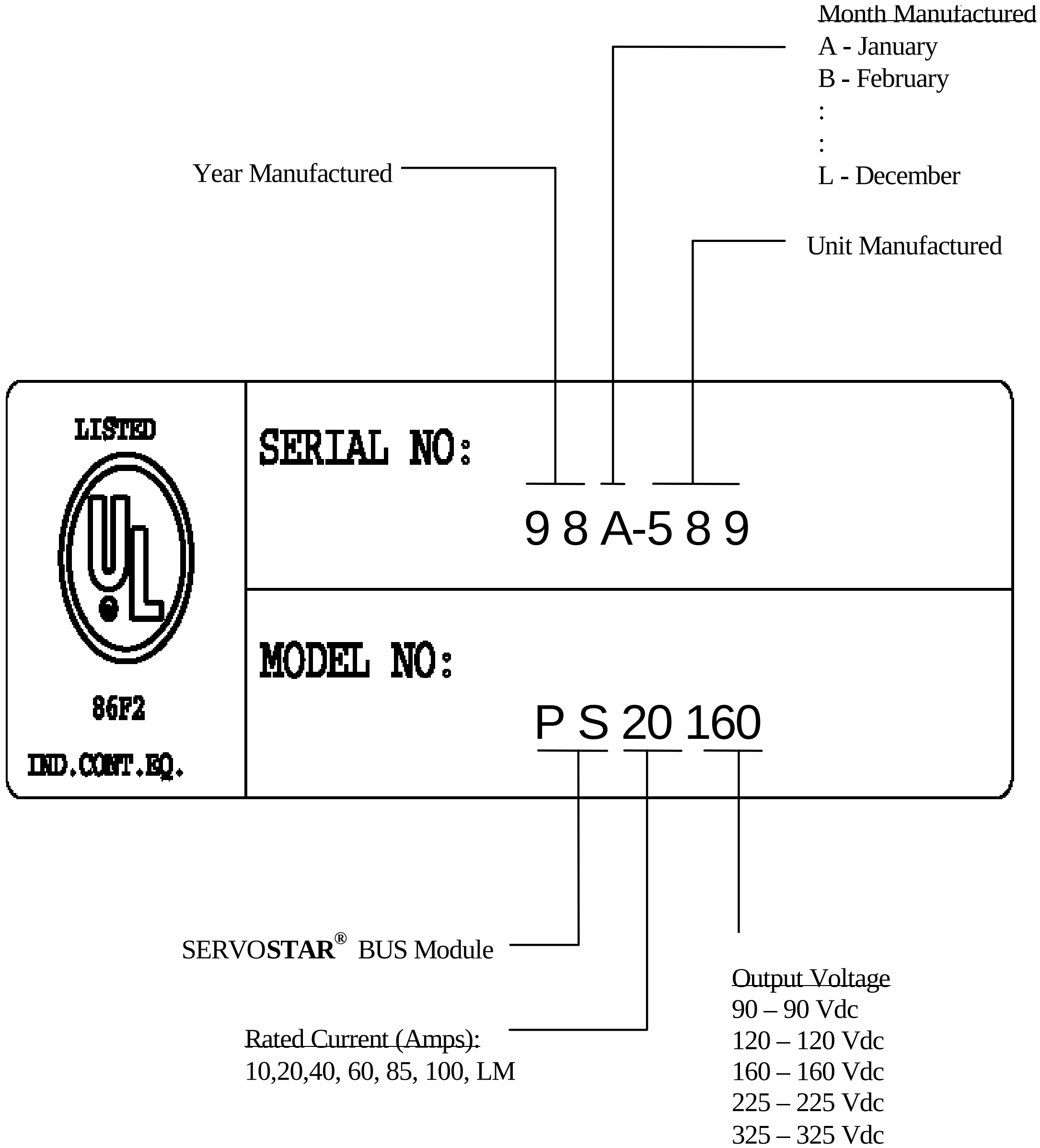
Indicator	PS10	PS20/40	PS50/75/85
[1]Green LED	X	X	X
[2]Yellow LED	n/a	X	X
[3]Red LED	n/a	n/a	X
[4]Fault Relay	n/a	X	X
[5]SoftStart	X	X	X
[6]Regeneration	n/a	I/E	E

[1] Indicates when voltage is on the caps.
[2] Indicates unit is operating in regen and may flash during aggressive accelerations.
[3] Indicates unit is still in SoftStart. This LED is also used to indicate when an OverVoltage fault has occurred from too much power being pumped back into the system during regen.
[4] The relay is a normally-open contact and closes after the unit is powered-up and out of SoftStart. The contact will open if there is an improper BUS module voltage (dropping in and out of SoftStart), an over-heated internal regen resistor, or the main heatsink becomes too hot.
[5] Contains SoftStart capability
[6] E-external, I-internal

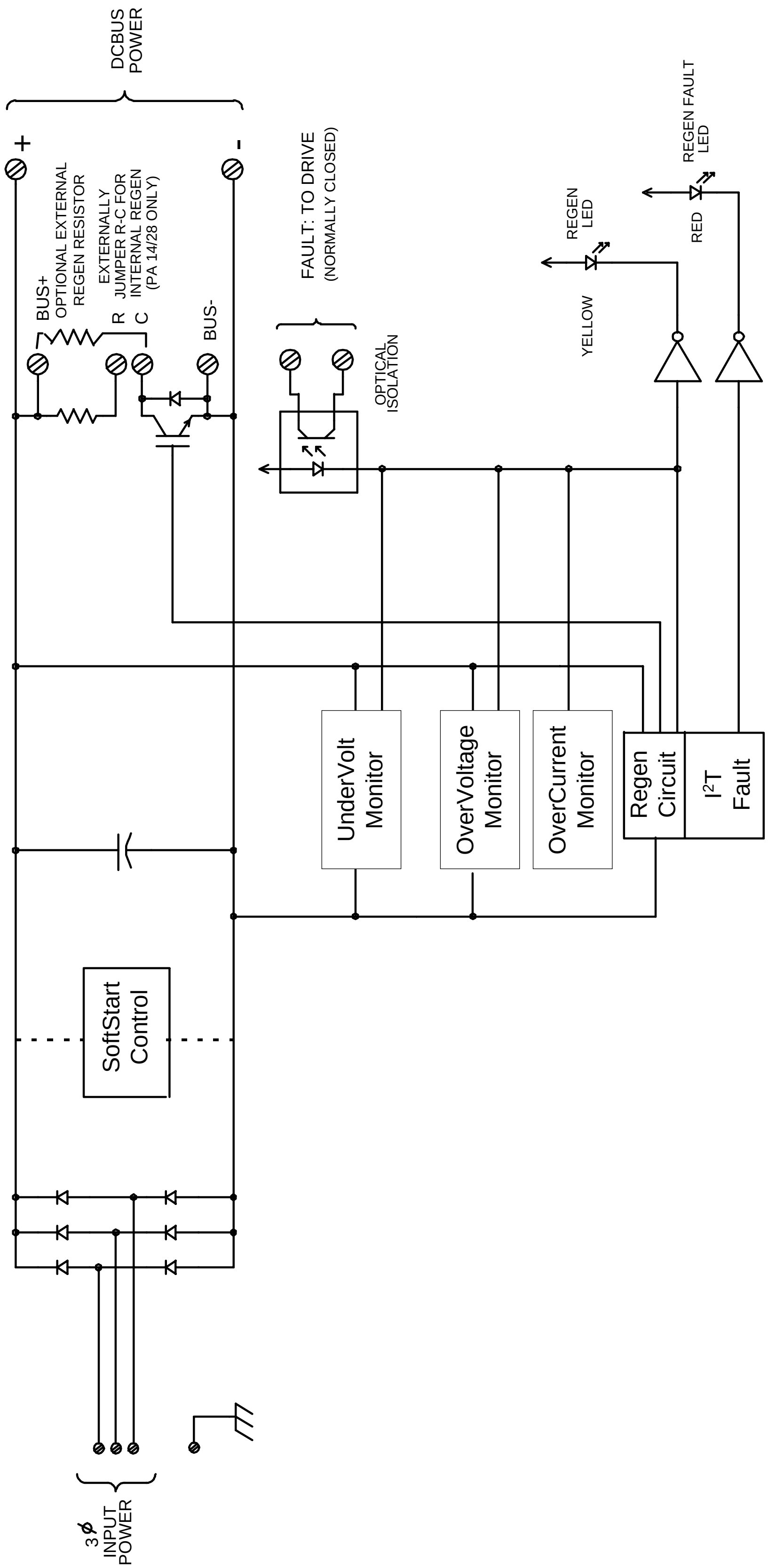
- The PA-LM unit is a logic supply only and should be used in multi-axis applications where the bus power supply already exists. This unit comes with three green LEDs that verify the presence of the +15V, -15V, and 8V sources.

See BUS Electrical Specifications *on page* ***Error! Bookmark not defined.*** *far details on the features.*

PART NUMBER DESCRIPTION



SIMPLIFIED SCHEMATIC



BUS ELECTRICAL SPECIFICATIONS

		PSx0090	PSx0120	PSx0160	Px20225	Px20325
Main Input Power	Voltage (VAC_{L-L}) Nominal ±10%	64 (1ϕ/3ϕ)	85 (1ϕ/3ϕ)	115 (1ϕ/3ϕ)	160 (1ϕ/3ϕ)	230 (1ϕ/3ϕ)
	Line Frequency	47/63	47/63	47/63	47/63	47/63
	PS20 Rated Continuous Input Current (Amps/Phase)	14	14	14	14	14
	PS40 Rated Continuous Input Current (Amps/Phase)	28	28	28	28	28
	Peak Current (amps) for 2sec / 50msec	28/42	28/42	28/42	28/42	28/42
	Line Fuses (FRN, LPN, or eqv) PS20/PS40	20 / 40	20/40	20/40	20/40	20/40
Main Output Power	DC BUS Voltage (Nominal) (VDC)	90	120	160	225	365
	PS20 Bus Current (Amps DC) (1ϕ/3ϕ)	20	20	20	20	20
	PS40 Bus Current (Amps DC) (3ϕ Only)	40	40	40	40	40
	Max. # of Drives Sourced	2	2	2	2	2
Logic Input Power	Voltage (VAC nominal +/- 10%)	115 (1ϕ)	115 (1ϕ)	115 (1ϕ)	115 (1ϕ)	115 (1ϕ)
	Current (Amps AC)	1	1	1	1	1
Logic Power Output	+8 V Supply (Volt Range/Amps)	7.25-8.5 / 2.2	7.25-8.5 / 2.2	7.25-8.5 / 2.2	7.25-8.5 / 2.2	7.25-8.5 / 2.2
	Analog Supplies (Volt Range / Amps)	+/- 14.25-16 / 0.8	+/- 14.25-16 / 0.8	+/- 14.25-16 / 0.8	+/- 14.25-16 / 0.8	+/- 14.25-16 / 0.8
	Internal Fusing (8V/15V Amps)	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5
Soft Start	Turn-Off Level (on power-up) VDC Bus	50	50	90	120	180
	Turn-On Level (normal)	30	30	70	100	160
	Max. Charge Time (sec)	0.75	0.75	0.75	0.75	0.75
Protection	Fault Contact Rating	1 Amp 115VAC	1 Amp 115VAC	1 Amp 115VAC	1 Amp 115VAC	1 Amp 115VAC
	Fault Contact Closing Period (mSec)	250	250	250	250	250
	Over Temperature trip (°C)	90	90	90	90	90
Environmental	Internal heat dissipation (watts) (20/40)	70/125	70/125	70/125	70/125	70/125
	Operation temperature (°C)	5 to 45	5 to 45	5 to 45	5 to 45	5 to 45
	Storage temperature (°C)	0-70	0-70	0-70	0-70	0-70
	Altitude (Ft) Derate 5% per 1000 over 3300	3300	3300	3300	3300	3300
	Vibration (g)	0.5	0.5	0.5	0.5	0.5
	Ambient humidity	10-90	10-90	10-90	10-90	10-90

BUS MODULE REGEN INFORMATION

Product Model		PS20	PS40
Internal Shunt	Peak current (amps)	30	32
	Resistance (ohms)	7.5	12.5
	Watts	40	40
	Fuse Rating (amps)(internal)	7	8
External Shunt	Peak current (amps)	40	45
	Minimum resistance (ohms)	V Regen/40	V Regen / 45
	Watts (max)	300	400
Application Info	Capacitance (Farads)	.00165	.00198
Internal Regen	Resistance (Ω)	12.5	
	Power Rating (Watts)	40	

For guidance on application sizing of Regen Kits, see Application Note, SERVOSTAR** S/C-Series Regeneration Requirements on the PSP CD-ROM, or the Kollmorgen website (www.MotionVillage.com).*

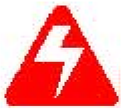
Kit Parts and Models

Kit Parts / Kit Models		ERH-26	ERH-40
Resistor	Resistance (Ω)	20	8.8
	Power Rating (Watts)	200	100
	Kollmorgen Part No.		P-97742-001
Overload Relay (Fast Trip)	Relay Trip Setting (amps)	n/a	n/a
	Kollmorgen Part No.	n/a	n/a
	Auto/Manual Setting	n/a	n/a
Thermostat	Thermal Rating (°C)	Internal to Box	Internal to Box
Hookup	Wire Gauge / Temp. Rating	#8awg / 125°C	

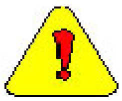
Hardware Installation

UNPACKING AND INSPECTION

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



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.



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.

MOUNTING

For proper ventilation the SERVO**STAR** and BUS module units should be mounted vertically. No horizontal distance between the drive and BUS module is required. In systems using more than two SERVO**STAR**s per BUS module, divide the drives equally on either side of the BUS module. They are designed for mounting in an electrical enclosure to protect them from physical and environmental damage and to protect nearby personal from hazardous electrical potentials.

*SERVO***STAR CT Hardware Specifications**

Amplifier Model		**CT03**	**CT06**	**CT10**
Unit Weight	lbs / Kgs	3.56 / 1.61	4.9 / 2.22	5.94 / 2.69
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 / .25		
	Main Input (AWG/ mm^2)	14 / .25	12 / 4	
	Configurable I/O wire gauge	22-18 AWG (.3-.75mm^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 (1.5mm2): Hollingsworth XSS0954S OR SS20947SF or equivalent 12/10 AWG (4-6mm2): Hollingsworth XSS20836 OR SS20832F or equivalent		
	Ring Terminals	8 AWG (10mm2): Hollingsworth R3027BF or equivalent 6 AWG (16mm2): Hollingsworth R4001BF or equivalent 4 AWG (25mm2): Hollingsworth R5100BF or equivalent 2 AWG (35mm2): 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		
	C2	Phoenix #: MVSTBW 2,5/20-ST-5,08 Kollmorgen #: A-96516		
	C5	Kollmorgen #: A-81014-004 Vendor Info: PCD ELFP04110		
	Connector Screw Torque	2.25 lb-in (0.25m)		
	24V Logic (optional)	PCD ELFP02210 or equivalent		

*SERVO*STAR *ST Hardware Specifications*

Amplifier Model		ST03	ST06	ST10	ST20	ST30	ST55	ST85
Unit Weight	lbs / Kgs	6.3 / 2.85		7.3 / 3.3	9.9 / 4.5	11.5 / 5.2	14.3 / 6.5	19.7 / 9.0
Mounting Hardware	English (Metric)	10-32 (M4)						
	Applied Torque	20 lb-in (2.26Nm)						
Connection Hardware	BUS Screw Size/Torque	6-32 / 12lb-in (1.35Nm)						
	Motor Screw Size/Torque	6-32 / 12lb-in (1.35Nm)				10-32 / 20lb-in (2.26Nm)		M5 / 20lb-in
	Ground Screw Size/Torque	M4 / 12lb-in (1.35Nm)				10-32 / 20lb-in (2.26Nm)		Box Lug
Wire Size (AWG#)	Control Logic (AWG/ mm^2)	18/.75				M4 / 20lb-in		M5 / 20lb-in
	Motor Line (AWG/ mm^2)	14/.25			10/4	8/10	4/25	2/35
	Main Input (AWG/ mm^2)	**See BUS Module Hardware Specifications**						
	Configurable I/O wire gauge	22-18 AWG (.3-.75mm^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						
	Side-to-Side	No Distance Required						
Clearance Distance	Top/Bottom	2.5in (63.5mm)						
	CK100 Kit	Includes: C1, C2, C4, C7 (plus 2ft / 0.25m of stranded bus ribbon), C8						
Mating Connector Hardware	C2	Phoenix #: MVSTBW 2,5/20-ST-5,08 Kollmorgen #: A-96516						
	C5	Kollmorgen #: A-81014-004 Vendor Info: PCD ELFP04110						
	Connector Screw Torque	2.25 lb-in						

BUS Module Hardware Specifications

<table>
<tr><th colspan="2">BUS Module Model</th><th>PA-LM</th><th>PS08</th><th>PS20</th><th>PS40</th></tr>
<tr><td>Unit Weight</td><td>lb / Kg</td><td>2.5 / 1.32</td><td>4.74 / 2.16</td><td>8.18 / 3.72</td><td>14.32 / 6.51</td></tr>
<tr><td rowspan="2">Mounting Hardware</td><td>English (Metric)</td><td colspan="4">10-32 (M4)</td></tr>
<tr><td>Applied Torque</td><td colspan="4">20 lb-in (2.26Nm)</td></tr>
<tr><td rowspan="5">Connection Hardware</td><td>Line Screw Size/Torque</td><td></td><td>6-32/ 12lb-in (1.35Nm)</td><td colspan="2">10-32/ 12lb-in (1.35Nm)</td></tr>
<tr><td>BUS Screw Size/Torque</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Ground Screw Size/Torque</td><td colspan="4">M4 / 12lb-in (1.35Nm)</td></tr>
<tr><td>Control Logic</td><td colspan="4">18/.75</td></tr>
<tr><td>Main Input (gauge based on 90°C wire)</td><td></td><td>14/2.5</td><td>12/4</td><td>8/6</td></tr>
<tr><td rowspan="3">Wire Size AWG#/mm²</td><td>BUS bar wire</td><td></td><td>14/2.5</td><td>12/4</td><td>8/6</td></tr>
<tr><td>Spade Terminals</td><td colspan="4">16/14 AWG (1.5mm²): Hollingsworth XSS0954S OR SS20947SF or equivalent
12/10 AWG (4-6mm²): Hollingsworth XSS20836 OR SS20832F or equivalent</td></tr>
<tr><td>Ring Terminals</td><td colspan="4">8 AWG (10mm²): Hollingsworth R3027BF or equiv.
6 AWG (16mm²): Hollingsworth R4001BF or equiv.
4 AWG (25mm²): Hollingsworth R5100BF or equiv.
2 AWG (35mm²): Hollingsworth R7998BFN or equiv.</td></tr>
<tr><td rowspan="2">Clearance Distance</td><td>Side-to-Side</td><td colspan="4">No Distance Required</td></tr>
<tr><td>Top/Bottom</td><td colspan="4">2.5” (63.5mm)</td></tr>
<tr><td rowspan="5">Mating Connectors</td><td>CK100 Kit</td><td colspan="4">Includes: C1, C2, C4, C7 (plus 2’ of stranded bus ribbon), C8</td></tr>
<tr><td>C6</td><td colspan="4">Kollmorgen #: A-81014-002 Vendor Info: PCD ELFP02110</td></tr>
<tr><td>C7</td><td colspan="4">Kollmorgen #: A-81014-004 Vendor Info: PCD ELFP04110</td></tr>
<tr><td>C8</td><td colspan="4">Kollmorgen #: A-81014-003 Vendor Info: PCD ELFP03110</td></tr>
<tr><td>Connector Screw Torque</td><td colspan="4">2.25 lb-in (.25Nm)</td></tr>
</table>

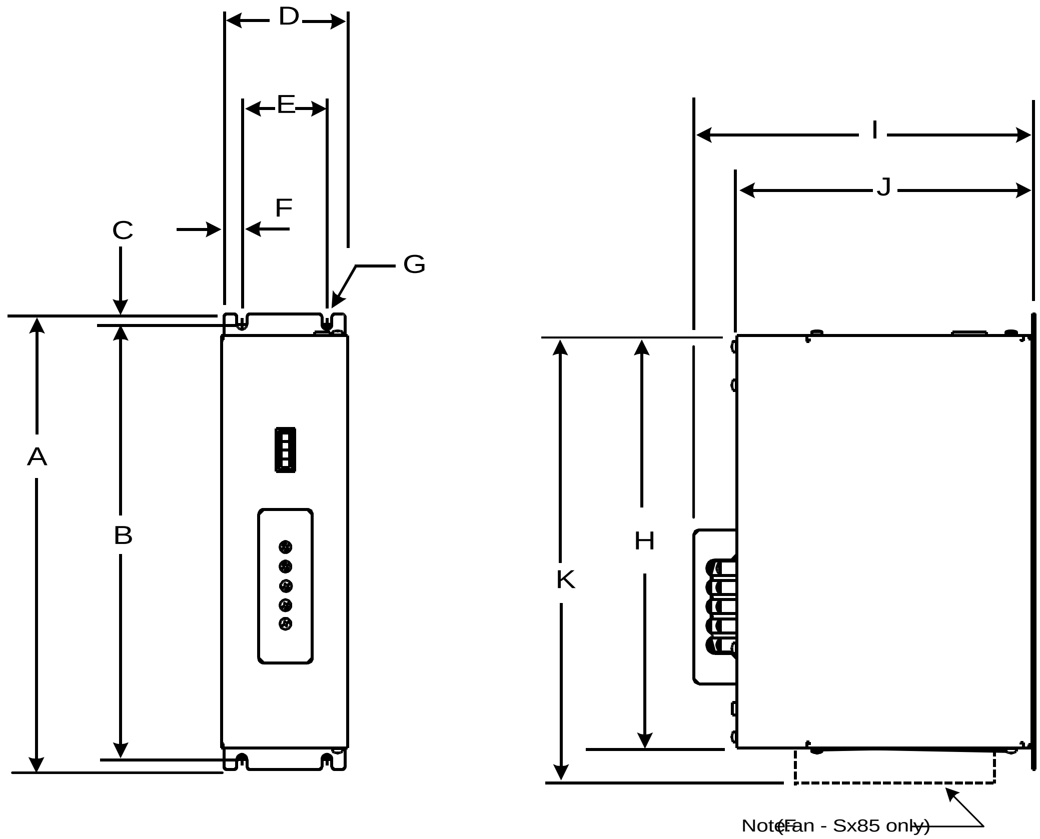
System Phasing Information

The SERVO**STAR** SBD Series drive outputs a positive voltage (Ma with respect to Mc) for a clockwise command (Diff High input more positive than Diff Low Input) and expects to receive a positive tachometer voltage (Tach High with respect to Tach Low). Reference points for Kollmorgen motors:

- Motor Armature positive lead is orange, negative green
- Tachometer Positive Lead is white, negative is black
- Clockwise reference is looking into the motor from the output shaft end

OUTLINE DIMENSIONS

ST and PS Units



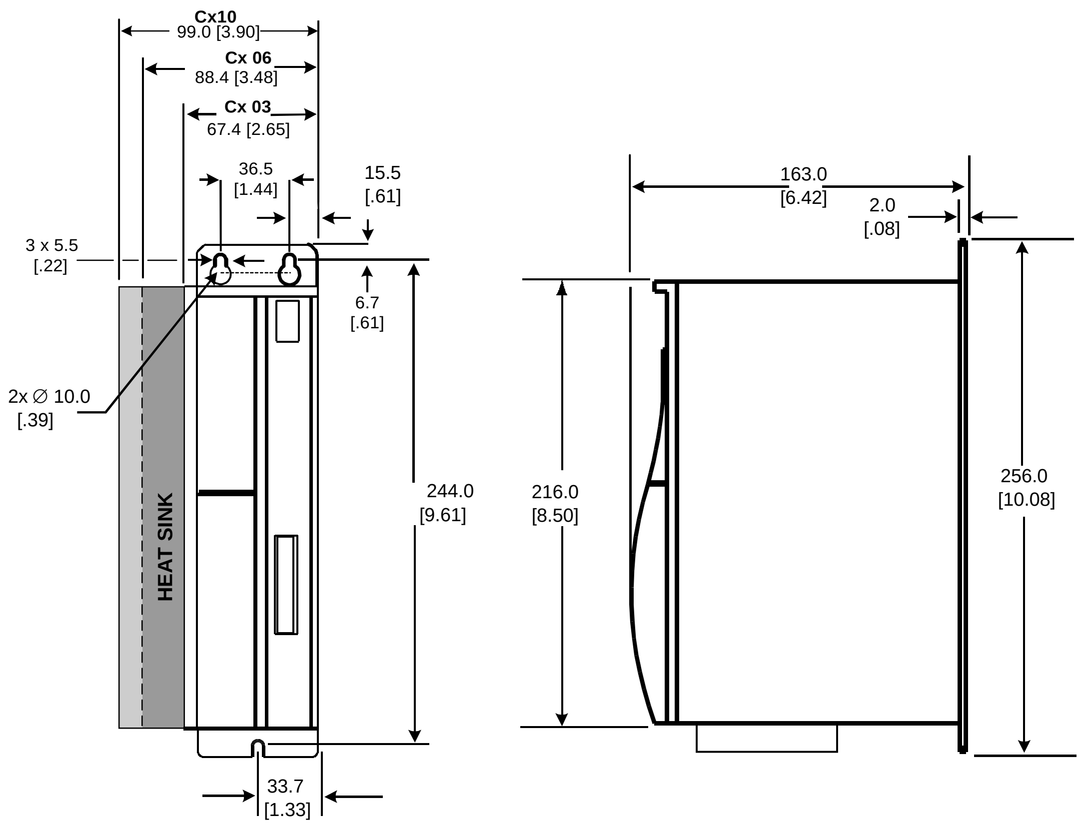
Inches

PRODUCT	A	B	C	D	E	F	G	H	I	J	K
ST03/06	10.39	9.921	.24	2.91	1.969	.49	.228	9.37	7.95	6.89	X
ST10	10.3	9.921	.24	3.54	1.96	.79	.228	9.37	7.95	6.89	X
ST20	10.3	9.921	.24	4.67	1.96	1.35	.228	9.37	7.95	6.89	X
ST30	10.3	9.921	.24	5.59	2.95	1.32	.228	9.37	8.27	6.89	X
ST55	11.8	11.10	.24	6.30	4.00	1.13	.228	10.39	8.30	7.00	X
ST85	11.8	11.07	.40	7.27	4.00	1.64	.228	10.37	8.61	6.91	12.63
PS08	10.3	9.921	.24	2.50	1.96	.24	.228	9.37	7.95	6.89	X
PS20/40	10.3	9.921	.24	4.90	1.96	1.46	.228	9.37	7.95	6.89	X
PS50/75/85	11.8	11.10	.24	6.53	4.00	1.22	.228	10.39	8.35	7.01	X

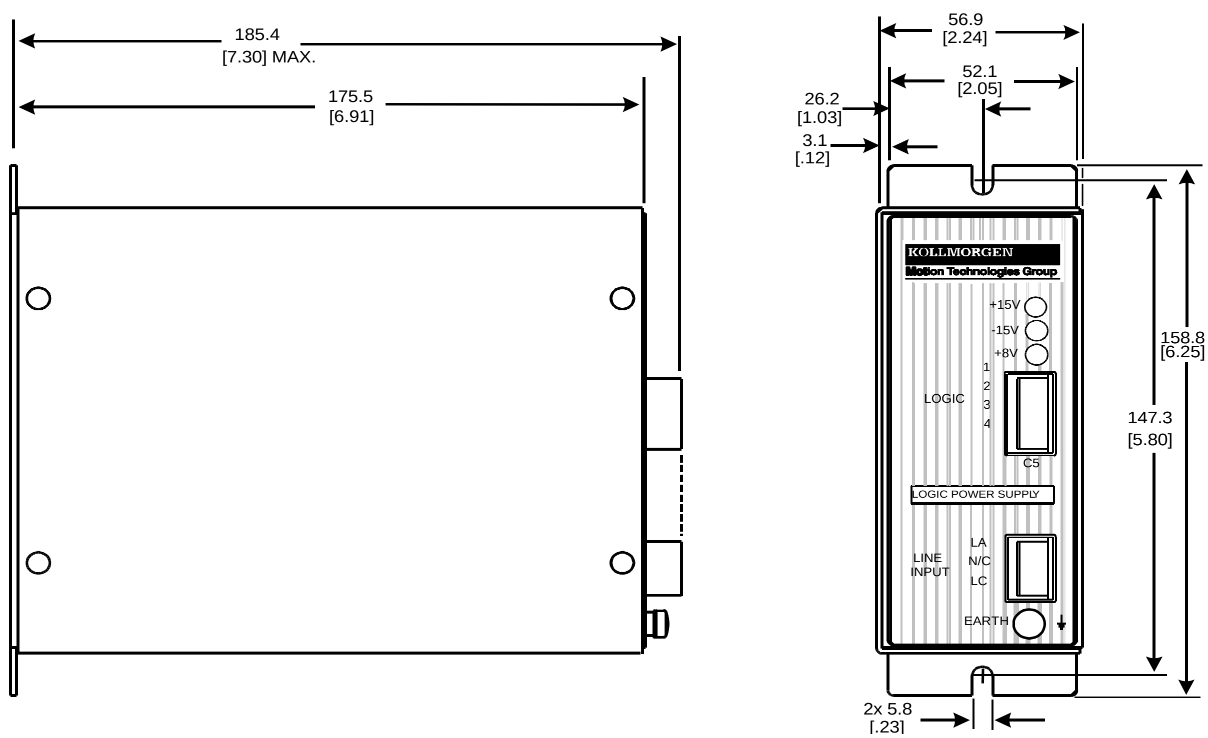
Millimeters

PRODUCT	A	B	C	D	E	F	G	H	I	J	K
ST03/06	264	252.00	6.0	75	50.00	12.5	5.80	238	202	175	X
ST10	264	252.0	6.0	90	50.0	20	5.80	238	202	175	X
ST20	264	252.0	6.0	118.6	50.0	34.3	5.80	238	202	175	X
ST30	264	252.0	6.0	142	75.0	33.5	5.80	238	210	175	X
ST55	302	282.0	6.0	160	101.	33.0	5.80	264	211	178	X
ST85	301.	281.2	10.2	184.7	101.	41.6	5.80	263.4	218.8	175.6	320.8
PS08	264	252.0	6.0	63.5	50.0	6.75	5.80	238	202	175	X
PS20/40	264	252.0	6.0	124.4	50.0	37.2	5.80	238	202	175	X
PS50/75/85	302	282.0	10	166	101.	31	5.80	264	202	178	X

CT Units



PA-LM Units



INSTALLATION PRACTICES

The environment that any electronic control system 'lives' in can effect its operation. Kollmorgen recommends that the SERVO**STAR** system be operated and stored under the environmental conditions stated in the product specification tables. 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 chapter. In addition to these practices, some localities and industries may require applicable electrical and safety codes, laws, and standards.

Enclosure

The Kollmorgen SERVO**STAR** series of electronic system components are designed for panel assembly. This panel assembly 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.

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. A distance of 20cm (8in) is 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 to reduce the field coupling effect.

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.

Bonding

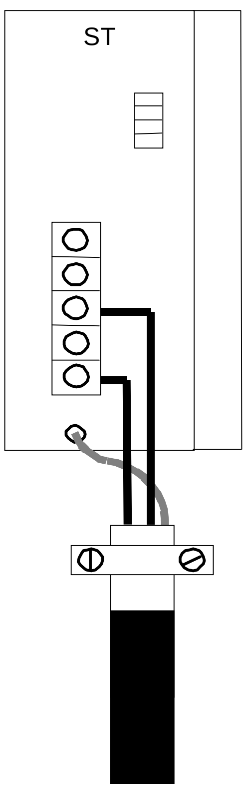
The proper bonding of shielded cables is *imperative* for minimizing noise emissions and increasing immunity levels of the drive system. Its effect is to reduce the impedance between the cable shield and the back panel. Kollmorgen recommends that all shielded cables be bonded to the back panel.

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.

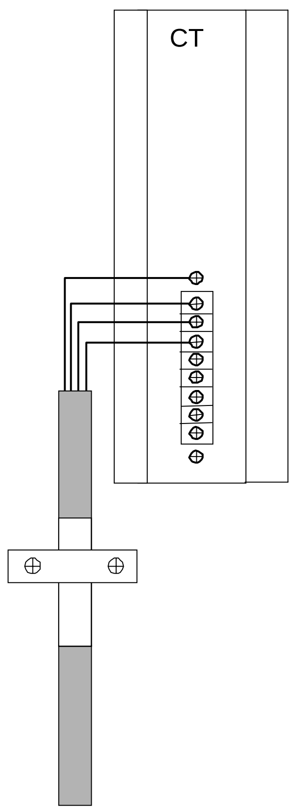
The motor and feedback cables should have the shield exposed as close to the drive as possible. This exposed shield can be bonded to the back panel using one of the two suggested methods below:

Non-insulated Cable Clamp

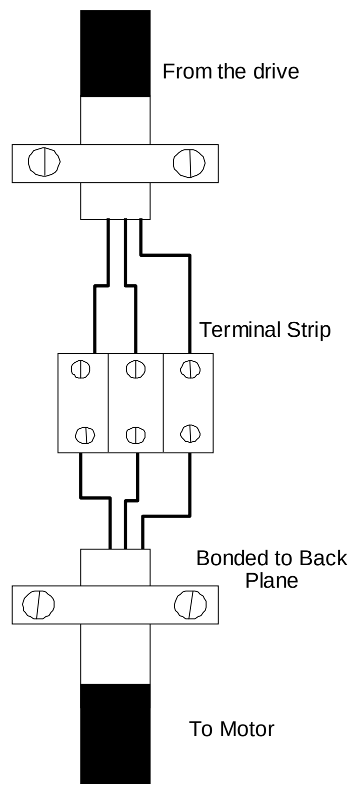
The following figures shows how cable bonding can be implemented using non-insulated metallic cable clamps. The first figure demonstrates clamping to the back panel in the vicinity of the drive. The second shows a technique for bonding a terminal strip (for best results, it is recommended not to break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



Sx Drive Clamp



Cx Drive Clamp



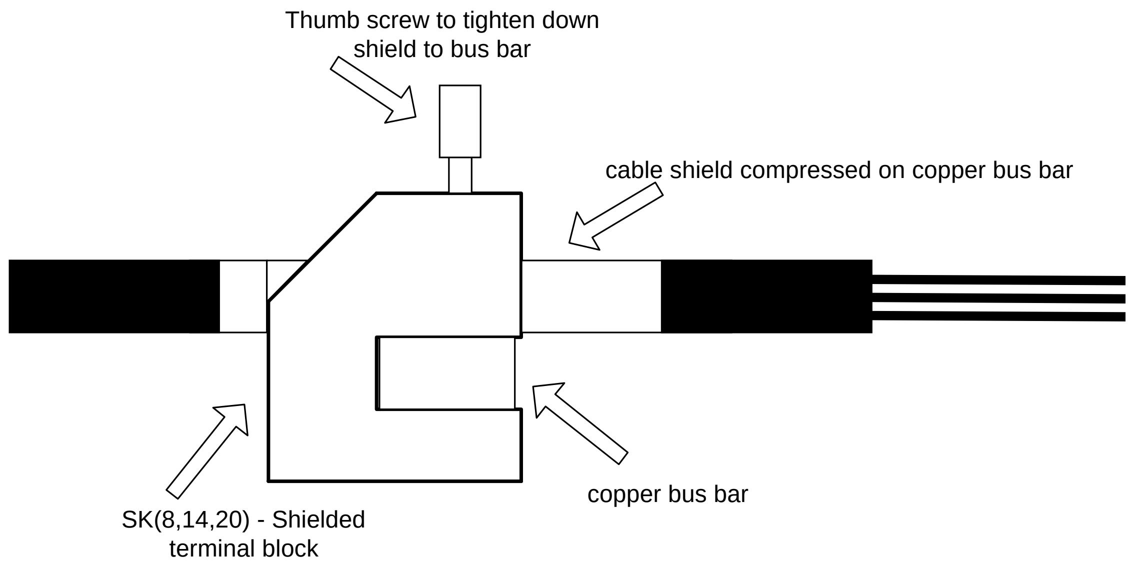
Terminal Clamp

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 TypeSK14	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

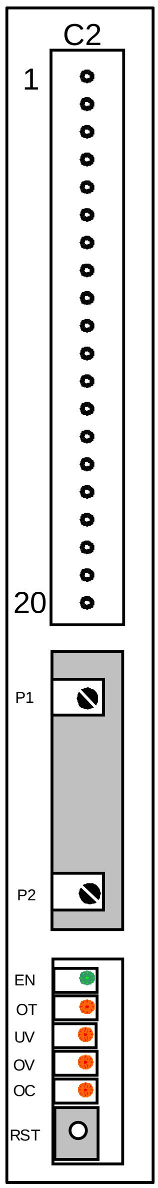
The figure below represents a side and top view of the SK device that clamps down on the shield of the cable. The use of the Phoenix SK device is an excellent method for providing a low impedance path between cable shield and the back panel.



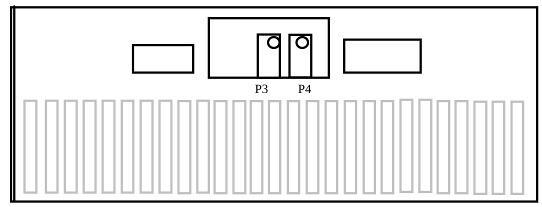
SYSTEM INTERCONNECT

The following sections provide connector information and the system connections up to the motor power and feedback connections. Cabling purchased from Kollmorgen directly completes the system connections.

Views



Front View



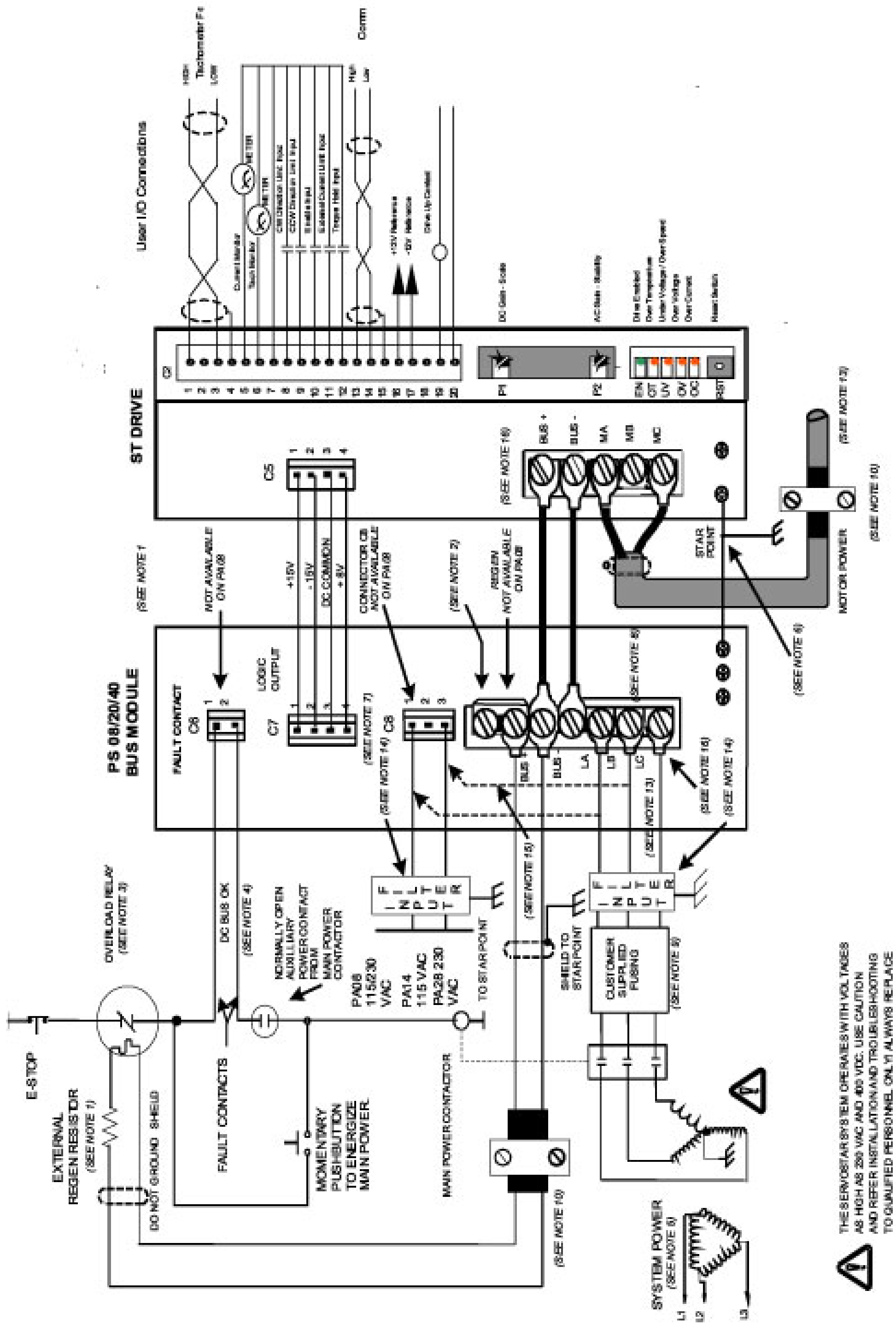
Top View

C2: User I/O Connector	
Pin	**Function**
1	Tachometer Input High
2	No Connection
3	Tachometer Input Low
4	Tachometer Shield Connection
5	Current Monitor Output
6	Tachometer Monitor Output
7	DC Common Reference for Monitors
8	CW Direction Limit Input
9	CCW Direction Limit Input
10	Enable Input
11	External Current Limit Input
12	Torque Hold Input
13	Analog Command Input – High
14	Analog Command Input - Low
15	Shield Connection for Analog Cable
16	+12 V Reference (10mA Max)
17	- 12 V Reference (10mA Max)
18	No Connection
19	Drive Up Contact
20	Drive Up Contact

LEDs and Switch	
Ref	**Function**
EN	Enabled
OT	Over Temperature
UV	Under Voltage
OV	Over Voltage
OC	Over Current / Over Temp
RST	Fault Reset

Potentiometers	
Ref	**Function**
P1	DC Gain (Scale)
P2	AC Gain (Stability)
P3	DC Balance (Offset)
P4	Current Limit Adjustment

ST Wiring Diagram with PS 08, 20, or 40



ST System Wiring Diagram Notes

Note 1 Resistor is connected to high voltage. Please ensure sufficient electrical clearance when mounting. Resistor may become very hot during operation. Do not mount near materials that are flammable or damaged by heat. Ventilation may be required. Each kit has different series/parallel resistor connectors to obtain specific resistance and power rating. For guidance on application sizing of Regen Kits, see Application Note, SERVO**STAR** S/C-Series Regeneration Requirements on the PSP CD-ROM, or the Kollmorgen website (www.MotionVillage.com) and Kit Parts and Models on page 13 for more details.

Note 2 When using internal regen, leave jumper installed between terminals “R” and “C”. Remove when using external regen kit.

Note 3 A thermal overload relay is supplied in the regen resistor kit. The thermal overload relay was sized for the resistance and power rating of the resistor. The output contacts of the relay must be wired to drop power to the main power contactor during a fault condition, as shown in the drawing. Do not wire Logic Control power through the main power contactor. Control power should not be removed if BUS module’s fault contacts open as this resets fault LEDs.

Note 4 The fault contacts must be wired in series with the overload relay as shown in the drawing. This contact is normally open and will close after application of control and main power. This contact opens in fault conditions. See BUS Electrical Specifications on page 12.
* Attempting to enable the drive before this BUS OK becomes active may cause BUS module to remain inactive.

Note 5 Transformer may be omitted if correct voltage source is applied. See BUS Electrical Specifications on page 12 for correct line input.

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

Note 7 Up to 2 drives can be supplied from a PS08 or PALM. All other power supplies can drive up to 4 drives for logic power.

Note 8 The BUS module line inputs are not phase sensitive.

Note 9 See BUS Electrical Specifications on page 12 for recommended line input fusing.

Note 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 Installation Practices on page 21 for full details.

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 Reserved

Note 13 See SERVO**STAR** ST Hardware Specifications on page 17 and BUS Module Hardware Specifications on page 18 for wire gauge and ferrule sizes.

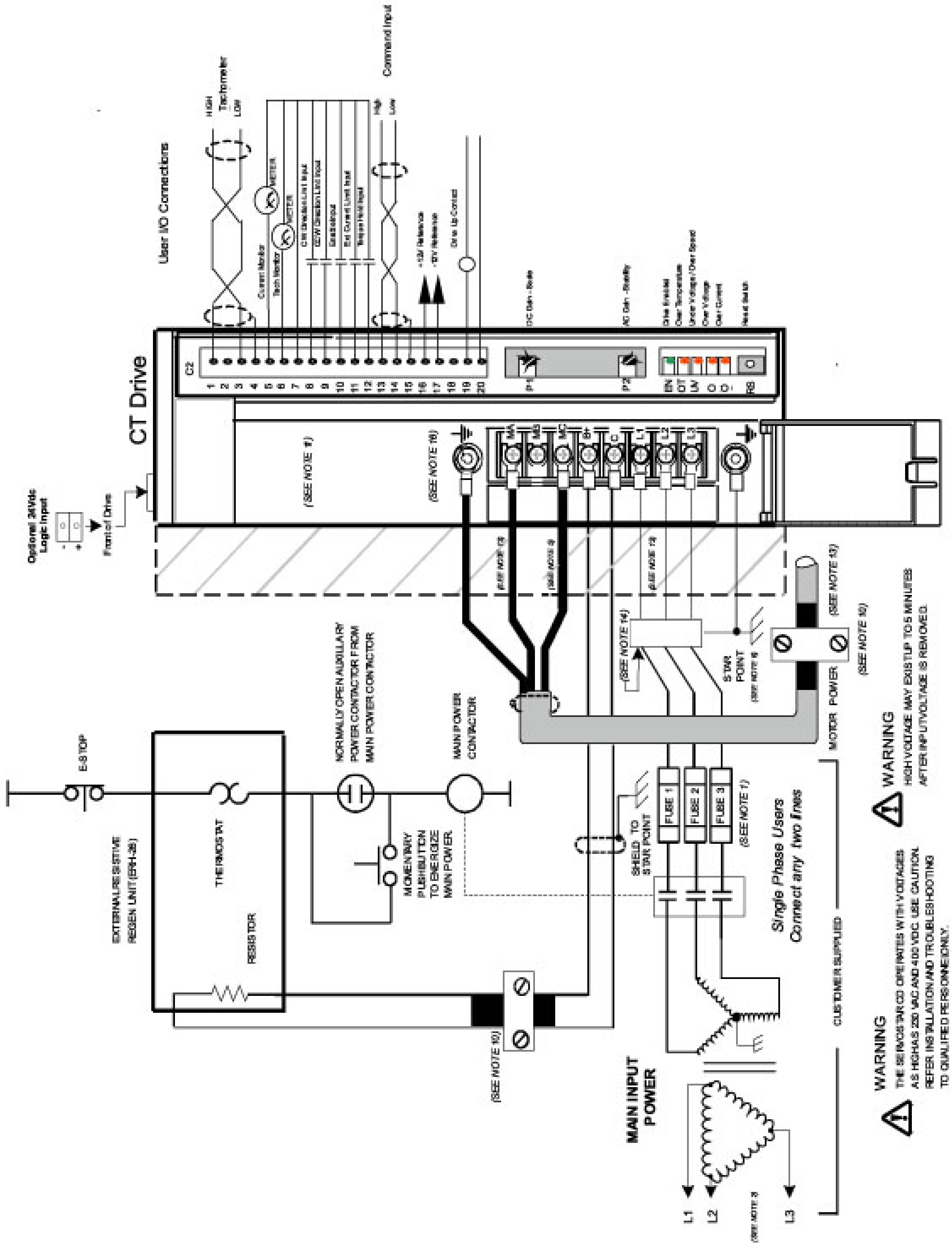
Note 14 Reserved

Note 15 Control logic input can be tapped directly off the main line input. If this source is used, the user must recognize that if the main line power is lost, all latched fault data will be reset and unavailable.

Note 16 See SERVO**STAR** ST Hardware Specifications on page 17 and BUS Module Hardware Specifications on page 18 for spade and ring terminal sizes.

Note 17 This system is suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical amperes, 240V maximum.

CT Wiring Diagram



CT 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 BUS Electrical Specifications on page 12 for recommended line input fusing.
Note 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 Installation Practices on page 21 for full details.
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	Reserved
Note 13	See **SERVO**STAR CT Hardware Specifications on page 16 and BUS Module Hardware Specifications on page 18 for wire gauge and ferrule sizes.
Note 14	Reserved
Note 16	See **SERVO**STAR CT Hardware Specifications on page 16 and BUS Module Hardware Specifications on page 18 for spade and ring terminal sizes.
Note 17	This system is suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical amperes, 240V maximum.

Operation Information

The normal operation of the LEDs is that all are off to indicate no fault and the drive is disabled. When the drive is enabled (Enable Input (C2 pin 10) tied to Common (C2 pin 7)) the green Enabled LED is illuminated. Illumination of any red LEDs indicates a fault.

A special reset circuit is provide to automatically reset an Under Voltage fault condition if power is applied after the drive is enabled. This allows separate power-up of logic and bus voltage without the need to reset an under voltage fault.

SYSTEM I/O

Tachometer Input (C2 Pins 1 and 3)

The DC tachometer generator signals are brought to these terminals. The voltage must not exceed 100 volts. The system is normally phased such that a clockwise motor rotation causes a positive voltage on these terminals. The tachometer signal is considered a low-level analog signal and careful routing and shielding must be performed to minimize noise pickup. It is recommended that a shielded, twisted pair wire be used with the shield connection tied to earth ground at the drive-end of the cable. The cable should be routed free from noise sources such as solenoid and relay wires and the motor armature cable.

The analog signal wires should be twisted, shield pair cable run free from any noise signals such as relay and solenoid wires as well as the motor armature and power line wires. The cable shield should be tied to earth ground at the drive. While a shield pin (C2 pin 4) is provided, it is best to bring this drain directly to the drive case.

Current Monitor (C2 Pin 5)

The current supplied to the motor can be monitored at this pin referenced to common (C2 pin 7). The scaling of this output is 8 volts = drive peak current rating.

Tachometer Monitor (C2 pin 6)

The motor velocity can be monitored on this pin referenced to common (C2 pin 7). The scaling of this output is 8-volts = motor's rated speed.

CW and CCW Limit Inputs (C2 pins 8 and 9)

The CW/CCW Limit inputs are used to limit the ability of the motor to produce toque in the stated direction (Assuming proper motor phasing). Each input may be tied to common (C2 pin 7) to disable torque in that direction.

Remote Enable Input (C2 Pin 10)

The Remote Enable input provides a hardware drive enable switch. This input disables or enables the power stage output to the motor. The signal must be tied to common (C2 pin 7) to enable the power to the motor. The toggling of this input (Open-to common) will also initiate an attempt to recover from a fault condition.

External Current Limit (C2 pin 11)

This input can be left open to obtain full torque to the motor. Taken to common, this input will reduce the amount of current to the motor by a percentage determined by the compensation component #27. See current clamp description for values.

Torque Hold Input (C2 pin 12)

This input can be tied to common (C2 pin 7) to cage the velocity loop amplifier. This prevents the drive from creating any significant current command to the motor.

Analog Input (C2 pins 13 and 14)

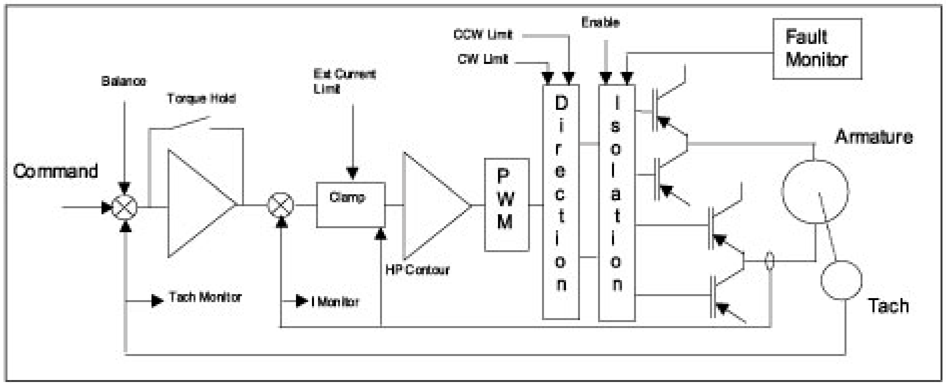
The drive receives its command from an analog voltage source connected to these terminals. The voltage range of this input is from –10 volts to +10 volts. The analog input to the SERVO**STAR** is differential; meaning that the signals received at the two inputs are subtracted from each other to create a difference used to command the rest of the system. This type of input has a high degree of noise immunity and, in many cases, allows for ground isolation between systems.

The input voltage from the differential receiver is applied to a gain-adjust potentiometer (called Scale) located on the compensation card to allow you to adjust the volts/RPM scaling of the drive. The SERVO**STAR** adds an analog offset to allow for drift-control through the adjustment of the trimmer potentiometer located at the top of the drive unit. Under normal system phasing, a positive voltage on these terminals commands the motor in a clockwise direction.

The analog signal wires should be a twisted, shielded-pair cable run free from any noise signals such as relay and solenoid wires as well as the motor armature and power line wires. While a shield pin (C2 pin 15) is provided, it is usually best to tie the shield of this cable at the source-end. If it is impractical to tie this cable at the source end, it is best to tie this cable directly to the drive case.

CONTROL LOOPS

The SERVO**STAR** provides high performance motor control by controlling motor current with an inner current loop which is controlled by an outer velocity loop.

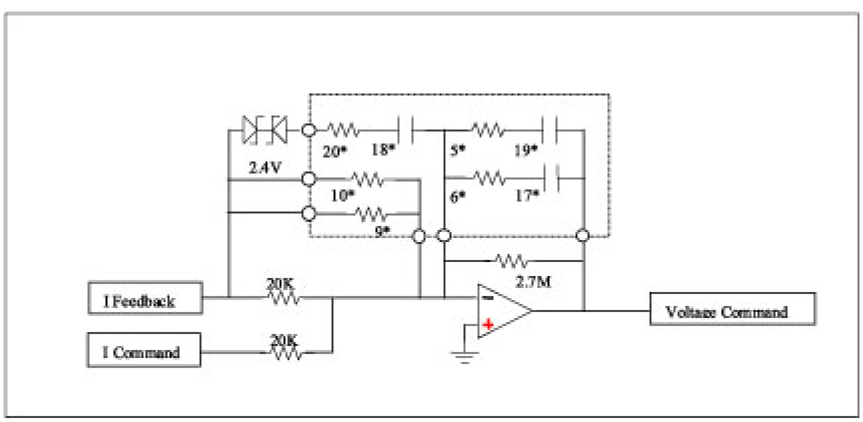


Each servo loop (current and velocity) is subject to a compensation network (as described below) to allow appropriate servo loop tuning. In addition, the current loop is subject to clamping protection for current limiting due to input request, compensation limits, or commutation limits, as described below.

Current Loop

Since current and torque are proportional in a Permanent Magnet (PM) motor, the current loop is often referred to as the torque loop. The purpose of the current loop is to control the current through the motor for protection and the creation of output torque. The commanded current is compared against the actual motor current, allowing any error between the two to adjust the voltage at the motor terminals by raising or lowering the current appropriately. The amount of current supplied by the current loop is a function of commands, drive size ratings, and clamp conditions (see below).

The ability to supply current to drive the motor and the ability to remove energy from the motor while being able to command the motor in either direction are characteristics referred to as four-quadrant operation. During deceleration, energy must be removed from the motor. This energy is pumped back into the capacitors on the DC Bus. This action is referred to as regeneration or regen. The energy causes the bus voltage to raise. The drive monitors this bus voltage for unsafe levels and shuts the drive down in an over-voltage fault, if the voltage gets too high.



The current loop compensator circuit is a simple integrating double low pass filter (5*/19* and 6*/17*) with a lead network (20*/18*) and the ability to scale the current feedback (10*, 9*). The current feedback signal is scaled to 8 Volts = Drive Peak Current Rating. Resistors 9* and 10* offer the ability to change this scaling to make the sensors more sensitive. The lead network can allow for a more responsive current loop but lead networks tend to add noise. This circuit features the 2.4V zener diodes to clamp noise from entering the lead network.

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 10 kHz (see CT Regen Information on page 6 for specific details).

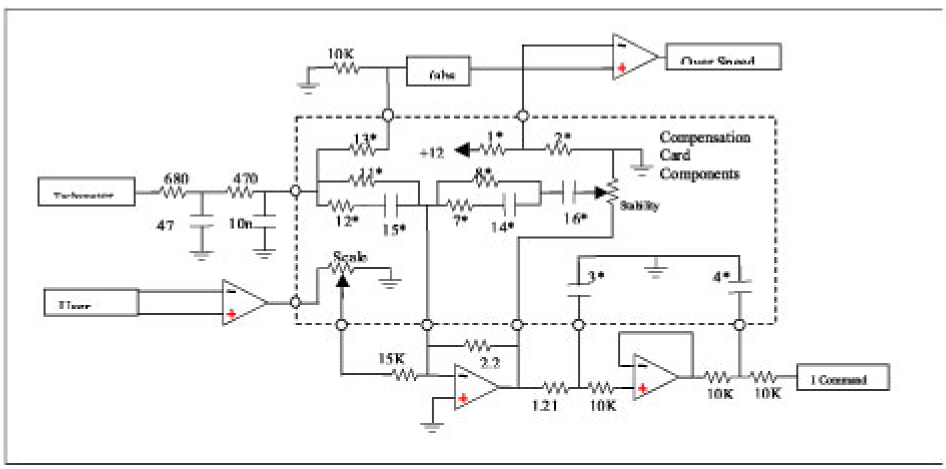
A simple approximation can be made by simply using a single low-pass filter designed to slow the rate-of-change of the voltage command to prevent double-pulsing the PWM output. Components for the tuning the current loop can be calculated with the following equation.

Resistor (5*) ≤ (1x10^9 * Drive's Peak Current Rating * Motor inductance) / (VAC*1.6)
Capacitor (19*) = 1/(625 * Resistor)

All other components should be open-circuit.

Velocity Loop

The purpose of the velocity loop is to regulate motor speed. The velocity loop compares the commanded velocity to the actual velocity (tachometer signal) and generates a current command to bring the two in equilibrium. The difference between actual and desired velocity is filtered through a compensator (as shown in the following diagram).



The input to the velocity loop comes from an external analog source and is scaled with the Scale potentiometer that provides the ability to adjust a DC Gain component. When the pot is fully clockwise, the input is scaled so that full rated motor speed occurs with a 10V input. When the drive is used inside an external positioner control loop, it is typical to adjust this potentiometer to allow full speed with an 8V input to allow for overshoot.

The velocity feedback is from an external tachometer generator going through a 5kHz low pass filter before entering the comp card where it must be scaled for the velocity loop with resistor component 11*. The appropriate value for this resistor can be calculated using the following formula:

R11* (In Ohms)= (Tachometer Voltage (V/KRPM) * Rated Speed *1.2 *1.875) – 1,150

The velocity loop has the ability to be bandwidth limited for stability purposes. Resistor 8* and capacitor 16* are used for this purpose. Resistor 8* establishes a minimum gain while capacitor 16* determines the roll-off frequency. The stability pot allows some adjustment in the AC gain portion of the compensator to allow for changing external characteristics, such as inertia. Components resistor 7 and capacitor 14 allow for even more roll off at higher frequencies, which is sometimes required to reduce higher frequency noises.

The velocity compensator offers a feed-forward (or lead) network for the tachometer using components 12* and 15*. Resistor 12* is nominally chosen as 1/3 the value of R11 and C15 is adjusted (under test) to allow best transient response to a step function while keeping the decel overshoot to a maximum of 10%. While a lead network adds responsiveness, it can also add noise into the system and tends to tune the system for a given inertia and makes the system less tolerant to changes in the inertia. It is perfectly acceptable to not use the lead network. In cases with large load-to-motor inertia ratios or where there is changing load inertia.

In systems requiring a starting spot for the lead-lag components the following method provides good results:

1. **Determine the value for resistor 8***
   With C 16* a short circuit, C 15* removed, and the stability pot about centered, apply a 1V square wave to the input, allowing the motor to rotate freely. For best results, the frequency of the square wave should be about ¼ the desired bandwidth. Start with resistor 8* at a low value (1KΩ). Raise the value of resistor 8* until the response shows good, critically-damped response (little to no overshoot). This establishes the value of resistor 8*.

2. **Determine the value of capacitor 16***
   With the new value installed in R 8*, replace the short circuit with a capacitor substitution box. Beginning with a very high capacitance value, lower the value until the response now shows some overshoot. In systems not using the lead network, a 10% overshoot is usually optimal. In systems using a lead network, 20% to 30% overshoot is usually optimal.

3. **Determine the value of resistor 12***
   Omit this component if a lead network is not used. This resistor determines how much effect the lead network has on the system. This resistor is simply set to ¼ the value of resistor 8* for most systems. In systems ising some lead but more sensitive to noise issues or having larger inertial variations, this resistor can be set higher.

4. **Determine the value of capacitor 15***
   Omit this component if a lead network is not used. Install a capacitor substitution box. Start with the lowest value and raise it until the tachometer shows a square response. (Remove the overshoot inserted in step 2). This is the value to use for 15*.

5. **For systems requiring the best performance, it is possible to repeat steps 2 and 4 once, while expecting only a marginal increase in overall bandwidth.**

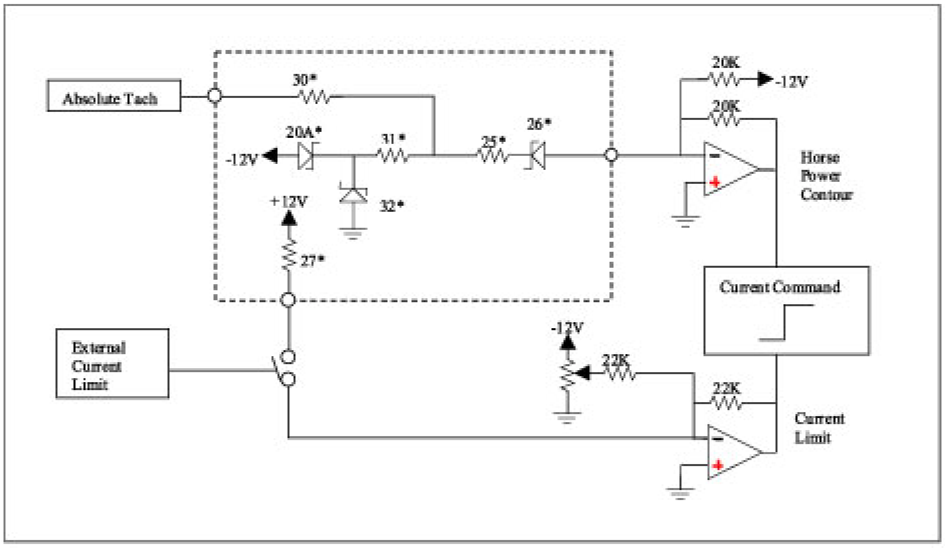
For best results, this procedure must be performed with a load on the motor that is very similar to the actual machine load for the motor. The stability pot allows some adjustment in the actual system gain to compensate for small differences. Higher frequency noise is eliminated using a resistor and capacitor in locations 12* and 15*, if required. Resistor 12* is typically ¼ the value of resistor 8*.

Capacitor components 3* and 4* allow the ability to add torsional resonance filters and are not generally used.

The velocity loop monitors the tachometer feedback signal for an over-speed condition and is typically set to detect speeds in excess of 120% of the motor's rated speed. Resistor components 1* and 2* set the reference trip voltage for the over-speed comparator. Considering the absolute tach signal is scaled for 8V=max speed, adjusting the voltage divider to provide a 10-volt trip point allows this circuit to perform satisfactorily and is established using 1.2k ohms for 2* and 7.2k ohms for 1*. The tachometer must also be scaled for the over-speed circuit using resistor component 13* calculated as follows:

R13*(in Ohms) = (Tachometer Voltage (V/KRPM) * Rated Speed * 1.2) - 1150

Current Clamps



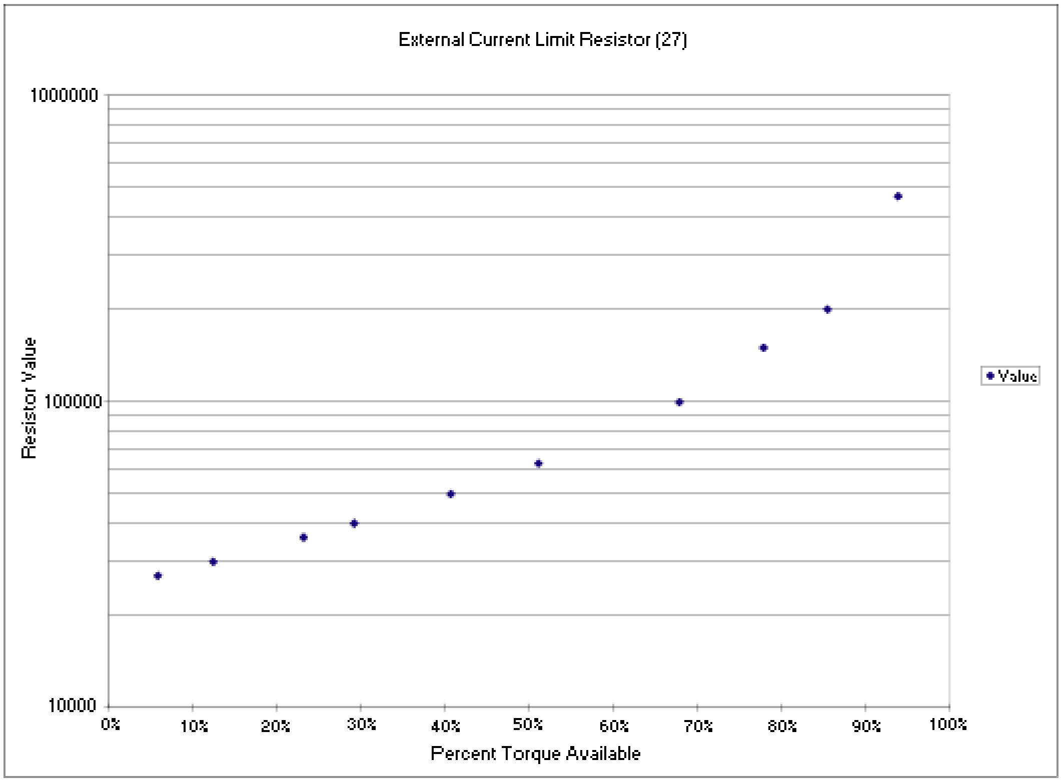
The current to the motor is clamped according to 3 separate signals as shown in the above figure (Torque Limit pot, External Current Limit Input, and the Horsepower contour circuit). All clamps work on the following fundamental scaling: Full speed is 8V and peak drive current is 8V. The clamp circuits work to limit the current command voltage signal to something less than 8V.

Torque Limit Pot

The torque limit pot allows an adjustment of maximum allowable current. When set clockwise, the pot allows peak rated current of the drive to the motor. Turning the pot counter-clockwise clamps the maximum current to less than the drive's peak rating.

External Current Limit

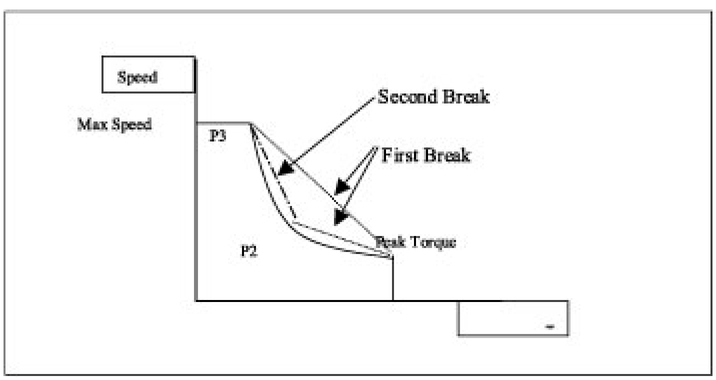
The external current limit is a user input at connector J2. Tying this input to common activates the limiting circuit. The limit that is asserted when this input is low is a proportion of the drive's peak current limited by the Torque Limit pot and established by the value of component (23) on the comp card. Component (23) is a resistor whose value is determined from the following chart.



The value of (23) is given on the Y-axis while the percentage of available torque is given on the X-axis. The value of (23) should not be less than shown on the chart or the torque to the motor is asymmetrical.

Horse Power Contour

The horse power contour circuit exists to protect the system. Brush motors have a limit of how much power can be transferred from the brushes to the commutator before an arc occurs from brush-to-brush (known as flashover). Drive and motor damage can occur if flashover happens. The horsepower contour circuit limits the current to the motor as a function of speed, effectively creating a simulated constant horsepower curve. The circuit is established as a one- or two-line approximation (P1-P3 and P1-P2-P3, respectively), as shown in the following diagram. The circuit uses zener diodes, which are inherently inaccurate and non-linear yet the tolerance of the flashover conditions make this circuit design adequate.



Establishing a Single, or one Break Line Limit

Diode 26 sets the speed at which horsepower contouring will begin (P1).

D26 is calculated as:

$$V_Z = 8*N_s / N_{max} - 1.5$$

Where:

V_Z is the Zener Diode Voltage Rating
N_s is the speed at which contouring begins
N_{max} Is the Maximum System Speed.

The first line segment, P1-P2 or P1-P3, has its slope established by R25. If a single-line segment approximation is suitable, the resistor must have the line segment intersect at P3 and R30 is a 0Ω jumper. The value of R25 is determined as follows:

$$R25 = \frac{20{,}000 * (8-V_z)}{12-(8*I_{clamp} / I_{peak})}$$

Where:

V_z is the Zener Diode Voltage Rating
I_{clamp} is the Maximum current at the breakpoint
I_{peak} is the Drives Peak Current Rating (2* continuous)

Establishing a Two-Line or Break Limit

If a two-line segment is required, R30 is set to 2KΩ, D26 is calculated as above, and R25 is calculated for the first line segment (P1-P2) with the following equation:

$$R25 = \frac{20{,}000 * ((8*N_b/N_r)-V_z)}{12-(8*I_{clamp}/ I_{peak})} - 2000$$

Where the new variables:

N_b = Desired Speed for second break
N_r = Motor's Rated Speed

The second line segment (P2-P3) is established using D20A and R31.

POTENTIOMETER ADJUSTMENTS

This section describes the purpose and effects of adjusting each of the drive's 4 adjustment potentiometers. Two potentiometers (DC Gain and AC Gain) are located on the comp card and face the user. The other two potentiometers (Balance and Current limit) are located at the top of the drive unit.

DC Gain – Scale

This potentiometer adjusts the velocity scaling of the drive. The analog input to the drive causes a commanded velocity to the motor. This potentiometer adjusts the amount of input voltage signal required to command a given motor velocity. This potentiometer is typically adjusted for 10-volts = rated speed for systems requiring only velocity control. In systems where the drive is used inside a position loop, it is common to adjust this pot so that 8-volts = rated motor speed to allow servo headroom.

AC Gain – Stability

This potentiometer is used to adjust the AC gain of the velocity loop. There is a low-pass filter network around the velocity loop amplifier, allowing the velocity loop to be bandwidth-limited for stability. This pot is used to modify the exiting bandwidth. When the velocity loop compensator components are properly selected, this pot allows some adjustment to variation in the load dynamics. Adjust this potentiometer for best system response while maintaining servo-loop stability.

Balance – DC Offset

This pot adds a DC offset signal into the velocity loop to null any offsets in the system. In systems where the drive is used as a velocity controller this pot is adjusted for zero motor speed when applying a zero speed command input. In systems where the drive is used inside of a position loop, it is common to adjust this potentiometer when the motor is at rest for a command of 0.000 volts input signal.

Current Limit

This pot is used to limit the peak current to the motor to something less than the drive's peak current.

System Startup

Check the system wiring before applying power. It is important that the proper voltages are wired to the appropriate terminals at the drive. It is extremely important that the system is properly grounded. The motor frame should have a ground wire back to the frame of the drive. Voltage should not be applied to any of the drive’s input control signals. These signals are controlled by leaving them open or tying them to the drive’s common.

The phasing of the system must be correct. If either the armature or the tachometer is reverse-phased, the velocity loop causes a potentially unsafe run away condition, allowing the motor to run uncontrolled. When used inside a position loop, the command signal must be phased correctly or the position loop may cause a run away condition.

INITIAL STARTUP

Most drives are shipped from the factory already configured for a particular motor. You can verify this by checking the drive’s model number and comparing the compensation portion of the model number to both the motor’s number and the applied voltage.

Caution must be taken when applying power to the drive. Any incorrect phasing or incorrect compensation components may cause the motor to act uncontrollably. It is your responsibility to be certain that damage to equipment or personnel cannot occur during startup. Verify that the hardware Remote Enable input is disabled.

Power-Up Sequence

The SERVO**STAR** is insensitive to power-up sequence meaning that bus power or logic power can be applied independently.

Enabling the System

With the input command signal at 0 volts, enable the drive. The green Enable LED should illuminate and there should be no fault LEDs (red) illuminated. Be certain the motor does not run away. If the motor does run away, the phasing of the armature or tachometer must be incorrect. Check the motor to see that there is applied torque by carefully commanding velocity first in one direction and then the other.

Drive Tuning

The drive should control the motor in a proper servo-stability fashion where the system is responsive yet stable. When using an external position loop controller the velocity loop is to be tuned first, independent of the position loop. The AC Gain pot may be trimmed for best transient response for the system. If the system is unstable, the system is going to require tuning by someone experienced in such maters. The Control Loops section of this manual is also useful.

ADJUSTMENTS

Refer to Potentiometer Adjustments on page 36 for a description of the potentiometer functions. Adjust each as required, beginning with the Balance pot.

SERVOSTAR **Help**

Problems with the drive can be through actual faults, bad compensation values installed on the comp-card, or self-inflicted by misunderstanding of the system's operation. If the system has been running and is experiencing faults, review the fault-codes in the following section.

Be certain that remote inputs (Enable, CW Limit, CCW Limit, External Current Limit, and Torque Hold) are in the correct and expected state.

A miss wired system, such as a reverse-polarity tachometer or a missing tachometer connection, can cause many faults.

FAULT MONITORING SYSTEM

The SERVO**STAR** SBD-Series is constantly monitoring the status of many different components. In general, the philosophy of the SERVO**STAR** is to latch all fault conditions so you can readily determine the source of the problem. When a fault is detected, it is latched, indicated in an LED, and causes a drive disable. Many faults can be reset by toggling the hardware remote enable input (rising edge sensitivity) or by depressing the reset switch.

The following is a list of some of the more frequent faults the drive may detect in the unit hardware:

- **Drive Over Temperature:** The internal heatsink temperature is monitored for an unsafe condition (Heat sink over 80 degrees C). The drive eventually cools enough to allow reset of this condition. More common causes for this fault is excessive loading on the drive and/or operation in elevated ambient temperature environments.
- **Bus Over Voltage:** An over-voltage condition shuts down the drive. This fault occurs mostly during regen operation where the BUS is raised to higher values than that produced by the power supply. In such a case, either an external regen resistor is required or the deceleration rate must be decreased. This fault also occurs if the incoming power supply voltage is excessively high.
- **Bus Under Voltage:** There is a jumper internal to the drive to determine the function of this fault detection circuit. If JP1 is in place (normal shipping state), an under-voltage condition is latched and shuts down the drive. This fault normally occurs when the incoming line voltage drops out or a fault occurs in the power supply. If JP1 is removed, the drive does not look for this fault condition. A special power-up circuit is provided to reset an under voltage fault after power is first applied to allow appropriate power sequencing.
- **Power Stage Fault (Over Current):** Hardware circuitry monitors load short-circuit, transistor failure, transistor over temperature, gate drive power and instantaneous over-current to latch this fault condition. The most common reason for this fault is a shorted motor lead external to the drive. Try removing the motor armature connections from the drive and see if the problem exists. If it does, replace the drive. If it does not, correct the short.
- **Over Speed Fault:** The drive continuously monitors the actual (feedback) speed. If the motor speed exceeds the typical value of 20% above the motor's rated speed, the drive is disabled. This normally occurs when there is an improperly-tuned system and the load overshoots its commanded speed or the tachometer or armature is wired in the wrong polarity causing a positive-feedback run-away condition.

TROUBLESHOOTING LIST

Symptom	Likely Cause
Motor Runs Uncontrolled	1.) Incorrect phasing on armature or tachometer 2.) Broken or missing tachometer connection 3.) Bad tachometer 4.) Improper compensation components
Motor turns in wrong direction	1.) Improper command phasing 2.) Both Armature and tachometer are reverse-phased
Motor does not obtain desired speed	1.) Insufficient bus voltage to drive motor 2.) Incorrect tachometer scaling
Enable LED does not come on	1.) Missing logic voltage supply 2.) RED Fault LED is indicating a fault condition
Under Volts fault occurs while running	1.) Bus voltage source sags during acceleration
Motor lags in position loop	1.) Insufficient DC Gain
Motor Overshoots	1.) Insufficient DC Gain 2.) Too much AC Gain
Motor drifts slowly	1.) DC Offset in system (Balance pot)
System Stability seems sensitive to load changes	1.) Adjust Stability pot for less bandwidth 2.) Reduce lead network effect.
Position loop pulls motor into a slightly incorrect position	1.) Adjust balance pot.
System peak currents are erratic	1.) Worn tachometer causing intermittent signal loss.

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 our customer's product needs. 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 not aware of your local sales representative, please contact us at the number above. Visit our website for upgrades, technical articles, and the most resent version of our product manuals.