UPGRADE NOTICE for BDS5T / VSA

The following are features of the MC3 board that is incorporated into the BDS5T and the VSA.

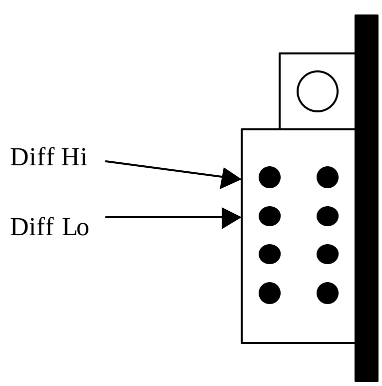
NOTICE: Some changes may be required to existing wiring or probram in order to make the BDS5T compatible to the BDS5 or the VSA, or the VSA compatible to the VFS5.

HARDWARE:

- On-board analog input
  The analog input is on the connector T1 of the BDS5T and connector C10 on the VSA, Pin 5 is Diff. Hi and Pin 6 is Diff. Low.
- Tach output
  Scaled for 1750 RPM/volts
- Communications
  To convert from RS232 to RS485 install a jumper between pins 9 and 10 on connector J1
- Inputs
  Built-in filters

SOFTWARE:

- Program Execution
  Twice as fast as BDS5
- PL, PLIM, TRIP, and PDF
  State is remembered through power-down
- A2D Switch
  When using the on-board analog input set A2D to 1. When using the encoder input for master / slave application set A2D to 0. The gear ration when using the on-board analog input is GEARI / GEARO = 700 / 16384 for 10 volts = 10000 RPM.
- CAM function
  Cam now has 1024 points, NORM) ECAM starts the CAM function.
- PDF switch
  Set to 1 for brushless motors. For induction motor control if PDF=1, the auto tune feature is available. If PDF=0, the control scheme is identical to the VFS5 and the auto tune feature is not available.
- Supports 10-bit resolver resolution for higher speed applications.
- User variables
  2,000 user variables (x1 – x2000)
- Program memory is 27K
- “P”
  May be omitted when printing one variable.



Front View of Connector C10 on VSA, T1 on BDS5T

BDS5

INSTALLATION AND SETUP MANUAL

Old Number M93101 - ISSUE 4

New Number MB5000H

TECHNICAL MANUAL CONFIGURATION

(INSTALLATION AND SETUP MANUAL M93101)

PAGE NO.	DESCRIPTION	ISSUE NO.*
--	Title Page	0
--	Technical Manual Configuration	0
--	Configuration Table	0
--	Customer Response	0
--	Copyright Page	0
--	Foreword	0
--	How to Use This Manual	0
i-ii	Table of Contents	0
iii / (iv blank)	List of Figures	0
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vii / (viii blank)	List of Drawings	0
1-1 -- 1-16	Text Pages	0
2-1 -- 2-26	Text Pages	0
3-1 -- 3-10	Text Pages	0
4-1 -- 4-4	Text Pages	0
5-1 -- 5-6	Text Pages	0
A-1 / (A-2 blank)	Appendix A Warranty Information	0
B-1 -- B-22	Appendix B Drawings	0
C-1 -- C-12	Appendix C Error Codes	0
D-1 -- D-2	Appendix D Regional Sales Offices	0
E-1 / (E-2 blank)	Appendix E On-line Reference Guide	0
Glossary-i -- xiv	Glossary	0
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* Zero in this column indicates an original page

CONFIGURATION TABLE

(INSTALLATION AND SETUP MANUAL M93101)

RECORD OF REVISIONS

ISSUE NO. (Revision)	DATE	CHANGED PAGES/BRIEF DESCRIPTION OF CHANGE	CHANGE NO.
3	15 Mar 95	Replaces issue dated 15 Feb 95	Original Release
4	10 Nov 95	Add Appendix E and include On-line Reference Guide Disk	- -

THANK YOU!

KOLLMORGEN
Motion Technologies Group

Thank you and congratulations for choosing Industrial Drives' servo products for your motion control requirements. We seek to provide our customers with quality products, excellent support and outstanding value. In an effort to provide you with dependable and useful documentation, we offer you an opportunity to critique this manual with your comments and suggestions. Your feedback on this reader comments form is very important to us. Please answer the questions below and return the form to:

INDUSTRIAL DRIVES - Technical Manual Department
201 Rock Road
Radford, VA 24141
U.S.A.
FAX: 703/731/0847

Name:________________ Title:________________

Company:________________

Street Address:________________

City:________________ State:________ Zip:______

Telephone:________________ Fax:________________

Product:________________

Manual Part Number:________________

Please check the rating that best represents your opinion on each topic.

		Excellent	Good	Fair	Poor
1.	Overall clarity and readability.	❑	❑	❑	❑
2.	Organization of the manual.	❑	❑	❑	❑
3.	Information completeness.	❑	❑	❑	❑
4.	Information accuracy.	❑	❑	❑	❑
5.	Installation procedures.	❑	❑	❑	❑
6.	Ability to quickly find information you need.	❑	❑	❑	❑
7.	Graphics.	❑	❑	❑	❑
8.	Figures (usefulness).	❑	❑	❑	❑
9.	Tables (usefulness).	❑	❑	❑	❑
10.	Overall rating of this manual.	❑	❑	❑	❑

Please list any errors.________________

What did you like least about this manual?________________

What did you like most about this manual?________________

How would you improve this manual?________________

Signature:________________ Date:________

WARNING

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

KOLLMORGEN
Motion Technologies Group

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FOREWORD

The commitment to quality at Industrial Drives is our first priority. In all aspects of our business: research, development, product design and customer service, we strive to guarantee total quality. This pledge is founded on a solid history of innovative technological achievements dating back to 1948. One of the finest tributes to that achievement can now be seen at the Smithsonian which has on display the first stellar inertial navigation system developed by Dr. Charles Stark Draper. This system contains the first models of torque motors built by the founding organization of Industrial Drives. During the period of 1948 to 1960, our "firsts" in the industry numbered more than a dozen; they ranged from the simple but invaluable (such as the direct-drive DC torque motor and movie theater projection motors) to the exotic: submarine periscope drive motors for the U.S. Navy, electric drives, Curtis Wright electric brake coils, and numerous other innovations.

For more than a decade, Industrial Drives (known in the early days as part of Inland Motor Division of Kollmorgen) has continued to enhance its sophisticated engineering solutions to pioneer new product development.

The results of these and other efforts has encouraged some of the most significant innovations in the servo industry. We developed the application of servo motors and drives in the Machine Tool market. We were the first with water-cooled servos, the integral brake, the flux forcing concept and the brushless motor. We developed the electronically commutated electric car motor. Industrial Drives pioneered rare earth magnet development for the servo motor industry.

Between 1974 and 1980, Industrial Drives continued to lead the industry in servo application innovations. Our commitment to engineering excellence never waivered. In fact, that commitment grew stronger with the development of brushless submarine and submersible motors (visiting the Titanic graveyard), multi-axis electronic drives and antenna pedestal drives (delivering unprecedented accuracy and revolutionizing the entire industrial automation process).

The decade of the 1980's brought continued advancements in technology and penetration of new markets requiring precise motion control. Already in the fifth generation of brushless products, Industrial Drives continues to lead the way with digital servo positioning capability and our newest motor offering, the GOLDLINE Series, incorporating the very latest high-energy, rare earth magnets (neodymium iron boron). Once again, we are setting the standards that others only hope to duplicate. Recently acknowledged by the Frost and Sullivan Foundation, a leading market specialist in the motion control industry, Industrial Drives and its parent, Kollmorgen Corporation, continue to rank first in servo technology.

Other achievements? Yes, too many in fact to mention. Each achievement stands as a testimony to the committed quality and excellence in design technology. This constancy of purpose is unyielding in an era of rapidly changing technology.

HOW TO USE THIS MANUAL

INTRODUCTION

This Installation and Setup Manual is designed to help you properly install a BDS5 Servo System. You do not have to be an expert in motion control to operate the system however this manual does assume you have the fundamental understanding of basic electronics and motion control concepts. Many of these are explained in the glossary of this manual.

The BDS5 is a programmable motion control device. An understanding of computer programming techniques will be beneficial to all users. For applications that require complex programs, a professional programmer should be consulted.

RECOMMENDATIONS

It is recommended that you read this entire manual before you attempt to install the BDS5 so you can promptly find any information you need. This will also familiarize you with system components, and their relationship to one another.

After installation and before you apply your own application check all system functions and features to insure you have installed your BDS5 properly.

Proper installation can prevent potential difficulties before they cause harm to your system. Be sure to follow all instructions carefully and pay special attention to safety.

CONVENTIONS

To assist you in understanding the material in this manual, conventions have been established to enhance reader comprehension. Explanations of these conventions are as follows:

- Safety warnings, cautions, and notes present material that is important to user safety. Be sure to read any safety notices you see as they could prevent equipment damage, personal injury, or even death to you or a co-worker.
- **Bold** text highlights other important information that is critical to system operations.
- CAPITALIZED text stresses attention to the details of the procedure.
- Underlined text emphasizes crucial words in sentences that could be misunderstood if the word is not recognized.
- ***DOUBLE BLOCKED*** text defines words that are to be typed into the computer by the user to interface with the BDS5.
- **SINGLE BLOCKED** text defines words that are displayed by the BDS5 on the computer terminal to inform the user of system operations or problems.

ABBREVIATIONS

CCW	Counter Clockwise
CW	Clockwise
D/L	Direction Limit
GC	Goldline Cable
GCS	Goldline Cable Set
LED	Light Emitting Diode
NEC	National Electrical Code
P/N	Part Number
R/D	Resolver-to-Digital
Regen	Regeneration
TL	Test Limits
UL	Underwriters Laboratories

NOTICE:

This manual is the first of a two part manual structure. The *User's Manual* is intended to instruct the user on the normal operating procedures and practices to be used with the BDS5. Programming is explained as well as other software considerations.

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CHAPTER 1

SYSTEM DESCRIPTION

1.1 INTRODUCTION

The information in this chapter will enable you to understand the BDS5's basic functions and features. These concepts will allow you to apply them to your own unique applications.

1.2 PRODUCT DESCRIPTION

The BDS5 is a full-featured, high-performance, brushless positioning servo in one compact enclosure —it is the smallest, totally-integrated package available to motion control users. The BDS5 combines a positioner, a servo amplifier, and an I/O interface into one unit. The BDS5 sets new standards for motion control with its simple BASIC-like command structure and sophisticated decision-making capability. The BDS5 provides the outstanding servo performance that you have come to expect from Industrial Drives. Using a high-performance microprocessor, the BDS5 does not have to compromise on either positioner software or servo performance. This single microprocessor closes all servo loops, resulting in a truly integrated positioning system. The BDS5 has the features and performance you need in your next positioning application.

1.3 FEATURES

The BDS5 offers a wide feature set to accommodate real world positioning requirements:

- LOW COST

The BDS5 is very affordable--even though it is full of advanced features. Use all or only a portion of these features to accomplish your application.

- EASY TO INSTALL

The BDS5 is easy to install because the servo amplifier and the positioner are integrated into one package. Many interconnects, including the tachometer and encoder, are eliminated.

- SIMPLE PROGRAMMING LANGUAGE

The BDS5 uses simple BASIC-like commands such as RUN, GOTO (for branching), and GOSUB / RETURN (for subroutines). In addition to a simple comparison statement, advanced IF / ELIF / ELSE / END IF statements result in more readable and less error-prone programs. You can comment every line in your program.

- ADVANCED MOTION CONTROL MOVES

The simple language does not prevent you from solving complex problems. The BDS5 has separate acceleration and deceleration rates, as well as linear, half S-curve, and full S-curve acceleration profiles. The BDS5 has Macro Moves for applications where simple indexes cannot do the job. A Macro Move is a combination of up to 30 accelerations, traverses, and decelerations, which are fully precalculated for faster execution. You can program teach modes where position end points can be changed by a factory operator

- MASTER/SLAVE - ELECTRONIC GEARBOX

The electronic gearbox is used to link two motors together so that the velocity of the slave is proportional to the velocity of the master. The ratio can be from 32767:1 to 1:32767 and can be negative to allow the slave to move in the opposite direction. Also, the "index-on-gearing" feature permits phase adjustments.

- MASTER/ SLAVE - PROFILE REGULATION

With profile regulation you can control the slave's motion profile according to an external master motor or frequency. Profile regulation modifies the velocity and acceleration of the slave axis without affecting the final position of the move. You can use profile regulation to implement "feed rate override."

- MOTION GATING AND REGISTRATION

The BDS5 can precalculate moves to begin motion within one millisecond after a transition on the GATE input. This provides rapid and repeatable motion initiation. The BDS5 has the ability to capture the current position within 25 microseconds after a transition of the HOME input. This results in fast homing and accurate registration sequences.

- MATHEMATICS Algebraic math is provided for commands such as:

$$X1 = 2 \times (X2 + X3)$$

The BDS5 has 100 program labels, 50 user-definable variables, and 50 user-definable switches. It also has 15 mathematical/logical operations and over 150 system variables.

- USER UNITS

Quantities such as position, velocity, and acceleration are automatically scaled into user-defined units. This feature lets you program the BDS5 in convenient units, such as feet, inches, miles, RPM, and degrees.

- SUPERIOR SERVO LOOP CONTROL

The BDS5 offers smooth, high-resolution control. Standard BDS5 position repeatability is better than one arc-minute, bidirectional. The BDS5 has a 32-bit position word. The BDS5 position loop completely eliminates the digital dither normally associated with positioning systems. Long-term speed stability is 0.01%. The standard system converter (12-bit) provides a resolution of 0.0005 RPM and a maximum speed of 8000 RPM.

- SELF-TUNING

The BDS5 can tune itself. You do not have to be a servo expert to set up a system quickly. Just specify the desired bandwidth, and let the BDS5 do the rest.

- POWERFUL MICROPROCESSOR

The heart of the BDS5 is the 16-bit processor that delivers high performance. The result: the BDS5 can control a motor and execute its motion program faster than a standard positioner can.

- DIGITAL SERVO LOOPS

Both the position and velocity loops are totally digital. The digital loops give the BDS5 features not available in standard velocity drives, such as self-tuning, very low velocity offset, and digitally-adjustable servo tuning parameters. The optional analog input permits you to use the BDS5 as an analog velocity drive.

- FEED-FORWARD GAIN

The digital feed-forward gain reduces following error and motion initiation delay, thereby increasing machine throughput.

- DIAGNOSTICS

The BDS5 offers a complete set of error diagnostics. When an error occurs, the BDS5 displays an English language error message. The BDS5 remembers the last 20 errors even through power loss. In addition, the BDS5 lets you write your own error handler. During a fault condition, you can use the error handler to set outputs, alert an operator, and shut down your process smoothly. The BDS5 offers trace and single-step modes so that you can debug your program. The BDS5 has complete fault monitoring, including travel limit switches, feedback loss, and software position limits, as well as hardware safety circuits (watchdogs) and checksums for more reliable and safer operation.

- I/O

The BDS5 has up to 32 I/O sections that you connect via ribbon cable to standard OPTO-22 compatible I/O boards or to INDUSTRIAL DRIVES I/O-32. The I/O-32 provides either fixed 24-volt or removable, industry standard, optically-isolated I/O in a GOLDLINE style package.

- SERIAL COMMUNICATIONS

The BDS5's serial communications provide a powerful link to other popular factory automation devices such as PLC's, process control computers, and smart terminals. The BDS5 offers RS-232 for most terminals and RS-422/RS-485 for multidrop communications. With multidrop you can put up to 26 axes on one serial line. The BDS5 can autobaud from 300 baud to 19.2k baud, eliminating the need to set dip switches to start communicating.

- MOTION LINK

Industrial Drives also offers MOTION LINK, a powerful, menu-driven communications package for your IBM-PC (c) compatible computer. With this package, the BDS5's programs and variables can be retrieved from or saved to a disk drive. Also, on-line help and a full screen editor are built into MOTION LINK.

- MENU-DRIVEN SOFTWARE

The BDS5's programming language allows you to write operator-friendly, menu-driven software. By incorporating an INDUSTRIAL DRIVES Data Entry Panel, or any other serial communications device, the operator can be prompted for specific process data.

- MONITOR MODE

The BDS5 provides interactive communications and permits all system variables and parameters to be examined and modified at any time--even during actual program execution or while the motor is running.

1.4 PART NUMBER DESCRIPTION

A model number is printed on a gold and black tag on the front of your BDS5, PSR4/5, Compensation Card and External Regen Resistor modules. The model number identifies how the equipment is configured. Each component is described to explain what the model configurations are. You should verify that the model numbers represent the equipment desired for your application. Also verify the compatibility between components of the servo system. The model numbers are as follows:

1.4.1 BDS5 Model Number

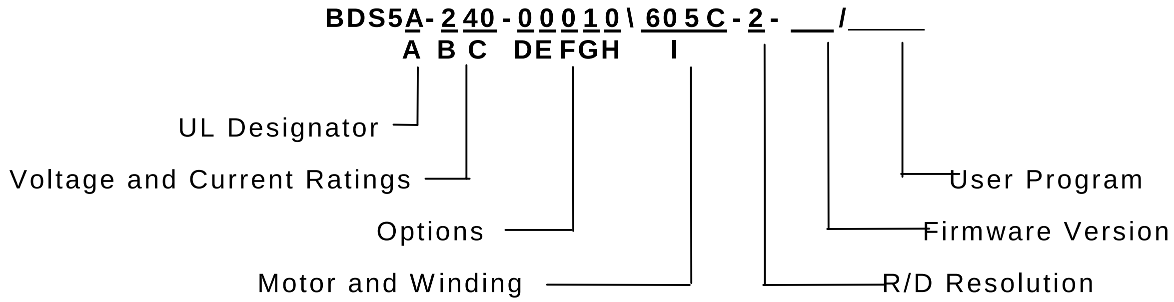


Figure 1.1. BDS5 Model Number Scheme

Table 1.1. BDS5 Model Number Scheme

LEGEND	DEFINITION
A A V	UL Designator UL Listed (standard) Non - UL Listed
B 1 2	Voltage Rating 115 VAC 230 VAC
C 03 06 10 20 30 40 55	Current Rating 3 Amps/Phase 6 Amps/Phase 10 Amps/Phase 20 Amps/Phase 30 Amps/Phase 40 Amps/Phase 55 Amps/Phase
D 0 E 0 1 F 0 1 2 9 G 0 1 H 0	Mechanical Options (0 indicates standard feature) Standard Communication Options RS-232 (standard) RS-422/RS-485 Input Options Encoder Input (standard) Analog Input Pulse Input No Input I/O Options 8 I/O (standard) 32 I/O R/D Accuracy Options 8 ARC min (standard)
I Motor and Winding	Motor and Winding Specifies Motor Model Type, Winding
R/D Resolution 2 4	R/D Resolution 12-Bit (4096 counts/rev) 14-Bit (16384 counts/rev)
Firmware Version	Firmware Version (Assigned by Industrial Drives, not normally specified when ordering) Most current firmware supplied -- unless otherwise specified.
User Program	User Program (This is reserved for systems that are programmed by Industrial Drives. This is not normally specified when ordering.)

1.4.2 Compensation Module Model Number

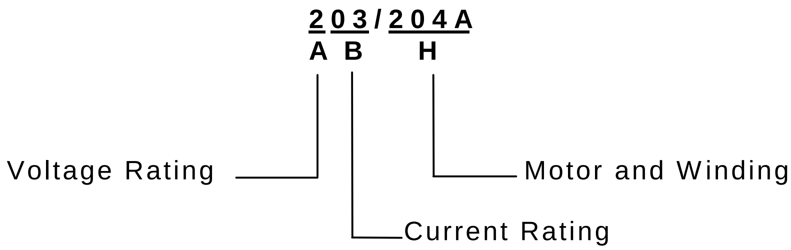


Figure 1.2. Compensation Model Number Scheme

A partial model number is printed on a gold and black tag on the front of the compensation module (the black plastic box secured to the front of your BDS5 by two screws). See Figure 1.2 for the descriptions of the model number (that is, what ABB and HHHH mean). The model number is as follows:

The compensation module depends on your motor and the voltage and current rating of your BDS5. It is important that the motor, the BDS5, and the compensation module model numbers all agree. For example, if your BDS5 model number is

BDS5-203-00000\204A-1-101/2021,

then your compensation module model number must be:

203/204A,

and your motor must be a 204A. An example of a 204A motor model number is:

B-204-A-21.

CAUTION

YOU MUST HAVE THE PROPER COMPENSATION MODULE INSTALLED FOR YOUR MOTOR AND BDS5. THE COMPENSATION MODULE CHANGES IF THE AMPLIFIER RATINGS CHANGE, EVEN FOR THE SAME MOTOR.

Failure to install the proper compensation module can cause damage to the BDS5, the motor, or both.

1.4.3 PSR4/5 Model Number

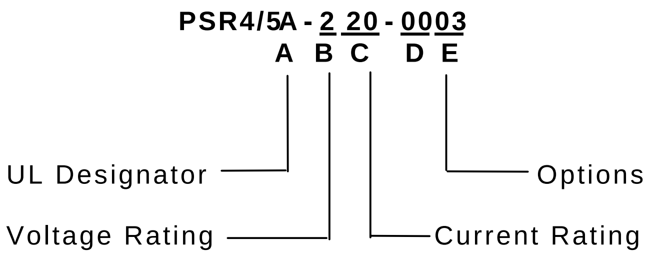


Figure 1.3. PSR4/5 Model Number Scheme

Table 1.2. PSR4/5 Model Number Scheme

LEGEND	DEFINITIONS
A A V	UL Designator UL Listed (standard) Non - UL Listed
B 1 2	Voltage Rating 115 VAC 230 VAC
C 12 20 50 75	Current Rating 12 Amps/Phase 20 Amps/Phase 50 Amps/Phase 75 Amps/Phase
D 00	Mechanical Options No Option (standard)
E 00 01 02 03	Electrical Regen Options for 12 and 20 Amp Models Only Standard Internal 40 W Regen (standard) External Regen (230 VAC Only) 8.8 Ohms, 400 W., Requires ER-01 Resistor Kit External Regen (115 VAC Only) 5.5 Ohms, 200 W., Requires ER-02 Resistor Kit External Regen (230 VAC Only) 5.8 Ohms, 700 W., Requires ER-03 Resistor Kit
E 00	Electrical Regen Options for 50 and 75 Amp Models Only No internal shunt regeneration (standard) Requires external regeneration resistor kit ER-2X

1.4.4 ER-External Resistor Kit Model Number

NOTE

Contact Industrial Drives Application Engineering to size regeneration capability.

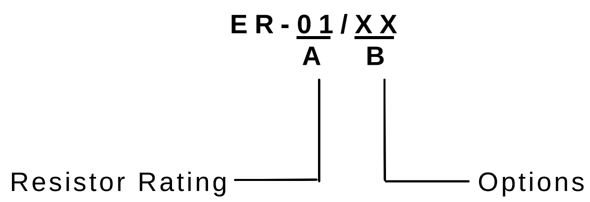


Figure 1.4. External Regen Resistor Model Number Scheme

Table 1.3. External Regen Resistor Model Number Scheme

LEGEND	DEFINITIONS
A	Resistor Rating
01	8.8 Ohms, 400 W., 230V, 12 & 20 Amp Models Only
02	5.5 Ohms, 200 W., 115V, 12 & 20 Amp Models Only
03	5.8 Ohms, 700 W., 230V, 12 & 20 Amp Models Only
20	4.5 Ohms, 500 W., 230V, 50 & 75 Amp Models Only
21	4.4 Ohms, 1000 W., 230V, 50 & 75 Amp Models Only
22	2.2 Ohms, 1000 W., 230V, 75 Amp Models Only
23	2.2 Ohms, 2000 W., 230V, 75 Amp Models Only
B	Options
00	None available at this printing.

1.4.5 Molex Assembly Tools

GOLDLINE series electronics (BDS4's, BDS5's, and PSR4/5's) use Molex MINI-FIT JR. series connectors. The necessary connectors and pins are included in your BDS5 and PSR4/5 connector kits.

You can obtain the crimping and extraction tools from your nearest Molex distributor or by contacting Molex at (708) 969-4550.

Hand Crimping Tool	Molex Order# 11-01-0122
Extractor Tool	Molex Order# 11-03-0038

1.5 SPECIFICATIONS AND RATINGS

Table 1.4. Specifications

BDS5-1XX-(90-160 VAC L-L OUTPUT TO MOTOR)				
DESCRIPTION	**BDS5-103**	**BDS5-106**	**BDS5-110**	**BDS5-120**
Main DC Bus Minimum Maximum	130 VDC 225 VDC	130 VDC 225 VDC	130 VDC 225 VDC	130 VDC 225 VDC
Unregulated Logic Bus	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS
Output Current (RMS/∅) Convection Cooled (45°C AMB) Continuous (RMS) Peak (2.0 sec) (RMS)	3.0 AMPS 6.0 AMPS	6.0 AMPS 12.0 AMPS	10.0 AMPS 20.0 AMPS	Fan Cooled 20.0 AMPS 40.0 AMPS
Output KVA (@ 160 VDC Bus) Continuous (45°C AMB) Peak (2.0 sec) (RMS)	0.6 KVA 1.2 KVA	1.2 KVA 2.4 KVA	2.0 KVA 4.0 KVA	4.0 KVA 8.0 KVA
Internal Heat Dissipation	30 WATTS	40 WATTS	60 WATTS	110 WATTS
PWM Switching Frequency	10.0 kHz	10.0 kHz	10.0 kHz	10.0 kHz
Motor Current Ripple Frequency ±10%	20.0 kHz	20.0 kHz	20.0 kHz	20.0 kHz
Resolver Excitation Frequency	8.5 kHz	8.5 kHz	8.5 kHz	8.5 kHz
Form Factor RMS/AVG	≤ 1.01	≤ 1.01	≤ 1.01	≤ 1.01
Fan (115 VAC)	N/A	N/A	N/A	0.2 AMPS

Table 1.4. Specifications (Cont.)

BDS5-2XX-(160-253 VAC L-L OUTPUT TO MOTOR)				
DESCRIPTION	**BDS5-203**	**BDS5-206**	**BDS5-210**	**BDS5-220**
Main DC Bus Minimum Maximum	 225 VDC 360 VDC	 225 VDC 360 VDC	 225 VDC 360 VDC	 130 VDC 225 VDC
Unregulated Logic Bus	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS	±15-20 VDC @0.25 AMPS +8-12 VDC @1.00 AMPS
Output Current (RMS/∅) Convection Cooled (45°C AMB) Continuous (RMS) Peak (2.0 sec) (RMS)	 3.0 AMPS 6.0 AMPS	 6.0 AMPS 12.0 AMPS	 10.0 AMPS 20.0 AMPS	 20.0 AMPS 40.0 AMPS
Output KVA (@ 160 VDC Bus) Continuous (45°C AMB) Peak (2.0 sec) (RMS)	 1.2 KVA 2.4 KVA	 2.0 KVA 4.0 KVA	 4.0 KVA 8.0 KVA	 8.0 KVA 16.0 KVA
Internal Heat Dissipation	35 WATTS	50 WATTS	75 WATTS	150 WATTS
PWM Switching Frequency	10.0 kHz	10.0 kHz	10.0 kHz	10.0 kHz
Motor Current Ripple Frequency ±10%	 20.0 kHz	 20.0 kHz	 20.0 kHz	 20.0 kHz
Resolver Excitation Frequency	8.5 kHz	8.5 kHz	8.5 kHz	8.5 kHz
Form Factor RMS/AVG	≤ 1.01	≤ 1.01	≤ 1.01	≤ 1.01
Fan (115 VAC)	N/A	N/A	N/A	0.2 AMPS

Table 1.4. Specifications (Cont.)

PSR4/5-1XX-(90 - 160 VAC L-L INPUT)		
DESCRIPTION	**PSR4/5-112-**	**PSR4/5-120-**
Main AC Line Input Voltage	90-160 VAC	90-160 VAC
Phase	1-3	1-3
Frequency	47-63 Hz	47-63 Hz
Current Cont. (RMS) 3-Phase Single-Phase	12.0 AMPS 10.0 AMPS	20.0 AMPS 16.0 AMPS
Peak (2.0 sec) 3-Phase Single-Phase	24.0 AMPS 20.0 AMPS	40.0 AMPS 32.0 AMPS
Peak (50.0 msec) 3-Phase Single-Phase	50.0 AMPS 42.0 AMPS	80.0 AMPS 64.0 AMPS
Control AC Line Input Voltage	90-132 VAC	90-132 VAC
Phase	1	1
Frequency	47-63 Hz	47-63 Hz
Main DC Bus Output Voltage (Nominal 115 VAC Input) Current 115 VAC	 160 VDC 1.1 AMPS RMS	 160 VDC 1.1 AMPS RMS
Regeneration Shunt Resistor (Internal)	15 OHM	7.5 OHM
Shunt Regulator Current (PK)	15.3 AMPS	30.6 AMPS
Power Dissipation (Cont.)	40 WATTS	40 WATTS
Power Dissipation (PK)	3.5 KW	7.0 KW
Internal Heat Dissipation	120 WATTS	120 WATTS
Regeneration Shunt Resistor (External Min)	5.5 OHM	5.5 OHM
Shunt Regulator Current (PK)	41.8 AMPS	41.8 AMPS
Power Dissipation (Cont.)	200 WATTS	200 WATTS
Power Dissipation (PK.)	9.6 KW	9.6 KW
Soft-Start Surge Current (Max)	80 AMPS	80 AMPS
Charge Time (Max)	25 MSEC	25 MSEC

Table 1.4. Specifications (Cont.)

PSR4/5-2XX-(160 - 253 VAC L-L INPUT)		
DESCRIPTION	**PSR4/5-212-**	**PSR4/5-220-**
Main AC Line Input Voltage	160 - 253 VAC	160 - 253 VAC
Phase	1-3	1-3
Frequency	47-63 Hz	47-63 Hz
Current Cont. (RMS) 3 Phase Single Phase	12.0 AMPS 10.0 AMPS	20.0 AMPS 16.0 AMPS
Peak (2.0 sec) 3 Phase Single Phase	24.0 AMPS 20.0 AMPS	40.0 AMPS 32.0 AMPS
Peak (50.0 msec) 3 Phase Single Phase	50.0 AMPS 42.0 AMPS	80.0 AMPS 64.0 AMPS
Control AC Line Input Voltage	90-132 VAC	90-132 VAC
Phase	1	1
Frequency	47-63 Hz	47-63 Hz
Main DC Bus Output Voltage (Nominal 115 VAC Input) Current 115 VAC	 325 VDC 1.1 AMPS RMS	 325 VDC 1.1 AMPS RMS
Regeneration Shunt Resistor (Internal)	25 OHM	12 OHM
Shunt Regulator Current (PK)	15 AMPS	30 AMPS
Power Dissipation (Cont.)	40 WATTS	40 WATTS
Power Dissipation (PK)	5.6 KW	11.2 KW
Internal Heat Dissipation	120 WATTS	150 WATTS
Regeneration Shunt Resistor (External Min)	8.8 OHM	8.8 OHM
Shunt Regulator Current (PK)	44.3 AMPS	44.3 AMPS
Power Dissipation (Cont.)	400 WATTS	400 WATTS
Power Dissipation (PK)	17.3 KW	17.3 KW
Soft Start Surge Current (Max)	150 AMPS	150 AMPS
Charge Time (Max)	25 MSEC	25 MSEC

Table 1.5. Environmental Specifications

Operating Temperature*: 3, 6, & 10 AMP Units (Convection Cooled) 20 Amp Units (Internal Fan Cooled)	 0^o C to 45^o C 0^o C to 45^o C
Storage Temperature	-20^o C to 70^o C
Humidity (Non-Condensing)	10% to 90%

* For operation ambients above 45°C, consult the Applications Group at Industrial Drives.

Table 1.6. Mechanical Specifications

MODEL NUMBER	WIDTH		HEIGHT		DEPTH	
	MM	IN.	MM	IN.	MM	IN.
BDS5-X03-	56	2.20	340	13.49	280	11
BDS5-X06-	76	2.99	340	13.49	280	11
BDS5-X10-	98	3.86	340	13.49	280	11
BDS5-X20-	98	3.90	340	13.49	280	11
PSR4/5- X12 & X20-	76	3.00	340	13.49	280	11

1.6 THEORY OF OPERATION

Drawing D-93030 shows a system overview.

- MICROPROCESSOR SYSTEM

The BDS5 is a digital positioner and servo drive combined into one unit. The velocity loop is 100% digital. The BDS5 has battery backup RAM to remember your program and most variables through power-down.

- RESOLVER-TO-DIGITAL CONVERTER

The BDS5 is based on a Resolver-to-Digital (R/D) converter. The R/D generates a tachometer signal for your convenience. However, the BDS5 does not use the analog tach signal.

- SERIAL PORT

The BDS5 has a serial port for communications. This port allows you to monitor the operation, issue commands, and transmit a program.

- DISCRETE INPUTS

The BDS5 has 23 discrete inputs, including REMOTE ENABLE which is on Connector C2 only. Note that two signals, HOME and CYCLE, can be input to the BDS5 on two connectors, C2 and C7. Connector C2 provides these three signals with optical isolation. Connector C7 expects non-isolated TTL signals on a 26-pin ribbon cable connector. Optional Connector C8 expects non-isolated TTL signals on a 50-pin ribbon cable connector.

- DISCRETE OUTPUTS

The BDS5 has 10 discrete outputs. Notice that O1 appears both on Connector C2 with optical isolation and on Connector C8.

- ENCODER INPUT

The BDS5 accepts external inputs in encoder format. This can come from a master motor in a master/slave system. Note that you must use a resolver, even if you use a feedback encoder with the BDS5.

- ENCODER EQUIVALENT OUTPUT

The BDS5 provides encoder format output derived from the R/D converter.

- ANALOG INPUT (OPT1 CARD)

As an option, the BDS5 can accept a ±10 volt analog input. This input is converted to digital format by the BDS5. Gain and offset adjustments are made digitally inside the BDS5, not with potentiometers.

- PULSE INPUT (OPT2 CARD)

The BDS5 can accept special pulse inputs. The standard BDS5 can accept signals directly from encoders or encoder-like devices. As an option, the BDS5 can accept other pulse formats, such as count/direction or up/down.

- LED'S

The BDS5 provides LED's for diagnostics. These LED's are on the front panel of the BDS5. The LED's are listed below:

ACTIVE
SYS OK
CPU
FAULT
RELAY

- CURRENT LOOP COMPENSATION

The BDS5 has analog current loops. The current loop compensation components are all contained in the compensation module located on the front of the BDS5. The current loop compensation changes when you change the motor model. You must install the correct compensation module when changing motor models.

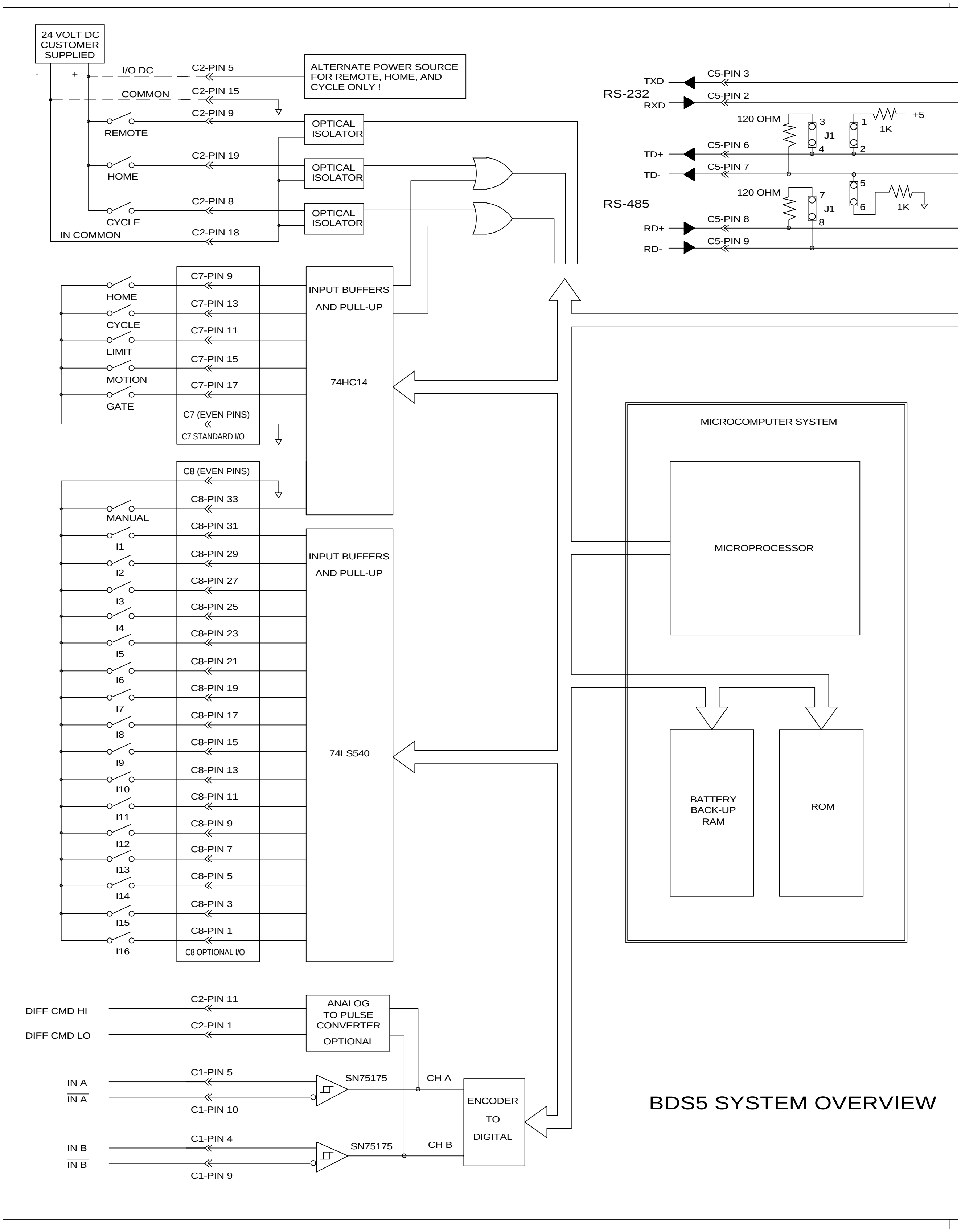
CAUTION

YOU MUST HAVE THE PROPER COMPENSATION MODULE INSTALLED FOR YOUR MOTOR

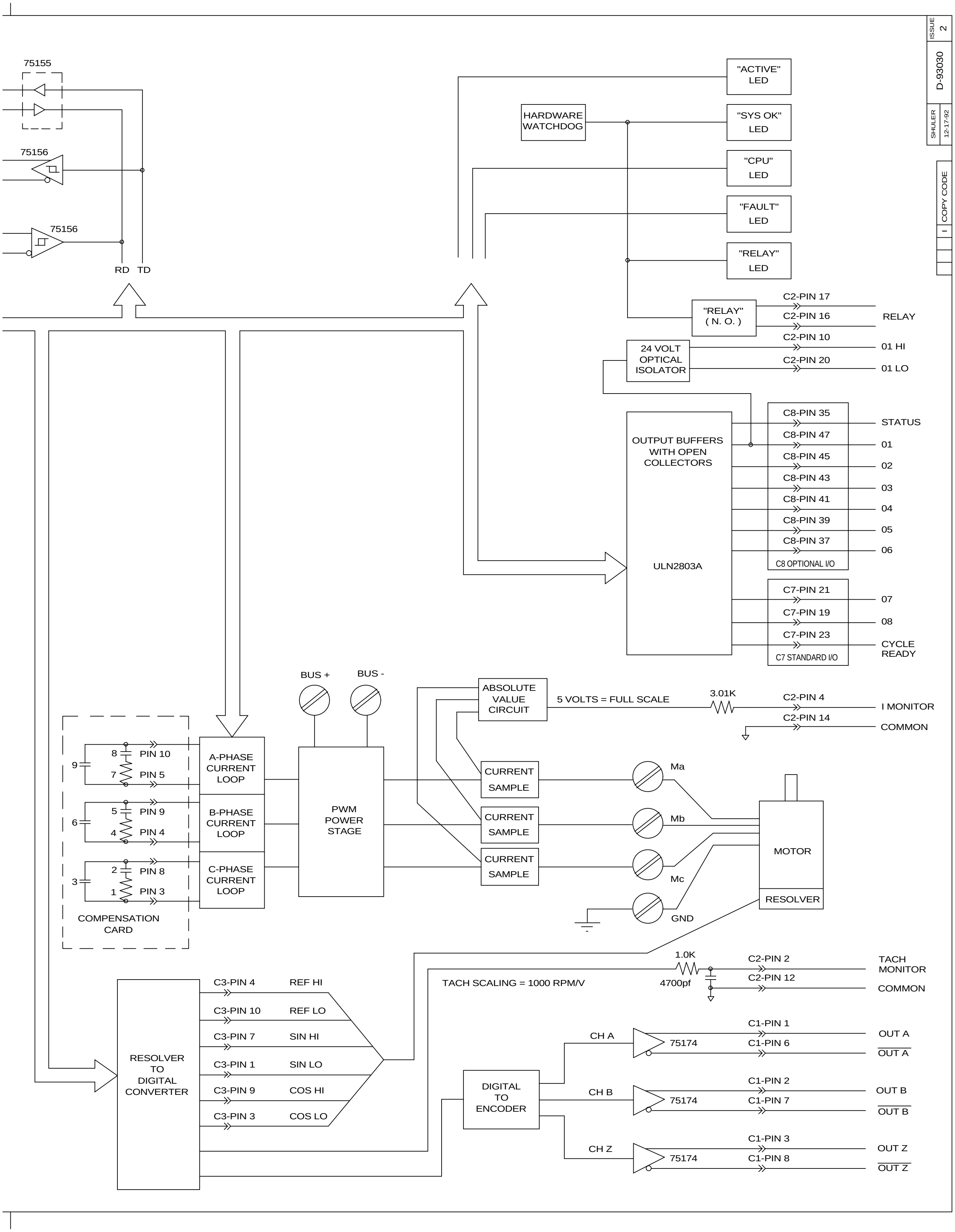
Failure to install the proper compensation module can cause damage to the BDS5, the motor, or both.

1.7 SIMPLIFIED SCHEMATIC DIAGRAM AND SYSTEM DIAGRAM

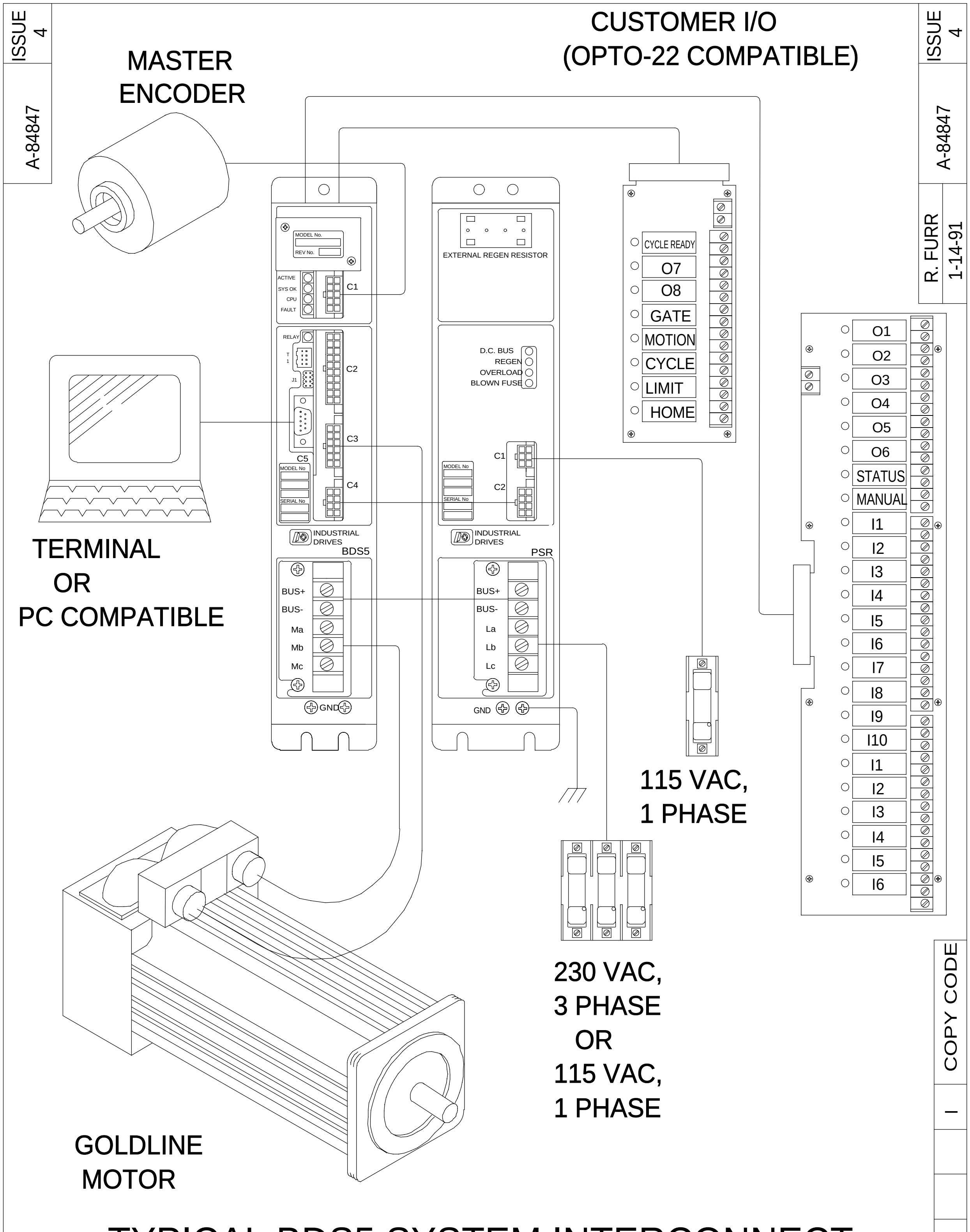
Drawings D-93030 and A-84847 illustrate a BDS5 servo system with all of the major components.



BDS5 SYSTEM OVERVIEW



ISSUE 2
D-93030
SHULER 12-17-92
COPY CODE I
75155
75156
75156
RD TD
HARDWARE WATCHDOG
"ACTIVE" LED
"SYS OK" LED
"CPU" LED
"FAULT" LED
"RELAY" LED
"RELAY" (N. O.)
C2-PIN 17
C2-PIN 16
RELAY
24 VOLT OPTICAL ISOLATOR
C2-PIN 10
01 HI
C2-PIN 20
01 LO
OUTPUT BUFFERS WITH OPEN COLLECTORS
ULN2803A
C8-PIN 35
STATUS
C8-PIN 47
01
C8-PIN 45
02
C8-PIN 43
03
C8-PIN 41
04
C8-PIN 39
05
C8-PIN 37
06
C8 OPTIONAL I/O
C7-PIN 21
07
C7-PIN 19
08
C7-PIN 23
CYCLE READY
C7 STANDARD I/O
BUS +
BUS -
ABSOLUTE VALUE CIRCUIT
5 VOLTS = FULL SCALE
3.01K
C2-PIN 4
I MONITOR
C2-PIN 14
COMMON
PIN 10
PIN 5
PIN 9
PIN 4
PIN 8
PIN 3
COMPENSATION CARD
A-PHASE CURRENT LOOP
B-PHASE CURRENT LOOP
C-PHASE CURRENT LOOP
PWM POWER STAGE
CURRENT SAMPLE
CURRENT SAMPLE
CURRENT SAMPLE
Ma
Mb
Mc
GND
MOTOR
RESOLVER
1.0K
4700pf
TACH SCALING = 1000 RPM/V
C2-PIN 2
TACH MONITOR
C2-PIN 12
COMMON
RESOLVER TO DIGITAL CONVERTER
C3-PIN 4 REF HI
C3-PIN 10 REF LO
C3-PIN 7 SIN HI
C3-PIN 1 SIN LO
C3-PIN 9 COS HI
C3-PIN 3 COS LO
DIGITAL TO ENCODER
CH A
75174
C1-PIN 1
OUT A
C1-PIN 6
OUT A
CH B
75174
C1-PIN 2
OUT B
C1-PIN 7
OUT B
CH Z
75174
C1-PIN 3
OUT Z
C1-PIN 8
OUT Z



TYPICAL BDS5 SYSTEM INTERCONNECT

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

The information in this chapter will familiarize you with safety information, unpacking and inspection, installation requirements, mounting procedures and wiring for installing the BDS5, PSR4/5 and/or External Regen Resistors. Read the entire chapter carefully. The chapter contains an extensive checkout procedure because most installation problems are caused by incorrect wiring or poor wiring practices. Complete the entire checkout procedure before attempting to put your BDS5 system into operation.

2.2 SAFETY INFORMATION

The purpose of this section is to alert you to possible safety hazards associated with this equipment and the precautions you can take to reduce the risk of personal injury and damage to the equipment.
Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

Figure 2.1. Safety-Alert Symbols

The safety-alert symbols are illustrated in Figure 2.1. When you see these symbols in this manual, be alert to the potential for personal injury. Follow the recommended precautions and safe operating practices included with the alert symbols.

"**Warning**" refers to personal safety. They alert you 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 your understanding or use of these products.

2.3 UNPACKING AND INSPECTION

CAUTION

Electronic components in this amplifier are static sensitive. Use proper procedures when handling component boards.

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

Carefully remove packing material and remove the equipment from the shipping container. Do not dispose of shipping materials until the packing list has been checked. Parts that are contained within the shipment, but not physically attached to the equipment, should be verified against the packing list. If any parts are missing, notify Industrial Drives at once.

2.4 INSTALLATION REQUIREMENTS

Proper installation and field wiring are of prime importance when considering the application of servo amplifiers. Many problems may be avoided if installation of the equipment is done properly. Users should familiarize themselves with and follow installation and wiring instruction in addition to all applicable codes, laws, and standards. Pay special attention to the following topics when installing Industrial Drives' equipment.

2.4.1 Environmental Considerations

The environment that this equipment is placed in can have dramatic effects on its operation. Industrial Drives recommends that the BDS5 and PSR4/5 be operated and stored under the following conditions:

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

2.4.2 Enclosures

It is suggested that the BDS5 and PSR4/5 be mounted in a cabinet or other suitable enclosure to protect them from physical and environmental damage. Refer to specifications for complete system dimensions.

CAUTION

Allow sufficient clearance for the large "regenerative" heat producing resistor(s) mounted at the upper edge of the PSR4/5 unit and the externally mounted regen (shunt regulator) power resistor(s).

2.5 MOUNTING

The BDS5 and PSR4/5 should be mounted in a cabinet or other suitable enclosure to protect them from physical and environmental damage.

The PSR4/5 and the BDS5 are provided with protective guards over the power terminal blocks. After wiring is complete, ALWAYS REPLACE THE PROTECTIVE GUARDS TO REDUCE SHOCK HAZARD.

WARNING

REPLACE THE POWER TERMINAL GUARDS AFTER WIRING THE SYSTEM!

2.5.1 Mounting the BDS5

Refer to drawing A-93703 in Appendix B for mounting dimensions. The BDS5 and PSR4/5 should be mounted in the vertical position. Since these units are convection cooled, there should be a minimum of 25 millimeters (1 inch) of unobstructed space above and below the units. In addition, there should be a minimum of 20 millimeters (0.8 inch) between units to ensure proper airflow for these convection-cooled units.

2.5.2 Mounting the PSR4/5

The PSR4/5 Power Supply module may be mounted on either side of the BDS5. However, a 20 millimeter (0.8 inch) space is required between units.

Some PSR4/5's have resistors which dissipate the energy returned to the PSR4/5 during regenerative braking. These are referred to as regen resistors. Some applications require externally mounted regen resistors, while others may require none at all. To determine if your PSR4/5 has internal regen resistors, check its model number.

CAUTION

REGEN RESISTORS GET HOT!

If your PSR4/5 has internal regen resistors, allow sufficient clearance above the PSR4/5.

NOTE

Refer to Drawing A-93703 for more information concerning mounting.

Refer to appropriate outline and dimension drawings in Appendix B for more information:

A-93569BDS5 3 and 6 Amp Unit
A-93571BDS5 10 Amp Unit
A-93570BDS5 20 Amp Unit
A-93880BDS5 30 and 40 Amp Unit
A-93010BDS5 55 Amp Unit
A-93581PSR4/5 12 and 20 Amp Unit
A-93031PSR4/5 50 and 75 Amp Unit

2.5.3 Mounting the External Regen Resistor

External mounting of regen resistors is an option on PSR4/5's. To determine if your unit uses external regen resistors, check its model number. Also, the model number indicates the standard resistor value. These resistors should be enclosed to reduce shock hazard. Regen resistors get hot! They are a burn hazard and they are a fire hazard. They can produce enough heat to melt insulation. Enclose these resistors! The enclosure must provide ventilation and withstand high temperatures. Do not mount the resistors underneath the BDS5 or PSR4/5.

WARNING

EXTERNAL REGEN RESISTORS ARE A SHOCK HAZARD!

Mount these resistors properly! Enclose these resistors to protect personnel and equipment!

CAUTION

EXTERNAL REGEN RESISTORS GET HOT!

If you are using external regen resistors, allow sufficient clearance around the resistors. Enclosures must provide ventilation.

2.6 WIRING

The customer is responsible for providing proper circuit breaker or fuse protection. The customer is responsible for providing proper wire gauge and insulation rating for all wiring, including motor, AC line, DC bus, and External Regen Resistor connections. The customer is responsible for making sure that all system wiring and electrical protection comply with all applicable national and local electric codes.

Drawing A-93103 is the System Wiring Diagram. It is a seven-sheet drawing. Carefully read all of Drawing A-93103 before wiring your BDS5 system, including all of the notes on the last sheet. Refer to BDS5 Connectors Diagram A-96372M, provided at the end of this chapter, for connector locations.

WARNING

Carefully read all seven sheets of Drawing A-93103 <u>before</u> wiring your BDS5 system, including ALL of the notes on the last sheet.

When wiring your BDS5 system, observe the following guidelines:

1. Twist all AC leads to minimize electromagnetic emissions (noise).

2. Avoid running signal leads in close proximity to power leads, motor stator leads, or other sources of electromagnetic noise. Run signal leads in separate conduit from power leads. Shields are recommended for signal leads.

3. Minimize lead lengths.

4. Connect the BDS5 system according to the System Wiring Diagram, A-93103; pay close attention to the grounding scheme and notes.

2.6.1 Wiring the Ground

Ground terminals are provided on the front of BDS4's, BDS5's, and PSR4/5's. These ground screws are directly below the Power Terminal Block of each unit.

To prevent shock hazard and to ensure proper operation of the system, the BDS5, PSR4/5, and the motor must be grounded. Each BDS5 and PSR4/5 has two ground screws on the front of its chassis.

WARNING

GROUND YOUR BDS5, PSR4/5, and motor PROPERLY! Failure to provide proper grounding can result in a shock hazard.

One of the ground screws on the PSR4/5 should be connected to Earth Ground or Machine Ground. The other should be connected to the adjacent BDS5 ground screw, along with the ground wire from the motor. The other ground screw on the BDS5 chassis should then be connected to the next BDS5, etc. Use 10 AWG or larger wire for grounding between BDS5's and PSR4/5's and from PSR4/5 to Earth Ground or Machine Ground.

2.6.2 Wiring the Power Connections

This section discusses how to wire the PSR4/5 and BDS5 power connections.

CAUTION

To prevent equipment damage, the AC Line and the DC bus must be connected as indicated by the System Wiring Diagram, A-93103.

The PSR4/5 and BDS5 are configured at the factory for operation from either a 115 volt or a 230 volt AC Line. The PSR4/5 and the BDS5 must both have the same voltage rating. Operating a PSR4/5 or a BDS5 with incorrect voltage can damage the units.

CAUTION

Use the proper AC Line voltage. PSR4/5's and BDS5's are configured at the factory for 115 volt or 230 volt AC Line voltage. See the model number description at the beginning of this chapter to determine the required voltage for your PSR4/5 and BDS5.

2.6.2.1 Wiring the Motor

Connect Pins A, B, and C of the motor connector through a motor cable to M_a, M_b, and M_c, respectively, on the Power Terminal Block located on the front of the BDS5 amplifier. Connect Pin D of the motor connector through the same motor cable to the BDS5 chassis ground screw located directly beneath the Power Terminal Block.

IT IS VERY IMPORTANT THAT YOU WIRE THE MOTOR PROPERLY. Brushless permanent magnet motors are not like induction motors. You cannot simply interchange two phases to reverse the direction of rotation.

Standard Industrial Drives motor cable has the color code as shown in Table 2.1.

Table 2.1. Motor Cable Color Code

Motor Connector	Wire Marker	BDS5 Power Terminal
Pin A	M_a	Terminal M_a
Pin B	M_b	Terminal M_b
Pin C	M_c	Terminal M_c

WARNING

Incorrect motor wiring can cause erratic or runaway motor operation. Use of factory supplied cable sets is highly recommended.

2.6.2.2 Motor Protection

Under normal conditions, you do not need to add protection for your motor; the BDS5 is normally configured to limit the continuous current below the rating of the motor. However, if the drive is oversized (that is, it can provide continuous current that greatly exceeds the motor's continuous current rating), you may want to add motor overload relays in series with the motor. Also, you can wire a contactor in series with the motor leads. ALWAYS BE CAREFUL TO WIRE THE MOTOR PROPERLY.

2.6.2.3 Motor Thermostat

Industrial Drives brushless motors have a thermostat. The thermostat contacts are closed during normal operation and open when the motor overheats. The BDS5 does not provide a direct input for the motor thermostat. You should connect the thermostat contacts to a BDS5 general purpose input, and program your BDS5 to bring about an orderly shutdown when the thermostat opens. The thermostat ratings are:

Rated Voltage:	277 VAC at 60 Hz 250 VAC at 50 Hz
Rated Current:	2.5 Amps at power factor of 1.0 1.6 Amps at power factor of 0.6
Resistance:	50 m Ohms

The thermostat resets (closes) when the motor cools. The customer is responsible for making sure that the motor does not begin moving unexpectedly when the thermostat closes. <u>Do not connect the thermostat directly in line with the BDS5 REMOTE ENABLE or LIMIT inputs, as this may allow the system to begin operation unexpectedly.</u> You must latch the thermostat switch, either in hardware or software. IT CAN TAKE SEVERAL MINUTES FOR THE MOTOR TO COOL ENOUGH TO ALLOW THE THERMOSTAT TO CLOSE. UNEXPECTED OPERATION SEVERAL MINUTES AFTER A FAULT IS A SAFETY HAZARD!

WARNING

LATCH THE MOTOR THERMOSTAT!

DO NOT CONNECT THE THERMOSTAT DIRECTLY TO THE BDS5 REMOTE ENABLE OR LIMIT INPUTS.

The motor thermostat resets (closes) when the motor cools. This can allow the motor to restart operation unexpectedly after a motor thermostat fault unless the thermostat is latched. Always latch the thermostat.

NOTE

B series (GOLDLINE) motors have the thermostat wired to the resolver connector at the motor.

BR series motors have the thermostat wired to the power connector at the motor.

Some electrical noise from the motor leads will couple capacitively with the thermostat leads. This occasionally causes false thermostat trips. That is, your controller senses that the thermostat opened even though the thermostat contacts were closed. If this occurs you can use the thermostat contacts to energize a relay and then connect the relay contacts to your controller. The electrical noise does not normally cause relay contacts to open.

2.6.2.4 Motor Brake

Fail safe brakes are an option with INDUSTRIAL DRIVES motors. With GOLDLINE motors, the brake connections are available as blue flying leads on the resolver cable. They are available in more than one voltage rating, so check the model number of your motor carefully to determine the voltage and current required by the brake on your motor. Normally, you should control the brake with the STATUS input discussed in Chapter 4.

2.6.2.5 Wiring the DC Bus

Connect the DC Bus from the PSR4/5 Power Terminal Block (BUS+, BUS-) to the BDS5 Power Terminal Block (BUS+, BUS-). You must observe polarity of DC Bus connections: always connect BUS+ to BUS+ and connect BUS- to BUS-. For the PSR4/5-12 and -20, the DC Bus can be connected to any combination of 3 BDS4's or BDS5's (for example, 2 BDS5's and 1 BDS4). The PSR4/5-50 and -75 can be connected to any combination of 6 BDS4's or BDS5's, although no more than 3 units can be on one side of the PSR4/5. Refer to Note 8 on A-93103.

WARNING

Failure to observe polarity of the DC Bus can result in personal injury.

CAUTION

Failure to observe the polarity of the DC Bus will result in damage to the PSR4/5 and BDS5.

2.6.2.6 Wiring the AC Line

Connect the three-phase AC Line to L_a, L_b, and L_c on the Power Terminal Block located on the front of the PSR4/5 unit.

The PSR4/5 will work with a single-phase AC Line. Depending on the PSR4/5 model number, either 110 VAC or 220 VAC single-phase input lines may be connected to any two terminals, L_a, L_b, or L_c. Note that the PSR4/5 must be derated for single-phase AC Line operation. A 12-Amp PSR4/5 with a single-phase AC Line can only provide 10 Amps; a 20-Amp PSR4/5 with a single-phase AC line can only provide 16 Amps.

CAUTION

The PSR4/5 must be derated when operated from a single-phase AC Line.

2.6.2.7 Wiring the Regen Resistor

If an external regen resistor is used, wire it to the External Regen Resistor Connector on the PSR4/5. Note that you must specify that you need an external regen resistor when ordering your PSR4/5 as this is an option. Refer to Notes 3 and 11 on System Wiring Diagram A-93103.

2.6.3 Wiring the PSR4/5 Front Panel Connectors

This section will discuss wiring of the PSR4/5 front panel connectors, C1 and C2. The mating connectors for C1 and C2 are supplied with the PSR4/5.

2.6.3.1 Wiring the Control Power to C1

The Control Power for the PSR4/5 is 115 VAC. Connect the Control Power to Connector C1 of the PSR4/5. Connect one 115 VAC line to Pin 2 and the other to Pin 3. Other 115 VAC connections (such as fans on 20 Amp BDS4's and BDS5's) can be made from Connector C1 Pin 5 (one side of the 115 VAC line) and Pin 6 (the other side). See Drawing A-93103 for more information.

2.6.3.2 Wiring to the PSR4/5 Fault Output on C1

The PSR4/5 Fault Output Contact closes approximately 250 milliseconds after power is applied to the PSR4/5. This contact opens if a fault occurs in the PSR4/5. This is a relay contact from Pin 1 to Pin 4 of Connector C1. You can connect this contact to your controller or to a BDS4/5 remote inhibit. You should inhibit the entire system if a PSR4/5 fault occurs! See Note 2 of A-93103.

The ratings of this relay are:

2 amps at 28 Volts DC, resistive.
1 amp at 120 Volts AC, resistive.

CAUTION

INHIBIT YOUR SYSTEM IF A PSR4/5 FAULT OCCURS! YOU MUST WIRE YOUR SYSTEM FOR THIS FUNCTION!

2.6.3.3 Wiring PSR4/5 Connector C2

Connector C2 is the Logic Power Supply for the BDS5. Wire the Logic Power Supply from Connector C2 on the PSR4/5 to Connector C4 of the BDS5. Each logic power supply voltage is connected to two pins so that you can wire from the PSR4/5 to the nearest BDS4 or BDS5. For example, +18 volts appears side by side on Pins 1 and 5. Note that the PSR4/5 12 and 20 amp models can have a maximum of three units (axis) connected, while the 50 and 75 amp models made have six units connected. Table 2.2 lists the ratings of the PSR4/5 logic power supplies.

Table 2.2. PSR4/5 Logic Power

VOLTAGE	CURRENT (PER AXIS)	BDS5 Connector C4 PIN	PSR4/5 Connector C2 PIN
+ 18 VDC ±20%	0.25 AMP	1, 5	1, 5
- 18 VDC ±20%	0.25 AMP	2, 6	2, 6
COMMON	---	3, 7	3, 7
+ 10 VDC ±20%	1 AMP	4, 8	4, 8
LOGIC POWER SUPPLY MAXIMUM RATINGS			

CAUTION

Failure to observe the polarity of the logic power supply will result in damage to the PSR4/5 and BDS5

CAUTION

Connecting more than a total of three units (either BDS4's or BDS5's) to one PSR4/5 (12 & 20 amp models) can damage the PSR4/5.

2.6.4 Wiring the BDS5 Front Panel Connectors

This section will discuss wiring of the BDS5 front panel connectors: C1, C2, C3, C4, C5, and C6 (C6 is on 20 Amp units only). Mating connectors for C1-C6 are supplied with the BDS5.

2.6.4.1 Wiring C1, Encoder Equivalent

The Encoder Equivalent Connector connects encoder inputs and encoder equivalent outputs. The BDS5 uses standard encoder format (A-B quadrature). This format has excellent noise immunity because only one channel changes at a time. As an option, pulse inputs in different formats are also supported.

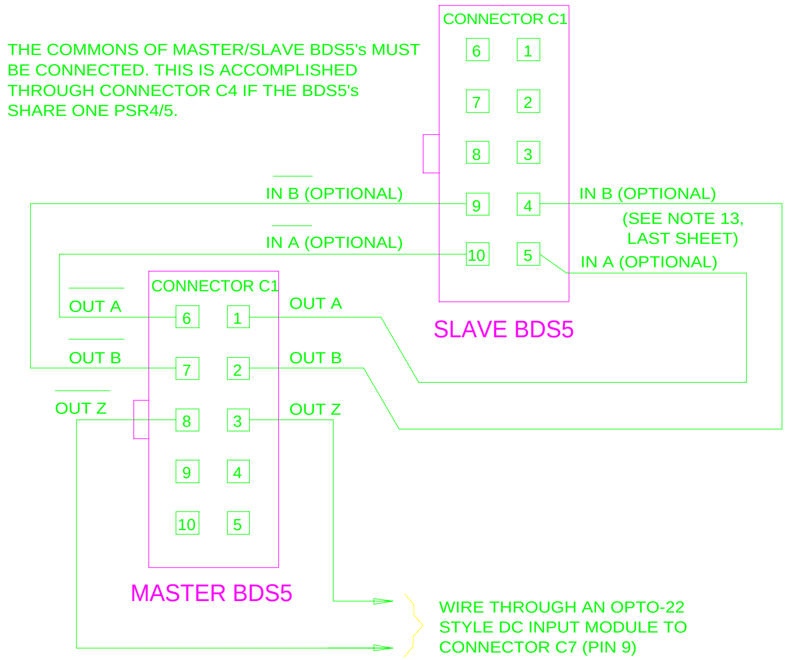
The Encoder Equivalent Connector is used for master/slave systems. If your BDS5 is the slave axis, then connect the output from the master to INA and INB. If your BDS5 is the master axis, connect OUTA, OUTB, and OUTZ to the inputs on the slave axies. See Figure 2.2 and/or Drawing A-93103 for connection diagrams.

All encoder signals are differential (as opposed to single-ended) to increase noise immunity. This means that each signal is transmitted with its logical inverse (for example, OUTA and OUTA'). Logical inverse means that if OUTA is 5 volts, then OUTA' is 0 volts and that if OUTA is 0 volts, then OUTA' is 5 volts. (Note that Drawing A-93103 shows the inverse of OUTA as OUTA with a bar drawn directly above it; here, the inverse of OUTA will be designated OUTA'.)

The encoder equivalent inputs and outputs conform to RS-485. One standard RS-485 output can drive up to 32 standard RS-485 inputs, provided that the interconnecting cable's capacitance is small enough. Capacitance increases with cable length, which implies that the transmitter (OUT's) and receivers (IN's) should be as close to each other as is practical.

You should use 120 ohm cable. For longer distances (over a 100 feet), consider using reduced capacitance cables such as those available from Black Box (Pittsburgh, PA). The cable should be run from point to point, as opposed to branching out from a single point. Branches could cause reflections (a transmission line effect) that can interfere with the signals. If the cable is very long, ringing (also a transmission line effect) may occur. If this happens, you should connect a 120 ohm resistor across each signal and its logical inverse at both ends of the cable.

The Encoder Equivalent Connector uses RS-485 compatible 75174 line drivers and 75175 line receivers, which are available from many IC manufacturers, including Texas Instruments.



REFERENCE TO NOTE 13 LAST SHEET STATES,

NOTE 13 - IF THE BDS5 USES THE OPTIONAL ANALOG INPUT CARD (BDS5 - OPT1), THE OPTIONAL ENCODER INPUTS IN CONNECTOR C1 ARE NOT USED.

Figure 2.2. Master BDS5 and Slave BDS5 (Part of Drawing A-93103)

The BDS5 uses the same phasing for the encoder inputs and outputs; for clockwise rotation, Channel A leads Channel B. For standard systems, the inputs are Channel A (Pins 5, 10) and Channel B (Pins 4, 9). The outputs are Channel A (Pins 1, 6), Channel B (Pins 2, 7), and the marker channel, Channel Z (Pins 3, 8). There is no input Channel Z, though this signal often would be connected to HOME (see *User's Manual*). Refer to Figure 2.3 for a phasing diagram. The logic power supply common is not available on Connector C1. If you are wiring from one BDS5 to another BDS5 on the same PSR4/5, then you need not connect common, as the commons of the two drives will be connected through the logic power supply connector, C4. If you need to connect to common, you must obtain it from Connector C2 or C4. BE SURE THAT THE COMMON OF THE BDS5 AND OF THE ENCODER POWER SUPPLY ARE ELECTRICALLY CONNECTED TO EACH OTHER.

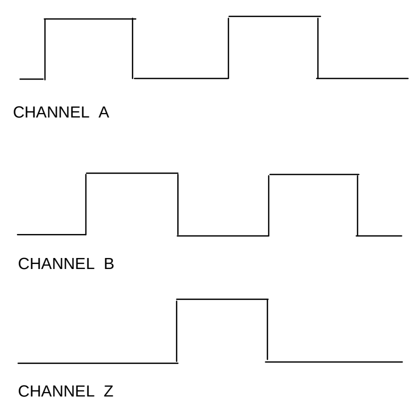


Figure 2.3. Encoder Phasing For Clockwise Rotation

$\overline{\text{OUT A}}$	6	1	OUT A
$\overline{\text{OUT B}}$	7	2	OUT B
$\overline{\text{OUT Z}}$	8	3	OUT Z
$\overline{\text{IN B}}$ (Standard)	9	4	IN B (Standard)
$\overline{\text{IN A}}$ (Standard)	10	5	IN A (Standard)

Figure 2.4. BDS5 (C1)

2.6.4.2 Encoder Equivalent Input

The encoder and pulse inputs are for signals from a master encoder (for example, an encoder on another motor, or the encoder output of another BDS5). The BDS5 can also use an encoder for feedback in some cases. The encoder equivalent input is not available when the analog input (OPT1 Card) or pulse input (OPT2 Card) is installed.

If the encoder input is being used for a velocity command, as is the case for electronic gearbox applications, then you must be careful to connect the encoder input for the correct direction of rotation. If the BDS5 is being used as a velocity drive, and another controller is closing a position loop, reversing the encoder inputs can cause the BDS5 to run away or oscillate. BE CAREFUL TO CONNECT THE ENCODER/PULSE INPUT SO THAT THE DIRECTION IS CORRECT!

WARNING

Phase the encoder/pulse input correctly. Incorrect phasing of the encoder input can cause excursions, oscillations, or runaways.

Note that if your BDS5 is configured with the optional analog input, then encoder equivalent inputs are not available. The outputs are still available.

NOTE

Systems with the optional analog inputs do not have encoder equivalent inputs.

2.6.4.3 Pulse Input (OPT2 Card)

As an option, you can also purchase your BDS5 with a Pulse Input option. This option allows you to:

1. Control the BDS5 from a stepper-motor controller. For this function, configure the BDS5 as an electronic gearbox and select the format that is compatible with your controller.

2. Input a single-phase clock from your computer. There are occasions when you want to control the BDS5 with a unidirectional clock (for example, feedrate override). The Pulse Input option accepts a single-phase clock, such as would be generated from an electronic timer/counter chip.

The Pulse Input Option board (BDS5-OPT2) is mounted inside the BDS5 unit. This board accepts pulse inputs in three formats: count/direction, up/down, or single-phase. Use the toggle switch on the board to select the formats. See Drawing A-93146 for more information.

2.6.4.4 Encoder Equivalent Output

The Encoder Equivalent Output provides position information to another device in the system. The output is in standard encoder format. The Encoder Equivalent Output must be phased correctly. If the BDS5 is being used as a velocity drive, and another controller is closing a position loop, reversing the Encoder Equivalent Output can cause the BDS5 to run away or oscillate. BE CAREFUL TO CONNECT THE ENCODER EQUIVALENT OUTPUT SO THAT THE DIRECTION IS CORRECT!

WARNING

Phase the Encoder Equivalent Output correctly. Incorrect phasing of the Encoder Equivalent Output can cause excursions, oscillations, or runaways.

2.6.4.5 Wiring C2, Customer I/O

Connector C2 has a variety of signals:

- Analog Input Pins 1, 11

The BDS5 accepts an analog input as an option. This option is specified when you order your system. If you use the analog input, then the encoder input is not available. If you use the analog input, refer to the User's Manual paragraph 4.11 for a program that configures the BDS5 as a velocity drive.

The input is scaled for ±10 volts = full scale. Input impedance is > 20 k Ohm. The analog input is differential; that is, the input voltage is taken to be the voltage at Pin 11 minus the voltage at Pin 1. Differential (two-wire) signals have higher noise immunity than single-wire signals, since noise picked up by the wires is eliminated when the two voltages are subtracted.

Typically, one of the two wires will be at a voltage nominally the same as Common. Preferably, this wire should be connected to Pin 1. It is important to note that swapping Pins 1 and 11 reverses the polarity of this input.

When using the analog input you must be careful to shield it properly. You should use shielded, twisted-pair cable. Connect the shield to Pin 13 or 3 on Connector C2 on the BDS5, or to the frame at the source of the signal, or at both ends. Determining the best shield connection is often a matter of trial-and-error. Begin by wiring the shield only at the BDS5.

If the BDS5 is being used as an analog velocity drive, then you must be careful to connect the analog input with the correct polarity, since the polarity determines the direction of rotation. If the BDS5 is being used as a velocity drive, and a different controller is closing a position loop, reversing the polarity of the analog input can cause the BDS5 to run away or oscillate. BE CAREFUL TO CONNECT THE ANALOG INPUT SO THAT ITS POLARITY IS CORRECT!

WARNING

Phase the analog input correctly. Incorrect polarity of the analog input can cause excursions, oscillations, or runaways.

- Tach Monitor Pin 2

Tach monitor indicates velocity. It is referenced to Common and scaled for 1000 RPM clockwise = +1 volt. This output has a 1k Ohm resistor in series and a 4700 pF filter capacitor connected to Common.

- I Monitor Pin 4

I monitor is a Common-referenced signal scaled for full (peak) current = 5 volts. This output has a 3.01k Ohm resistor in series. I Monitor is always positive.

- Common Pins 12, 14, 15

Logic Power Supply Common is provided on several pins since it is used in several places. Do not connect shields to Common.

- Shield Pins 3, 13

The shield pins are connected directly to the BDS5 frame. You should connect shields from cables to the shield pins.

- Relay Pins 16, 17

These two pins are connected to a set of normally open relay contacts. The contacts are open on power-up, and close after the power-up self-tests and autobauding. The relay is controlled by the watchdog timer. If the contacts open once the BDS5 is running, then there is a serious fault and you cannot depend on the microprocessor to operate properly. Always wire all BDS5 relays to disconnect all power in the event of the relay contacts opening. These contacts are rated for a maximum current of 1 Amp and a maximum voltage of 115 volts AC or DC. The maximum switched power is 30 Watts DC or 60 volt-amps AC.

- CYCLE/CYCLE RETURN Pins 8, 7

CYCLE is on Pin 8; CYCLE RETURN is on Pin 7. CYCLE is normally used to start a cycle of a user program; it can also be used as a general purpose input. CYCLE is optically isolated. CYCLE should be pulled up to between 12 and 30 volts with reference to CYCLE RETURN (not Common) to turn on, or activate, the CYCLE input. Exceeding 30 volts could damage this input. Observe polarity when connecting CYCLE and CYCLE RETURN.

Note that CYCLE is also available on Connector C7. The CYCLE signal on the Connector C7 is not optically isolated. If you use both CYCLE inputs, then the BDS5 will sense that CYCLE is on if the CYCLE signal from either Connector C2 or C7 is on.

- REMOTE/REMOTE RETURN Pins 9, 6

REMOTE is on pin 9; REMOTE RETURN is on pin 6. REMOTE is an input that must be activated for the BDS5 to be enabled. REMOTE is optically isolated. It should be pulled up to between 12 and 30 volts with reference to REMOTE RETURN (not common) to activate the REMOTE input. Exceeding 30 volts could damage this input. Observe polarity when connecting REMOTE and REMOTE RETURN.

- HOME/HOME RETURN Pins 19, 18

HOME is on pin 19; HOME RETURN is on pin 18. HOME is intended to be connected to a home limit switch; it can also be used as a general purpose input. HOME is optically isolated. HOME should be pulled up to between 12 and 30 volts with reference to HOME RETURN (not Common) to activate the HOME input. Exceeding 30 volts could damage this input. Observe polarity when connecting HOME and HOME RETURN.

Note that HOME is also available on Connector C7. The HOME signal on Connector C7 is not optically isolated. If you use both HOME inputs, then the BDS5 will sense that HOME is on if the HOME signal from either Connector C2 or C7 is on.

- I/O DC Pin 5

I/O DC is provided for occasions when you do not need optical isolation for HOME, CYCLE, and REMOTE ENABLE. An unregulated, low current power supply is provided on I/O DC to power those three inputs. Do NOT use I/O DC as a power supply for anything except these three isolated inputs!

If you want to use I/O DC, then connect the return lines (HOME RETURN, CYCLE RETURN, and/or REMOTE RETURN) to Common. Then you can connect HOME, CYCLE, and/or REMOTE ENABLE to I/O DC (usually through a relay contact) to activate those inputs.

CAUTION

Using BDS5 internal power supply (I/O DC) for any purpose except power for HOME, CYCLE, and REMOTE ENABLE can damage the PSR4/5.

- O1 Pins 10, 20

O1 is an optically-isolated output. It is a solid state relay rated for 0.25 Amps and 30 VDC maximum. Only DC voltages, with the more positive voltage on Pin 10, may be applied to this output. You must observe polarity when connecting O1. You should install a 0.25 amp fuse in series with O1, as it is not fused internally.

Note that O1 is also available on Connector C8. The O1 signal on Connector C8 is not optically isolated. You can use both O1 signals at the same time.

2.6.4.6 Wiring C3, Resolver

WARNING

Connect the resolver leads correctly. Incorrect motor resolver phasing can cause erratic operation, runaway, or damage to the system. Use of Industrial Drives resolver cable sets is highly recommended.

Install the resolver cable between the motor and the BDS5. Make the connection at the motor resolver connector and Connector C3 on the BDS5.

If you are making your own resolver cables, you must obtain the procedure from INDUSTRIAL DRIVES to make cables.

2.6.4.7 Wiring C4, Logic Power Supply

Wiring C4 is discussed above with "Wiring PSR4/5 Connector C2" since these two connectors are connected to each other.

2.6.4.8 Wiring C5, Serial Communications

Connector C5, the Serial Communications Connector, is on the front of the BDS5. It is a 9-pin, D-type, sub-miniature plug connector (DE-9P). The communications cable must have the mating DE-9S connector. See the System Wiring Diagram (A-93103, Sheet 3). Note that wiring for RS-232 and RS-485 is completely different. Refer to the model number to determine if your unit is RS-232 or RS-485. Be sure that the common of the BDS5 and the power supply common of your computer or terminal are electrically connected to each other, whether you are using RS-232 or RS-485. Use the COM pin on the serial connector (Connector C5) for the BDS5 common.

- RS-232 VS RS-485

The BDS5 can communicate with a terminal or a computer over a serial data line with EIA RS-232-C, the most common electrical interface for terminals and personal computers. It can also communicate with EIA RS-485, a standard that supports multiple devices on one serial line. RS-485 is an upgrade of RS-422; RS-422 is restricted to one transmitter per serial line; otherwise, the devices will work with RS-485 devices. You should specify the communication standard that you want when you order your BDS5.

When choosing between RS-232 and RS-485, there are a number of factors to take into consideration. RS-232 is much more common than RS-485. Most terminals and computer serial ports are RS-232; however, RS-485 is becoming more available on personal computers. RS-485 is differential; RS-232 is single-ended. To illustrate this, RS-232 transmits one output, TxD. Alternatively, RS-485 simultaneously transmits TxD+ and TxD-, the logical inverse of TxD+. (Logical inverse means that if TxD+ = 1, then TxD- = 0). RS-232 transmitters typically have series-terminated outputs, while RS-485 transmitters do not. All this makes RS-485 less susceptible to noise and able to transmit over much longer distances. On the other hand, RS-232 is easier to use and much less susceptible to transmission line effects. RS-232 is also less expensive. A major advantage of RS-485 is that it allows multidrop communication, where many axes can be connected on one serial line.

If you have an RS-232 terminal or computer, and you want to use RS-485, either for multidrop or for noise immunity, then you can purchase an RS-232-to-RS-485 converter. For example, Anaheim Automation (Anaheim, CA) produces Model DC 2170 for this purpose.

The RS-232 serial input and outputs connect to 75155 line driver/receivers. The RS-485 serial input and outputs connect to 75176B line driver/receivers. These chips are available from many IC manufacturers, including Texas Instruments.

Table 2.3. Communication Requirements

To Communicate With Your BDS5, You Will Need:
RS-232 Terminal or IBM-PC Compatible with Communication Software or RS-485 Terminal and Connector for Your Terminal DE-9S Connector (Provided with BDS5) 3-Wire-with-Shield Cable (RS-232)* 5-Wire-with-Shield Cable (RS-485)*

* Use one of the conductors to connect the power supply commons. The shield should not be used for this connection, but should connect to earth ground.

- LINE TERMINATION

The BDS5 provides line termination for RS-485. An RS-485 line may need to be terminated to reduce ringing on long cables. (In this section, Line refers specifically to the RxD+/RxD- pair or the TxD+/TxD- pair.)

A line is terminated by connecting a resistor from RxD+ to RxD- or TxD+ to TxD-. Terminating resistors are provided inside the BDS5. These resistors are connected by installing jumpers across Pins 3 and 4, and across Pins 7 and 8 on J1 on the front of the BDS5. The lines should only be terminated at the end of the communication cable. For example, if you are using several BDS5's in multidrop, then you should install the jumpers only on the units at the ends of the serial cable.

NOTE

For RS-485, you should install jumpers across Pins 3-4 and 7-8 on J1 on the front of the BDS5 at the end of the communication cable. If the device you are using to communicate with the BDS5 is at one end of the line, you should terminate the line at that end with a 120 ohm resistor.

- DISTANCE

RS-232 generally works well up to 50 feet using standard cable. Special low capacitance cable can extend this range up to 500 feet, although the baud rate may need to be reduced. These cables are available from many companies, including Black Box (Pittsburgh, PA).

RS-485 can be used up to 4000 feet. Be forewarned, however, that using very long cables may be more difficult than just making the connections. Special attention must be paid to AC loading, transmission line effects, noise pickup, and common-mode voltages. It would be wise to have a person who is knowledgeable in these matters to review the cable design beforehand. Again, baud rates may need to be reduced as the length increases, and low capacitance cables may be required.

You can obtain a copy of the specification for RS-232 or RS-485 by contacting:

Electronic Industries Association
Engineering Department
2001 Eye Street, N.W.
Washington, D.C. 20006

- CONNECTING TO A TERMINAL

Connect the pins on the DE-9S connector that came with your BDS5 as follows:

Table 2.4. Terminal Wiring

WIRING TO MOST RS-232 TERMINALS				
BDS5 (DE-9) Female			Terminal (DB-25) Male or Female	
1		SHIELD*		1
2	RxD	←	TxD	2
3	TxD	→	RxD	3
5		COM		7

* Usually, you will only connect the shield at one end. Sometimes, the shield should be connected at both ends. This is system dependent and generally found by trial and error.

The table above assumes that your terminal has an RS-232 serial port which is configured as Data Terminal Equipment (DTE), the usual configuration. If your terminal is configured as Data Communications Equipment (DCE), then interchange Pins 2 and 3 at one end of the cable.

Note that handshaking signals (CTS, DTR, etc.) are not supported.

- CONNECTING TO A COMPUTER

Connect the pins on the DE-9 connector that came with your BDS5 as follows:

Table 2.5. PC Wiring

WIRING TO AN IBM-PC COMPATIBLE COMPUTER					
BDS5 (DE-9P) Female		IBM-PC (DB-25S) Female	BDS5 (DE-9P) Female		IBM-AT (DE-9S) Female
1	SHIELD*	1	1	SHIELD*	FRAME+
2 RxD	<--	TxD 2	2 RxD	<--	TxD 3
3 TxD	-->	RxD 3	3 TxD	-->	RxD 2
5	COM	7	5	COM	5

* Usually, you will only connect the shield at one end. Sometimes, the shield should be connected at both ends. This is system dependent and generally found by trial and error.

\+ The PC-AT does not have a pin for shield. If you want to hook the shield to the PC-AT end of the cable, you must connect it directly to the frame of the computer.

The table above assumes your PC has an RS-232 serial port that is configured as Data Terminal Equipment (DTE), the usual configuration. If your port is configured as Data Communications Equipment (DCE), then interchange Pins 2 and 3 at one end of the cable.

Note that handshaking signals (CTS, DTR, etc.) are not supported.

If the PC-compatible computer is AC-line powered (that is, not battery powered), use extreme caution when interconnecting the PC to the BDS5 serial port. Both the PC and the BDS5 must share the same power supply common. If they do not, the voltage difference between the two commons could damage either or both machines.

CAUTION

Make sure that the Computer and BDS5 share the same power supply common. Either your computer or the BDS5 or both can be damaged if the commons are not at the same potential.

If you use a computer, you will need communications software. The recommended communications software for use with the BDS5 is Motion Link, an Industrial Drives software package that is specially designed for the BDS5. Other communications software packages include XTALK, QMODEM, PROCOM, KERMIT, and PC-TALK. See the *User's Manual* for more information about Motion Link.

2.6.4.9 Wiring C6, Fan Power (20 Amp Units Only)

Connect the 115 VAC Control Power from the PSR4/5 (Connector C1) to the fan power connector on all 20 Amp BDS4's (Connector C4) and BDS5's (Connector C6). As the wiring diagram (A-93103, Sheet 1) shows, 115 VAC appears side by side on each connector, similar to the logic power supply connector. This allows you to "daisy-chain" the Control Power to each unit that requires it.

NOTE

Connector C6 is only used on BDS5 and BDS4 amplifiers with continuous ratings of 20 Amps and above.

2.6.4.10 Wiring C7, Standard I/O

C7 is a 26-pin ribbon cable connector. It provides non-isolated, 5-volt TTL-level inputs and outputs and directly interfaces to 8-line OPTO-22 compatible I/O boards. These boards are widely available and use industry standard optical isolation modules, available from several companies, including Potter and Brumfield, Grayhill, Gordos, OPTO-22, and Crydom. This connector is on top of the BDS5.

Note that you must provide a separate power supply when using standard OPTO-22 compatible I/O boards. This supply must provide 5 volts DC to power the I/O modules on the BDS5 side of the isolation. The common of this supply will normally be connected to the common of the BDS5 through the even numbered pins on Connector C7. DO NOT USE THE BDS5 5 VDC POWER SUPPLY TO POWER I/O MODULES!

Additionally, a second power supply may be needed to provide power for those devices which are isolated from the BDS5 by the I/O modules. The common of this supply should not be connected to the BDS5 common.

NOTE

You must provide an additional power supply for the I/O modules.

- HOME Pin 9

HOME is the input for the home limit switch. It is also the registration input. If your application has both a home limit switch and a registration input, use HOME for the registration input and connect the home limit switch to a general purpose input. This input can be used as a general purpose input if these primary functions are not required.

HOME is available on two connectors. See the description of HOME on Connector C2 in section 2.6.4.5.

- LIMIT Pin 11

This input must be turned on for normal operation. Connect the normally closed contacts of the overtravel limit switches in series with LIMIT.

If your application does not allow you to use hardware travel limit switches, then you must hardwire LIMIT on. If you are not using Connector C7 you can hardwire LIMIT on by installing a jumper directly on C7 between Pins 11 and 12. The BDS5 is shipped from the factory with this jumper installed.

- CYCLE Pin 13

CYCLE is an input that is normally used to start a cycle of a user program. It can be used as a general purpose input if this primary function is not required. See the description of CYCLE on Connector C2 above.

- MOTION Pin 15

MOTION is used to enable motion of any kind. If MOTION is off, then no motion will be allowed. MOTION is often connected to a stop button.

If MOTION is off during power-up, the BDS5 will autobaud.

If your application does not allow you to use MOTION, then you must hardwire it on. If you are not using Connector C7, you can hardwire MOTION, by installing a jumper directly on C7 between Pins 15 and 16. The BDS5 is shipped from the factory with this jumper installed.

- GATE Pin 17

The GATE input starts precalculated motion profiles. It is used to synchronize motion with external events. This line may be used as a general purpose input if its primary function is not used
.

- O7, O8 Pins 19, 21

O7 and O8 are general purpose outputs.

- CYCLE READY Pin 23

CYCLE READY is an output that indicates that the BDS5 is ready for the CYCLE line to be activated. CYCLE READY is often connected to PLC's or to a lamp on an operator panel.

2.6.4.11 Wiring C8, Optional I/O

C8 is a 50-pin ribbon cable connector as shown in drawing A-93103. It provides non-isolated, 5 volt TTL-level inputs and outputs and directly interfaces to 24-line, OPTO-22 compatible I/O boards. These boards are widely available and use industry standard optical isolation modules. This connector is optional. It is on top of the BDS5.

Note that you must provide a separate power supply when using standard OPTO-22 compatible I/O boards. This supply must provide 5 volts DC to power the I/O modules on the BDS5 side of the isolation. The common of this supply will normally be connected to the common of the BDS5 through the even numbered pins on Connector C7. DO NOT USE THE BDS5 5 VDC POWER SUPPLY TO POWER I/O MODULES!

Additionally, a second power supply may be needed to provide power for those devices which are isolated from the BDS5 by the I/O modules. The common of this supply should not be connected to the BDS5 Common.

NOTE

You must provide an additional power supply for the I/O modules.

- O1-O6 Odd numbered Pins from 37 to 47

O1-O6 are general purpose outputs.

- STATUS Pin 35

The STATUS output indicates the status of the BDS5. You can configure STATUS to indicate "active" or "ready to be activated" with the software switch STATMODE. See the Enable and Fault Logic Diagram, Drawing A-84732, for more information.

The state of the STATUS output is undefined for up to 25 milliseconds on power-up.

WARNING

STATUS may turn on for up to 25 milliseconds after power-up.

- MANUAL Pin 33

MANUAL is used to change the BDS5 from AUTO mode to MANUAL mode. For more information, refer to User's Manual Chapter 4. MANUAL may be used as a general purpose input if its primary function is not required.

- I1-I16 Odd numbered Pins from 1 to 31

I1-I16 are general purpose inputs.

2.6.4.12 J1 Configuration Jumper

Jumper J1 connects the RS-485 line terminators. Refer to the section on line termination for information.

2.6.5 Establishing Communications

Industrial Drives supplies a communications package called, Motion Link, that is designed especially for communicating with the BDS5. Other terminal emulators can also be used as long as the required data format is followed. This manual is written for use with Motion Link. For more information on Motion Link, refer to the *User's Manual*.

2.6.5.1 Required Data Format

The BDS5 and your terminal must use the same format for serial data. RS-232-C and RS-485 describe hardware only. There are other specifications left to up to the user: full- or half-duplex, the number of bits per character, whether or not parity is used, the number of stop bits, and the baud rate. Full-duplex means both the terminal and the BDS5 can send and receive at the same time. Half-duplex means only one system can talk at a time. Bits per character refers to the number of actual data bits sent at one time. The parity is a bit sent for error detection. The number of start and stop bits sets a minimum delay between characters. The baud rate is the rate at which bits are transmitted and received.

The BDS5 requirements are:

Full-duplex
8 bits per character
No parity
1 Start bit
1 Stop bit
Baud rates equal 300, 600, 1200, 2400, 4800, 9600, or 19200.

Most terminals and computers will allow you to set these options with little difficulty. Motion Link sets these requirements automatically.

2.6.5.2 First Transmission

Before you attempt to establish communications, you must:

1. Mount the BDS5 and PSR4/5 system as described earlier in this chapter.

2. Make all connections as described in the earlier sections of this chapter, especially connecting the BDS5 serial connector to your terminal or computer.

2.6.5.3 Checking the Control Power

WARNING

SHOCK HAZARD!

115 VAC is present on the Control Power. Be very careful when measuring these voltages.

NOTE

Control Power is the 115 VAC connection at PSR4/5 Connector C1, pins 3 and 4.

Turn off control power. Remove PSR4/5 Connector C1. Turn on control power. Use an AC voltmeter to confirm that the voltage on PSR4/5 Connector C1, Pins 2 and 3 is 115 VAC +/- 15%.

Turn off control power. Re-install PSR4/5 Connector C1. Remove PSR4/5 Connector C2. Turn on control power. Use a DC voltmeter to confirm the logic supply (measure the pins in the PSR4/5 Connector C2).

Table 2.6. PSR4/5 C2 Voltages

+18 Volts ±20%	Pins 1 and 5
-18 Volts ±20%	Pins 2 and 6
Common	Pins 3 and 7
+10 Volts ±20%	Pins 4 and 8

If none of these voltages are present, check control power (115 VAC) on PSR4/5 Connector C1, Pins 2 and 3. If one or more of the voltages are missing, one or more fuse in the PSR4/5 may be open. Refer to the spare parts lists in Chapter 5 for descriptions of the fuses.

Turn off control power. Re-install PSR4/5 Connector C2.

Turn on control power. The green CPU LED on the front of the BDS5 should begin flashing, about 10 times per second. This indicates that the BDS5 is autobauding to establish communications.

If the CPU LED is not blinking...

Check the logic voltages from Table 2.6 above. If one or more of the voltages are missing, a fuse in the PSR4/5 opened because the logic supply was miswired. You may have miswired either Connector C2 on the PSR4/5, Connector C4 on any BDS5, or Connector C3 on any BDS4. Check your wiring carefully.

Make sure the MOTION input is off (contacts are open) when you power-up the BDS5. If the contacts are closed, open them and power-down the BDS5 and immediately power-up again. If the CPU LED is still not blinking, contact the factory.

1. If you are using Motion Link with an IBM-PC, type "ML" from DOS to start Motion Link. Motion Link will establish communications. Refer to User’s Manual for more information on installing and running Motion Link.

2. Whether you are using a terminal or a PC, press the return key 5 to 10 times, pressing the key about twice per second.

These steps cause carriage return characters to be sent to the BDS5. When autobauding, the BDS5 looks for these characters and uses them to determine the *baud rate* or speed at which your terminal is transmitting. Once the baud rate is determined, the BDS5 can establish communications with your terminal or computer.

Then the BDS5 should print this message (or one similar to it) on your terminal:

```
BDS5 V02.0.4
(C) 1991 INDUSTRIAL DRIVES
-->
```

The green SYS OK LED on the front of the BDS5 should turn on and remain on at all times after power-up (and autobauding). The "-->" means that your BDS5 is in the "interactive mode" and is ready to accept commands.

2.6.5.4 If You Can't Communicate...

If the BDS5 does not respond, then check to be sure that Connector C5 is wired properly. A common mistake is that of having the transmit and receive lines swapped. Also, make sure that none of the wires in the cable are broken.

If the CPU LED has stopped blinking...

the BDS5 has established communications. However, the transmission from the BDS5 is not being displayed on your terminal. Check carefully for miswired cable, broken wires, or possibly a shorted transmit line from the BDS5 to your terminal.

If the CPU LED is still blinking...

the BDS5 has not established communications. You can determine that your terminal is working by disconnecting the serial cable at your terminal. Then, temporarily connect the transmit and receive pins to each other (usually Pins 2 and 3 on a 25-Pin DB-25 connector) and press a few keys. The characters that you type should appear on the terminal screen. If they do not, then your terminal is not functioning properly.

If your terminal is functioning properly...

the serial communications cable may have open circuits (broken or missing wires) or may not be connected to the proper pins. You can determine if your serial cable has open circuits by connecting your terminal on one end and disconnecting the cable on the BDS5 end. Again, temporarily connect the transmit and receive pins (this time on the far end of the cable), then type on the keyboard. The characters that you type should appear on the terminal screen. If they do not, then your cable is not functioning properly.

If your cable is functioning properly...

the serial cable may still be the problem. You can determine if your cable is wired properly with an oscilloscope. For RS-232 systems, disconnect the cable from Connector C5. Connect ground on the scope probe to Pin 5 of the DE-9 connector on the cable. Use the oscilloscope to monitor Pin 2, with the time base between 1 and 20 milliseconds/division and the voltage sensitivity to 5 volts/division. While monitoring Pin 2, press several keys on the keyboard. The oscilloscope display should show Pin 2 changing between ±9 volts every time you press a key. If not, check Pin 3. If Pin 3 is responding, then Pins 2 and 3 are reversed. Remove power and exchange Pins 2 and 3. If there is no response, then the terminal may not be properly connected.

If you do not have an oscilloscope...

you may be able to use a digital voltmeter. Many digital voltmeters are quite sensitive and can detect character transmissions. You should see some activity (change in voltage) on the meter display every time you press a key.

If you think the cable is correct, but you still cannot communicate...

your terminal may not be configured for the data format listed on page 16. Check the manual for your terminal or computer (virtually all IBM-PC compatible computers conform to this format). If you are using a terminal, be sure your terminal is set properly.

2.7 INITIAL CHECK-OUT

This section will discuss the procedure for checking most of the wiring on the system before enabling your BDS5. Communications must be established with your BDS5 before continuing.

In this section, the BDS5 will be used to check wiring to most of the BDS5 inputs and outputs. You will need to enter some BDS5 commands. This section will use a few commands that are described in more detail elsewhere in this manual. The first command is the print command. You can print the discrete inputs. For example, after the BDS5 has printed the prompt "-->," you can type:

```
P LIMIT
```

and the BDS5 will print 1 or 0. 1 means that the input is on, indicating that the contacts are closed. 0 means that the input is off, indicating that the contacts are open.

NOTE

In this manual, instructions that you enter will be shown in italics and surrounded by a double line box. The response from the BDS5 will be in plain upper case letters.

2.7.1 Checking Discrete Inputs

You can check the state of all of the discrete inputs with the print command. This process will be demonstrated with the hardware travel limit switch, LIMIT. If you are not using the LIMIT switch, you can substitute another hardware switch, such as CYCLE or HOME which are available on Connector C2. In this case, substitute the words "CYCLE" or "HOME" for "LIMIT" in the following discussion.

1. Open the switch contacts.

2. Verify that the contacts are open. If you are using an Industrial Drives Input Module or an industry standard OPTO-22 compatible input module, there will be an LED on each input to indicate its state. The LED will be off if the contacts are open.

3. Use your terminal to enter:

P LIMIT

4. The BDS5 should respond with "0" indicating that the contacts are open.

5. Close the switch contacts.

6. Verify that the contacts are closed. (LED should be on.)

7. Use your terminal to enter:

P LIMIT

8. The BDS5 should respond with "1" indicating that the contacts are closed.

Repeat this process for each discrete input that you are using:

__I1	__I2	__I3	__I4
__I5	__I6	__I7	__I8
__I9	__I10	__I11	__I12
__I13	__I14	__I15	__I16
__CYCLE	__GATE	__HOME	__LIMIT
__MANUAL	__MOTION	__REMOTE**	

** Note that if a fault condition exists, the state (on or off) of REMOTE may not be available. In this case, the value of REMOTE will print as -1.

2.7.2 Checking General Purpose Outputs

You can check all of the general purpose outputs by turning them on and then off. Be careful. The procedure in this section will activate all of the general purpose outputs. Be sure that activating an output will not cause a hazard to personnel or damage to equipment.

WARNING

Commands in this section will turn on all general purpose outputs. Be certain that this is not a safety hazard. Make sure this will not damage equipment.

1. Turn on O1 by typing:

O1 ON

2. Verify that the output is on. If you are using an Industrial Drives Input Module, or an industry standard OPTO-22 compatible input module, there will be an LED on each output to indicate its state. The LED will be on if the output is on.

3. Turn off O1 by typing:

O1 OFF

4. Verify that the output is off.

Repeat this process for each discrete output that you are using:

__O1	__O2	__O3	__O4
__O5	__O6	__O7	__O8

2.7.3 Cycle Ready

CYCLE READY cannot be checked without a program. The *User's Manual* discusses this topic. Later, when you are familiar with programming, you can write a program that turns CYCLE READY on. Check this output at that time.

2.7.4 Checking STATUS

Check STATUS later in this chapter when the BDS5 is active. The STATUS output will turn on when you enable the BDS5.

2.7.5 Checking Encoder Output

Check the encoder output with a two-channel oscilloscope. Place Channel 1 on OUTA and Channel 2 on OUTA'. Rotate the motor by hand. You should see the encoder output on your scope. Repeat this process for OUTB and OUTB' and for OUTZ and OUTZ'. Note that OUTZ changes state only at one point during a full motor revolution.

2.7.6 Checking Encoder Input

If you have encoder input, connect your encoder to Connector C1. The encoder should not be moving. Type:

```
P PEXT
```

Now rotate the encoder. Type:

```
P PEXT
```

PEXT should have changed when you rotated the encoder shaft.

If the results are not what you expected, use an oscilloscope to verify that <u>all four</u> signals are reaching Connector C1.

Note that encoder equivalent inputs are not available if your system has analog input.

2.7.7 Checking Pulse Input (Optional)

If you have a pulse input option, connect your pulse input to Connector C1. Stop the pulse train. Type:

```
P PEXT
```

Now inject a few pulses. Type:

```
P PEXT
```

PEXT should have changed by the number of pulses you injected. If the results are not what you expected, make sure that you have set the pulse format switch properly. Then, use an oscilloscope to verify that <u>all four</u> signals are reaching Connector C1.

2.7.8 Checking Analog Input (Optional)

If you have analog input, connect your input voltage to Connector C2. Adjust the voltage to zero volts. Type:

```
P PEXT
```

Wait a few seconds and type:

```
P PEXT
```

PEXT should not have changed or should have changed very little. Now raise the input voltage to a few volts. Type:

```
P PEXT
```

and PEXT should have changed much more than it did with the input zeroed.

2.7.9 Checking the Resolver

The BDS5 provides a feedback loss circuit which is designed to detect broken wires; it can detect relatively few wiring errors. You should use the following procedure to verify feedback circuit.

WARNING

The feedback loss circuit is designed to detect broken wires. In general, it does not detect wiring errors.

Turn the motor shaft by hand until the R/D converter output is within the ranges listed below. You can display the R/D output by repeatedly typing:

```
P PRD
```

The standard R/D resolution is 12 bits. The resolution of your BDS5 is listed as part of the model number, which is shown on the front of the drive and described at the beginning of this chapter.

Rotate the motor shaft by hand until PRD is in the target range listed below:

Table 2.7. Target of PRD vs. R/D Resolution

R/D Resolution	12-Bit	14-Bit	16-Bit
Target Minimum	0	0	0
Target Maximum	250	1000	4000

Now rotate the motor shaft approximately 1/4 revolution CLOCKWISE. PRD should now fall in the range listed below:

Table 2.8. Target of PRD Versus R/D Resolution After Clockwise 1/4 Revolution

R/D Resolution	12-Bit	14-Bit	16-Bit
Target Minimum	800	3500	12500
Target Maximum	1300	5500	22500

If PRD does not fall into the range as listed above, then either the resolver is improperly wired or the feedback circuitry is not functioning correctly. The first step is to check the cable.

2.7.10 Checking the Resolver Cable

Follow this procedure if you are experiencing problems with the resolver. Disconnect the resolver cable at both ends and use an ohm meter to verify this resolver cable wiring table:

Table 2.9. Goldline Resolver Cable Wiring

BDS5 C3	Signal	Resolver Connector
1	Sine Low	B
2	Shield	No Connect
3	Cosine Low	C
4	Reference High	F
5	Shield	No Connect
6	Not Used	No Connect
7	Sine High	A
8	Shield	No Connect
9	Cosine High	D
10	Reference Low	E
11	Shield	No Connect
12	Not Used	No Connect
Flying Lead	Thermostat (Black)	T
Flying Lead	Thermostat (Black)	U
Flying Lead	Optional Brake (Blue)	N
Flying Lead	Optional Brake (Blue)	P
Flying Lead	Optional Tach (Black)	R
Flying Lead	Optional Tach (White)	S

NOTE

The following procedure uses an oscilloscope to measure the amplitude of signals with a frequency of 8 kHZ. Some digital voltmeters can measure the amplitude of signals at high frequencies (like 8 kHZ). However, many meters are designed to read 60 Hz and cannot be relied upon to read 8 kHZ signals.

If the cable is correct, check the resolver reference signal. Install the resolver cable at both ends. Connect an oscilloscope probe to Connector C3, Pin 4 (extend the probe with a short length of wire to reach inside the connector housing if necessary) and connect the probe ground to common (Connector C3, Pin 10). Apply control power (115 VAC). The reference signal should be between 11.8 and 12.0 V peak-to-peak (4.17 and 4.24 V RMS) at a frequency of about 8 KHZ. If necessary, adjust the reference amplitude with potentiometer 219. This potentiometer is located between Connectors C2 and C3 and can be adjusted from the front of the unit without disassembly.

If the reference signal is correct and the feedback circuitry is not working, your BDS5 may be malfunctioning. Contact the factory.

2.7.11 Checking the AC Line Voltages

WARNING

SHOCK HAZARD!

Large voltages are present on the AC Line. Be very careful when measuring these voltages.

Open the circuit breaker or remove the fuses in the AC Line.

Turn on the AC Line. Use an AC voltmeter to check and record the 1- or 3-phase line-to-line voltage at the circuit breaker or fuse holders. Turn off the AC Line. Note the model number of the PSR4/5 and refer to the Model Number Tables, in Chapter 1, to confirm correct AC Line voltage.

2.7.12 Checking the DC Bus Voltage

Remove the AC Line. Wait 5 MINUTES for the DC BUS to discharge.

WARNING

WAIT 5 MINUTES FOR THE DC BUS to DISCHARGE!

The DC Bus is connected to large capacitors inside the PSR4/5. These capacitors can store a lot of energy.

Remove the BUS+ and BUS- leads from the PSR4/5 Power Terminal Block. Disconnect Connector C2 from the PSR4/5.

Turn on Control Power to PSR4/5 Connector C1 and turn on the AC Line to the PSR4/5 Power Terminal Block (L_a, L_b, and L_c).

WARNING

SHOCK HAZARD!

Large voltages are present on L_a, L_b, L_c, BUS+ and BUS-. Be very careful when measuring these voltages.

Check and record the DC Bus output voltage at BUS+ with respect to BUS- on the PSR4/5 Power Terminal Block. It should be approximately 325 VDC for 230 VAC line voltage, or 162 VDC for 115 VAC line voltage.

REMOVE THE AC LINE VOLTAGE. WAIT 5 MINUTES FOR THE DC BUS TO DISCHARGE.

Reconnect the BUS+ and BUS- leads to the Power Terminal Block on the PSR4/5. Be careful to reconnect the leads with the correct polarity. Re-install Connector C2 on the PSR4/5.

WARNING

OBSERVE POLARITY OF THE DC BUS!

When interconnecting Industrial Drives GOLDLINE Series Products, connect BUS+ to BUS+ and connect BUS- to BUS-.

2.7.13 Checking the Motor

The MOTOR command is provided to ensure that your BDS5 is properly configured for your motor. Type:

```
MOTOR
```

The BDS5 should respond with something like:

```
MOTOR = B-204B
```

You can then verify that your motor is a 204B. Always check the motor nameplate to verify that you have wired the correct motor to your BDS5. This should agree with the part of your BDS5 model number as described in chapter 1.

WARNING

Wiring the BDS5 to a motor for which it is not configured can cause the system to become unstable. Verify that you are connecting the correct motor.

Verify that motor wiring is correct. IT IS VERY IMPORTANT THAT YOU WIRE THE MOTOR PROPERLY. Brushless motors are not like induction motors. You cannot simply interchange two phases to reverse the direction of rotation. You MUST connect Pin A of the motor connector to M_a of the BDS5 power connector, Pin B of the motor connector to M_b, and Pin C of the motor connector to M_c.

Follow this procedure to check motor wiring:

1. Turn off the AC Line and the Control Power.

2. Remove all loads from the motor. The motor must be able to rotate freely for this test.

3. Rotate the motor by hand until PRD is in the zero position as shown in Table 2.10. Note that the position must be less than the small number **OR** greater than the large number.

To display PRD, type:

```
P PRD
```

Table 2.10. PRD Range for "Zero Position"

R/D Resolution	PRD Less Than	PRD Greater Than
12-Bit	25	4070
14-Bit	100	16300
16-Bit	400	65000

4. Turn on (close contacts of) LIMIT, MOTION, and REMOTE.

5. Turn on Control Power only.

6. Put the BDS5 into the zeroing mode. Type:

```
ZERO ON
```

7. Turn on AC Line.

8. Enable the BDS5. Type:

```
EN
```

The motor may move a small amount, but PRD should remain in the zero position. Type:

```
P PRD
```

If the motor rotates to the zero position, then type:

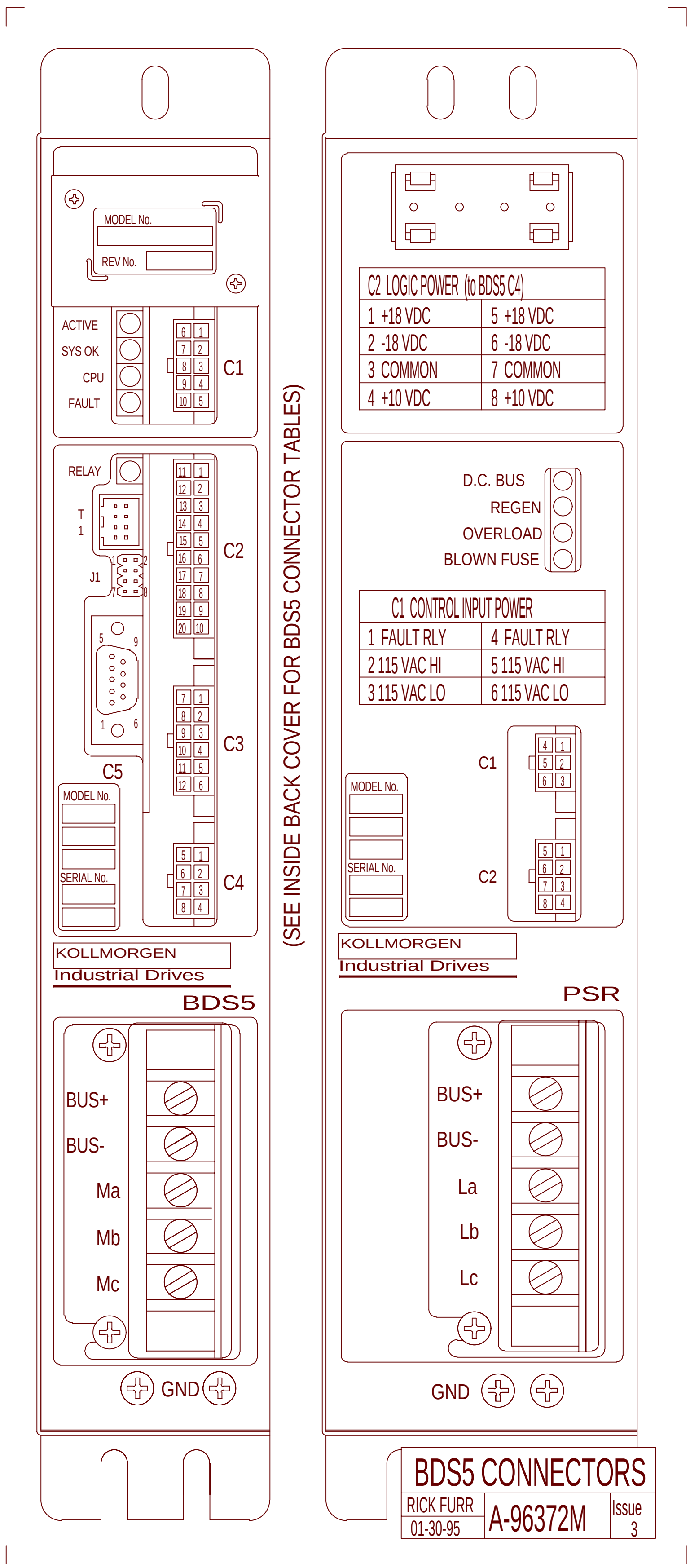
```
DIS
ZERO OFF
```

and continue to the next section.

If the motor rotated to the wrong position, then you must stop and correct this problem. Either the resolver is improperly wired, the motor is improperly wired, the motor is not functioning properly, or the resolver is not functioning properly. In most cases, the wiring is the problem. Check your motor and resolver wiring carefully. Follow the procedure in "Checking the Resolver Cable" in section 2.7.10. If you have wired the motor through motor-overload relays, verify that the relay is closed. Contact the factory if your motor does not rotate to the zero position and you can not correct the problem.

WARNING

DO NOT PROCEED IF YOUR MOTOR IS NOT ZEROING PROPERLY.



MODEL No.
REV No.
ACTIVE
SYS OK
CPU
FAULT
C1
RELAY
T1
J1
C2
C3
C5
MODEL No.
SERIAL No.
C4
KOLLMORGEN
Industrial Drives
BDS5
BUS+
BUS-
Ma
Mb
Mc
GND
(SEE INSIDE BACK COVER FOR BDS5 CONNECTOR TABLES)
C2 LOGIC POWER (to BDS5 C4)
1 +18 VDC
5 +18 VDC
2 -18 VDC
6 -18 VDC
3 COMMON
7 COMMON
4 +10 VDC
8 +10 VDC
D.C. BUS
REGEN
OVERLOAD
BLOWN FUSE
C1 CONTROL INPUT POWER
1 FAULT RLY
4 FAULT RLY
2 115 VAC HI
5 115 VAC HI
3 115 VAC LO
6 115 VAC LO
C1
MODEL No.
SERIAL No.
C2
KOLLMORGEN
Industrial Drives
PSR
BUS+
BUS-
La
Lb
Lc
GND
BDS5 CONNECTORS
RICK FURR
01-30-95
A-96372M
Issue
3

CHAPTER 3

OPERATION

3.1 INTRODUCTION

The information in this chapter will enable you to become familiar with system components and their dependence upon one another. Also, it will help you ensure each component is configured and functions properly. At this point, all safety stops and other precautions should be in place and working properly. Be prepared to stop the machine if necessary.

3.2 START-UP AND CHECKOUT

You should now be ready to supply power to test the servo systems functions and features. Work with only one axis section at a time. Confirm all other BDS5 amplifiers are inhibited, meaning the enable circuits are open (high).
Appropriate precautions should be taken to stop the machine if necessary. Limit switches and safety devices should be in place.

WARNING

THE MOTOR MAY MOVE UNEXPECTEDLY!

BE PREPARED TO DISABLE THE BDS5!

Commands in this section will enable the BDS5. The system may be unstable. The motor may begin oscillating or run away. Be prepared to disable the BDS5 quickly. You can disable the BDS5 by turning off (opening the contacts) of LIMIT or REMOTE.

This section discusses how to enable the BDS5. Follow this procedure:

1. Turn on (close contacts of) LIMIT, MOTION, and REMOTE.

2. Turn on Control Power.

3. Turn on the AC Line.

4. Enable the BDS5. Type:

```
EN
```

The motor should be still. If your motor is oscillating, disable the BDS5 by typing:

```
DIS
```

3.2.1 If You Get ERROR 17, FEEDBACK LOSS

If the BDS5 generates ERROR 17, FEEDBACK LOSS, then a lead in the resolver cable is probably broken. First, verify that the cable is wired correctly using the procedure in "Checking the Resolver Cable" in section 2.7.10.

If the cable appears to be wired correctly, use an oscilloscope to verify that the sine (Connector C3, Pin 7) and the cosine (Connector C3, Pin 9) are present. Note that the amplitudes of both these signals vary with motor position, so you will need to rotate the motor by hand to force sine and cosine to their maximum values. Expect a sine wave with a maximum peak-to-peak level of about 6.5 Volts at 8 kHZ.

If both sine and cosine are present on the connector and your BDS5 continues to generate ERROR 17, your unit may be malfunctioning; contact the factory.

3.2.2 If You Get ERROR 14, POWER BUS

ERROR 14, "POWER BUS," is generated when the BDS5 detects either an undervoltage or an overvoltage. If the BDS5 cannot be enabled because ERROR 14 continually reoccurs, it is probably because of undervoltage. Return to "Checking the AC Line Voltage" and "Checking the DC BUS Voltage" beginning in section 2.7.11 to ensure that the DC Bus is present.

If this error occurs only when the system is powered up, it is probably because your program attempts to enable the BDS5 before bus voltage is present. OK2EN is a switch that is ON when your BDS5 can be enabled without generating a fault. You can delay enabling the BDS5 until bus voltage is present by modifying your program to wait for OK2EN to be ON.

```
TIL  OK2EN  EQ  ON
EN
```

If the error occurs occasionally, it could be overvoltage or undervoltage. Overvoltage is usually caused by regenerative energy from a deceleration which forces the DC BUS voltage to rise above the BDS5 overvoltage level--about 200 VDC for 115 VAC line voltage systems and about 400 VDC for 230 VAC. If the error occurs only during deceleration, it is probably an overvoltage error. This can be corrected by reducing the deceleration rate (although often, it must be reduced dramatically) or by adding increased regeneration capability. Contact Industrial Drives Application Engineering to add regeneration capability.

Undervoltage is caused by the loss of the AC Line. The undervoltage detection level is set well under 100 VDC (70 VAC) so that low line (from "brown out") almost never causes an undervoltage fault. Your system may include protective circuits that remove power from the BDS5 when a problem is detected elsewhere in the system. This can cause the BDS5 to generate ERROR 14 and lead you to suspect the BDS5 of causing the original problem. If the problem occurs only rarely, you may have to purchase or rent a device to monitor the DC BUS voltage to determine the cause.

3.2.3 If Your BDS5 System is Unstable...

If the motor was oscillating, you need to retune your system. First, try to stabilize the system with the TUNE command. Type:

```
TUNE  10  2
```

Enable the drive. If your system is stable, you can skip ahead to the next section. If you want to improve the response, see Section 3.5 for details on the TUNE command.

If your system is not stable, disable the BDS5. You need to detune the system. First, disable the position loop. Type:

```
PL OFF
```

Disable the integrating velocity loop (in other words, enable the proportional velocity loop). Type:

```
PROP ON
```

On power-up, the integrating velocity loop will be enabled (that is, PROP is turned off) and the position loop will be turned on. Be careful to turn PROP on and PL off every time you power-up until you stabilize the system for an integrating loop.

WARNING

PROP is turned off and PL is turned on at power-up. If you are following this procedure to stop oscillations, be certain to turn PROP on and PL off every time you power-up the drive.

Now enable the drive by typing:

```
EN
```

Reduce the proportional gain (KPROP) until oscillations stop. Type:

```
KPROP = KPROP/2
```

You may need to repeat this command a few times.

After oscillations stop, enable the position loop by typing:

```
PL ON
```

Next, reduce the position loop gain (KP) until oscillations stop. Type:

```
KP = KP/2
```

You may need to repeat this command a few times.

If you need to tune your system for better performance, see Section 3.3.

3.2.4 Jogging the Motor

If you can enable the BDS5 without motor oscillations, then you can jog the motor. First, you should temporarily disable the BDS5 software position limits. Type:

```
PLIM  OFF
```

Now type:

```
J 10
```

and the motor should rotate at 10 RPM. If PROP is on, the motion will be very unsteady. You need an integrating velocity loop for good low speed performance.

Disable the BDS5 and enable the software position limits. Type:

```
DIS
PLIM  ON
```

3.2.5 Low Speed Adjustment

<u>SKIP THIS SECTION IF YOU HAD TO TURN PROP ON TO STABILIZE YOUR SYSTEM.</u> The BDS5 has a low-speed adjustment. This adjustment helps smooth very low-speed motion. This adjustment is made with the variable KC which is normally set to 200. This value of KC produces sufficiently smooth low speed performance for almost all applications. However, if your application is very demanding, you may want to adjust KC somewhat. <u>It is rare for this procedure to be required</u>.

1. Turn PL off by typing:

```
PL  OFF
```

2. Twist the motor shaft back and forth <u>lightly</u> at about 1 or 2 twists per second. You should feel very slight "graininess." This graininess is similar to the feel of anti-backlash gears. If you want to make the graininess more pronounced (so that you can feel it), set KC to zero. Type:

```
KC  =  0
```

3. Adjust KC so that the graininess is minimized. The best way to do this is by attaching a mirror to the motor shaft and shining a laser onto the mirror and observing the reflected dot about 10-20 feet from the motor. You can attempt to "feel" the graininess, but that measurement is so coarse that you should probably just set KC to 200 and skip this procedure. The normal

range for KC is between 175 and 225. This adjustment must be repeated when either the motor or the amplifier is changed out.

4. Restore PL. Type:

PL ON

This completes the initial check-out.

3.3 SYSTEM COMPENSATION

Feedback systems (like a motor controller) require tuning to attain high performance. Tuning is the process whereby the position and velocity loop gains are set, attempting to optimize the performance of a system (a BDS5 and a motor connected to a load) to a three-part criterion:

Table 3.1. Tuning Criterion

Noise Susceptibility
Response
Stability

Tuning is normally a laborious procedure requiring an experienced person. However, the BDS5 provides many tools to aid tuning, making it a much simpler process than it has been in the past.

In a broad sense, the performance of a system is characterized by its noise susceptibility, response, and stability. These quantities tend to be mutually exclusive. The system designer must decide what noise susceptibility (in the form of a "busy" motor) is acceptable.

"Busyness" is random activity in the motor and can often be felt on the motor shaft. Busyness in a motor should not be confused with PWM noise. PWM noise is high pitched, relatively constant noise and cannot be felt on the motor shaft.

Response is a measure of the system's quickness. Response can also be characterized by bandwidth and by rise time in response to a step command. Normally, designers want high bandwidth, though sometimes the response is purposely degraded to reduce stress on mechanical components. This is called *detuning*. Typical velocity loop bandwidths range from 20 to 60 Hz. Typical position loop bandwidths range from 0.1 to 0.2 times the velocity loop bandwidth.

Stability measures how controlled the system is. Stability can be measured with damping ratio or with overshoot in response to a step command. A discussion of different levels of stability follows.

3.3.1 Critical Damping

Generally, the most desirable amount of damping is Critical Damping. Critically damped systems respond as fast as possible with little or no overshoot. In Figure 3.1, the graph shows the response of a BDS5 TACH signal (on Connector C2, Pin 2) to a square wave input when the system is critically damped.

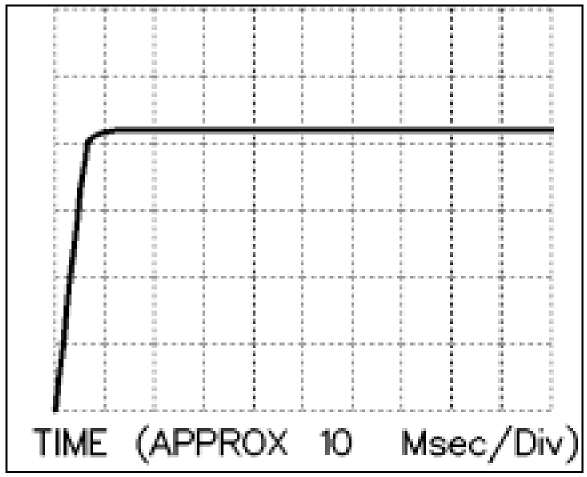


Figure 3.1. Critical Damping

3.3.2 Underdamping

Sometimes the system is tuned for critical damping and the system is still too slow. In these cases, you may be willing to accept less than critical damping. For applications that can work properly with a slightly underdamped system, you may reduce the stability to improve the response. The graph in Figure 3.2 shows a BDS5 slightly underdamped.

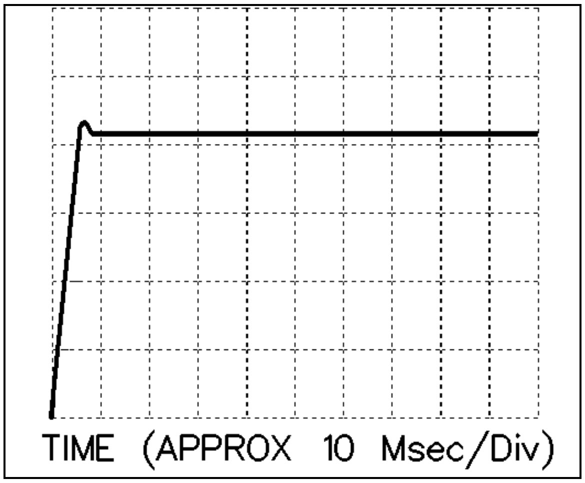


Figure 3.2. Underdamping

3.3.3 Overdamping

An overdamped system is very stable but has a longer response time than critically damped or underdamped systems. Also, overdamped systems are noisier than less damped systems with the same response rate. The graph in Figure 3.3 shows an overdamped system.

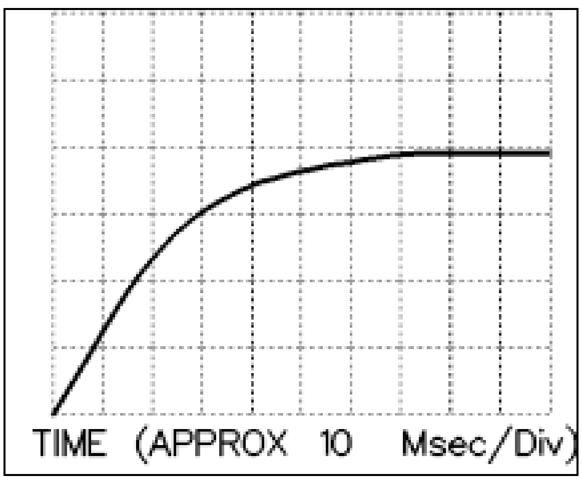


Figure 3.3. Overdamping

3.3.4 Ringing

When you are tuning the BDS5 you may tune it so that the response rings. Ringing is caused when you attempt to tune the BDS5 for either too rapid response (too high bandwidth) or too much stability (too much damping) or both. The only solution is to reduce the bandwidth or the stability or both. In Figure 3.4, the graph shows a system that rings.

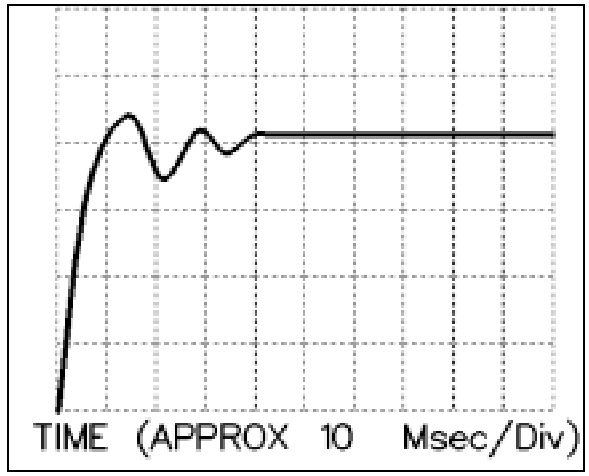


Figure 3.4. Ringing

3.4 TUNING

WARNING

The TUNE command shakes the motor vigorously. Secure the motor before tuning.

The BDS5 is usually shipped with a tuning that will work reasonably well with the load inertia between 0 to 4 times the rotor inertia. Many applications have approximately matching inertia. If your system does, you may not have to adjust the tuning of your BDS5. The following section describes how you can re-tune your system.

NOTE

When tuning a system, it may be desirable to disable the BDS5 quickly. You can use K, the KILL command, to disable with a one-letter command.

The BDS5 provides self-tuning. This is a feature that senses the inertial load of your system and then attempts to set tuning parameters accordingly. Note that self-tuning is not fool-proof. You may need to adjust one or two of the tuning parameters to get exactly the response you need.

WARNING

THE MOTOR MAY OSCILLATE!

Unloaded motors tuned for a large inertia load may become unstable when the system is activated. If the system becomes unstable, remove the power immediately.

3.4.1 If Your System Is Completely Unstable...

If your system is completely unstable when you enable it, remove power immediately. After restoring power, but before enabling the BDS5, turn off the switch PL, reduce KV to 100, and reduce KVI to 0. This should make the system stable.

```
;TYPE THESE LINES ONLY IF YOUR
;BDS5 IS UNSTABLE WHEN YOU
;ENABLE IT.  DON'T FORGET TO
;RESTORE PL WHEN YOU HAVE
;FINISHED TUNING.
PL  OFF
KVI = 0
KV = 100
```

If the BDS5 is still unstable, remove power and contact the factory. If it is stable, continue on with tuning. Do not forget to turn PL back on when you have finished tuning. Also, PL is always turned on during the BDS5 power-up.

3.4.2 Reducing ILIM

You may need to reduce ILIM before executing the TUNE command since the TUNE command causes the motor to "shake" at about 15 Hz and at full torque. This may damage some machines. Also, lightly loaded motors can overspeed if ILIM is too high. You should raise ILIM to the highest level that does not cause problems, because the tuning may not be acceptable if ILIM is too low. The effect can be that the torque the BDS5 produces is "swamped out" by friction. If you are not sure how much ILIM is necessary, reduce ILIM to a low value (say 5 or 10%) and gradually raise it. If the tuning is acceptable (that is, it does not ring or overshoot excessively, and it does respond fast enough), then you are done. Do not forget to restore ILIM to its original value.

CAUTION

The TUNE command shakes the motor vigorously. You may need to reduce ILIM before executing the TUNE command to protect your machine. Do not forget to restore ILIM when tuning is complete.

NOTE

The TUNE command can cause the motor to overspeed. You may need to reduce ILIM to prevent overspeed errors. Do not forget to restore ILIM when tuning is complete.

3.5 TUNE COMMAND

When you enter a TUNE command, you specify the response time and the stability level. The response time is specified in the form of bandwidth. The higher the bandwidth, the faster the response. The level of stability is specified as follows:

Table 3.2. Allowed Tune Command Stability Settings

1	Slightly overdamped
2	Critically damped
3	Slightly underdamped

WARNING

The drive will be enabled and the motor will turn. Make sure the motor is secured. Even if the BDS5 is disabled, it will enable long enough to execute the TUNE command.

Enable the BDS5 and type this command:

```
TUNE  30  2
```

The BDS5 will shake the motor and set the tuning so that the velocity loop has a bandwidth of approximately 30 Hz and is critically damped. The allowed bandwidths are 5, 10, 15, 20, 25, 30, 40, and 50 Hz.

The tune command does not always provide an acceptable tuning. If not, you can tune the BDS5 yourself.

3.6 TUNING THE BDS5 YOURSELF

If you use the TUNE command, and the resulting tuning variables cause the system to oscillate, there are generally two reasons:

1. The bandwidth in the TUNE command is set too high for the system to function properly.

2. The low-pass filter is set too low (this only applies if LPF is on).

In either case, first raise the low-pass filter frequency (LPFHZ) to as high a level as is acceptable. You may even decide to remove it by setting LPF to off.

If the TUNE command does not provide a suitable set of tuning variables, then you have the option of tuning the BDS5 yourself. You will need an oscilloscope. Connect an oscilloscope channel to TACH MONITOR on Connector C2, Pin 2; attach the scope ground to COMMON on Connector C2, Pin 14. Use the TUNE command to get as close as possible.

3.6.1 Tuning the Velocity Loop

WARNING

The drive will be enabled and the motor will turn. Make sure the motor is secured.

Drawing A-84888 shows how to manually tune an integrating velocity loop. This procedure sets KV and KVI. First, you should use the TUNE command to set KV and KVI close to optimum values. Apply DC bus voltage to the BDS5. Follow the instructions shown on Drawing A-84888. The motor should start and stop every second. Press the escape key to enter the monitor mode where you can change tuning constants. The tach should be on the oscilloscope, showing the motor performance. As the drawing notes, you should increase KV for increased stability and increase KVI to make the system more responsive.

You need to make several decisions: Is the unit underdamped? Is the system response too fast? Is the system ringing? Is there a resonance present? Then, take the action listed on Drawing A-84888.

There is a close relationship between the response of the system and the variable KVI. Response is often measured by the system *bandwidth*. Bandwidth is the frequency with which the system response falls to 70% of the nominal response. For example, if your velocity command was a sine wave with peaks of ±100 RPM, the bandwidth would be the frequency that the response fell to a sine wave with peaks of ±70 RPM. The relationship between velocity loop bandwidth and KVI is shown in Table 3.3.

Table 3.3. Velocity Loop Bandwith vs. KVI

KVI	VELOCITY LOOP BANDWIDTH
1400	5 Hz
2650	10 Hz
4000	15 Hz
5000	20 Hz
6250	25 Hz
7500	30 Hz
8750	40 Hz
10000	50 Hz

If you are using a proportional velocity loop (PROP is on), then adjust KPROP until the motor is performing appropriately.

3.6.2 Tuning the Position Loop

Once the velocity loop is tuned, you can tune the position loop. Break program execution and stop motion by typing S. Type in the following commands:

WARNING

The drive will be enabled and the motor will turn. Make sure the motor is secured.

```
PEMAX  30000
ZPE            ;ZERO POSITION
               ;ERROR TO AVOID
               ;POSITION ERROR
               ;OVERFLOW WHEN
               ;ENABLING POSITION
               ;LOOP
PL  ON
KF=0
RUN  80
```

The motor should again begin turning. Now adjust KP until the motor is performing appropriately. Table 3.4 shows the relationship between a properly tuned position loop (that is, the highest setting for KP) and velocity loop bandwidth. Note that the position loop bandwidth will be substantially lower than the velocity loop bandwidth (usually by a factor of 5 to 10).

Table 3.4. Velocity Loop Bandwidth vs. KP_{MAX}

KP_{MAX}	VELOCITY LOOP BANDWIDTH
500	5 Hz
1000	10 Hz
1500	15 Hz
2000	20 Hz
2500	25 Hz
3000	30 Hz
4000	40 Hz
5000	50 Hz

If you want to eliminate some or all of the following error, you can raise KF as high as unity feed-forward (Unity is defined as KF = 16384). However, the larger you make KF, the more you must reduce KP to eliminate overshoot and thus reduce the position loop performance. If you cannot get the desired performance from the position loop, then try reducing ACC and DEC to reduce overshoot. This can be a good way to limit overshoot in the position loop, and you may be able to raise KP slightly (about 20%) to improve performance.

3.7 RECORD AND PLAY

The RECORD command allows you to record most BDS5 variables in real time for later playback. You can simultaneously record up to four variables. You can record any variable except PE, REMOTE, TMR1, TMR2, TMR3, TMR4, VAVG, VXAVG, or any user switches. You can specify the time between points from one millisecond to one minute. You can record up to 1000 instances of 1 variable, 500 instances of 2 variables, 333 instances of 3, and 250 instances of 4 variables.

The format of the RECORD command is

RECORD <Number> <Time> <1 to 4 Variables>

Where number is the number of intervals over which the variables will be recorded, and time is the time in milliseconds of each interval.

Note: <Number> <= 1000 for 1 Variable
<Number> <= 500 for 2 Variables
<Number> <= 333 for 3 Variables
<Number> <= 250 for 4 Variables

For example,

```
405$                ;BEGINNING LABEL
EN                  ;ENABLE BDS5
RECORD 500 1 VFB    ;RECORD VFB FOR
J  1000             ;1/2 SECOND JOG
B                   ;1000 RPM
```

Records the velocity response of the BDS5 to a jog command.

After data is recorded, you can use the PLAY command to print each point on the screen. However, Motion Link provides all the routines to retrieve, plot, print, and store recorded data on your computer and line printer.

The RECORD command is useful when tuning a system because you can display the BDS5 response to commands without an oscilloscope. However, it is not limited to tuning. For example, you can record VCMD to plot a motion profile, or you can plot VEXT to watch the external encoder/analog input. You can also plot user variables to watch the performance of your program.

3.8 PROBLEMS

Some times there are problems tuning. Usually the TUNE command will provide you with a tuning that is either acceptable or close to acceptable. If not, you can tune the system yourself. Sometimes there are physical factors that prevent you from attaining the performance you need. These problems fall into four categories:

1. Overloading the Motor
2. Compliance
3. Resonance
4. Changing Load Inertia or Reflected Inertia

3.8.1 Overloading the Motor

Overloading the motor is the most common problem for positioning systems (that is, systems with PL on). If you overload the system, the position error can grow to very large values. When the command stops, the motor "reels in" the following error and can overshoot excessively. It looks like a tuning problem, but it is actually caused by the motor being undersized, ACC or DEC being set too high, or ILIM being set too low.

When a motor is overloaded, it has the following characteristics:

- The system overshoots, sometimes excessively, but does not ring or oscillate.
- Reducing ACC and DEC eliminates the problem.
- Turning off PL eliminates the problem.
- The motor current is near or at saturation during a large part of the move. Use the BDS5 RECORD function to record ICMD.

  If ICMD is equal to ILIM for more than a few milliseconds, then your system is saturated.

Overloading the motor can be corrected by the following actions:

- Reducing ACC and DEC.
- Reducing the load on the motor.
- Increasing ILIM (if it is less than IMAX).
- Using a BDS5 with a higher current rating.
- Using a motor with more peak stall torque.

3.8.2 Compliance

In compliant systems, the load is not tightly coupled to the motor shaft. If you move the load by hand, you can feel springiness. Compliant systems often are very stable when you tune with lower target bandwidths. However, they oscillate vigorously at low frequencies when you try to tune them for higher bandwidths.

When a system is compliant, it has the following characteristics:

- There is springiness between the motor and the load or at the motor mounting plate.
- The TUNE command calculates tuning variables that cause the system to oscillate.
- The frequency of oscillation is less than 100 Hz.

Compliance can be corrected by the following actions:

- Reduce the bandwidth of the system.
- Stiffen the machine so the load is not springy.

3.8.3 Non-Linear Mechanics

BDS5 tuning is based on linear control theory. The most important requirement of a linear motor controller is that the total reflected inertia should not change substantially during operation. Load inertia includes all the inertia reflected to the motor, such as inertia through gearboxes and leadscrews. Inertia can change in ways that are easy to understand, such as the inertia of a spool of cable decreasing when the cable is unrolled. It can also change in less intuitive ways, such as chain drives (which have load in one direction but are unloaded in the other) and systems with excessive backlash (where there is no load when gear teeth are not touching).

When the inertia changes, the system has the following characteristics:

- System performance is excellent when the motor is in some positions and unacceptable when the motor is in other positions.
- Reducing the bandwidth eliminates the problem.

If the system performance is poor because of changing inertia, you can make the following corrections:

- Correct the system mechanics so that inertia is constant.
- Detune (that is, reduce the bandwidth of) the system. If the times when your system will have excessively changing inertia are predictable, you can write your program to detune your system in these regions.

3.8.4 Resonance

Resonance is a high frequency (> 500 Hz) where the system mechanics oscillate. Normally, systems with resonance will be very stable when you tune with lower target bandwidths. As you increase the target bandwidth, you will begin to hear a fairly pure, high pitch. If you want to decrease resonance, use shorter, larger diameter driving shafts. Often, the low-pass filter can help you raise the bandwidth 20% or 30%, but this can be a difficult trial-and-error process: you slowly lower the low-pass filter frequency (LPFHZ) and attempt to raise the target bandwidth for tuning.

When your system has a resonance, it will have the following characteristics:

- The system will make a clear, high pitch (>500 Hz). Do not confuse this problem with compliance, which has a low pitch.

If the system performance is poor because of changing inertia, you can make the following corrections:

- Enable the low-pass filter (LPF) and reduce LPFHZ, if necessary.
- Reduce the bandwidth of the system.
- Shorten the length and increase the diameter of shafts and lead screws.

3.8.5 Low-Pass Filters

The LPF switch enables the low-pass filter. It can be turned on and off when the drive is operating. The frequency of the low-pass filter is stored in LPFHZ in Hz. It can also be changed when the drive is operating. For example, if LPFHZ is 200 and LPF is on, then a 200 Hz low-pass filter is run in the BDS5. The filter can be modeled as two cascaded, low-pass, single-pole filters, both with a 3 dB frequency of 200 Hz. LPFHZ should be set as high as possible, since it degrades the system performance.

For example, the following sequence sets the low-pass filter to 250 Hz and enables the drive.

```
LPF  ON     ;ENABLE LOW_PASS FILTER
LPFHZ  250  ;SET BREAK FREQ. TO 250
            ;HZ
```

NOTE

If the low-pass filter is on, the TUNE command may not work well.

CHAPTER 4

MAINTENANCE

4.1 INTRODUCTION

The information in this chapter will enable you to maintain the systems components ensuring smooth, efficient operation of the motor. Preventative maintenance of the equipment is also specified along with periodic maintenance. Follow these practices when operating your servo system.

4.2 PREVENTATIVE MAINTENANCE

Preventative maintenance can prevent situations that will damage your equipment. Four types of preventive maintenance are presented below. Following each of the procedures can reduce problems with and add life to your equipment
.

CAUTION

Preventative maintenance to this equipment must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the application.

CAUTION

Electronic components in this amplifier are static sensitive. Use proper procedures when handling component boards.

Preventative maintenance should be performed with the BDS5 system out of operation and disconnected from all sources of power.

4.2.1 Transient Voltages

NOTE

All transient-producing devices must be properly suppressed.

Solid state controls of the BDS5 may be affected by transient voltages. These voltages are in excess of the specified voltage for any given circuit. When these peak voltages occur, even for less than a second, permanent damage to the BDS5 can occur.

In order to help avoid transient voltages that may interfere with electronic circuit functions within the PSR4/5 and BDS5, all switched inductive devices or their wiring (solenoids, relay coils, starter coils, etc.) must be suppressed. A 220 ohm, 1/2 watt resistor in series with a 0.5 micro farad, 600 volt capacitor or equivalent is suggested.

4.2.2 Surge Current

Excessive current greater than that of the specified limits of the PSR4/5 and BDS5 can cause permanent damage to the system. Current limiting means are recommended to protect from these currents.

CAUTION

If the short circuit inrush current generated by the power source is in excess of 5000 amps RMS symmetrical current, an isolation transformer or line inductor must be utilized in the incoming power circuit. Failure to observe this precaution could result in damage to, or destruction of the PSR4/5 and BDS5.

Input transformers step up or step down input voltage and can be either autotransformers or isolation transformers. Isolation transformers help eliminate the following:

- Damaging AC line voltage transients reaching the PSR4/5 and BDS5.
- Damaging currents which may develop if a point inside the PSR4/5 or BDS5 becomes grounded.

4.2.3 Electrical Noise

The low levels of energy in the BDS5 control circuits may cause them to be vulnerable to electrical noise. Sources of electrical noise are those pieces of equipment that have large, fast changing voltages and currents when they switch on and off. These devices have the capability of inducing critical current and voltage transients on their respective power lines. These transients must be accommodated for with noise immunity provisions.

Electrical noise is prevented with the same methods as Surge Current and Transient Voltages. However, there are other methods of preventing electrical noise. Such as:

- Maintain physical separation between electrical noise sources and the BDS5 amplifier.
- Maintain physical separation between electrical noise sources and the BDS5 control wiring. This can be accomplished by using separate conduits or wiring trays for control wiring and power wiring.
- Use twisted-pair wiring for control circuits of the BDS5.
- Follow good grounding practices when wiring the PSR4/5 and BDS5. Be careful not to create a grounding loop with multiple ground paths. Follow the NEC's provisions on grounding.

4.2.4 Radio Frequency Energy

NOTE

This equipment generates radio frequency energy.

This equipment uses, and can radiate radio frequency energy and must be installed and used in accordance with this installation and service manual in order to prevent possible interference with radio communications or other electronic equipment.

4.3 PERIODIC MAINTENANCE

Periodically you will need to inspect your equipment for possible problems to insure ongoing safe and efficient operation. Periodic maintenance should be performed at scheduled intervals to insure proper equipment performance. It must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the BDS5 and its application. Power should be disconnected during all maintenance procedures.

4.3.1 Ventilation

The PSR4/5 and BDS5 should be mounted vertically to allow maximum ventilation of the components. This configuration allows the heat generated by the components to vent through the top and draft in cooler air through the bottom. The top and bottom of the components are vented to allow this drafting to occur. These ventilation passages should be kept open. If the PSR4/5 requires auxiliary cooling with fans, inspect the fans on a regular basis.

4.3.2 Grounding Integrity

The method employed for grounding or insulating the equipment from ground should be checked to assure its integrity on a regular basis. This check should be performed with the power off and the testing equipment grounded.

CHAPTER 5

TROUBLESHOOTING

5.1 INTRODUCTION

The information in this chapter will enable you to order spare parts and isolate and resolve common system hardware problems. The BDS5 aids in diagnostic evaluation through its LED Status Indicators and the BDS5 Error Log. Both of these features are explained to assist you in finding solutions. As another part of Industrial Drives' obligation to it's customers, Factory Support and Repair is also defined.

5.2 SPARE PARTS

There are no user serviceable parts on the BDS5.

There are several fuses that are user serviceable on the PSR4/5. Remember, the PSR4/5 can be damaged by ESD (Electro-static discharge). Observe proper ESD protection practices.

CAUTION

The PSR4/5 can be damaged by ESD (electro-static discharge). Observe proper ESD protection practices.

5.2.1 BDS5 Spare Parts List

Connector Kit for 20 Amp BDS5's (BDS5-x20):
BDS5C-101

Connector Kit for 3, 6, and 10 Amp BDS5's (BDS5-x03, BDS5-x06 and BDS5-x10):
BDS5C-100

5.2.2 PSR4/5 Spare Parts List

Connector Kit:
PSR4C-100

1.5 Amp Glass Fuse A-78896-008 Qty. 2

4.0 Amp Glass Fuse A-78896-012 Qty. 1

Regen Fuses:

Internal Regen, 12 Amp Units (PSR4/5-x12-xx00)
5 Amp Fuse: A-80552-007

Internal Regen, 20 Amp Units (PSR4/5-x20-xx00)
8 Amp Fuse: A-80552-009

8.8 Ohms External Regen, 230 Volt Units
(PSR4/5-2xx-xx01)
12 Amp Fuse: A-80552-002

5.5 Ohms External Regen, 115 Volt Units
(PSR4/5-1xx-xx02)
10 Amp Fuse: A-80552-001

Soft-Start without Regen (PSR4/5-xxx-xx80)
6 Amp Fuse: A-80552-008

5.2.3 Ordering Information

If you need to order parts for the BDS5 and/or PSR4/5, you can order them through your local distributor. For a complete list of Industrial Drives' representatives contact us directly at:

INDUSTRIAL DRIVES
201 Rock Road
Radford, VA 24141
U.S.A.

Telephone: 703/639-2495
FAX: 703/731-0847
TWX: 710/875-3743

5.3 LED STATUS INDICATORS

5.3.1 BDS5 LED's

The BDS5 provides LED's for diagnostics. These LED's are on the front panel of the BDS5. When the BDS5 is powered up, all LED's on the front panel turn on to verify they are operational. The states (on or off) of each LED are listed below.

- ACTIVE

This LED shows whether the BDS5 is active. "Active" means that the BDS5 is enabled and the REMOTE input switch is on. This LED is on when the BDS5 is active and off when it is not active.

- SYS OK

This LED indicates the state of the hardware watchdog protection circuit. It should be on during normal operation. However, it is off during autobauding. If SYS OK turns off, take the BDS5 out of service and contact the factory.

- CPU

This LED indicates the state of the software watchdog protection circuit. It is on during normal operation and blinks for the most serious errors. This LED also blinks during autobauding.

- FAULT

This LED indicates that a fault has occurred. A fault is an error that is serious enough to disable the BDS5. You can turn the FAULT LED on or off from your program. The FAULT LED is turned off when you enable the BDS5.

- RELAY

This LED indicates the status of the BDS5 relay. It is on when the relay contacts are closed and off otherwise.

5.3.2 PSR4/5 LED's

The PSR4/5-X12 and PSR4/5-X20 (12 and 20 Amp versions) have 4 indication LED's:

- D.C. BUS

This green LED is on when AC Line Voltage is applied.

- REGEN

This yellow LED turns on when the PSR4/5 regen circuit is active.

- OVERLOAD

This red LED indicates a fault. It turns on when the PSR4/5 circuitry detects that the regen resistor has absorbed too much energy. It is turned off when power is removed and then reapplied. Normally, this is caused when the motor decelerates too rapidly or too often. If you get this fault, you may need to increase the power rating of your regen resistor and the PSR4/5 may need to be modified at the factory. If your system has an internal regen resistor, you will need a new PSR4/5 power supply designed for external regen. Contact the factory.

- BLOWN FUSE

This red LED indicates a fault. It turns on when the fuse that protects the regen resistor has absorbed too much energy. You must remove power and replace the fuse. The spare parts list at the end of this chapter provides ordering information for this fuse. If the fuse blows during normal operation, see the section above on "OVERLOAD" because similar conditions cause both faults and similar actions must be taken to correct the conditions. If you replace the fuse and it blows within a few seconds of applying power, then the regen transistor is probably shorted. The PSR4/5 must be returned to the factory for repair.

The PSR4/5-X50 and PSR4/5-X75 (50 and 75 Amp versions) have 3 indication LED's:

- D.C. BUS

This green LED is on when AC Line Voltage is applied.

- REGEN

This yellow LED turns on when the PSR4/5 regen circuit is active.

- FAULT

This red LED indicates an overtemperature fault. It turns on when the PSR4/5 thermostat opens. It turns off when the thermostat closes. If this fault occurs, it means that the regen resistor is on too often or for too long. If you get this fault, you may need to increase the power rating of your regen resistor and the PSR4/5 may need to be modified at the factory. Contact the factory.

5.4 ERROR LOG

The BDS5 responds to a variety of conditions, both internal and external, hardware and software, which are grouped in a single broad category: errors. An error indicates that there is a problem somewhere. More serious errors are grouped as faults.

5.4.1 Error Levels

The BDS5's response to an error depends on the error's severity. There are four levels of severity, listed below in increasing order:

Table 5.1. Error Severity Levels and Actions

1.	Errors which cause warnings.
2.	Errors which cause a program break and stop motion, in addition to Level 1 Actions.
3.	Errors which disable the system and set the FAULT LED, in addition to Level 2 Actions.
4.	Errors which disable almost all BDS5 functions (including communications) and flash the CPU LED to indicate the error number. These are called firmware errors.

When any error except a firmware error occurs, a message is displayed on the screen. The following items are printed: the error number, the offending entry, and an abbreviated error message. For example, disable the drive and type in a jog:

```
DIS
J  100
```

The BDS5 will respond with:

```
ERR  50 'J 100'            BDS5 INHIBITED
```

The error number (50), the offending entry (the whole line), and the error message (you cannot command a jog when the drive is inhibited) are given on one 80-character line. The error message starts at character 40 so that if a 40-character display is used, the error message will not be printed. You can display the line directly, either with the Motion Link editor (GOTO A LINE NUMBER selection or ^Q^I), or with the BDS5 Editor (P command).

Sometimes only an entry is bad and not the whole line. In this case only the bad entry is printed. For example,

```
PROP  2
```

generates:

```
ERR   83  '2'   ;BAD OR OUT OF RANGE
```

since PROP is a switch and cannot be set to 2. If the error comes from the program, the line number of the offending entry is also printed. Use the Editor to enter these lines at the top of the user program:

```
11$
PROP 2
B
```

Exit the Editor and type:

```
RUN 11
```

and the response should be:

```
ERR 83 LINE 2 '2'    ;BAD OR OUT OF
                     ;RANGE
```

This message shows that the error occurred on line 2. You can enter the Editor and type:

```
P 2
```

and the line:

```
PROP 2
```

will be displayed.

5.4.2 DEP

If your BDS5 prints to a Data Entry Panel (DEP-01) or any other 40 character wide display, the standard error messages will not print properly. The problem is that error messages are based on an 80 character wide display and the DEP-01 is only 40 characters wide. To correct this problem, the BDS5 provides the DEP switch, which, when turned on, cuts all error messages down to 40 characters. If your BDS5 prints to a DEP-01, type:

```
DEP ON
```

5.4.3 Error History

The BDS5 stores the twenty most recent errors in the Error History. To display the entire Error History, type:

```
ERR HIST
```

This causes the Error History to be sent to the terminal, with the most recent error sent first. When the BDS5 is powered up, a "DRIVE POWERED UP" message is inserted into Error History even though this is not an actual error.

To clear the Error History, type:

```
ERR CLR
```

Error History remains intact even through power-down.

5.4.4 Displaying Error Messages

The ERR command can also be used to display an abbreviated description of the error. For example, type:

```
ERR 50
```

The BDS5 responds with:

```
ERR 50 BDS5 INHIBITED
```

You may display messages for errors from 1 through 999. If you type in an error number that the BDS5 does not recognize, it will respond with:

```
ERROR NOT FOUND.
```

A description of all errors is given in Appendix C.

5.4.5 Firmware Errors

Firmware errors are an indication of a serious problem with the BDS5. These errors stop communications, disable the drive, and flash the CPU LED. The CPU LED flashes several times, then turns off and pauses. The number of flashes represents the error number. These error numbers range from 2 to 9. See Appendix C for information on these errors. Contact the factory should one of these errors occur.

5.5 ENABLE AND FAULT LOGIC

This section of this chapter discusses how the BDS5 is enabled and disabled. This discussion will center around Drawing A-84732 "BDS5--ENABLE and FAULT LOGIC DIAGRAM." This drawing has six areas, each of which is labeled with an encircled number, 1-6. Note that this drawing is a functional diagram; it does not directly represent the actual hardware and software used to implement these functions.

5.5.1 Firmware Faults, Area 1

Area 1 shows how firmware faults are combined. Firmware faults are the most serious errors. They include checksums (to help verify computer memory), watchdogs (to help verify that the computer is running properly), and the 5-volt logic power supply monitor.

These circuits are designed to watch the basic operation of the microprocessor. They do not generate error messages because the detected fault affects the microprocessor directly. Instead, they just blink the Central Processing Unit (CPU) LED.

As shown on Drawing A-84732, firmware faults set a latch to turn off communications and blink the CPU LED. The CPU LED blinks in cycles consisting of 2 to 8 blinks and a pause. The number of blinks corresponds to the error number, which you can look up in Appendix C. The only way to reset these faults is to power-down the BDS5. These faults are serious and you should consult the factory if they occur. Do not confuse these faults with autobauding on power-up. When autobauding, the CPU LED blinks at a constant rate, about three times per second. The autobaud mode is described in the User’s Manual.

5.5.2 Fault Logic, Area 2

The large OR gate in Area 2 combines three types of faults: hardware, software, and firmware. The circuits that generate these faults are typical of motor controllers and are listed on the drawing. These faults are errors that are serious enough to disable the BDS5, as described in Appendix C.

5.5.3 Fault Latch, Area 3

The latch in Area 3 turns on the FAULT LED, the FAULT software switch, and the FAULT output on Connector C8. Any fault sets this latch; you can also write your program to turn it on if you detect a fault condition. The fault latch can be reset by:

1. Turning FAULT off,
2. Typing the enable command (EN), or
3. Powering down the BDS5.

5.5.4 Ready Latch, Area 4

Area 4 shows the logic required to make the drive ready. If there are no faults, the EN command sets the ready latch. This turns the READY software switch on. This latch is reset with the Kill (K) command, the Disable (DIS) command, or a fault. These turn READY off.

5.5.5 ACTIVE, Area 5

Area 5 shows that ACTIVE will be on if both READY and REMOTE are on. This turns on the ACTIVE LED. It also allows the BDS5 to actively control the motor.

REMOTE (Remote Enable) is an isolated input that is accessed from Connector C2 on the front of the drive. You can print REMOTE with the P command. It must be 1 to activate the BDS5. Note that some faults "hide" the value of the REMOTE input from the BDS5 microprocessor. This does not normally matter because all faults must be cleared before the drive will enable. If this condition exists, the BDS5 will print REMOTE as "-1".

5.5.6 Relay and STATUS Control, Area 6

Area 6 shows how software switch STATUS and the relay work. You can configure STATUS to indicate either drive READY (but not necessarily ACTIVE) or drive ACTIVE. The difference is in how you want to use STATUS. STATUS can be used for an interlock. In this case, you want STATUS to indicate drive ACTIVE. If the BDS5 becomes inactive for any reason (including the REMOTE input turning off), then STATUS will turn off. As an alternative, you can use STATUS to indicate that the BDS5 is ready for the REMOTE input to turn on. That is, if REMOTE turns on, the BDS5 will be ACTIVE. In this case, you want STATUS to indicate drive READY.

The software switch STATMODE controls which state STATUS will indicate. If STATMODE is on, then STATUS will indicate drive READY. If STATMODE is off, then STATUS will indicate drive ACTIVE.

The operation of STATUS is shown by the and-gate and or-gate in area 6. If STATMODE is on, then READY will turn on STATUS through the and-gate. If STATMODE is off, then only ACTIVE (from area 5) will turn on STATUS through the other leg of the or-gate. The STATUS output on optional Connector C8, Pin 35, is always the same as the STATUS software switch. Note, however, that the state of the STATUS output is undefined for 25 milliseconds after power-up.

WARNING

STATUS may turn on for up to 25 milliseconds during power-up.

5.5.7 Motor Brake

Industrial Drives motors can be purchased with an optional brake. The brake is fail-safe in that if no current is applied the brake is active. If you set STATMODE to 0, you can use STATUS to control the brake. Then, when the BDS5 is disabled or powered down, the brake will be active.

5.5.8 Output Relay

The relay (Connector C2, pins 16 and 17) represents the state of the hardware watchdog. The hardware watchdog makes a system more reliable because the watchdog is independent of the microprocessor. If the processor is not working, the watchdog will usually detect it (though this is not guaranteed).

On power-up, the contacts are open until the BDS5 passes its power-up self tests. Then the contacts close and the BDS5 begins normal operation. Note that if the BDS5 is set to autobaud on power-up, the contacts will not close until after autobauding and establishing communications.

One way to use the relay is to interconnect it with the main power contactor. In this case, a hardware watchdog fault will disconnect all power to the system.

The SYS OK LED indicates that there is not a hardware watchdog fault. If this LED goes out, you should remove the BDS5 from operation and contact the factory.

5.6 FACTORY SUPPORT AND REPAIR POLICIES

Industrial Drives is committed to helping you install, operate, maintain and troubleshoot your BDS5 servo system. If your BDS5 did not pass the "Initial Check Out" tests or is not operating properly, then contact the Field Service Department of Industrial Drives. Please see the *User's Manual* before calling about software or programming questions. Be prepared to provide the full BDS5 and PSR4/5 model numbers listed on the front of your BDS5 and PSR4/5. Contact us at:

INDUSTRIAL DRIVES
ATTN: Field Service Dept.
201 ROCK ROAD
RADFORD, VA 24141

TELEPHONE: 703/639-2495
703/731-0847 (FAX)
710/875-3743 (TWX)

APPENDIX A

WARRANTY INFORMATION

Industrial Drives, a Kollmorgen Division, warrants that equipment, delivered by it to the Purchaser, will be of the kind and quality described in the sales agreement and/or catalog and that the equipment will be free of defects in design, workmanship, and material.

The terms and conditions of this Warranty are provided with the product at the time of shipping or in advance upon request.

The items described in this manual are offered for sale at prices to be established by Industrial Drives and its authorized dealers.

APPENDIX B

DRAWINGS

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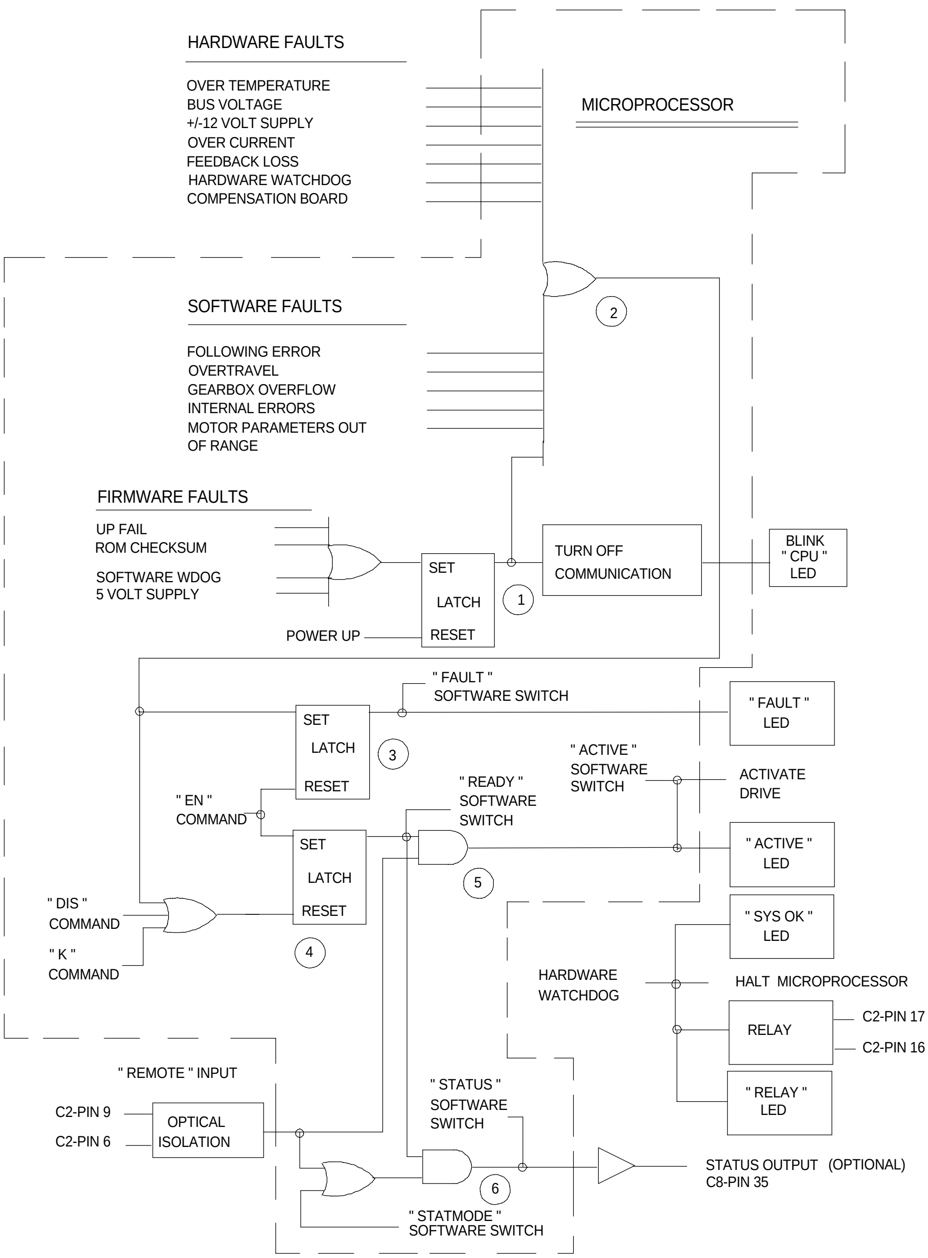
ISSUE 4

A-84732

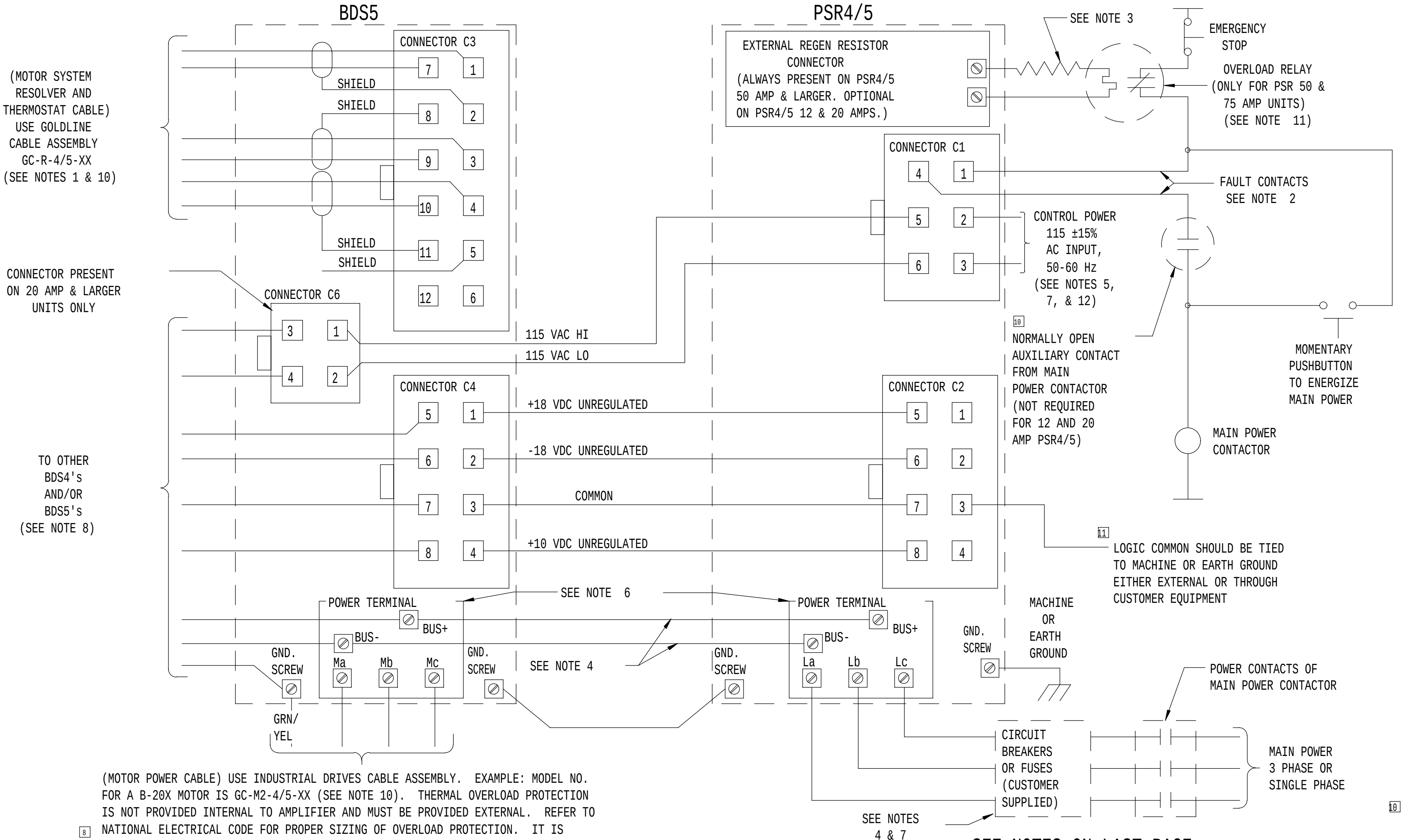
SCHULER 03-04-91

COPY CODE I



BDS5-ENABLE/FAULT LOGIC DIAGRAM

DWG. NO. SHEET 1 OF 7	ISSUE
A- 93103	14



(MOTOR POWER CABLE) USE INDUSTRIAL DRIVES CABLE ASSEMBLY. EXAMPLE: MODEL NO. FOR A B-20X MOTOR IS GC-M2-4/5-XX (SEE NOTE 10). THERMAL OVERLOAD PROTECTION IS NOT PROVIDED INTERNAL TO AMPLIFIER AND MUST BE PROVIDED EXTERNAL. REFER TO
8 NATIONAL ELECTRICAL CODE FOR PROPER SIZING OF OVERLOAD PROTECTION. IT IS
14 RECOMMENDED THAT MOTOR WIRING BE A SHIELDED CABLE. USE PROPER SIZE WIRE. USE COPPER WIRE AND 60°C OR 75°C TABLE FROM NEC FOR WIRE SIZE.

SEE NOTES ON LAST PAGE

CAD DWG.

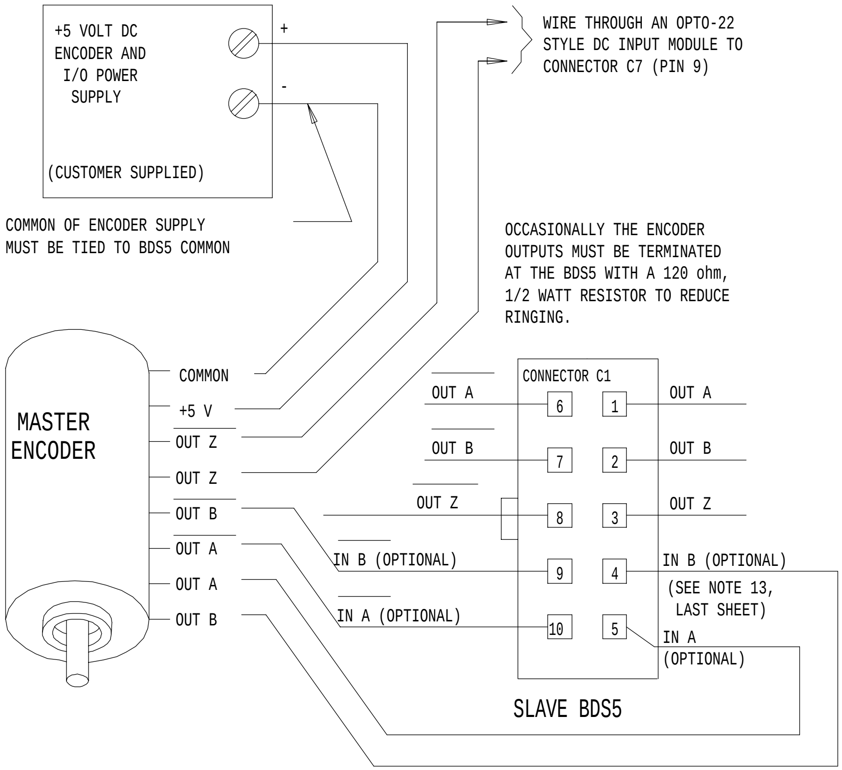
			I	COPY CODE	ISS.	ECN NO.	DATE	APP'D.
ISS.	ECN NO.		DATE	APP'D.	2	83906 V. ALLIE	3-12-91	G.H.E.
7	84451 TDG		4-30-92	CJF	3	83964 V. ALLIE	4-17-91	C.J.F.
8	84719 EWR		9-01-92	CJF	4	84008 V. ALLIE	5-21-91	G.H.E.
9	84826 TDG		10-29-92	RCF	5	84051 V. ALLIE	7-01-91	C.J.F.
10	84924 TDG		1-11-93	CJF	6	84129 EWR	8-21-91	G.H.E.

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

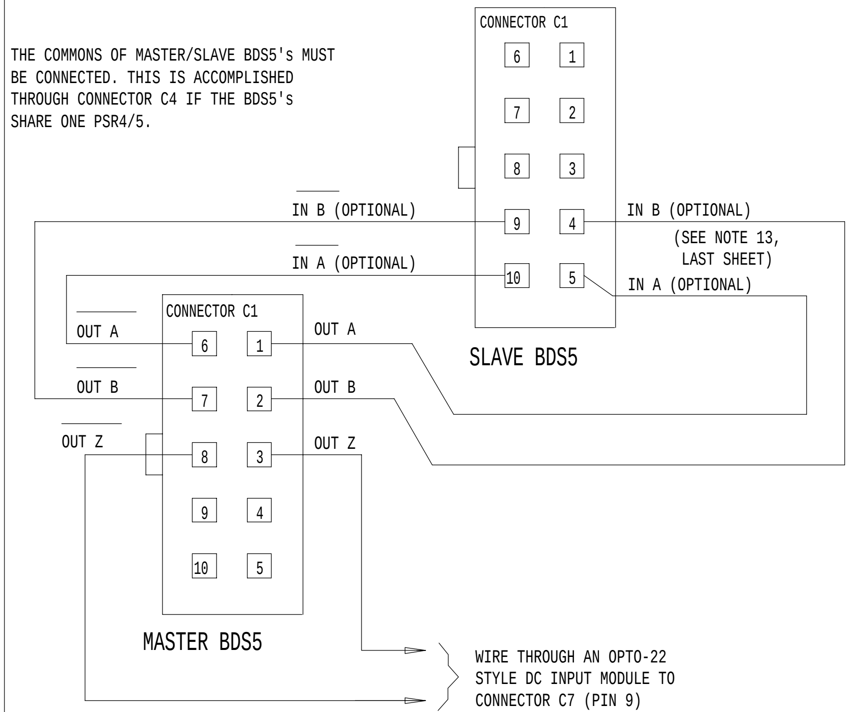
BDS5 WIRING DIAGRAM
(PSR4/5 & MOTOR CONNECTIONS)

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO. SHEET 1 OF 7	ISSUE
VA	1-09-91	FDO	1-10-91	GHE	1-11-91	1:1	A- 93103	14

DWG. NO.	SHEET 2 OF 7	ISSUE
A- 93103		14



MASTER ENCODER AND SLAVE BDS5



MASTER BDS5 AND SLAVE BDS5

ISS.	ECN NO.	DATE	APP'D.

COPY CODE

ISS.	ECN NO.	DATE	APP'D.
11	85228 TDG	5-7-93	SCM
12	85244 LLS	5-18-93	SCM
13	85698 LLS	3-16-94	SGD
14	85972 MAW	6-14-94	

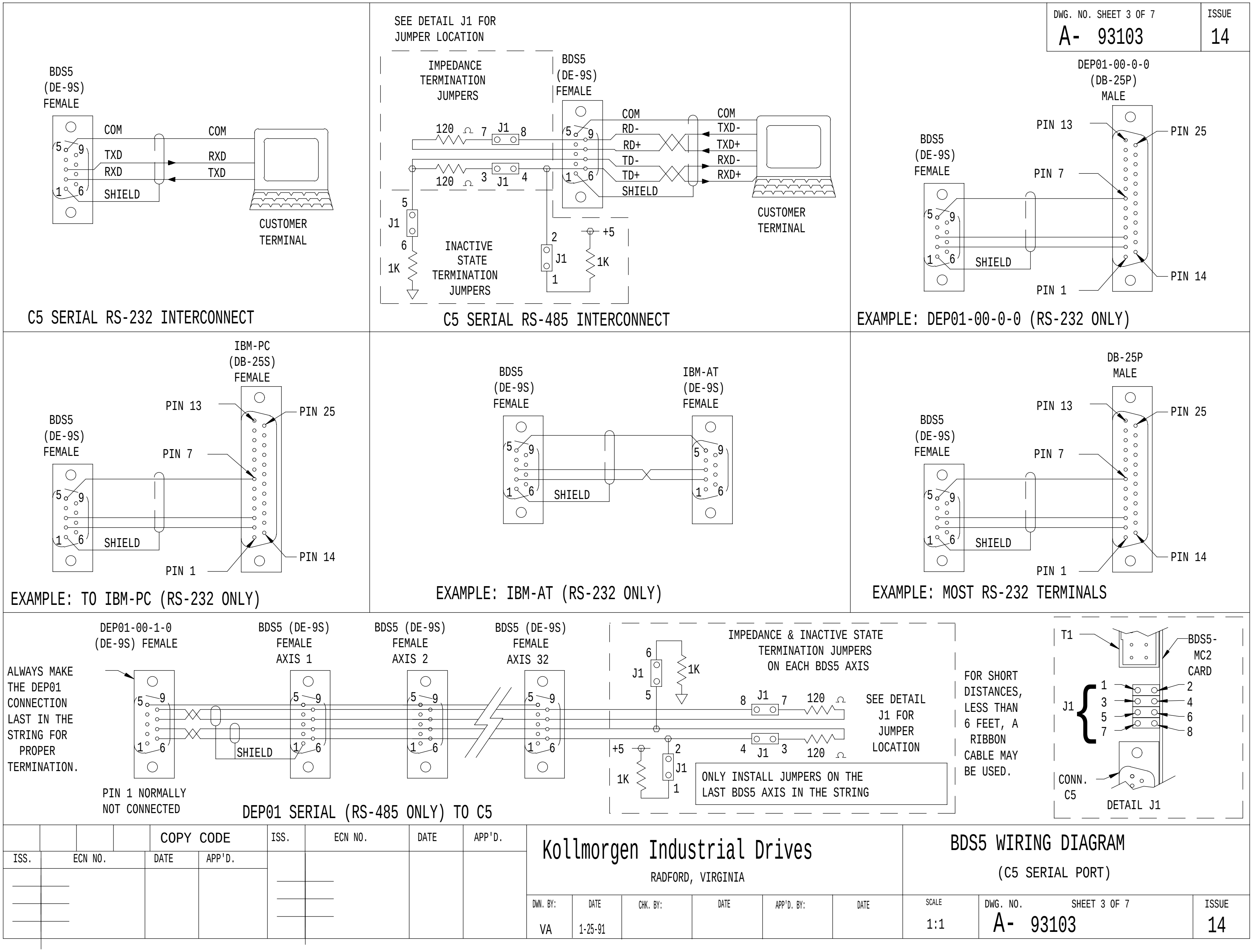
Kollmorgen Industrial Drives

RADFORD, VIRGINIA

BDS5 WIRING DIAGRAM

(C1 ENCODER EQUIVALENT)

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	SHEET 2 OF 7	ISSUE
VA	1-25-91					1:1	A- 93103		14


DWG. NO. SHEET 3 OF 7
A- 93103
ISSUE
14
BDS5
(DE-9S)
FEMALE
COM
TXD
RXD
SHIELD
COM
RXD
TXD
CUSTOMER
TERMINAL
C5 SERIAL RS-232 INTERCONNECT
SEE DETAIL J1 FOR
JUMPER LOCATION
IMPEDANCE
TERMINATION
JUMPERS
120
J1
INACTIVE
STATE
TERMINATION
JUMPERS
1K
+5
COM
RD-
RD+
TD-
TD+
TXD-
TXD+
RXD-
RXD+
C5 SERIAL RS-485 INTERCONNECT
DEP01-00-0-0
(DB-25P)
MALE
PIN 13
PIN 25
PIN 7
PIN 1
PIN 14
EXAMPLE: DEP01-00-0-0 (RS-232 ONLY)
IBM-PC
(DB-25S)
FEMALE
EXAMPLE: TO IBM-PC (RS-232 ONLY)
IBM-AT
(DE-9S)
FEMALE
EXAMPLE: IBM-AT (RS-232 ONLY)
DB-25P
MALE
EXAMPLE: MOST RS-232 TERMINALS
ALWAYS MAKE THE DEP01 CONNECTION LAST IN THE STRING FOR PROPER TERMINATION.
DEP01-00-1-0
(DE-9S) FEMALE
BDS5 (DE-9S)
FEMALE
AXIS 1
AXIS 2
AXIS 32
PIN 1 NORMALLY
NOT CONNECTED
DEP01 SERIAL (RS-485 ONLY) TO C5
IMPEDANCE & INACTIVE STATE
TERMINATION JUMPERS
ON EACH BDS5 AXIS
SEE DETAIL
J1 FOR
JUMPER
LOCATION
ONLY INSTALL JUMPERS ON THE
LAST BDS5 AXIS IN THE STRING
FOR SHORT DISTANCES, LESS THAN 6 FEET, A RIBBON CABLE MAY BE USED.
T1
BDS5-
MC2
CARD
CONN.
C5
DETAIL J1
COPY CODE
ISS.
ECN NO.
DATE
APP'D.
Kollmorgen Industrial Drives
RADFORD, VIRGINIA
BDS5 WIRING DIAGRAM
(C5 SERIAL PORT)
DWN. BY:
VA
DATE
1-25-91
CHK. BY:
APP'D. BY:
SCALE
1:1
DWG. NO.
SHEET 3 OF 7
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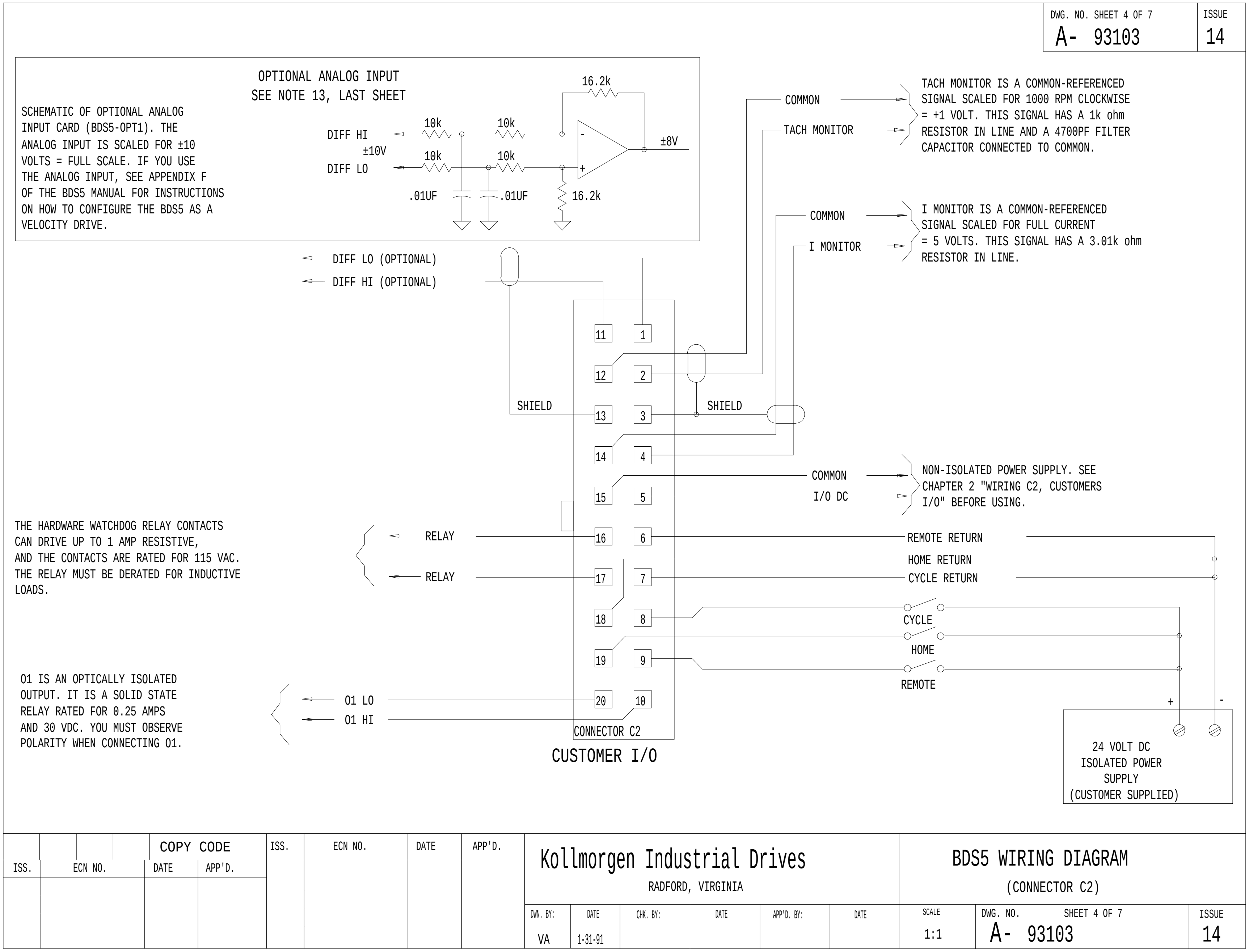
ISSUE
14



A-93103 Sheet 4 of 7

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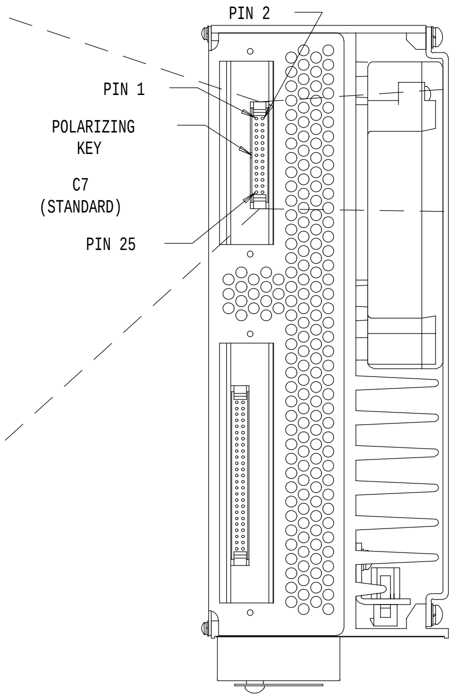
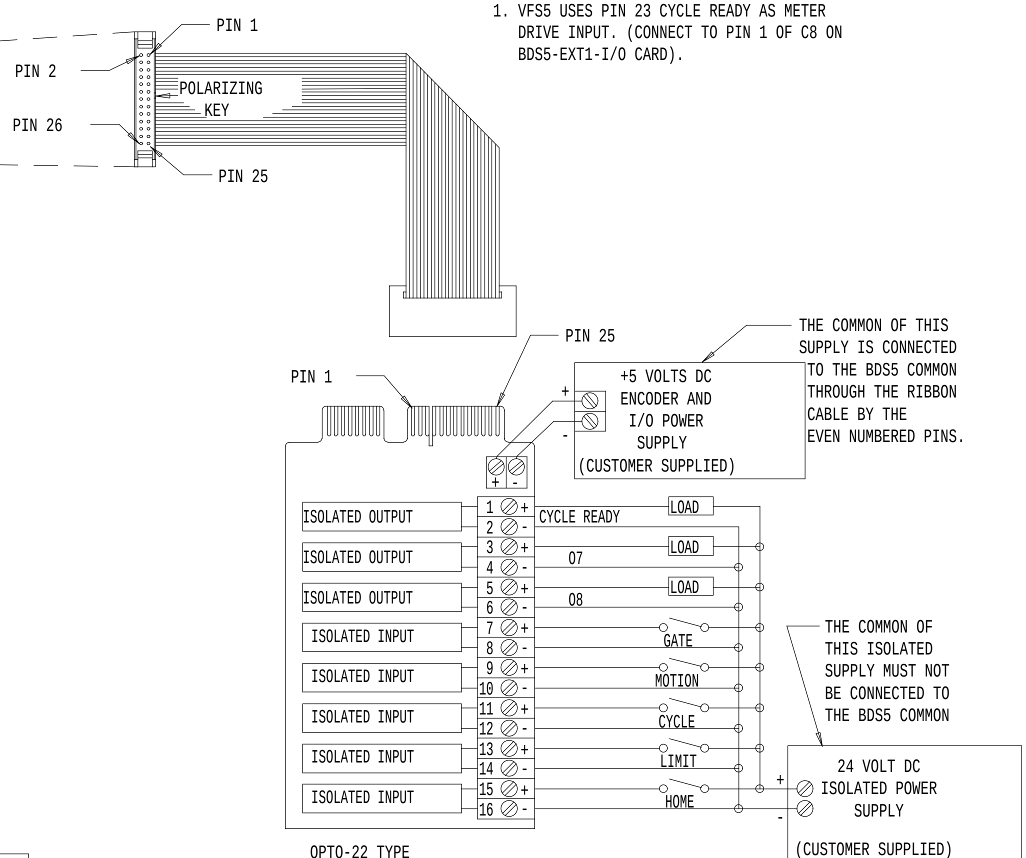
PIN	SIGNAL
1	N/C
3	N/C
5	N/C
7	N/C
9	HOME
11	LIMIT
13	CYCLE
15	MOTION
17	GATE
19	O8
21	O7
23	CYCLE READY
25	N/C
EVEN PINS	SIGNAL RETURN/ COMMON



TOP VIEW OF BDS5
(20-AMP UNIT SHOWN)

NOTES:

1. VFS5 USES PIN 23 CYCLE READY AS METER DRIVE INPUT. (CONNECT TO PIN 1 OF C8 ON BDS5-EXT1-I/O CARD).



OPTO-22 TYPE
8 POSITION I/O BOARD

A WIDE SELECTION OF ISOLATION MODULES, BOTH INPUT AND OUTPUT, ARE AVAILABLE FROM SEVERAL SOURCES. A TYPICAL I/O CONFIGURATION, USING DC ISOLATION MODULES, IS ILLUSTRATED. HOWEVER, YOUR I/O IS NOT LIMITED TO ONLY DC MODULES AS THE FOLLOWING LIST INDICATES.

MODULE TYPE	INPUT MODULE	LOAD VOLTAGE
INPUT AC	90-280VAC	N/A
OUTPUT AC	N/A	120-240VAC
INPUT DC	3-32VDC	N/A
OUTPUT DC	N/A	10-60VDC

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ISS.	ECN NO.	DATE	APP'D.

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

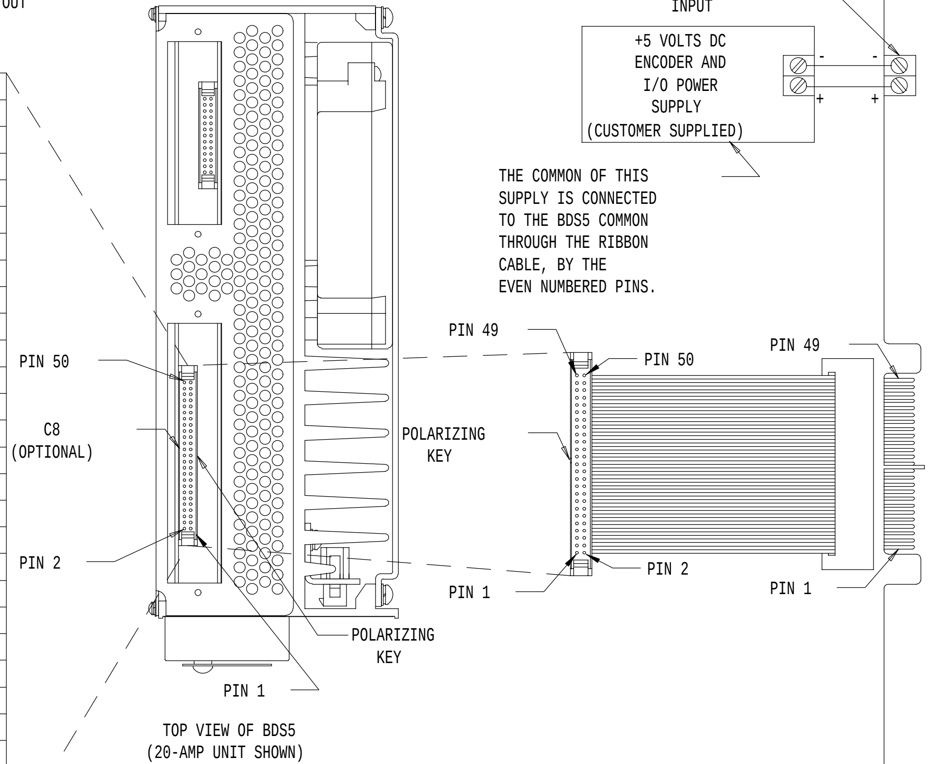
BDS5 WIRING DIAGRAM
(C7 STANDARD I/O)

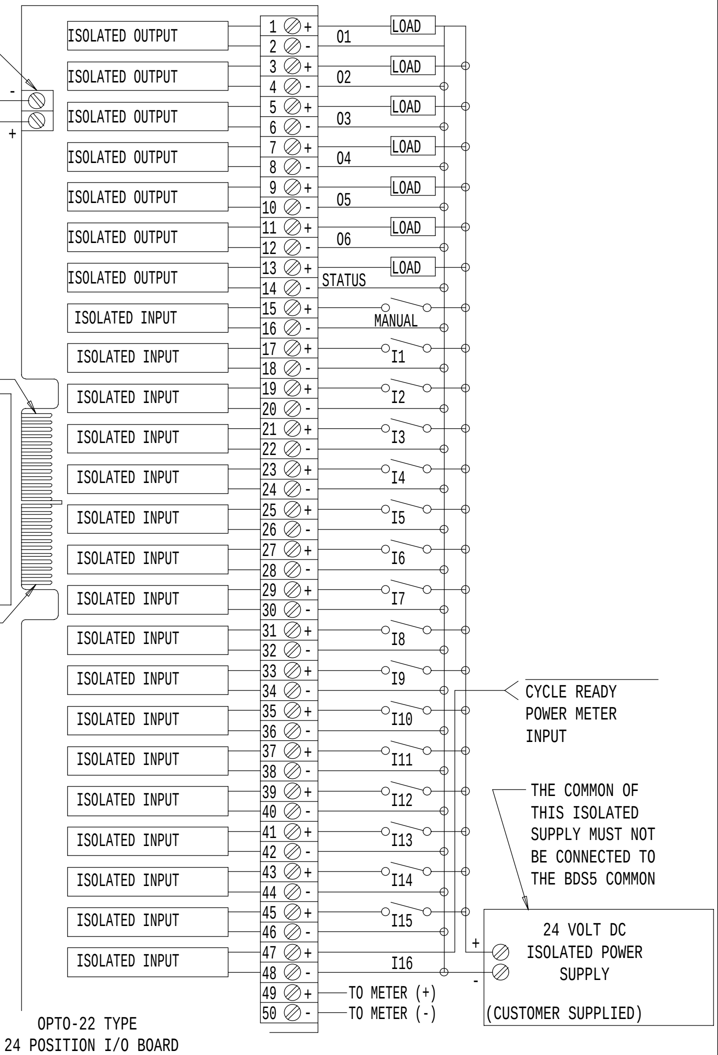
DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO. SHEET 5 OF 7	ISSUE
VA	2-7-91					1:1	A- 93103	14

NOTES:
1. VFS5 USES BDS5-EXT1-I/O WITH FILTERED INPUTS AND POWER METER DRIVER.
2. INPUT #16 (PIN 1) IS POWER METER INPUT. PIN 49 IS METER DRIVE OUT

PIN	SIGNAL
49	MET. OUT
47	01
45	02
43	03
41	04
39	05
37	06
35	STATUS
33	MANUAL
31	I1
29	I2
27	I3
25	I4
23	I5
21	I6
19	I7
17	I8
15	I9
13	I10
11	I11
9	I12
7	I13
5	I14
3	I15
1	I16 *
EVEN PINS	SIGNAL RETURN/ COMMON

* POWER METER INPUT ON VFS5 ONLY





A WIDE SELECTION OF ISOLATION MODULES, BOTH INPUT AND OUTPUT, ARE AVAILABLE FROM SEVERAL SOURCES. A TYPICAL I/O CONFIGURATION, USING DC ISOLATION MODULES, IS ILLUSTRATED. HOWEVER, YOUR I/O IS NOT LIMITED TO ONLY DC MODULES AS THE FOLLOWING LIST INDICATES.

MODULE TYPE	INPUT MODULE	LOAD VOLTAGE
INPUT AC	90-280VAC	N/A
OUTPUT AC	N/A	120-240VAC
INPUT DC	3-32VDC	N/A
OUTPUT DC	N/A	10-60VDC

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Kollmorgen Industrial Drives
RADFORD, VIRGINIA

BDS5 WIRING DIAGRAM
(C8 OPTIONAL I/O)

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO. SHEET 6 OF 7	ISSUE
VA	2-7-91					1:1	A- 93103	14

NOTES: (ALL WIRES TO BE COPPER WITH MIN. TEMP RATING OF 60°C)

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A- 93103	14

1. WARNING: THE MOTOR THERMOSTAT AUTOMATICALLY RESETS WHEN THE MOTOR COOLS. THE CUSTOMER IS RESPONSIBLE FOR LATCHING THIS SIGNAL TO INHIBIT OPERATION AFTER A MOTOR THERMOSTAT FAULT. CONNECT THERMOSTAT USING TWISTED PAIR WIRE.

7 10 2. CAUTION: THE PRS4/5 FAULT CONTACTS (RATED 115 VAC 1AMP) MUST BE WIRED IN SERIES WITH THE OVERLOAD RELAY AS SHOWN ON SHEET 1.
ON 12 & 20 AMP PSR4/5: THIS CONTACT IS NORMALLY OPEN AND WILL CLOSE WITHIN 250 MSEC. AFTER APPLICATION OF CONTROL AND MAIN POWER. THIS CONTACT OPENS IN FAULT CONDITIONS.
ON 50 & 75 AMP PSR4/5 THIS CONTACT CLOSES ON APPLICATION OF CONTROL POWER AND WILL OPEN IN FAULT CONDITION.

3. CAUTION: RESISTOR IS CONNECTED TO HIGH VOLTAGE; 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.
SEE WIRING DRAWING FOR SPECIFIC REGEN RESISTOR KIT. EACH KIT HAS DIFFERENT SERIES/PARALEL RESISTOR CONNECTIONS TO OBTAIN SPECIFIC RESISTANCE AND POWER RATING.

4. WIRE SIZES, BREAKERS AND FUSES FOR PSR4/5:
PSR4/5-X12 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 12 AMPS RMS,
PSR4/5-X20 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 20 AMPS RMS,
PSR4/5-X50 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 50 AMPS RMS,
PSR4/5-X75 HAS A MAXIMUM MAIN POWER INPUT CURRENT OF 75 AMPS RMS.

THE ACTUAL APPLICATION MAY REQUIRE LESS CURRENT. USE 600 VAC INSULATED WIRE AND REFER TO LOCAL ELECTRICAL CODES FOR PROPER WIRE SIZE FOR THE CURRENTS LISTED ABOVE. FUSES FOR MAIN POWER SHOULD BE A U.L. RATED TIME DELAY TYPE, SUCH AS, BUSS FRN-R SERIES.

THE POWER BUS BETWEEN A PSR4/5 AND BDS5 SHOULD USE THE FOLLOWING WIRE GAUGE WITH 600 VAC INSULATION:
PSR4/5-X12, 14 AWG (OR LARGER) WIRE,
PSR4/5-X20, 10 AWG WIRE,
PSR4/5-X50, BUS BARS SUPPLIED WITH UNIT, OR 8 AWG (OR LARGER) WIRE,
PSR4/5-X75, BUS BARS SUPPLIED WITH UNIT, OR 8 AWG (OR LARGER) WIRE.

5. ALL SIGNAL AND CONTROL WIRES TO BE 22-18 AWG WIRE. THE CRIMP TERMINALS FOR 22-18 AWG WIRE ARE SUPPLIED FOR USE WITH BDS5 CONNECTORS C1, C2, C3, C4, C6 AND PSR4/5 CONNECTORS C1 AND C2. FOR 16 AWG WIRE USE MOLEX #39-00-0078 TERMINALS.

6. IN THE BDS5 3 AMP THRU 20 AMP AND THE PSR4/5 12 AMP AND 20 AMP, THE SCREWS IN THE POWER TERMINAL BLOCKS ARE CAPTIVE. DO NOT ATTEMPT TO REMOVE THEM TO USE RING TERMINALS. USE LOCKING SPRING SPADE TERMINALS SUCH AS HOLLINGSWORTH #XSS20954S OR #SS20947SF FOR 16 AWG WIRE AND #XSS20836 OR #SS20832F FOR 12/10 AWG WIRE.

7. ALL AC LINES SHOULD BE TWISTED CABLES.

8. THE TOTAL NUMBER OF AXES ALLOWED, PER PSR4/5, DEPENDS ON THE PSR4/5 MODEL AND THE COMBINATION OF BDS4's AND/OR BDS5's:
PSR4/5-X12: A MAXIMUM OF 4 BDS4s OR 3 BDS5s,
PSR4/5-X20: A MAXIMUM OF 4 BDS4s OR 3 BDS5s,
PSR4/5-X50: A MAXIMUM OF 6 BDS4s OR 6 BDS5s,
PSR4/5-X75: A MAXIMUM OF 6 BDS4s OR 6 BDS5s.
(IF THE BDS's ARE MIXED, THEN THE TOTAL NUMBER OF AXES THAT CAN BE USED WOULD BE THE MAXIMUM GIVEN FOR THE BDS5s.)
AXIS EXPANSION ON THE PSR4/5 50 AND 75 AMP UNITS ARE ALSO LIMITED TO A MAXIMUM OF 4 BDS4s OR 3 BDS5s ON EITHER SIDE OF THE PSR4/5.

9. THE BDS5 IS CONFIGURED AT THE FACTORY FOR EITHER RS-232 OR RS-485.

10. XX IN THE CABLE NUMBER STANDS FOR CABLE LENGTH IN METERS. CABLE LENGTH IS AVAILABLE FROM 3 TO 75 METERS IN INCREMENTS OF 3 METERS.

11. A THERMAL OVERLOAD RELAY IS SUPPLIED IN THE REGEN RESISTOR KIT FOR THE 50 AND 75 AMP PSR4/5's. THE THERMAL OVERLOAD RELAY, INCLUDED IN THE KIT, WAS SIZED FOR YOUR RESISTANCE AND POWER RATING. THE OUTPUT CONTACTS OF THE RELAY MUST BE WIRED TO DROP POWER TO THE MAIN POWER CONTACTOR IN A FAULT CONDITION, AS SHOWN ON SHEET 1.

12. DO NOT WIRE CONTROL POWER (PSR4/5 CONNECTOR C1) THROUGH THE MAIN POWER CONTACTOR. THIS IS SO THAT CONTROL POWER WON'T BE REMOVED IF PSR4/5 FAULT CONTACTS OPEN (THIS WOULD TURN OFF ANY FAULT LEDS).

13. IF THE BDS5 USES THE OPTIONAL ANOLOG INPUT CARD (BDS5-OPT1), THE OPTIONAL ENCODER INPUTS IN CONNECTOR C1 ARE NOT USED.

14. RECOMMENDED TORQUES FOR CONNECTION TO TERMINAL BLOCKS AND GROUND.

A. BDS4/5-3 TO 20 AMP AND PSR4/5-12 AND 20 AMP
MAX TORQUE PER UL IS 12 IN/LB, EXTERNAL REGEN, MAIN POWER AND BUS CONNECTION.
MAX TORQUE 12 IN/LB GROUND SCREW

B. BDS4/5-30 TO 55 AMP
MAX TORQUE 20 IN/LB MOTOR, BUS CONNECTION AND GROUND STUD

C. PSR4/5-50 TO 75 AMP
MAX TORQUE 20 IN/LB MAIN POWER, BUS CONNECTION AND GROUND STUD
MAX TORQUE 12 IN/LB EXTERNAL REGEN CONNECTION

FOR GROUNDING TO MACHINE OR EARTH GROUND, A SCREW LUG SHOULD BE ATTACHED TO GROUND SCREW OR STUD. RECOMMENDED TORQUE OF 12 IN/LB FOR GROUND SCREWS AND 20 IN/LB FOR GROUND STUDS. MAY ALSO REFER TO NATIONAL ELECTRICAL CODE (NEC) OR UL STANDARD 486B FOR RECOMMENDED TORQUES

THERMAL OVERLOAD PROTECTION DOES NOT PROVIDE INTERNAL TO AMPLIFIER AND MUST BE PROVIDED EXTERNAL. REFER TO NATIONAL ELECTRICAL CODE FOR PROPER SIZING OF OVERLOAD PROTECTION.

ISS.	ECN NO.	DATE	APP'D.	COPY CODE	ISS.	ECN NO.	DATE	APP'D.

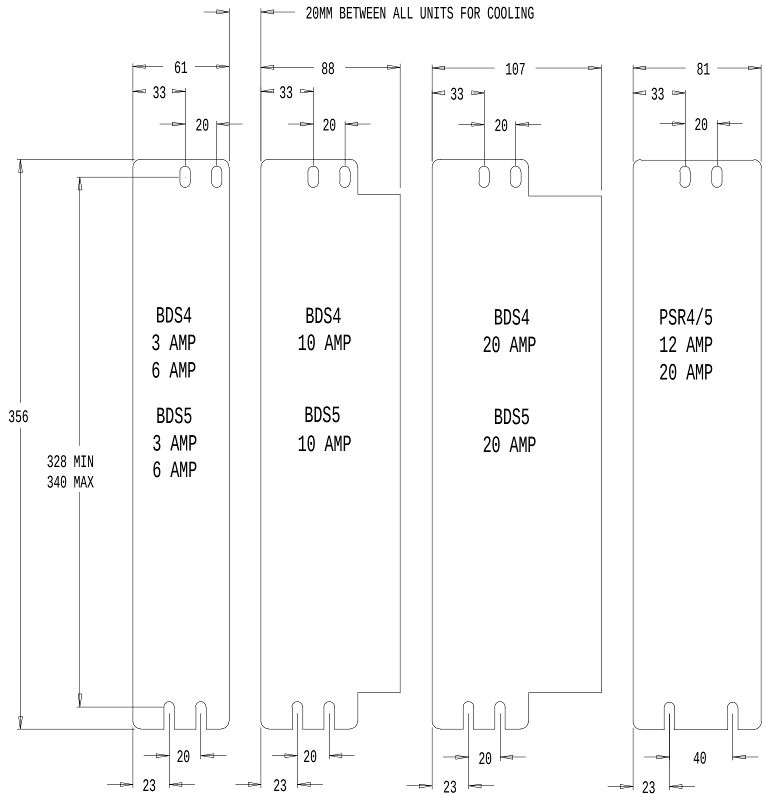
Kollmorgen Industrial Drives
RADFORD, VIRGINIA

BDS5 WIRING DIAGRAM
(NOTES)

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO. SHEET 7 OF 7	ISSUE
VA	2-13-91					1:1	A- 93103	14

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS. UNLESS OTHERWISE SPECIFIED.	DWG. NO. SHT 1 OF 2 A- 93703	ISSUE 2

METRIC



1-A 25mm MINIMUM FREE SPACE SHOULD BE MAINTAINED AROUND THE SYSTEM.
2-LOCATE THE HIGHEST CURRENT BDS4/5 AMPLIFIER NEXT TO THE PSR4/5 POWER SUPPLY AND REMAINING BDS4/5 AMPLIFIERS IN DESCENDING ORDER.

CAD DWG.

			B	COPY CODE

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.
				2	84949 TDG	1-20-93	CJF

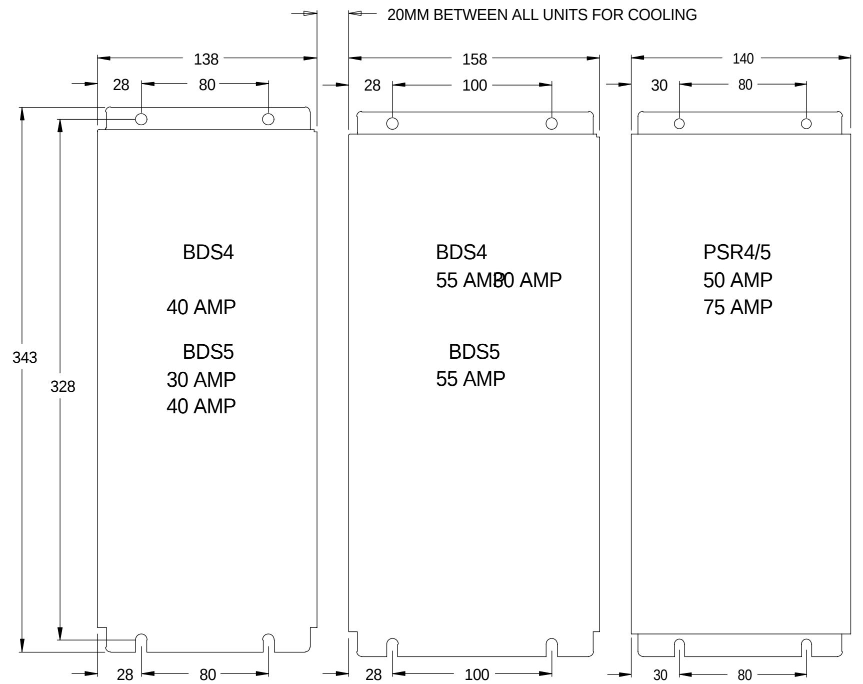
Kollmorgen Industrial Drives
RADFORD, VIRGINIA

MOUNTING HOLE PATTERN
BDS4A, BDS5A, PSR4/5A

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	SHT 1 OF 2	ISSUE
TDG	1-6-93			CJF	1-8-93	1:4	A- 93703		2

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS. UNLESS OTHERWISE SPECIFIED.	DWG. NO. SHT 2 OF 2 A- 93703	ISSUE 2

METRIC



SEE NOTES ON SHEET 1.

CAD DWG.

COPY CODE

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.

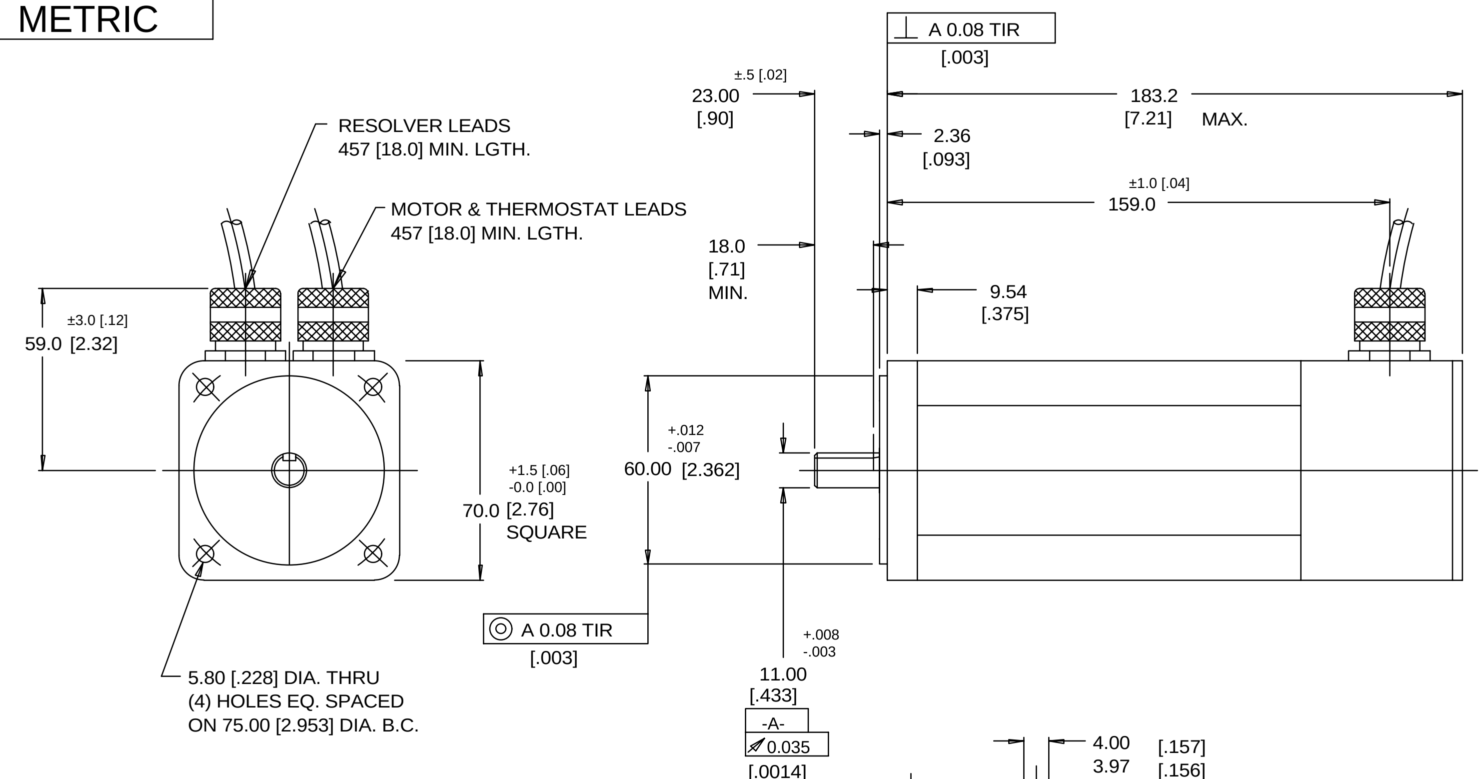
Kollmorgen Industrial Drives
RADFORD, VIRGINIA

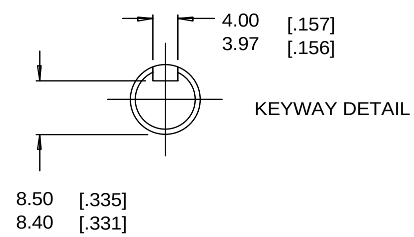
MOUNTING HOLE PATTERN
BDS4A, BDS5A, PSR4/5A

DWN. BY:	DATE	CHK. BY:		APP'D. BY:	DATE	SCALE	DWG. NO. SHT 2 OF 2	ISSUE
TDG	1-6-93					1/4	A- 93703	2

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 62370 / ISSUE 2

METRIC





NOTES:
1-PRESSURE ON SHAFT SEAL MUST NOT EXCEED 0.21 kg/cm2 [3 PSI]
2-MOTOR CAN BE MOUNTED IN ANY POSITION.
3--12 MODEL HAS BEEN DESIGNED WITH INTENT TO MEET IP-65 SEALING.
-14 MODEL HAS BEEN DESIGNED WITH INTENT TO MEET IP-65 SEALING, EXCEPT FOR MOUNTING FACE.
4-ELECTRICAL HOOK-UP PER HD-100.

CAD DWG

STANDARD OPTIONS	
MODEL NO.	SHAFT SEAL
-12	YES
-14	NO

		B	C	COPY CODE

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.
				2	84634 GLK	8-4-92	

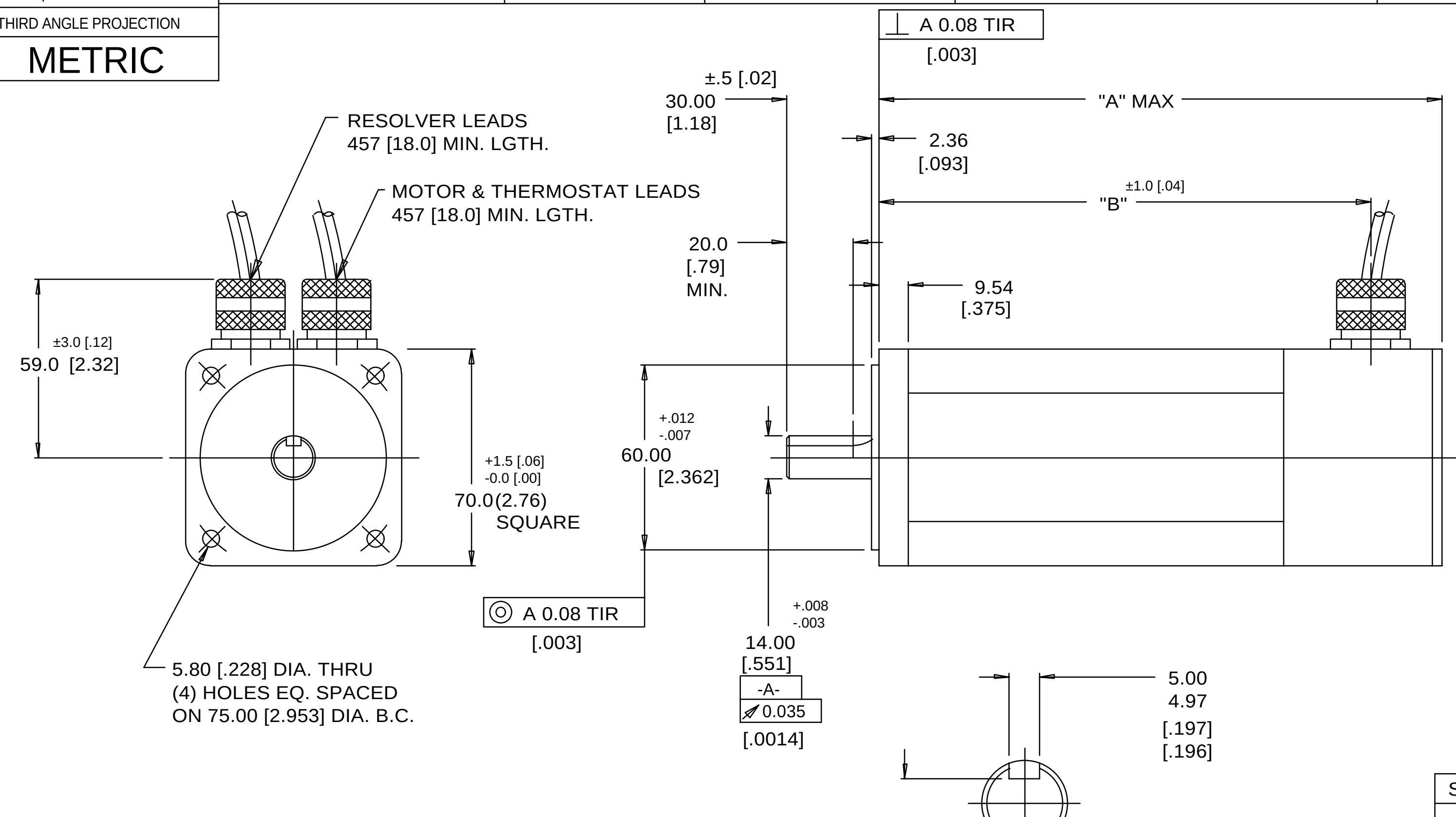
INDUSTRIAL DRIVES
RADFORD, VIRGINIA
A KOLLMORGEN DIVISION

OUTLINE
B-102-X-12,14

DWN. BY:	DATE	CHK. BY:		APP'D. BY:	DATBATE	SCALE	DWG. NO.	ISSUE
S.P.	12-90	J.S.	5-91	MKB	5-91	HALF	A- 62370	2

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 62371	ISSUE 2

METRIC



CAD DWG

STANDARD OPTIONS	
MODEL NO.	SHAFT SEAL
-12	YES
-14	NO

NOTES:
1-PRESSURE ON SHAFT SEAL MUST NOT EXCEED 0.21 kg/cm2 [3 PSI]
2-MOTOR CAN BE MOUNTED IN ANY POSITION.
3--12 MODEL HAS BEEN DESIGNED WITH INTENT TO MEET IP-65 SEALING.
-14 MODEL HAS BEEN DESIGNED WITH INTENT TO MEET IP-65 SEALING, EXCEPT FOR MOUNTING FACE.
4-ELECTRICAL HOOK-UP PER HD-100.

MODEL	"A" MAX	"B"
B-106	244.2 (9.61)	220.0 (8.66)
B-104	213.7 (8.41)	189.5 (7.46)

		B	C	COPY CODE

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.
				2	84634 GLK	8-4-92	

INDUSTRIAL DRIVES
RADFORD, VIRGINIA
A KOLLMORGEN DIVISION

OUTLINE
B-104,6,-X-12-14

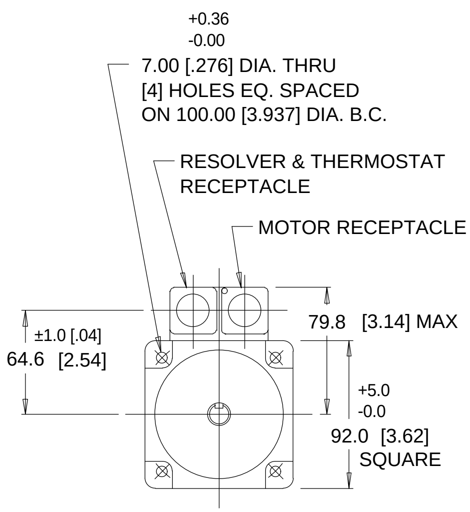
DWN. BY:	DATE	CHK. BY:		APP'D. BY:	DATBATE	SCALE	DWG. NO.	ISSUE
S.P.	12-90	J.S.	5-91	MKB	5-91	HALF	A- 62371	2

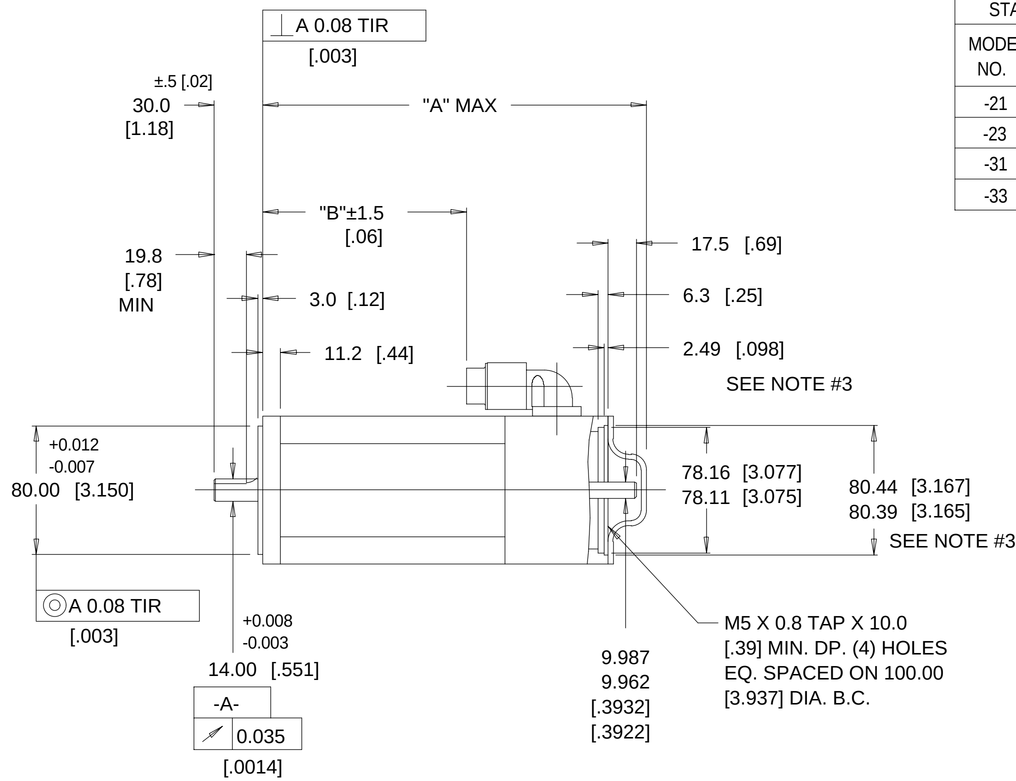
THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 43268	ISSUE 5

METRIC

STANDARD OPTIONS

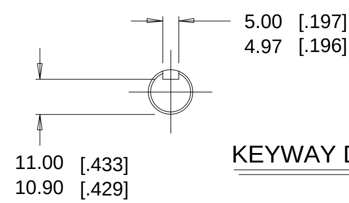
MODEL NO.	MATING PLUGS	SHAFT SEAL
-21	NO	YES
-23	NO	NO
-31	YES	YES
-33	YES	NO





NOTE:

1. - PRESSURE ON SHAFT SEAL MUST NOT EXCEED:
   STANDARD MODEL 0.21 kg/cm2 (3 PSI)
   -S MODEL 0.35 kg/cm2 (5 PSI).
2. - MOTOR CAN BE MOUNTED IN ANY POSITION.
3. - COUNTERBORE FOR O-RING SEAL.
4. - -21 & -31 MODELS HAVE BEEN CERTIFIED TO MEET IP-65 SEALING.
   -S MODEL HAS BEEN CERTIFIED TO MEET IP-67 SEALING
   AND HAS VITON SHAFT SEAL & VITON O-RINGS.
5. - -23 & -33 MODELS MEET SEALING SPECS EXCEPT FOR MOUNTING FACE.
6. - I.D. APPROVED MATING PLUGS WITH FILLER PLUGS MUST BE
   INSTALLED BEFORE MOTOR MEETS SEALING SPECS.
7. - ELECTRICAL HOOK-UP PER HD-200.



KEYWAY DETAIL

CAD DWG

MODEL	"A" MAX	"B"
B-206	315.4 [12.42]	203.1 [8.00]
B-204	275.8 [10.86]	163.5 [6.44]
B-202	236.2 [9.30]	123.9 [4.88]

		L	I	COPY CODE

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.		DATE	APP'D.
				2	76523	J.S.	12-89	S.P.
				3	76615	J.S.	05-90	S.P.
				4	84634	GLK	08-04-92	REG
				5	84835	GLK	12-21-92	

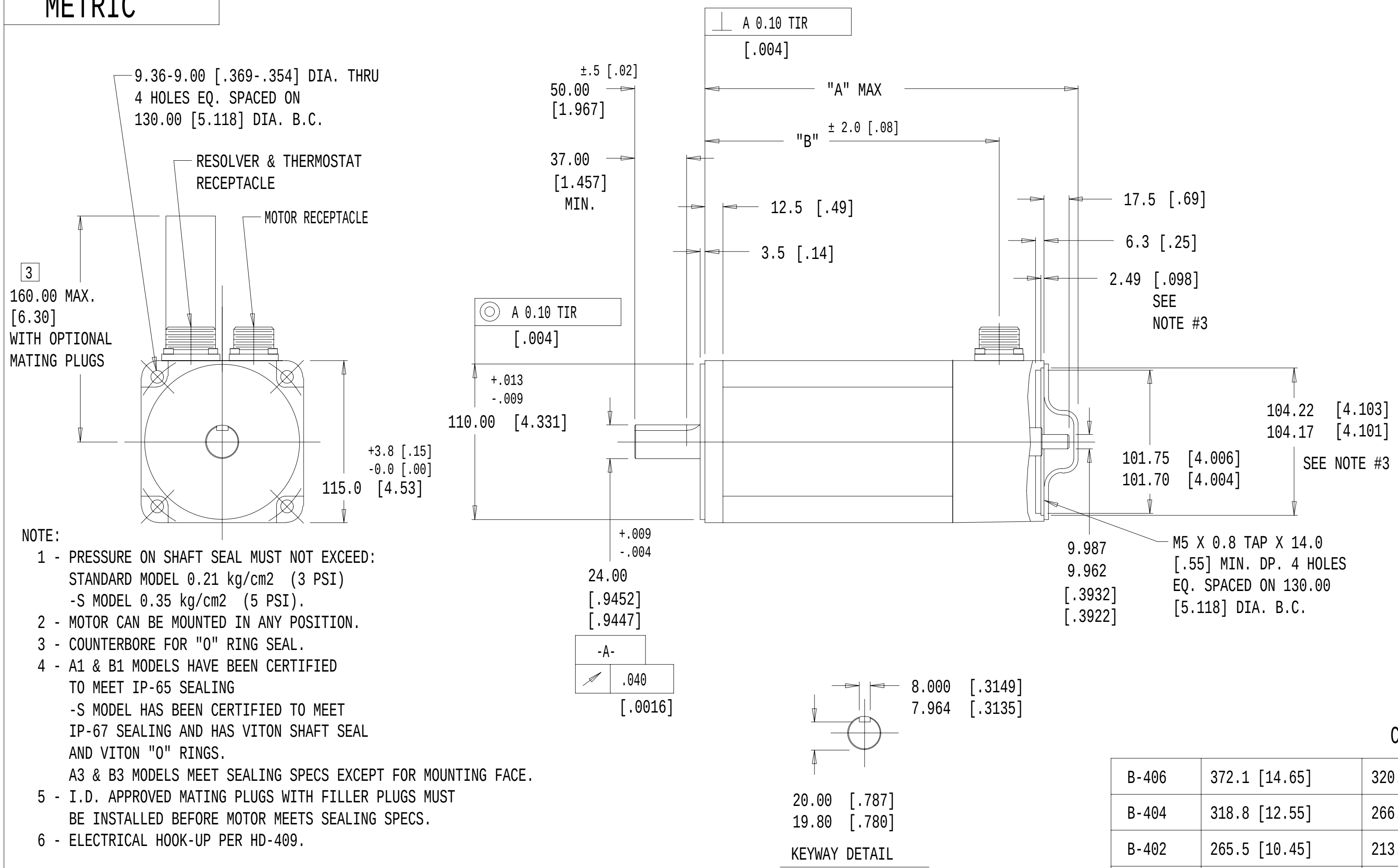
Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE
B-20X-X-21,31,23,33(-S)

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
MLA	05-89	C.A.	06-89	GWB	06-89	1.4	A- 43268	5

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 63093	ISSUE 3

METRIC



NOTE:

1 - PRESSURE ON SHAFT SEAL MUST NOT EXCEED:
STANDARD MODEL 0.21 kg/cm2 (3 PSI)
-S MODEL 0.35 kg/cm2 (5 PSI).
2 - MOTOR CAN BE MOUNTED IN ANY POSITION.
3 - COUNTERBORE FOR "O" RING SEAL.
4 - A1 & B1 MODELS HAVE BEEN CERTIFIED TO MEET IP-65 SEALING
-S MODEL HAS BEEN CERTIFIED TO MEET IP-67 SEALING AND HAS VITON SHAFT SEAL AND VITON "O" RINGS.
A3 & B3 MODELS MEET SEALING SPECS EXCEPT FOR MOUNTING FACE.
5 - I.D. APPROVED MATING PLUGS WITH FILLER PLUGS MUST BE INSTALLED BEFORE MOTOR MEETS SEALING SPECS.
6 - ELECTRICAL HOOK-UP PER HD-409.

CAD DWG

MODEL	"A" MAX	"B"
B-406	372.1 [14.65]	320.2 [12.61]
B-404	318.8 [12.55]	266.9 [10.51]
B-402	265.5 [10.45]	213.6 [8.41]

COPY CODE

ISS.	ECN NO.		DATE	APP'D.
2	84835	GLK	12-14-92	J.B.
3	84977	J.B.	2-08-93	

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE
B-40X-X-A1,A3,B1,B3,(-S)

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
GLK	4-13-92	S.P.	5-26-92	MKB	6-92	1:4	A- 63093	3

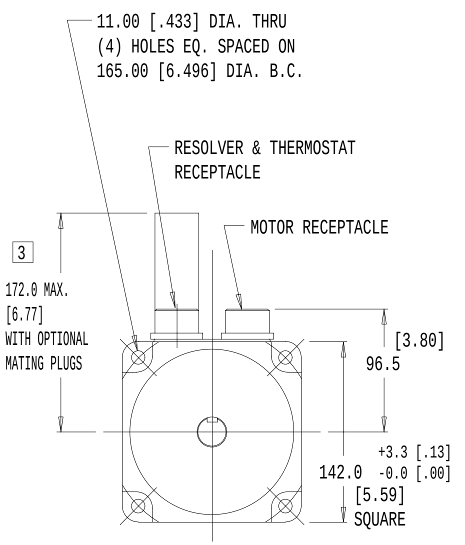
THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

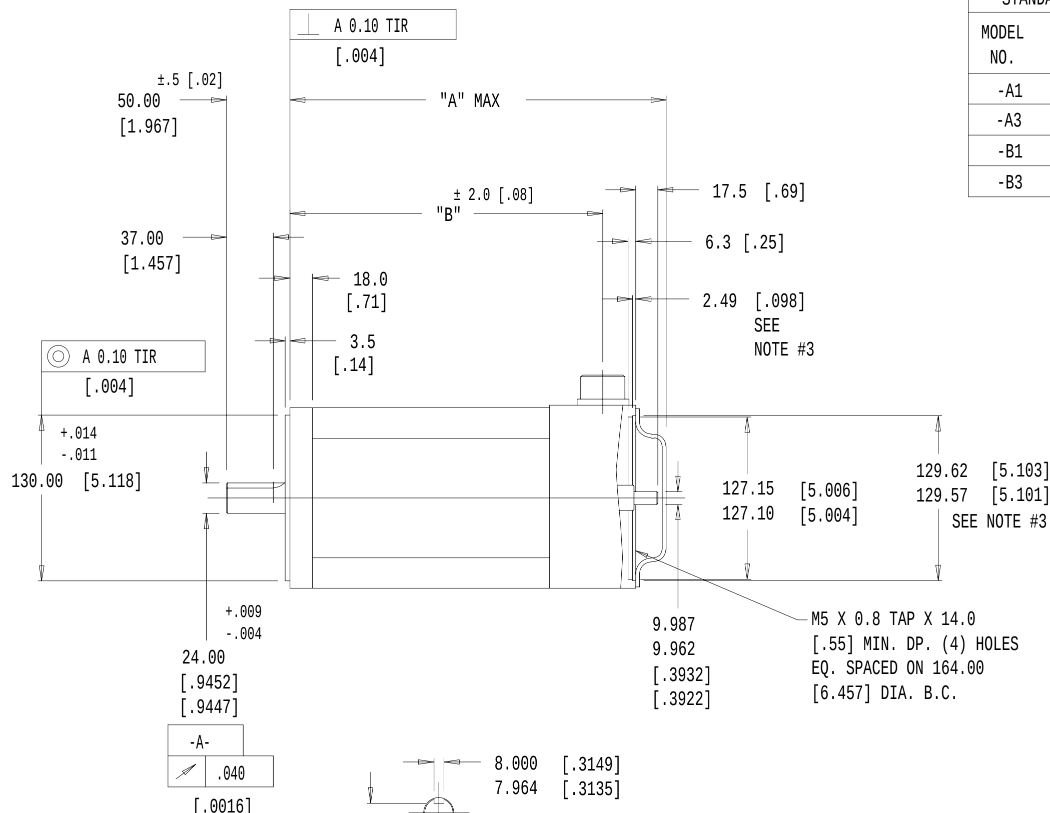
DWG. NO. A- 63099 ISSUE 3

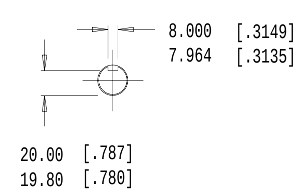
METRIC

STANDARD OPTIONS

MODEL NO.	SHAFT SEAL	MATING PLUGS
-A1	YES	NO
-A3	NO	NO
-B1	YES	YES
-B3	NO	YES







KEYWAY DETAIL

NOTES:

1 - PRESSURE ON SHAFT SEAL MUST NOT EXCEED:
STANDARD MODEL 0.21 kg/cm2 (3 PSI)
-S MODEL 0.35 kg/cm2 (5 PSI).
2 - MOTOR CAN BE MOUNTED IN ANY POSITION.
3 - COUNTERBORE FOR "O" RING SEAL.
4 - A1 & B1 MODELS HAVE BEEN CERTIFIED TO MEET IP-65 SEALING
-S MODEL HAS BEEN CERTIFIED TO MEET IP-67 SEALING AND HAS VITON SHAFT SEAL AND VITON "O" RINGS.
A3 & B3 MODELS MEET SEALING SPECS EXCEPT FOR MOUNTING FACE.
5 - I.D. APPROVED MATING PLUGS WITH FILLER PLUGS MUST BE INSTALLED BEFORE MOTOR MEETS SEALING SPECS.
6 - ELECTRICAL HOOK-UP PER HD-606.

CAD DWG

MODEL	"A" MAX	"B"
B-604	367.8 [14.48]	316.6 [12.46]
B-602	299.2 [11.78]	248.0 [9.76]

COPY CODE

ISS.	ECN NO.	DATE	APP'D.
2	84835 GLK	12-14-92	J.B.
3	84977 J.B.	2-08-93	

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE
B-602,4-X-A1,A3,B1,B3(-S)

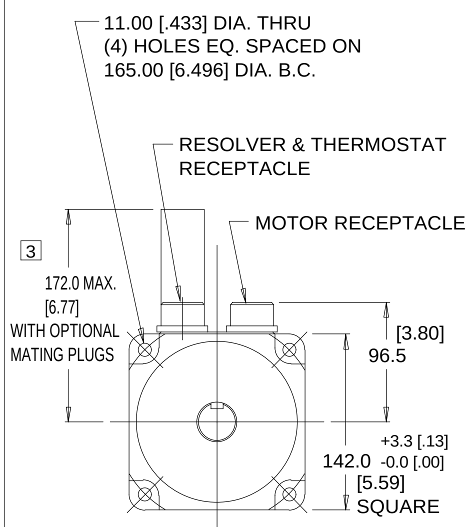
DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
TDG	04-15-92	S.P.	5-26-92	MKB	7-92	1:5	A- 63099	3

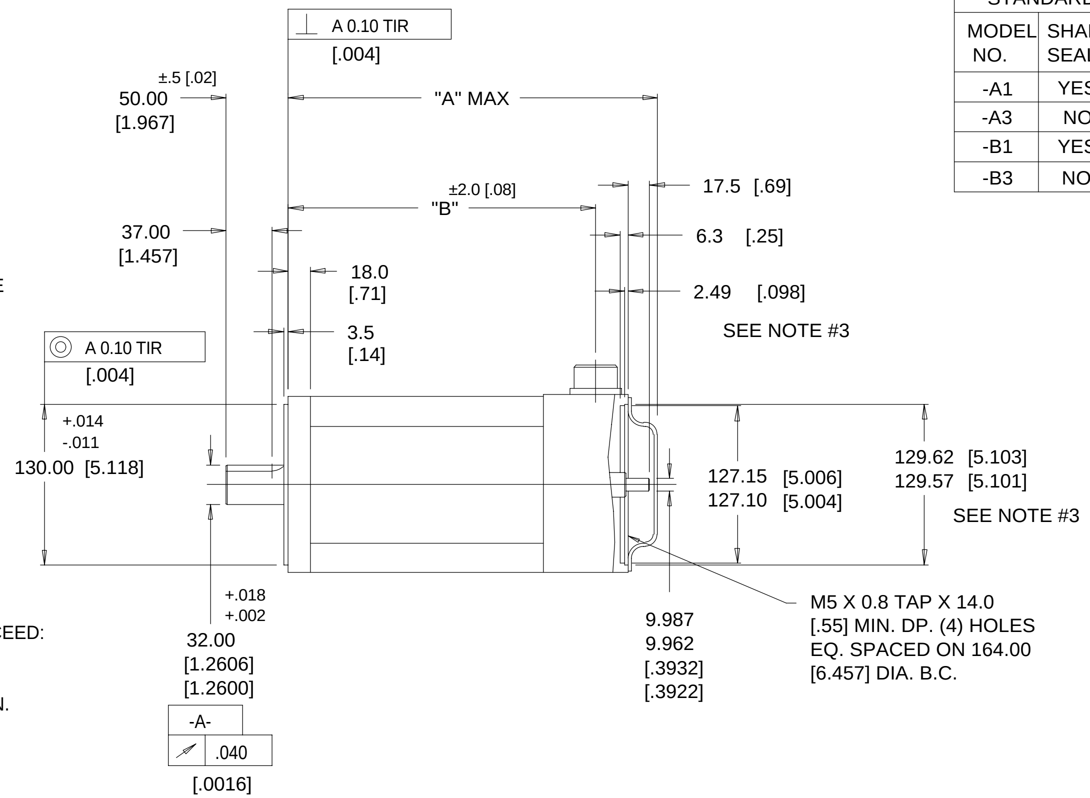
THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 63100	ISSUE 3

METRIC

STANDARD OPTIONS

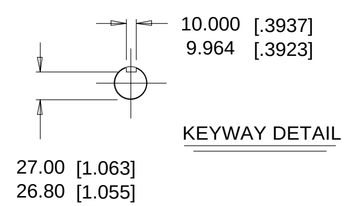
MODEL NO.	SHAFT SEAL	MATING PLUGS
-A1	YES	NO
-A3	NO	NO
-B1	YES	YES
-B3	NO	YES





NOTES:

1 - PRESSURE ON SHAFT SEAL MUST NOT EXCEED:
STANDARD MODEL 0.21 kg/cm2 (3 PSI)
-S MODEL 0.35 kg/cm2 (5 PSI).
2 - MOTOR CAN BE MOUNTED IN ANY POSITION.
3 - COUNTERBORE FOR "O" RING SEAL.
4 - A1 & B1 MODELS HAVE BEEN CERTIFIED TO MEET IP-65 SEALING
-S MODEL HAS BEEN CERTIFIED TO MEET IP-67 SEALING AND HAS VITON SHAFT SEAL AND VITON "O" RINGS.
A3 & B3 MODELS MEET SEALING SPECS EXCEPT FOR MOUNTING FACE.
5 - I.D. APPROVED MATING PLUGS WITH FILLER PLUGS MUST BE INSTALLED BEFORE MOTOR MEETS SEALING SPECS.
6 - ELECTRICAL HOOK-UP PER HD-606.



KEYWAY DETAIL

CAD DWG

MODEL	"A" MAX	"B"
B-606	385.2 [15.17]	436.4 [17.18]

COPY CODE

ISS.	ECN NO.	DATE	APP'D.
2	84835 GLK	12-14-92	J.B.
3	84977 J.B.	2-08-93	

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE
B-606-X-A1,A3,B1,B3(-S)

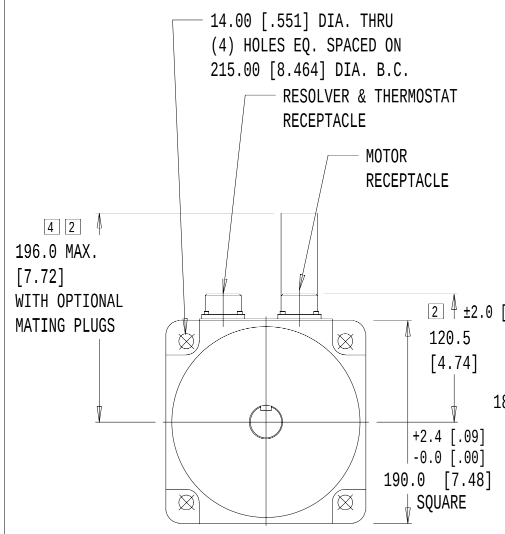
DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY: DATE		SCALE	DWG. NO.	ISSUE
TDG	04-15-92	S.P.	5-26-92	MKB	7-92	1:5	A- 63100	3

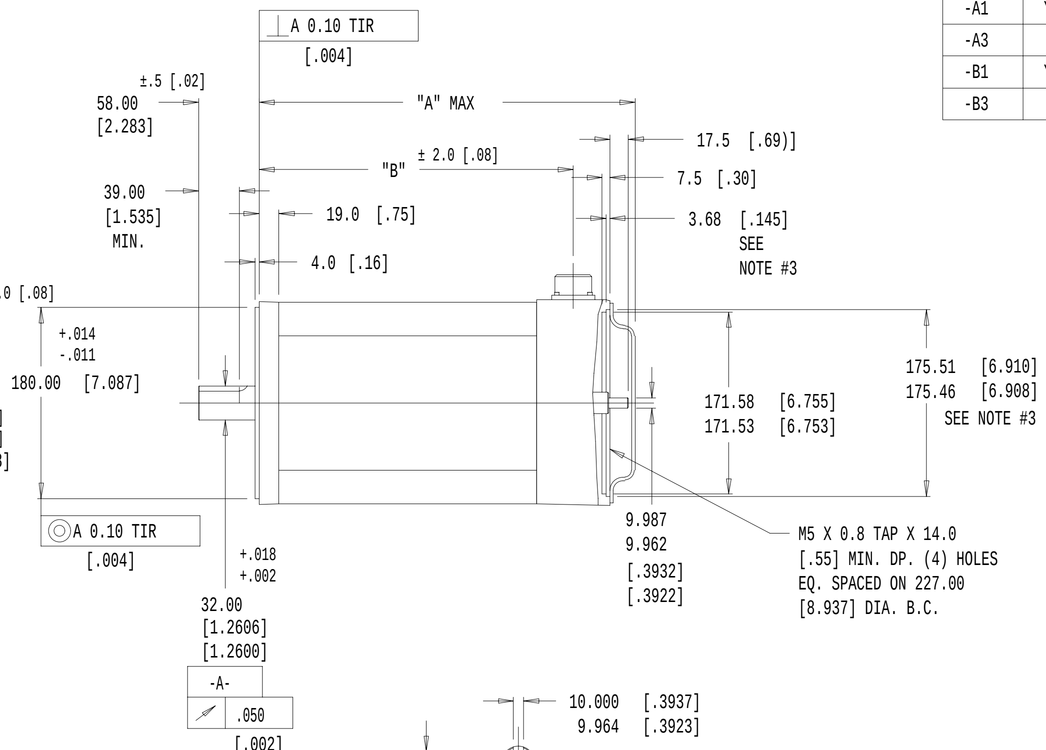
THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 63097	ISSUE 4

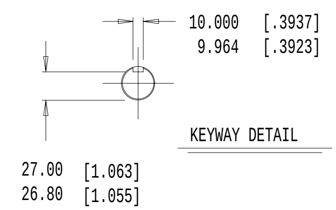
METRIC

STANDARD OPTIONS

MODEL NO.	SHAFT SEAL	MATINGS PLUGS
-A1	YES	NO
-A3	NO	NO
-B1	YES	YES
-B3	NO	YES







NOTE:

1 - PRESSURE ON SHAFT SEAL MUST NOT EXCEED STANDARD MODEL 0.21 kg/cm2 (3 PSI) -S MODEL 0.35 kg/cm2 (5 PSI)

2 - MOTOR CAN BE MOUNTED IN ANY POSITION.

3 - COUNTERBORE FOR "O" RING SEAL.

4 - A1 & B1 MODELS HAVE BEEN CERTIFIED TO MEET IP-65 SEALING
-S MODELS HAVE BEEN CERTIFIED TO MEET IP-67 SEALING AND HAS VITON SHAFT SEAL AND VITON "O" RINGS.
A3 & B3 MODELS MEET SEALING SPECS EXCEPT FOR MOUNTING FACE.

3 5 - I.D. APPROVED MATING PLUGS WITH FILLER PLUGS MUST BE INSTALLED BEFORE MOTOR MEETS SEALING SPECS.

6 - ELECTRICAL HOOK-UP PER HD-804.

CAD DWG.

MODEL	"A" MAX	"B"
B-804	449.9 [17.71]	390.0 [15.35]
B-802	360.4 [14.19]	300.5 [11.83]

COPY CODE

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.
				2	84768 TDG	9-24-92	S.P.
				3	84835 EWR	12-8-92	J.B.
				4	84977 J.B.	2-08-93	

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE
B-802,4-X-A1,A3,B1,B3 (-S)

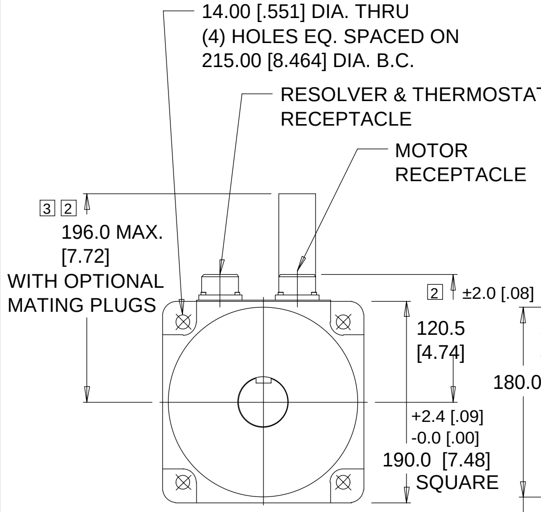
DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
LLS	04-10-92	S.P.	5-28-92	MKB	6-92	1:6	A- 63097	4

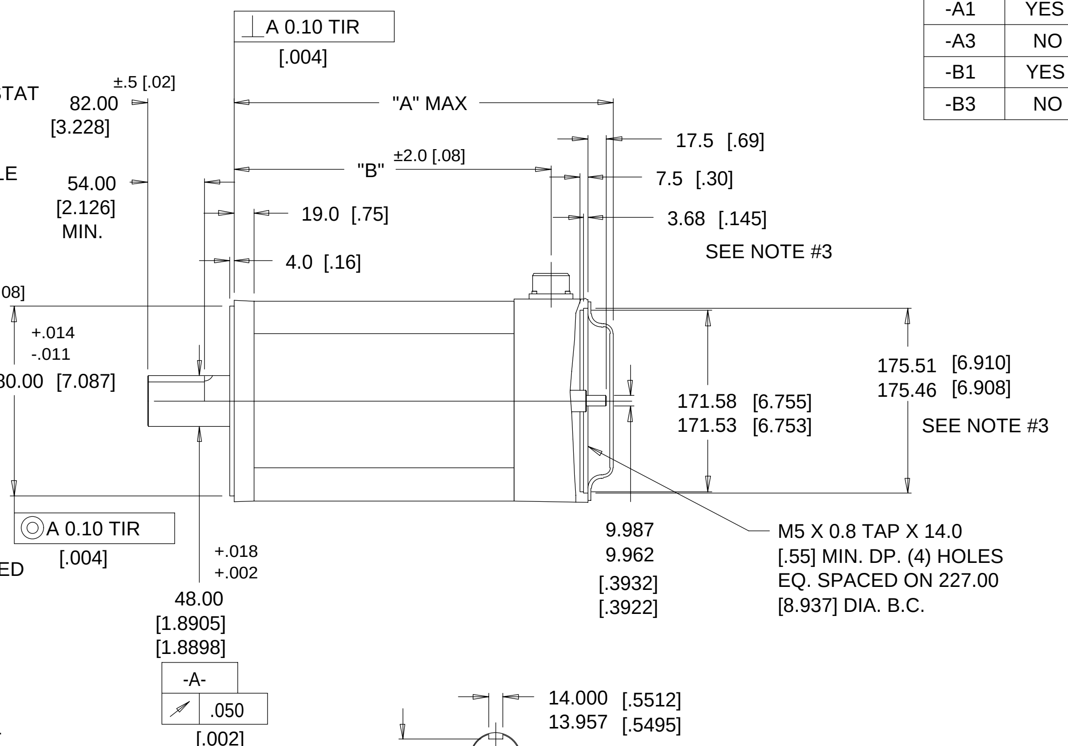
THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 63096	ISSUE 4

METRIC

STANDARD OPTIONS

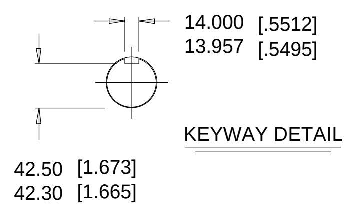
MODEL NO.	SHAFT SEAL	MATINGS PLUGS
-A1	YES	NO
-A3	NO	NO
-B1	YES	YES
-B3	NO	YES





NOTE:

1 - PRESSURE ON SHAFT SEAL MUST NOT EXCEED
STANDARD MODEL 0.21 kg/cm2 (3 PSI)
-S MODEL 0.35 kg/cm2 (5 PSI)
2 - MOTOR CAN BE MOUNTED IN ANY POSITION.
3 - COUNTERBORE FOR "O" RING SEAL.
4 - A1 & B1 MODELS HAVE BEEN CERTIFIED
TO MEET IP-65 SEALING
-S MODELS HAVE BEEN CERTIFIED TO MEET
IP-67 SEALING AND HAS VITON SHAFT SEAL
AND VITON "O" RINGS.
A3 & B3 MODELS MEET SEALING SPECS EXCEPT
FOR MOUNTING FACE.
3 5 - I.D. APPROVED MATING PLUGS WITH FILLER PLUGS MUST
BE INSTALLED BEFORE MOTOR MEETS SEALING SPECS.
6 - ELECTRICAL HOOK-UP PER HD-804.



CAD DWG.

MODEL	"A" MAX	"B"
B-806	539.4 [21.24]	479.5 [18.88]

COPY CODE

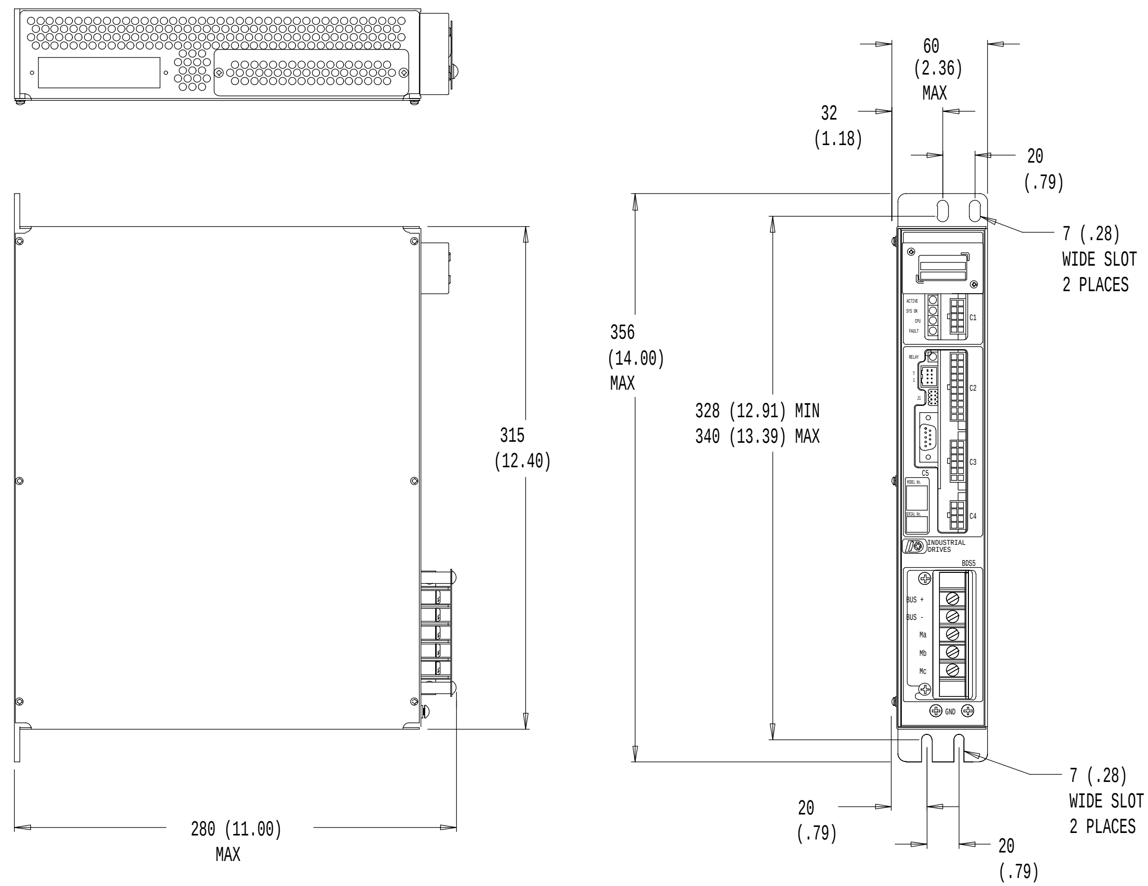
ISS.	ECN NO.		DATE	APP'D.
2	84768	TDG	9-24-92	S.P.
3	84835	EWR	12-8-92	J.B.
4	84977	J.B.	2-08-93	

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE
B-806-X-A1,A3,B1,B3 (-S)

DWN. BY:	DATE	CHK. BY:		APP'D. BY:	DATBATE	SCALE	DWG. NO.	ISSUE
LLS	04-10-92	S.P.	5-26-92	MKB	6-92	1:6	A- 63096	4

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1°	(METRIC) X DEC. PLACES ±.4 XX DEC. PLACES ±.13	(INCHES) XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN PARENTHESES. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 93569	ISSUE 1



THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL,HANDLE ACCORDINGLY.

CAD DWG.

			I	COPY CODE	ISS.	ECN NO.	DATE	APP'D.
ISS.	ECN NO.	DATE	APP'D.					

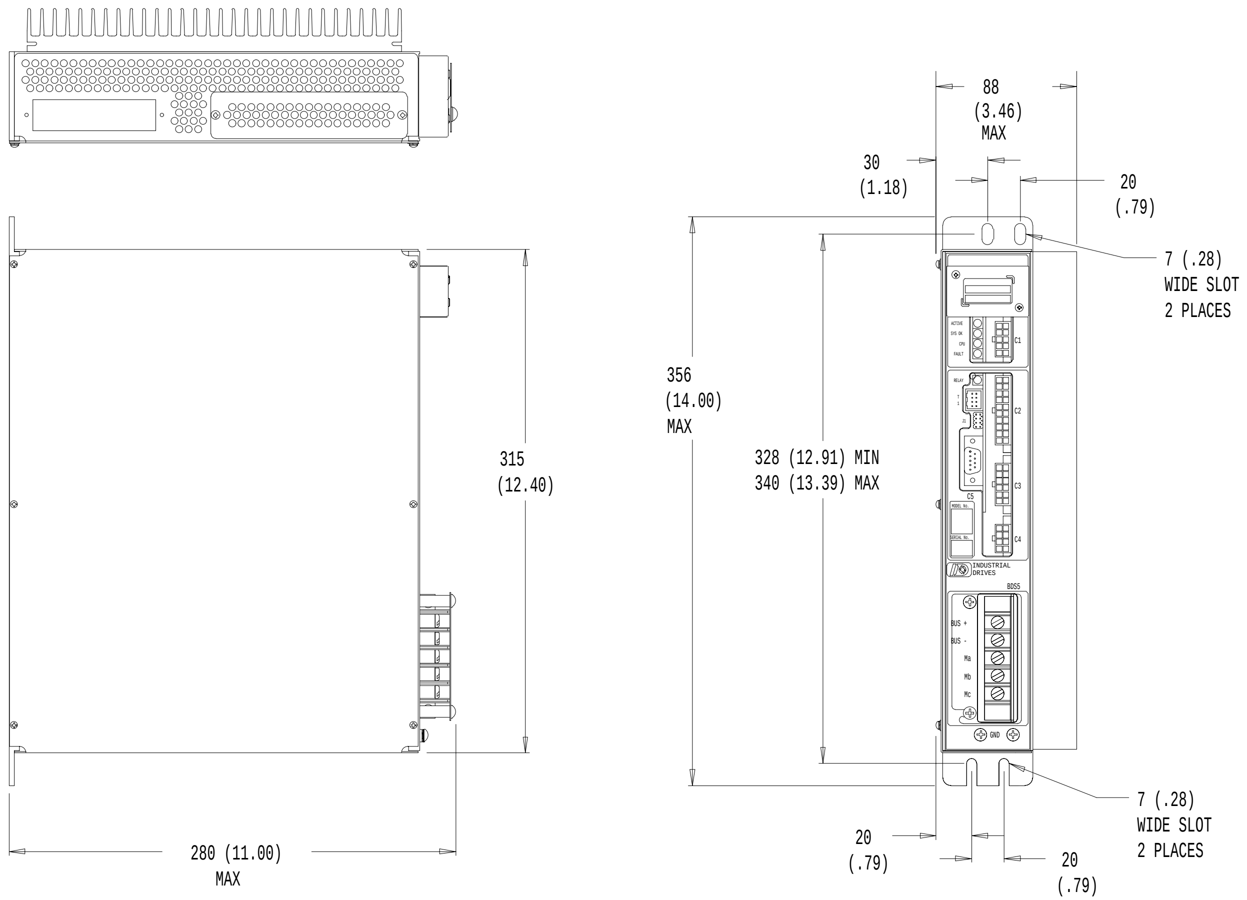
INDUSTRIAL DRIVES
RADFORD, VIRGINIA
A KOLLMORGEN DIVISION

OUTLINE & DIMENSION
BDS5-3 & 6 AMP

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	PLOT SCALE	DWG. NO.	ISSUE
EWR	8-03-92			CJF	8-03-92	1:4	A- 93569	1

A-93569 Sheet 1 of 1

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1°	(METRIC) X DEC. PLACES ±.4 XX DEC. PLACES ±.13	(INCHES) XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN PARENTHESES. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 93571	ISSUE 1



THIS UNIT CONTAINS STATIC SENSITIVE
MATERIAL,HANDLE ACCORDINGLY.

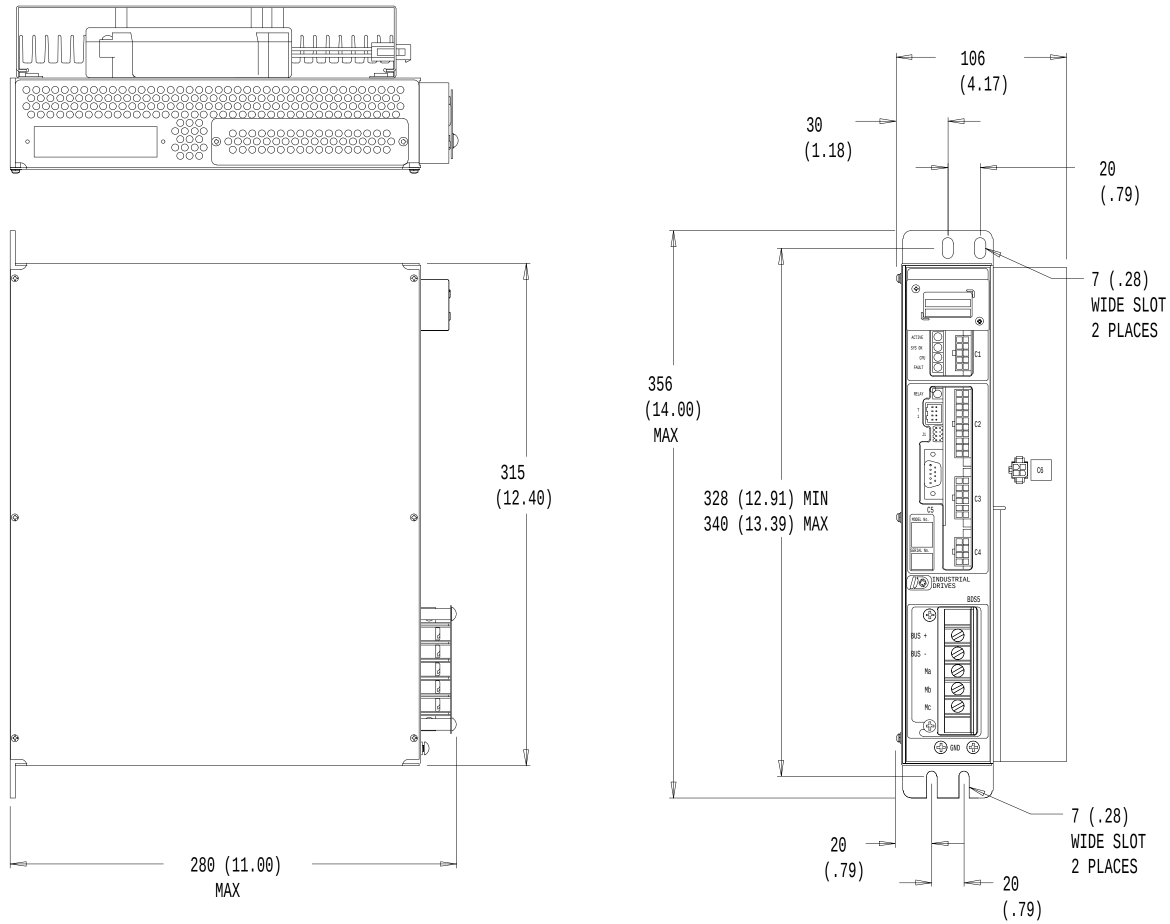
CAD DWG.

			I	COPY CODE	ISS.	ECN NO.	DATE	APP'D.
ISS.	ECN NO.	DATE	APP'D.				

INDUSTRIAL DRIVES RADFORD, VIRGINIA A KOLLMORGEN DIVISION						OUTLINE & DIMENSION BDS5-10AMP
DWN. BY: EWR	DATE 8-03-92	CHK. BY:	DATE	APP'D. BY: CJF	DATE 8-03-92	PLOT SCALE 1:4

DWG. NO. A- 93571	ISSUE 1

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1°	(METRIC) X DEC. PLACES ±.4 XX DEC. PLACES ±.13	(INCHES) XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN PARENTHESES. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 93570	ISSUE 1



THIS UNIT CONTAINS STATIC SENSITIVE
MATERIAL,HANDLE ACCORDINGLY.

CAD DWG.

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INDUSTRIAL DRIVES
RADFORD, VIRGINIA
A KOLLMORGEN DIVISION

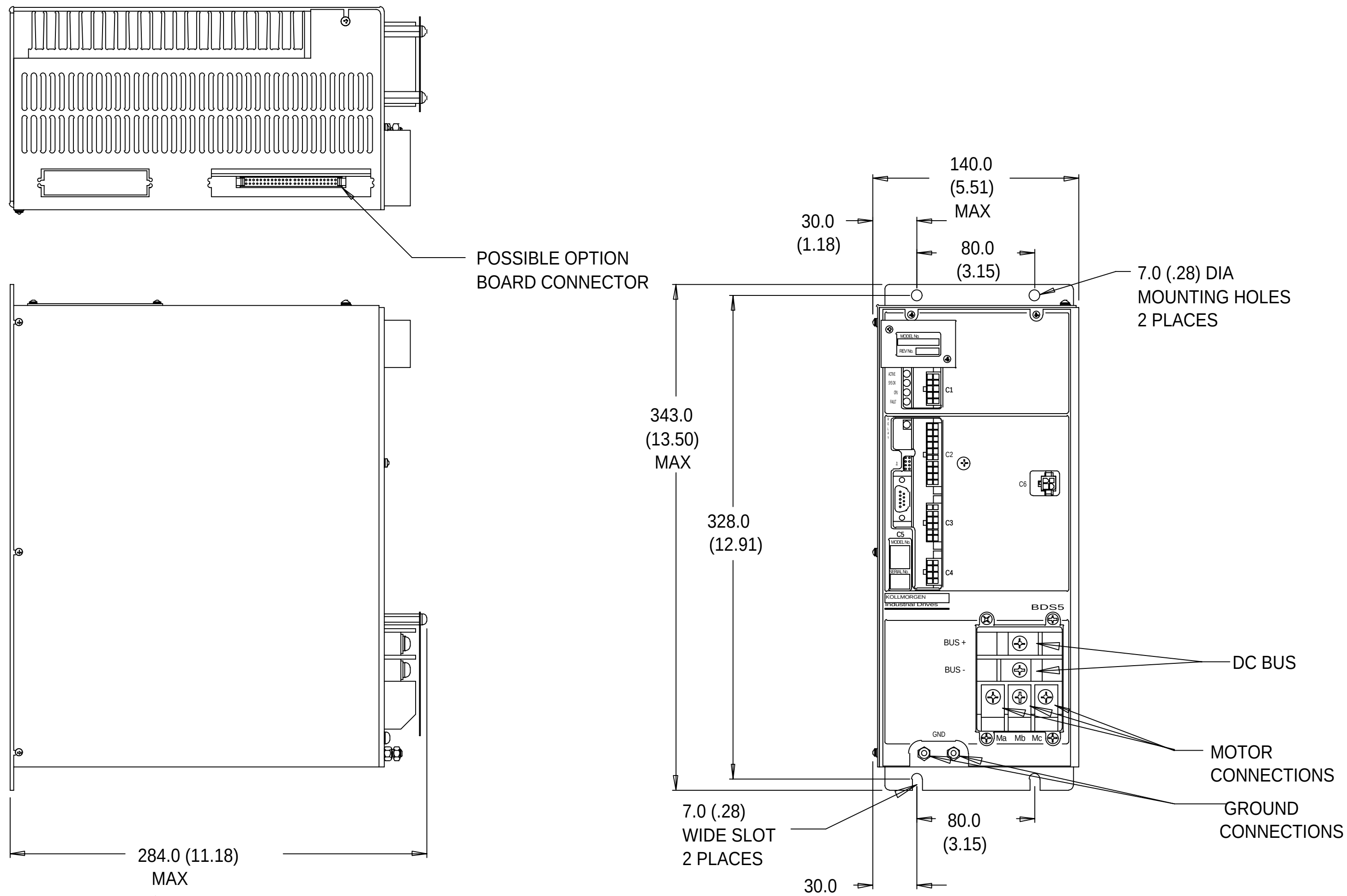
OUTLINE & DIMENSION
BDS5-20AMP

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	PLOT SCALE	DWG. NO.	ISSUE
EWR	8-03-92			CJF	8-03-92	1:4	A- 93570	1

A-93570 Sheet 1 of 1

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 93880	ISSUE 1

METRIC



THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL,HANDLE ACCORDINGLY.

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ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.

Kollmorgen Industrial Drives
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OUTLINE AND DIMENSION
BDS5A-30/40 AMP

DWN. BY:	DATE	CHK. BY:		APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
LLS	11-09-93					1:4	A- 93880	1

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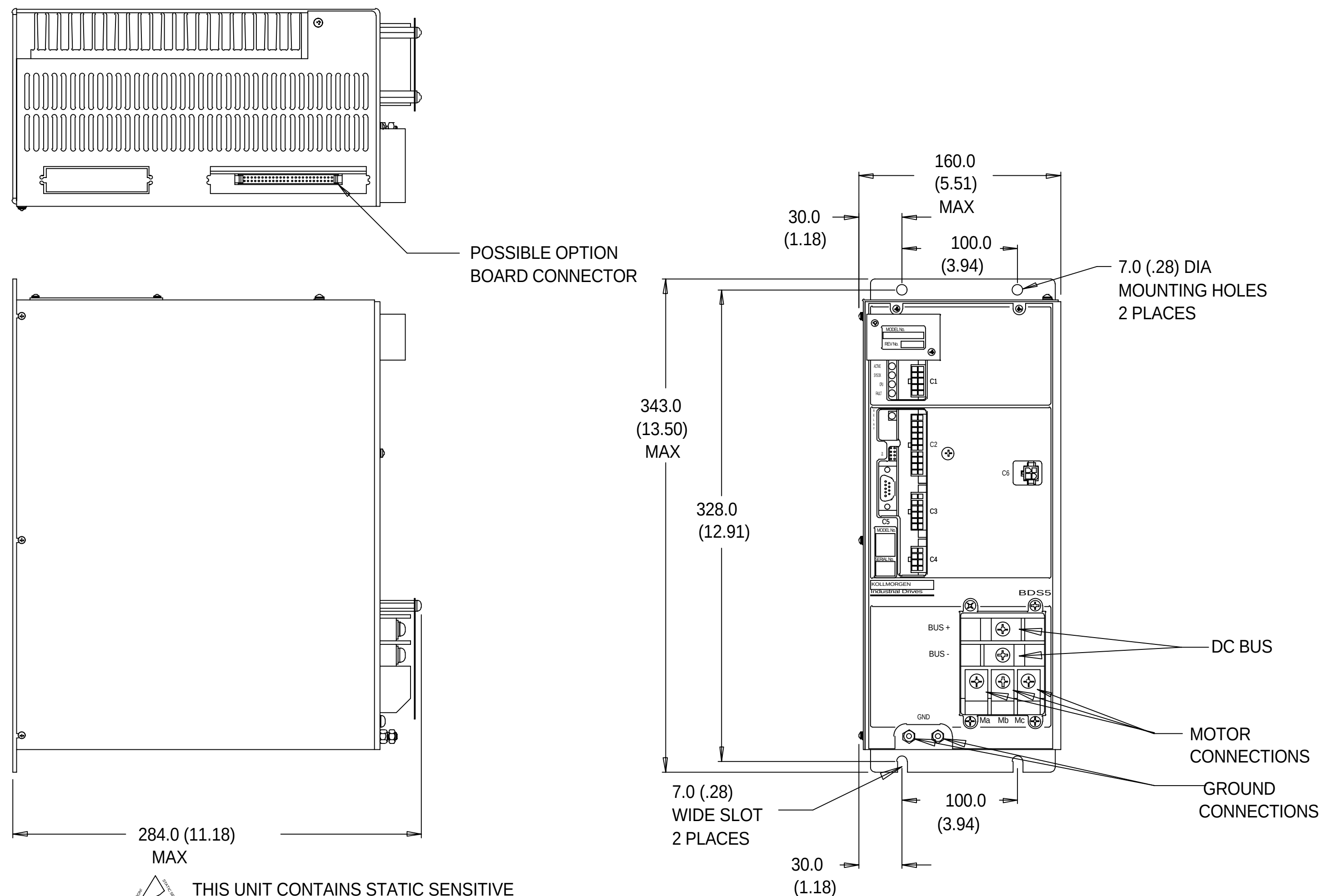
THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 96010	ISSUE 1

METRIC



THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL,HANDLE ACCORDINGLY.

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CAD DWG

ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.

Kollmorgen Industrial Drives
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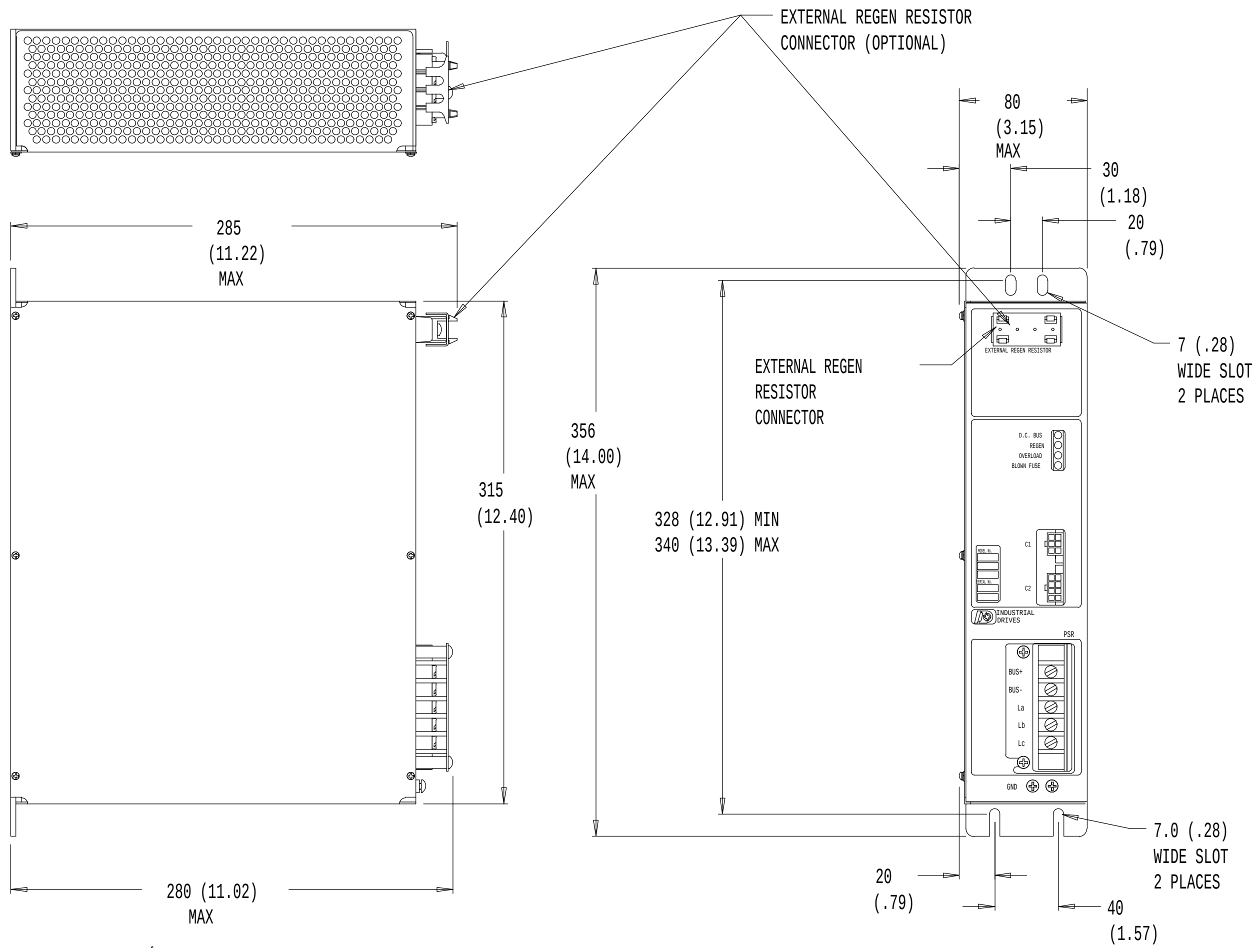
OUTLINE AND DIMENSION
BDS5A-55AMP

DWN. BY:	DATE	CHK. BY:		APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
LLS	11-09-93					1:4	A- 96010	1

X-XXXXX

THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 93581	ISSUE 1

METRIC



THIS UNIT CONTAINS STATIC SENSITIVE
MATERIAL, HANDLE ACCORDINGLY.

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ISS.	ECN NO.	DATE	APP'D.	ISS.	ECN NO.	DATE	APP'D.
				X	XXXXX XXX	XX-XX-XX	XXX

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE & DIMENSION
PSR-4/5A-12 & 20 AMP

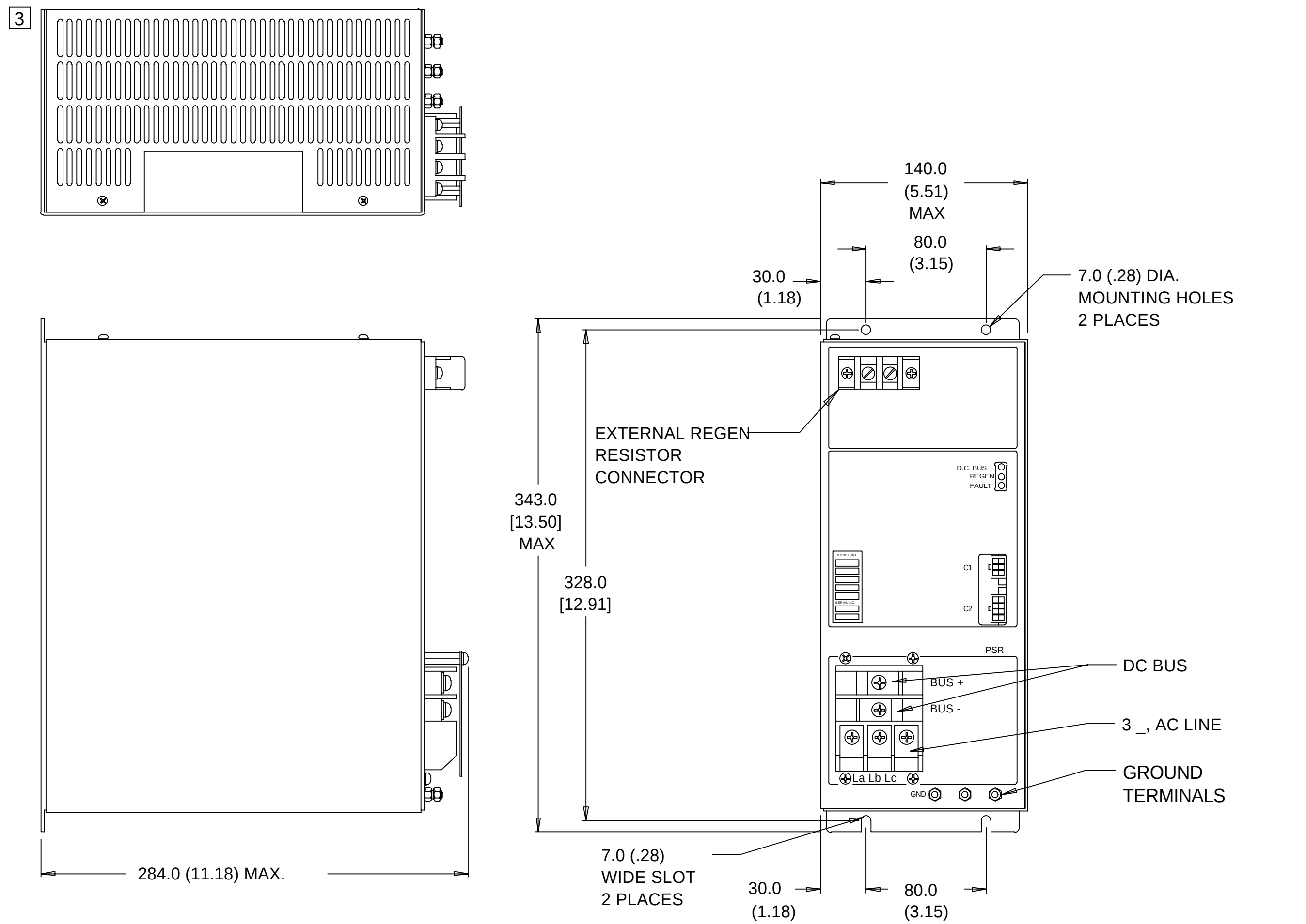
DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY:	DATE	SCALE	DWG. NO.	ISSUE
EWR	08-05-92	XXX	XX-XX-XX	XXX	XX-XX-XX	1:4	A- 93581	1

X-XXXXX

THIRD ANGLE PROJECTION

METRIC

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG.USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS.UNLESS OTHERWISE SPECIFIED.	DWG. NO. A- 93031	ISSUE 4



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CAD DWG

ISS.	ECN NO.	DATE	APP'D.

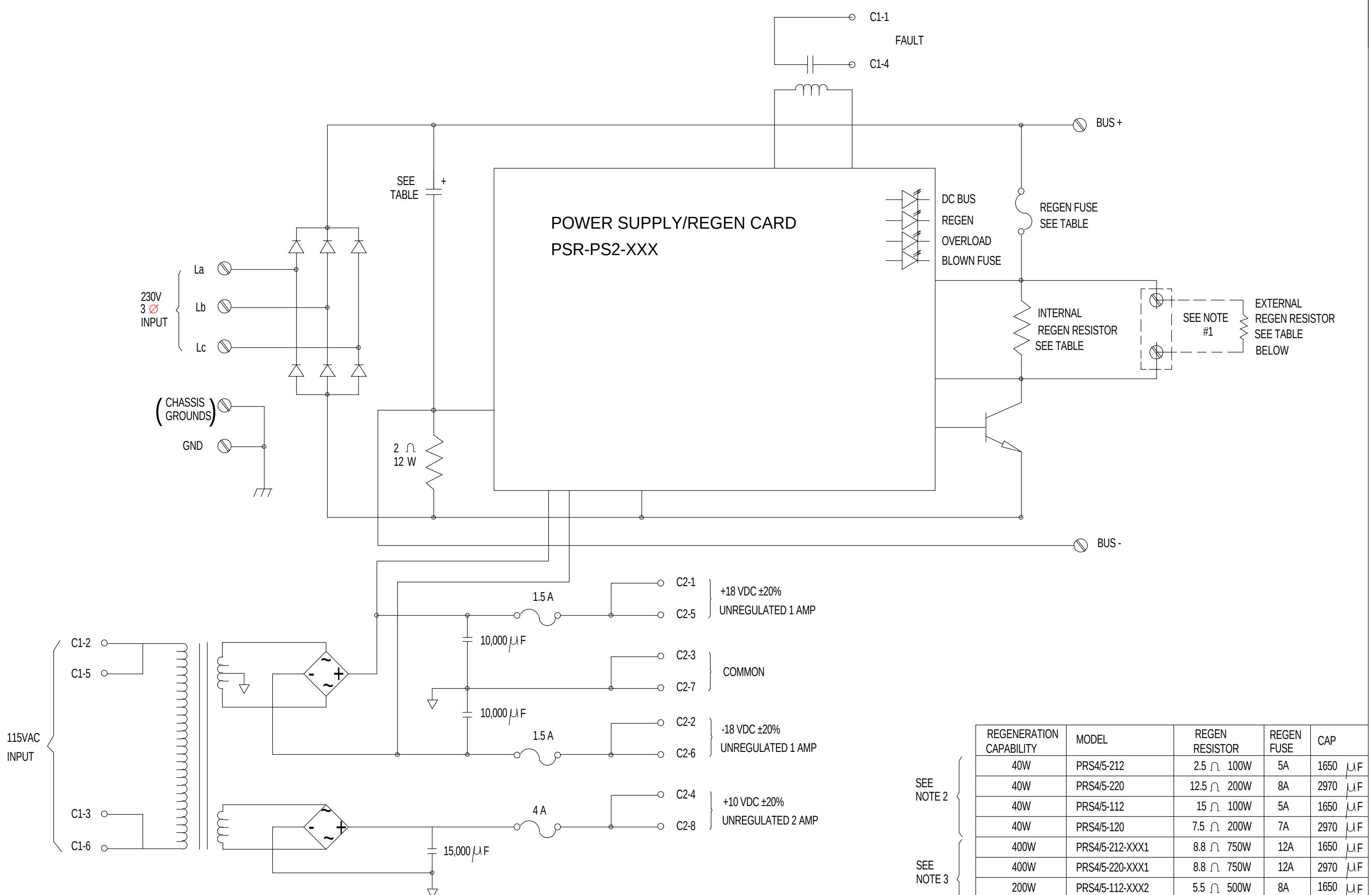
ISS.	ECN NO.	DATE	APP'D.
2	84111 EWR	08-05-91	CJF
3	85645 LL	02-22-94	CJF
4	85945 AWL	07-06-94	

Kollmorgen Industrial Drives
RADFORD, VIRGINIA

OUTLINE & DIMENSION
PSR4/5A-50 & 75 AMP

DWN. BY:	DATE	CHK. BY:	DATE	APP'D. BY: DATE		SCALE	DWG. NO.	ISSUE
V.A.	01-09-91	FDO	03-19-91	MP	03-19-91	1:4	A- 93031	4

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1°	(METRIC) X DEC. PLACES ±.4 XX DEC. PLACES ±.13	(INCHES) XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN PARENTHESES. UNLESS OTHERWISE SPECIFIED.	DWG. NO. C- 84723	ISSUE 3



	REGENERATION CAPABILITY	MODEL	REGEN RESISTOR	REGEN FUSE	CAP
SEE NOTE 2	40W	PRS4/5-212	2.5 Ω 100W	5A	1650 μF
	40W	PRS4/5-220	12.5 Ω 200W	8A	2970 μF
	40W	PRS4/5-112	15 Ω 100W	5A	1650 μF
	40W	PRS4/5-120	7.5 Ω 200W	7A	2970 μF
SEE NOTE 3	400W	PRS4/5-212-XXX1	8.8 Ω 750W	12A	1650 μF
	400W	PRS4/5-220-XXX1	8.8 Ω 750W	12A	2970 μF
	200W	PRS4/5-112-XXX2	5.5 Ω 500W	8A	1650 μF
	200W	PRS4/5-120-XXX2	5.5 Ω 500W	8A	2970 μF

NOTES

1)- TERMINAL BLOCK PROVIDED ONLY ON EXTERNAL REGEN RESISTOR MODELS. NO INTERNAL REGEN RESISTOR PROVIDED ON EXTERNAL RESISTOR MODEL.

2)- THESE VALUES FOR INTERNAL REGEN ONLY.

3)- THESE VALUES FOR EXTERNAL REGEN ONLY.

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INDUSTRIAL DRIVES
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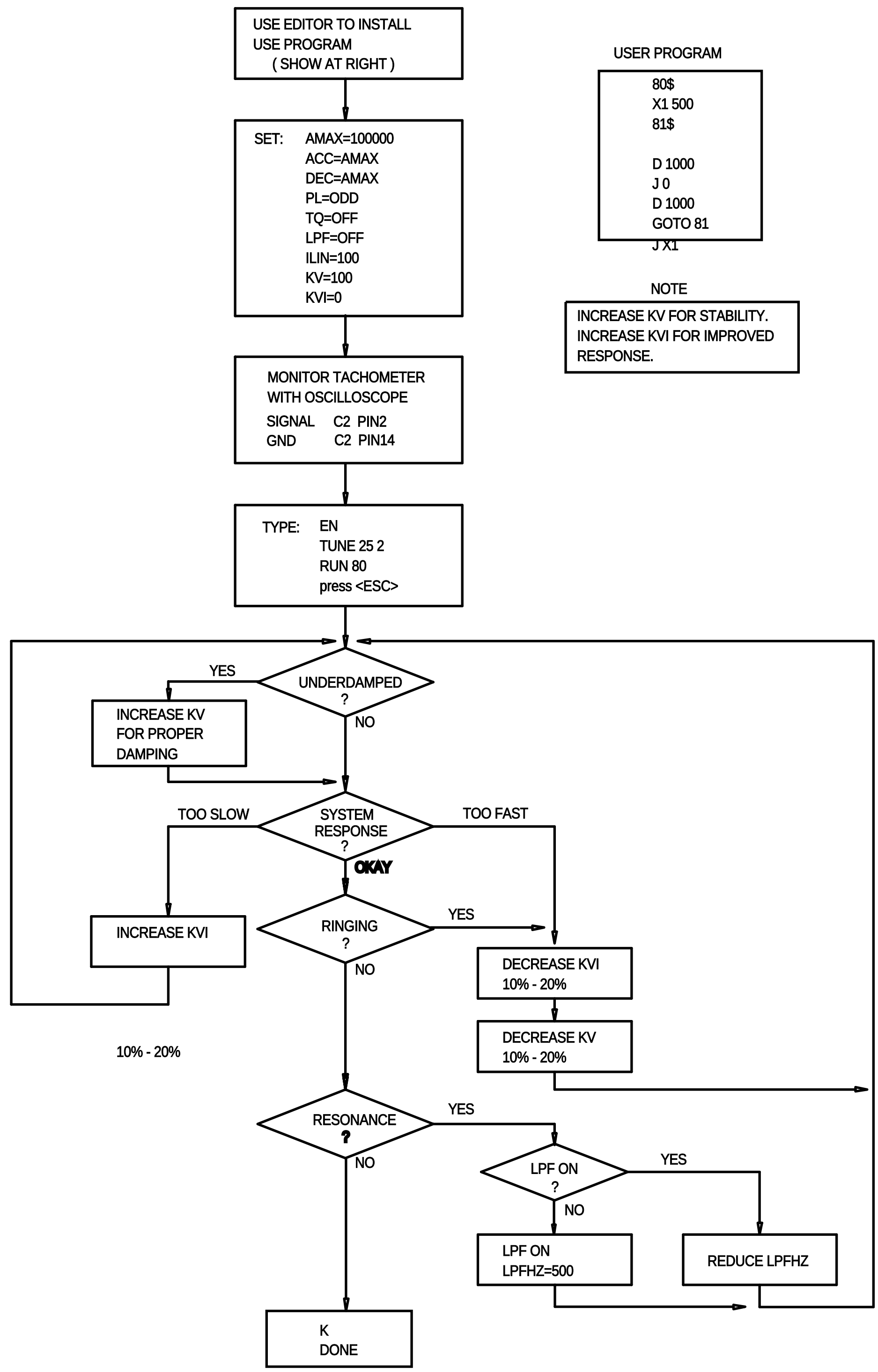
PSR4/5 SIMPLIFIED SCHEMATIC

DWN. BY: | DATE | CHK. BY: | DATE | APPD. BY: | DATE | PLOT SCALE | DWG. NO. C- 84723 | ISSUE 3

ISSUE 5
A-84888



VELOCITY LOOP TUNING FLOW CHART

ISSUE 5
A-84888
SCHULER 12-17-90
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APPENDIX C

ERROR CODES

C.1 INTRODUCTION

The BDS5's response to an error depends on the error's severity. There are four levels of severity, listed below in increasing order:

Table C.1. Error Severity Levels and Actions

1.	Errors which cause warnings.
2.	Errors which cause a program break and stop motion, in addition to Level 1 Actions.
3.	Errors which cause the system to disable and set the FAULT Hardware Output, in addition to Level 2 Actions.
4.	Errors which disable almost all BDS5 functions (including communications) and flash the CPU LED to indicate the error number. These are called firmware errors.

See Chapter 5 for more information about error severity. The following is a complete list of errors generated by the BDS5.

C.2 HARDWARE FAULTS

C.2.1 Firmware Faults

ERROR 2 "HARDWARE- U-P FAIL" SEVERITY 4

The microprocessor cannot pass self-test. This fault causes the microprocessor to blink the CPU light twice and then pause. The BDS5 will not communicate or run the user program. Contact the factory.

ERROR 3 "HARDWARE-CHECKSUM" SEVERITY 4

The microprocessor cannot pass the checksum self-test. This fault causes the microprocessor to blink the CPU light three times and then pause. The BDS5 will not communicate or run the user program. Contact the factory.

ERROR 4 "SOFTWARE WATCHDOG" SEVERITY 4

The microprocessor has failed the software watchdog self-test. This fault causes the microprocessor to blink the CPU light four times and then pause. The BDS5 will not communicate or run the user program. Contact the factory.

ERROR 5 "+5 VOLTS" SEVERITY 4

The +5 volts is too low. This fault causes the microprocessor to blink the CPU light five times and then pause. The BDS5 will not communicate or run the user program. Check the +10 VDC input into the BDS5 (Connector C4, Pin 4 or 8). If it is below 6.5 Volts for even a short time, this error will occur. This happens when the logic supply is loaded too heavily, or when the line voltage (PSR4/5 Connector C1, Pins 2 and 3) is below 98 VAC (115 VAC less 15%).

C.2.2 BDS5 Faults

ERROR 10 "REMOTE OFF" SEVERITY 2

You attempted to execute an instruction that requires the hardware input REMOTE on the signal connector to be active. This error breaks program execution.

ERROR 11 "OVER-TEMP" SEVERITY 3

The thermostat on the BDS5 heatsink opened, indicating overheating. Overheating may be caused by excessive ambient temperature, obstructed airflow, broken fan, etc. Correct any such condition before resuming operation. REMOVE ALL POWER BEFORE CHECKING THIS. If everything is functioning properly, a drive with a higher current rating may be required. This error breaks program execution and disables the BDS5.

ERROR 12 "OVER-CURRENT" SEVERITY 3

The BDS5 detected an overcurrent. This can be caused by a shorted motor winding, a shorted power transistor, or a short circuit in the wiring. Be sure to check all wiring before resuming operation. This error breaks program execution and disables the BDS5.

ERROR 13 "OVER-SPEED" SEVERITY 3

The BDS5 determined that the speed of the motor was greater than the variable VOSPD. If this occurs occasionally, it may be a nuisance fault that should be corrected by raising VOSPD by 5% or 10%. This error breaks program execution and disables the BDS5.

ERROR 14 "POWER BUS" SEVERITY 3

The power supply high voltage bus has either an overvoltage fault or an undervoltage fault. See Chapter 3 for more information. This error breaks program execution and disables the BDS5.

ERROR 15 "COMP BOARD" SEVERITY 3

You attempted to enable the BDS5 with the compensation board removed. Replace the compensation board. This error breaks program execution.

ERROR 17 "FEEDBACK LOSS" SEVERITY 3

The BDS5 has detected that one or more wires to the resolver have been broken, or the resolver connector has been removed. This error breaks program execution.

ERROR 18 "BAD TL" SEVERITY 3

The BDS5 has two boards: a small MC board and a larger IBD board. Both boards have the current and voltage rating encoded and they must match. If this error occurs because you exchanged the MC card, then you should replace the original card. If it occurs for some other reason, contact the factory. This error breaks program execution.

ERROR 19 "MOTION (HDWR LINE)" SEVERITY 2

The MOTION input was off at the beginning of a motion instruction, or it turned off during a motion instruction. This signal comes from the optional I/O card. This error breaks program execution.

ERROR 20 "TUNE FAILED" SEVERITY 3

The TUNE command failed. Either the inertia on the motor is too large for the desired bandwidth, the motor is not functioning properly, the bus voltage is too low, or the BDS5 is not functioning properly. Try reducing the desired bandwidth to correct this problem. Make sure REMOTE is on. If this does not work, attempt to tune the system by hand as described in Chapter 9.

ERROR 22 "+/- 12 VOLTS" SEVERITY 3

The ±12 volts is out of tolerance. Contact the factory. This error breaks program execution.

C.2.3 Positioner Faults

ERROR 23 "SOFTWARE OVERTRAVEL" SEVERITY 2

Software travel limits are enabled and either PMAX or PMIN (the software limits) have been exceeded. If your application does not need software travel limits, or if you want to disable software travel limits temporarily, type:

```
PLIM OFF
```

This error breaks program execution.

ERROR 24 "HARDWARE OVERTRAVEL" SEVERITY 3

The BDS5 detected an overtravel condition while it was enabled. You can print the state of the overtravel limit switch by typing:

```
P  LIMIT
```

If LIMIT is 0, then an overtravel condition exists. LIMIT should be connected to a limit switch that has contacts that are normally closed but which open where an overtravel condition occurs. Hardware overtravel limits cannot be disabled. This error breaks program execution and disables the BDS5.

ERROR 25 "PE OVERFLOW" SEVERITY 3

The variable PE, the position error, exceeded the variable PEMAX. This is also called a *following error overflow*. This error breaks program execution and disables the BDS5.

ERROR 26 "PFB ROLLOVER" SEVERITY 3

The variable PFB, the position feedback, exceeded +/-2,147,483,647 counts. If you are using position units, then PFB exceeded the position unit equivalent of +/-2,147,483,647 counts. This can occur if the motor rotates indefinitely in one direction. If your application requires this, consider using the rotary mode as described in Chapter 11.

ERROR 27 ***"R/D JUMPERS"*** ***SEVERITY 3***

Either the jumpers on your BDS5 MC2 card are incorrectly set or the wrong TL has been loaded. Contact the factory.

C.3 MOTION ERRORS

C.3.1 Position Calculation Errors

ERROR 30 ***"TOO MANY MOVES"*** ***SEVERITY 2***

You typed in too many move commands (MA, MI, MCGO) from the interactive mode. You can have one move executing and the other pending. The error does not occur when move commands are executed from the user program, because the BDS5 sees that the motion buffer is full and delays execution to prevent the error. This error breaks program execution.

ERROR 31 ***"TOO MANY MRD MOVES"*** ***SEVERITY 2***

You attempted to execute a motion instruction that required the profile buffer to be empty. This occurs when two MRD instructions are active at once. You should use a synchronizer to delay the execution of the instruction that caused the error. This error breaks program execution.

ERROR 32 ***"ACC/DEC TOO LOW"*** ***SEVERITY 2***

You entered a motion command that calculated a motion profile where either the acceleration or deceleration segment was more than 30 seconds long. You must increase ACC or DEC or reduce the speed change of the move. This error breaks program execution.

ERROR 33 ***"VEL OUT OF BOUNDS"*** ***SEVERITY 2***

You entered a motion command where the commanded velocity was out of the allowable range. The range for Jog (J) commands is ±VMAX. The range for other motion commands is 0 to +VMAX. This error breaks program execution.

C.3.2 Macro Move/JT/JF Errors

ERROR 40 ***"CHANGED DIRECTION"*** ***SEVERITY 2***

You attempted to change direction with an instruction that does not allow direction to change. These instructions include JT, JF and macro moves. This error breaks program execution.

ERROR 41 ***"MOVE NEEDS MOTION"*** ***SEVERITY 2***

You attempted to execute an instruction that requires the motor to be in motion. These instructions include JT, JF, and MCI/MCA with no velocity parameter specified. This error breaks program execution.

ERROR 42 ***"MOVE w/o TIME"*** ***SEVERITY 2***

You attempted to execute a move that required more time than was available. For example, you attempted a JT or macro segment where the final position could not be reached because of acceleration limits. You may have attempted a JT or JF when you were already well beyond the specified position. This error breaks program execution.

ERROR 43 ***"MACRO NOT READY"*** ***SEVERITY 2***

You attempted to execute a macro move (with the MCGO instruction) in which the last segment of the move did not end at zero speed, or the macro-move memory is empty. The macro-move memory is cleared every time the BDS5 is turned on. This error breaks program execution.

ERROR 44 ***"MCD w/MACRO MOVING"*** ***SEVERITY 2***

You attempted to insert a macro-move dwell when the previous macro-move segment ended at a speed other than zero. This error breaks program execution.

ERROR 45 ***"MCA ACTIVE"*** ***SEVERITY 2***

You attempted to insert an MCA segment after an MCI segment. This error breaks program execution.

ERROR 46 ***"MCI ACTIVE"*** ***SEVERITY 2***

You attempted to insert an MCI segment after an MCA segment in a macro move. This error breaks program execution.

ERROR 47 ***"MCI/MCA TOO COMPLEX"*** ***SEVERITY 2***

You attempted to execute a macro move that required too many segments. This error breaks program execution.

ERROR 48 ***"MCA/MCI RUNNING"*** ***SEVERITY 2***

You attempted to build a macro move while another macro move was running. This error breaks program execution.

C.4 SOFTWARE ERRORS

C.4.1 Programming Modes or Motion Modes

ERROR 50 ***"DRIVE INHIBITED"*** ***SEVERITY 2***

You attempted to execute an instruction that required the BDS5 to be enabled while it was inhibited. This error will break program execution if the instruction is issued from the user program.

ERROR 51 ***"DRIVE ENABLED"*** ***SEVERITY 2***

You attempted to execute an instruction that required the BDS5 to be inhibited while it was enabled. This error will break program execution if the instruction is issued from the user program.

ERROR 52 ***"NOT FROM TERMINAL"*** ***SEVERITY 1***

You attempted to execute an instruction from the terminal that is not allowed from the terminal. This error generates no action.

ERROR 53 "NOT FROM PROGRAM" SEVERITY 1

You attempted to execute an instruction from the program that is not allowed from the program. This error breaks program execution.

ERROR 54 "NOT FROM MONITOR" SEVERITY 1

You attempted to execute an instruction while in the Monitor mode that is not allowed from the Monitor mode. This error generates no action.

ERROR 55 "NOT FROM RECOVERY" SEVERITY 2

You attempted to execute an instruction from the error recovery (the user's error handler or "ERROR$") that is not allowed. This includes attempting to enable the BDS5, GOSUB, and GOTO. This error breaks execution.

ERROR 56 "NOT w/GEAR" SEVERITY 2

You attempted to execute an instruction when the Gear mode was enabled that is not allowed with the Gear mode. For example, MRD, MA, JT, and JF are not allowed with the Gear mode on. This error breaks execution if the instruction was issued from the program.

ERROR 57 "NOT w/PROFILE" SEVERITY 2

You attempted to execute an instruction that is not allowed while the BDS5 is profiling. Profiling occurs when move instructions (MA, MI, MRD) or macro moves are executing. Other examples of this are the traverse segment before the accel/decel portion of position dependent jogs (JT, JF), and the accel/decel portions of all jogs (J, JT, JF). This error breaks execution.

ERROR 58 "NOT w/JOGGING" SEVERITY 2

You attempted to execute an instruction that is not allowed when the BDS5 is jogging. This error breaks execution if the instruction was issued from the program.

ERROR 59 "NOT w/ROTARY" SEVERITY 2

You attempted to execute an instruction that is not allowed when the BDS5 is in the Rotary mode. Type:

```
ROTARY OFF
```

to turn the Rotary mode off. This error breaks execution if the instruction was issued from the program.

ERROR 60 "OUTSIDE PROTARY" SEVERITY 2

You attempted to make an absolute move (either MA or MCA) beyond PROTARY. For example, if PROTARY is 1000 and you typed:

```
MA 2000
```

Use incremental moves (MI and MCI) if you want to move beyond the rotary limit. This error breaks execution if the instruction was issued from the program.

ERROR 61 "NORMALIZE FIRST" SEVERITY 2

You attempted to turn on the Rotary mode when PFB was less than zero or greater than PROTARY. Use the NORM command to normalize the position to between 0 and PROTARY. This error breaks execution if the instruction was issued from the program.

ERROR 62 "RD ALREADY IN USE" SEVERITY 2

You attempted to execute RD when RD was in use from some other task. This error occurs when two task levels attempt to simultaneously use the RD command. This error breaks program execution.

ERROR 63 "NOT AT THIS LEVEL" SEVERITY 2

You attempted to execute a command that is not allowed at the present task level. For example, GOSUB and GOTO are not allowed from within an alarm. This error breaks program execution.

ERROR 64 "BACKWARD REGULATION" SEVERITY 3

The external input counted backwards more than 30,000 counts when REG was on. This error breaks program execution and disables the BDS5.

ERROR 65 "RECORD NOT READY" SEVERITY 3

You entered a PLAY command when nothing had been recorded since the last time the BDS5 powered up.

C.4.2 Improper Use of Labels

ERROR 70 "LABEL NOT FOUND" SEVERITY 2

You attempted to branch to a label (either from RUN, GOSUB, or GOTO) that does not exist. This error breaks program execution.

ERROR 71 "LABEL USED TWICE" SEVERITY 2

The user program has a label that is used more than once. This error breaks program execution.

ERROR 74 "ERROR$ MUST BE LAST" SEVERITY 2

The user's error (ERROR$) must be the last label in the program buffer. You cannot have labels after ERROR$, nor can you use the GOTO or GOSUB commands when the BDS5 is executing the error handler. The error handler is intended to provide a graceful exit during error conditions and cannot be used to restart the program. You can use the IF, TIL, and ? commands to execute conditional commands in the error handler. This error breaks program execution.

C.4.3 Invalid Instructions or Entries

ERROR 79 ***"BAD FORMAT"*** ***SEVERITY 2***

You entered a format that the BDS5 does not recognize. For example, you may have entered:

```
INPUT  "INPUT X1"  X1[.3]
```

In this case, the decimal point (following the "[") is incorrect. Pay careful attention to the rules for formats. This error breaks program execution if the instruction is issued from the user program.

ERROR 80 ***"INVALID INSTRUCTION"*** ***SEVERITY 2***

You attempted to execute an instruction or change a variable that the BDS5 does not recognize. This error breaks program execution if the instruction is issued from the user program.

ERROR 81 ***"NOT PROGRAMMABLE"*** ***SEVERITY 2***

You attempted to change a variable that is not programmable. This error will break program execution if the instruction is issued from the user program.

ERROR 82 ***"BAD NUMBER ENTRIES"*** ***SEVERITY 2***

The instruction that is executing has too many or too few parameters. Look up the instruction in Appendix B to determine the correct number of entries. This error breaks program execution if the instruction is issued from the user program.

ERROR 83 ***"BAD OR OUT OF RANGE"*** ***SEVERITY 2***

You entered a parameter to an instruction that was too large or too small. Check Appendix C for limits on variables. This error can also occur when a parameter is in the wrong format, such as a character string where a number is expected. This error breaks program execution if the instruction is issued from the user program.

ERROR 84 ***"OUT OF BOUNDS"*** ***SEVERITY 2***

The variable listed is out of bounds. If the variable is protected (that is, set by the factory as defined in Appendix C), contact the factory. If the variable is not protected, set it within its bounds. This error breaks execution.

ERROR 85 ***"BAD INDIRECTION"*** ***SEVERITY 2***

You attempted an indirect reference to a user variable that does not exist. For example:

```
X1  10000
P  X(X1)
```

X(X1) refers to user variable X10000, which does not exist. The "P X(X1)" will generate this error. This error breaks program execution if the instruction is issued from the user program.

ERROR 86 "USER PROGRAM FULL" SEVERITY 2

You attempted to load a program larger than the BDS5 can hold. This occurs with the >BDS instruction and from the Motion Link communications software "Program Transmit (^T)." This error breaks program execution.

ERROR 87 "EMBEDDED QUOTE" SEVERITY 2

You entered a command with an embedded quote. A space must precede an opening quote and follow a closing quote. For example:

```
P"BAD COMMAND"
```

has an embedded quote after the "P." This error breaks program execution if the instruction is issued from the user program.

ERROR 88 "NO CLOSING QUOTE" SEVERITY 2

You entered a command with an odd (as opposed to even) number of quotes. This error breaks program execution if the instruction is issued from the user program.

ERROR 89 "NOT FOR ALARM/HOLD/RECORD" SEVERITY 2

You have specified a switch that is not an allowable switch for an alarm or a hold or record command. For example:

```
A$  REMOTE  ON      ;ERROR--REMOTE NOT ALLOWED FOR ALARMS
```

This line causes Error 89 since REMOTE is not allowed to fire an alarm.

ERROR 90 "TOO MANY POINTS" SEVERITY 2

You specified too many points in a RECORD command. Only 1000 points total can be recorded. For example, if you are recording four variables, they can be recorded no more than 250 times, since 4*250 = 1000.

C.4.4 Math Errors

ERROR 92 "ZERO DIVIDE" SEVERITY 2

You attempted to divide a number by 0. This error breaks program execution if the instruction is issued from the user program.

ERROR 93 "MATH OVERFLOW" SEVERITY 2

The final result of a calculation or an intermediate result during the calculation of an expression was greater than 2^{31} or less than -2^{31}. This error breaks program execution.

ERROR 94 ">2 PARENTHESES" SEVERITY 2

The BDS5 evaluated an expression with more levels of parentheses than the BDS5 supports. Up to two levels of parentheses are allowed. This error breaks program execution.

ERROR 95 "UNEVEN PARENTHESES" SEVERITY 2

The BDS5 encountered an expression in which the number of closing parentheses was not equal to the number of opening parentheses. This error breaks program execution.

ERROR 96 ***"SCALING OVERFLOW"*** ***SEVERITY 2***

During a conversion to or from user units, the result was greater than 2^{31} or less than -2^{31}. This error breaks program execution if the instruction is issued from the user program.

ERROR 97 ***"GEAR OVERFLOW"*** ***SEVERITY 3***

The BDS5 encountered an overflow when calculating the velocity from the external pulse input. This can be caused when the variable GEARI is too small or GEARO is too large. That is, the input times the ratio of GEARO/GEARI was greater than the highest allowable input frequency, 2 MHz. This error breaks program execution and disables the BDS5.

C.4.5 Communication Errors

ERROR 103 ***"BAUD RATE"*** ***SEVERITY 1***

The variable BAUD contains a value that is not supported by the BDS5. This error occurs during the autobaud sequence and so is never printed to the terminal. You will only see it in the error history buffer. This error has no action.

ERROR 104 ***"ABAUD & MULTIDROP"*** ***SEVERITY 1***

This error is caused by attempting to autobaud while in multidrop communications, which is not allowed. The variable ABAUD is on, indicating request for autobaud, and the variable ADDR is not zero, indicating multidrop communications. This error occurs during the autobaud sequence and so is never printed to the terminal. You will only see it in the error history buffer. This error has no action.

ERROR 105 ***"SERIAL WDOG"*** ***SEVERITY 3***

The serial port did not receive a valid command for WTIME milliseconds when the serial watchdog was enabled (that is, WATCH = 1). This error breaks program execution and disables the BDS5.

C.4.6 Password Errors

ERROR 110 ***"EDIT PASSWORD"*** ***SEVERITY 1***

You attempted to execute an instruction that requires the Editor password. This occurs with the >BDS command. In this case, you must follow the command with the password.

ERROR 111 ***"FACTORY SETTABLE"*** ***SEVERITY 2***

You attempted to change a variable that is protected. These variables are set at the factory. This error breaks program execution if the instruction is issued from the user program.

C.4.7 Errors From IF, TIL and GOSUB Commands

ERROR 115 ***"IF w/o ENDIF"*** ***SEVERITY 2***

The program executed an IF command to begin an IF BLOCK, but could not find the corresponding ENDIF to end the IF block. This error breaks program execution.

ERROR 116 ***"IF NOT STARTED"*** ***SEVERITY 2***

An ELSE, ELIF, or ENDIF was encountered when there was no IF. This will occur, among other times, if you use a GOTO to branch to the middle of an IF/ELIF/ELSE/ENDIF block. This error breaks program execution.

ERROR 117 ***"TIL FOLLOWS ?/TIL"*** ***SEVERITY 2***

The ? or TIL instruction was used to execute a conditional TIL. This error breaks program execution.

ERROR 118 ***"TOO MANY GOSUBS"*** ***SEVERITY 2***

The last GOSUB was one GOSUB too many. The BDS5 has 4 levels of subroutines. This error breaks program execution.

ERROR 119 ***"RETURN w/o GOSUB"*** ***SEVERITY 2***

The BDS5 encountered a RET when it was not expecting one. This occurs when there are more returns than GOSUBs. This error breaks program execution.

C.4.8 Power-Up Marker (Not An Error)

ERROR 199 ***"DRIVE POWERED UP"*** ***N/A***

This is not a true error. ERROR 199 is used to mark the error history buffer when the BDS5 powers-up.

C.4.9 Internal Errors

ERROR 200 ***"FOLDBACK OUT"*** ***SEVERITY 3***

The factory set variables that control foldback are out of bounds. Contact the factory. This error breaks program execution and disables the BDS5.

ERROR 201 ***"SLIP TOO BIG"*** ***SEVERITY 3***

The induction motor variables that control slip are out of bounds. Contact the factory. This error breaks program execution and disables the BDS5.

ERROR 202 ***"USER PROGRAM CORRUPT"*** ***SEVERITY 3***

The user program is corrupt. Usually, this problem is caused by installing a new battery back-up RAM. This can also occur if power to the BDS5 is lost while editing the program. This error will break program execution.

ERROR 203 ***"AMPS BAD"*** ***SEVERITY 3***

The BDS5 variable AMPS is invalid. Contact the factory. This error breaks program execution.

ERROR 204 "PROGRAM OVERRUN" SEVERITY 3

This is an internal error. Contact the factory. This error breaks program execution and disables the BDS5.

ERROR 205 "MBUF OVRRUN" SEVERITY 3

This is an internal error. Contact the factory. This error breaks program execution and disables the BDS5.

ERROR 206 "PROFILE OVERFLOW" SEVERITY 3

This is an internal error. Contact the factory. This error breaks program execution and disables the BDS5.

ERROR 208 "GENERAL INTERNAL" SEVERITY 3

This is an internal error. Carefully write down the entire line that is printed with the error and contact the factory. This error breaks program execution and disables the BDS5.

ERROR 209 "STACK OVERFLOW" SEVERITY 3

This is an internal error. Carefully write down the entire line that is printed with the error and contact the factory. This error breaks program execution and disables the BDS5.

ERROR 211-219 "INTERNAL 1-9" SEVERITY 3

These are internal errors. Contact the factory. These errors break program execution and disable the BDS5.

ERROR 255 "UNKNOWN" SEVERITY 3

This is an internal error. If this error exists in the error history upon initial power-up, clear it with ERR CLR. Contact the factory if this error occurs during operation. This error breaks program execution and disables the BDS5.

APPENDIX D

Customer Support Network

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:

Kollmorgen Customer Support Network
203 Rock Road Suite A
Radford, VA 24141
Phone: (888) 774-KCSN (5276)
Fax: (540) 639-1640 Inside Sales
Fax: (540) 639-1574 Technical Support
Email: servo@Kollmorgen.com
http://www.Kollmorgen.com

Note! 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 resent version of our product manuals

APPENDIX E

ON-LINE REFERENCE GUIDE

INTRODUCTION

A BDS5 REFERENCE GUIDE on-line Technical Manual (diskette) is included as part of this product support documentation package. This diskette presents BDS5 Reference Information in a Windows on-line Help Format. This on-line reference manual provides rapid navigation to traverse between text, tables, and graphics.

CONTENTS

The BDS5 REFERENCE GUIDE on-line Technical Manual consists of two types of information files:

1. The BDS5 REFERENCE GUIDE on-line Technical Manual filename - bds5rg.hlp.

2. DIAGRAMS (referenced in the manual):
   filenames - a-84813m.doc
   a-84846m.doc
   a-93633m.doc

This convention is employed to facilitate distribution of diagram update revisions as engineering changes are incorporated. That is, an update disk can be issued which provides the latest revision of drawings while the BDS5 REFERENCE GUIDE on-line Technical Manual remains unchanged.

HOW TO USE THIS MANUAL

1. Insert the BDS5 REFERENCE GUIDE disk into Drive A (or your designated 3.5" disk drive letter).

2. *(Optional)* Copy the files from the BDS5 REFERENCE GUIDE disk to your hard drive.

3. *(Optional)* Print (Word 6.0 Format) diagrams provided in the <filename>.doc files. This allows the diagrams to be available for reference while viewing the contents of the BDS5 REFERENCE GUIDE on-line Technical Manual without having to exit the manual to view and/or print the diagrams referenced.

4. From the File Manager, double-click on the filename bds5rg.hlp to open the BDS5 REFERENCE GUIDE on-line Technical Manual.

5. Examine, to familiarize yourself with, the contents of the BDS5 REFERENCE GUIDE on-line Technical Manual.

GLOSSARY

Absolute Position

Position referenced to a fixed zero position.

Absolute Positioning

Refers to a motion control system employing position feedback devices (absolute encoders) to maintain a given mechanical location.

Absolute Programming

A positioning coordinate reference wherein all positions are specified relative to some reference, or "home" position. This is different from incremental programming, where distances are specified relative to the current position.

AC Adjustable-Speed Drive

All equipment required to adjust the speed or torque of AC electric motor(s) by controlling both frequency and voltage applied to the motor(s).

AC Servo Drive

A servo drive used to control either or both synchronous or induction AC motors.

Acceleration

The change in velocity as a function of time. Acceleration usually refers to increasing velocity and deceleration describes decreasing velocity.

Accuracy

A measure of the difference between expected position and actual position of a motor or mechanical system. Motor accuracy is usually specified as an angle representing the maximum deviation from expected position.

Actuator

A device which creates mechanical motion by converting various forms of energy to mechanical energy.

Adaptive Control

A technique to allow the control to automatically compensate for changes in system parameters such as load variations.

Ambient Temperature

The temperature of the cooling medium, usually air, immediately surrounding the motor or another device.

Amplifier

Electronics which convert low level command signals to high power voltages and currents to operate a servomotor.

ASCII

(American Standard Code for Information Interchange) This code assigns a number to each numeral letter of the alphabet. In this manner, information can be transmitted between machines as a series of binary numbers.

Back EMF

The voltage generated when a permanent magnet motor is rotated. This voltage is proportional to motor speed and is present regardless of whether the motor winding(s) are energized or un-energized.

Bandwidth

The frequency range in which the magnitude of the system gain expressed in dB is greater than -3 dB.

Baud Rate

The number of binary bits transmitted per second on a serial communications link (such as RS-232).

Bit (Binary Digit)

A unit of information equal to 1 binary decision or having only a value 0 or 1.

Block Diagram

A simplified schematic representing components and signal flow through a system.

Bode Plot

A plot of the magnitude of system gain in dB and the phase of system gain in degrees versus the sinusoidal input signal frequency in logarithmic scale.

Brownout

Low-line voltage at which the device no longer functions properly.

Brush

Conducting material which passes current from the DC motor terminals to the rotating commutator.

Brushless Servo Drive

A servo drive used to control a permanent magnet synchronous AC motor. May also be referred to as an AC Servo Drive.

Bus

A group of parallel connections carrying pre-assigned digital signals. Buses usually consist of address and data information and miscellaneous control signals for the interconnection of microprocessors, memories, and other computing elements.

Byte

A group of 8 bits treated as a whole with 256 possible combinations of ones and zeros, each combination representing a unique piece of information.

CAM Profile

A technique used to perform nonlinear motion electronically similar to that achieved with mechanical cams.

Characteristic Equation

1+GH = 0, where G is the transfer function of the forward signal path and H is the transfer function of the feedback signal path.

Circular Coordinated Move

A coordinated move where the path between endpoints is the arc of a circle.

Class B Insulation

A NEMA insulation specification. Class B insulation is rated to an operating temperature of 130 degrees centigrade.

Class H Insulation

A NEMA insulation specification. Class H insulation is rated to an operating temperature of 180 degrees centigrade.

Closed Loop

A broadly applied term relating to any system where the output is measured and compared to the input. The output is then adjusted to reach the desired condition. In motion control, the term is used to describe a system wherein a velocity or position (or both) transducer is used to generate correction signals by comparison to desired parameters.

Cogging

A term used to describe non-uniform angular velocity. Cogging appears as a jerkiness especially at low speeds.

Command Position

The desired angular or linear position of an actuator.

Commutation

A term which refers to the action of steering currents or voltage to the proper motor phases so as to produce optimum motor torque. In brush type motors, commutation is done electromechanically via the brushes and commutator. In brushless motors, commutation is done by the switching electronics using rotor position information typically obtained by hall sensors, a tachsyn, a resolver or an encoder.

Commutator

A mechanical cylinder consisting of alternating segments of conductive and insulating material. This cylinder used in DC motors passes currents from the brushes into the rotor windings and performs motor commutation as the motor rotates.

Compensation

The corrective or control action in a feedback loop system which is used to improve system performance characteristics such as accuracy and response time.

Compensation, Feedforward

A control action which depends on the command only and not the error to improve system response time.

Compensation, Integral

A control action which is proportional to the integral or accumulative time error value product of the feedback loop error signal. It is usually used to reduce static error.

Compensation, Lag

A control action which causes the lag at low frequencies and tends to increase the delay between the input and output of a system while decreasing static error.

Compensation, Lead

A control action which causes the phase to lead at high frequencies and tends to decrease the delay between the input and output of a system.

Compensation, Lead Lag

A control action which combines the characteristics of lead and lag compensations.

Compensation, Proportional

A control action which is directly proportional to the error signal of a feedback loop. It is used to improve system accuracy and response time.

Compliance

The amount of displacement per unit of applied force.

Computer Numerical Control

A computer-based motion control device programmable in a numerical word address format. A computer numerical control (CNC) product typically includes a CPU section, operator interface devices, input/output signal and data devices, software and related peripheral apparatus.

Control Systems or Automatic Control Systems

An engineering or scientific field that deals with controlling or determining the performance of dynamic systems such as servo systems.

Coordinated Motion

Multi-axis motion where the position of each axis is dependent on the other axis such that the path and velocity of a move can be accurately controlled. (Requires coordination between axes.)

Coupling Ratio

The ratio of motor velocity to load velocity for a load coupled to motor through a gear or similar mechanical device.

Critical Damping

A system is critically damped when the response to a step change in desired velocity or position is achieved in the minimum possible time with little or no overshoot.

Daisy Chain

A term used to describe the linking of several RS232C devices in sequence such that a single data stream flows through one device and on to the next. Daisy-chained devices usually are distinguished by device addresses which serve to indicate the desired destination for data in the stream.

Damping

An indication of the rate of decay of a signal to its steady state value. Related to setting time.

Damping Ratio

Ratio of actual damping to critical damping. Less than one is an underdamped system and greater than one is an overdamped system.

DC Adjustable-Speed Drive

All equipment required to adjust the speed or torque of DC motor(s) by controlling the voltages applied to the armature and/or field of the motors.

DC Drive

An electronic control unit for running DC motors. The DC drive converts AC line current to a variable DC current to control a DC motor. The DC drive has a signal input that controls the torque and speed of the motor.

Dead Band

A range of input signals for which there is no system response.

Decibel (dB)

A logarithmic measurement of gain. If G is a systems gain (ratio of output to input) then 20 log G = gain in decibels (dB).

Demag Current

The current level at which the motor magnets will be demagnetized. This is an irreversible effect which will alter the motor characteristics and degrade performance.

Detent Torque

The maximum torque that can be applied to an un-energized stepping motor without causing continuous rotating motion.

Dielectric Test

A high voltage breakdown test of insulation's ability to withstand an AC voltage. Test criterion limits the leakage current to a specified magnitude and frequency, applied between the specified test points.

Differential

An electrical input or output signal which uses two lines of opposite polarity referenced to the local signal ground.

Distributed Processing

A technique to gain increased performance and modularity in control systems utilizing multiple computers or processors.

DNC, Direct Numerical Control

Technique of transferring part program data to a numerical control system via direct electrical connection in place of paper tapes.

Drive

This is the electronics portion of the system that controls power to the motor.

Drive, Analog

Usually referring to any type of motor drive in which the input is an analog signal.

Drive, Digital

Usually referring to any type of motor drive in which the tuning or compensation is done digitally. Input may be an analog or digital signal.

Drive, Linear

A motor drive in which the output is directly proportional to either a voltage or current input. Normally both inputs and outputs are analog signals. This is a relatively inefficient drive type.

Drive, PWM

A motor drive utilizing Pulse-Width Modulation techniques to control power to the motor. Typically a high efficiency drive that can be used for high response application.

Drive, SCR

A DC motor drive which utilizes internal silicon controlled rectifiers as the power control elements. Usually used for low bandwidths, high power applications.

Drive, Servo

A motor drive which utilizes internal feedback loops for accurate control of motor current and/or velocity.

Drive, Stepper

Electronics which convert step and direction inputs to high power currents and voltages to drive a stepping motor. The stepping motor driver is analogous to the servo motor amplifier.

Duty Cycle

For a repetitive cycle, the ratio of an on time to total cycle time.

$$\text{Duty Cycle} = \frac{(\text{On Time})}{(\text{On Time} + \text{Off Time})} \times 100\%$$

Dynamic Braking

A passive technique for stopping a permanent magnet brush or brushless motor. The motor windings are shorted together through a resistor which results in motor braking with an exponential decrease in speed.

Efficiency

The ratio of power output to power input.

Electrical Time Constant

The ratio of armature inductance to armature resistance.

Electronic Gearing

A technique used to electrically simulate mechanical gearing. Causes one closed loop axis to be slaved to another open or closed loop axis with a variable ratio.

EMI: Electro-Magnetic Interference

EMI is noise which, when coupled into sensitive electronic circuits, may cause problems.

Encoder

A type of feedback device which converts mechanical motion into electrical signals to indicate actuator position. Typical encoders are designed with a printed disc and a light source. As the disc turns with the actuator shaft, the light source shines through the printed pattern onto a sensor. The light transmission is interrupted by the patterns on the disc. These interruptions are sensed and converted to electrical pulses. By counting these pulses, actuator shaft position is determined.

Encoder, Absolute

A digital position transducer in which the output is representative of the absolute position of the input shaft within one (or more) revolutions. Output is usually a parallel digital word.

Encoder, Incremental

A position encoding device in which the output represents incremental changes in position.

Encoder, Linear

A digital position transducer which directly measures linear position.

Encoder Marker

A ounce-per-revolution signal provided by some incremental encoders to specify a reference point within that revolution. Also known as Zero Reference signal or index pulse.

Encoder Resolution

A measure of the smallest positional change which can be detected by the encoder.

Explosion-proof

A motor classification that indicates a motor is capable of withstanding internal explosions without bursting or allowing ignition to reach beyond the confines of the motor frame.

Fall Time

The time for the amplitude of system response to decay to 37% of its steady-state value after the removal of a steady-state step input signal.

Feed Forward

A technique used to pre-compensate control a loop for known errors due to motor, drive, or lead characteristics. Provides improved response.

Feedback

A signal which is transferred from the output back to the input for use in a closed loop system.

Field Weakening

A method of increasing the speed of a wound field DC motor; reducing stator magnetic field instantly by reducing magnet winding current.

Filter (Control Systems)

A transfer function used to modify the frequency or time response of a control system.

Flutter

Flutter is an error of the basic cycle of an encoder per one revolution.

Following Error

The positional error during motion resulting from use of a position control loop with proportional gain only.

Form Factor

The ratio of RMS current to average current. This number is a measure of the current ripple in a PWM or other switch mode type of controller. Since motor heating is a function of RMS current while motor torque is a function of average current, a form factor greater than 1.00 means some fraction of motor current is producing heat but not torque.

Four Quadrant

Refers to a motion system which can operate in all four quadrants i.e. velocity in either direction and torque in either direction. This means that the motor can accelerate, run, and decelerate in either direction.

Friction

A resistance to motion caused by surfaces rubbing together. Friction can be constant with varying speed (coulomb friction) or proportional to speed (viscous friction) or present at rest (static friction).

Full Load Current

The armature current of a motor operated at its full load torque and speed with rated voltage applied.

Full Load Speed

The speed of a motor operated with rated voltage and full load torque.

Gain

The ratio of system output signal to system input signal.

Hall Sensors

A feedback device which is used in a brushless servo system to provide information for the amplifier to electronically commutate the motor. The device uses a magnetized wheel and hall-effect sensors to generate the commutation signals.

Holding Torque

Sometimes called torque, it specifies the maximum external force or torque that can be applied to a stopped, energized motor without causing the rotor to rotate continuously.

Home Position

A reference position for all absolute positioning movements. Usually defined by a home limit switch and/or encoder marker. Normally set at power up and retained for as long as the control system is operational.

Host Computer

An auxiliary computer system which is connected to a controller or controllers. The host computer in distributed control systems is frequently involved with controlling many remote and distributed motion control devices. It may also be used for off-line tasks such as program preparation, storage, and supervisory control and evaluation.

HP: Horsepower

One horsepower is equal to 746 watts. Since Power = Torque x Speed, horsepower is a measure of a motor's torque and speed capability (e.g. a 1 HP motor will produce 35 lb.-in. at 1800 rpm).

Hunting

The oscillation of the system response about a theoretical steady-state value.

Hybrid Stepping Motor

A motor designed to move in discrete increments or steps. The motor has a permanent magnet rotor and wound stator. These motors are brushless and phase currents are commutated as a function of time to produce motion.

Hysteresis

The difference in response of a system to an increasing or a decreasing input signal.

I/O: Input/Output

The reception and transmission of information between control devices. In modern control systems, I/O has two distinct forms: switches, relays, etc., which are in either an on or off state, or analog signals that are continuous in nature such as speed, temperature, flow, etc.

Idle Current Reduction

A stepping motor driver feature that reduces the phase current to the motor when no motor motion (idle) is commanded for a specified period of time. This reduces motor heating and allows high machine throughput to be obtained from a given motor.

Incremental Motion

A motion control term that is used to describe a device that produces one step of motion for each step command (usually a pulse) received.

Indexer

Electronics which convert high level motion commands from a host computer, programmable controller, or operator panel into step direction pulse streams for use by the stepping motor driver.

Inertia

The property of an object to resist changes in velocity unless acted upon by an outside force. Higher inertia objects require larger torques to accelerate and decelerate. Inertia is dependent upon the mass and shape of the object.

Inertial Match

An inertial match between motor and load is obtained by selecting the coupling ratio such that the load moment of inertia referred to the motor shaft is equal to the motor moment of inertia.

Inrush Current

The current surge generated when a piece of equipment such as a servoamplifier is connected to an AC line. This surge is typically due to the impulse charging of a large capacitor located in the equipment.

Instability

Undesirable motion of an actuator that is different from the command motion. Instability can take the form of irregular speed or hunting of the final rest position.

Lead Ball Screw

A lead screw which has its threads formed as a ball bearing race; the carriage contains a circulating supply of balls for increased efficiency.

Lead Screw

A device for translating rotary motion into linear motion, consisting of an externally threaded screw and an internally threaded carriage (nut).

Least Significant Bit

The bit in a binary number that is the least important, or having the least weight.

Limits

Properly designed motion control systems have sensors called limits that alert the control electronics that the physical end of travel is being approached and that motion should stop.

Linear Coordinated Move

A coordinated move where the path between endpoints is a line.

Linearity

For a speed control system it is the maximum deviation between actual and set speed expressed as a percentage of set speed.

Logic Ground

An electrical potential to which all control signals in a particular system are referenced.

Loop, Feedback Control

A control method that compares the input from a measurement device, such as an encoder or tachometer, to a desired parameter, such as a position or velocity and causes action to correct any detected error. Several types of loops can be used in combination (i.e. velocity and position together) for high performance requirements.

Loop Gain, Open

The product of the forward path and feedback path gains.

Loop, PID: Proportional, Integral, and Derivative Loop

Specialized very high performance control loop which gives superior response.

Loop, Position

A feedback control loop in which the controlled parameter is motor position.

Loop, Velocity

A feedback control loop in which the controlled parameter is mechanical velocity.

Master Slave Motion Control

A type of coordinated motion control where the master axis position is used to generate one or more slave axis position commands.

Mechanical Time Constant

The time for an unloaded motor to reach 63.2% of its final velocity after the application of a DC armature voltage.

Microstepping

An electronic control technique that proportions the current in a step motor's windings to provide additional intermediate positions between poles. Produces smooth rotation over a wide speed range and high positional resolution.

Mid-Range Instability

A phenomenon in which a stepping motor can fall out of synchronism due to loss of torque at mid-range speeds. The loss of torque is due to interaction between the motor's electrical characteristics and the driver electronics. Some drivers have circuitry to eliminate or reduce this phenomenon.

Most Significant Bit

The bit in a binary number that is the most important or that has the most weight.

Motor, AC

A device that converts electrical alternating current into mechanical energy. Requires no commutation devices such as brushes. Normally operated off commercial AC power. Can be single- or multiple-phase.

Motor, AC Asynchronous or Induction

An AC motor in which speed is proportional to the frequency of the applied AC. Requires no magnets or field coil. Usually used for non-precise constant speed applications.

Motor, AC Synchronous

Another term for brushless DC motor.

Motor Constant

The ratio of the motor torque to motor input power.

Motor, DC

A device that converts electrical direct current into mechanical energy. It requires a commutating device, either brushes or electronic. Usually requires a source of DC power.

Motor, DC Brushless

A type of direct current motor that utilizes electronic commutation rather than brushes to transfer current.

Motor, DC Permanent Magnet

A motor utilizing permanent magnets to produce a magnetic field. Has linear torque speed characteristics.

Motor, DC Wound Field

A direct current utilizing a coil to produce a magnetic field. Usually used in high power applications where constant horsepower operation is desired.

Motor, Stepping

A specialized AC motor that allows discrete positioning without feedback. Normally used for non-critical, low power applications, since positional information is easily lost if acceleration or velocity limits are exceeded. Load variations can also cause loss of position. If encoders are used, these limitations can be overcome.

NC, Numerical Control

Usually refers to any type of automated equipment or process used for contouring or positioning.

Negative Feedback

The type of feedbacks used in a closed loop system where the output value is inverted and combined with the input to be used to stabilize or improve system characteristics.

No Load Speed

Motor speed with no external load.

Open Collector

A term used to describe a signal output that is performed with a transistor. An open collector output acts like a switch closure with one end of the switch at ground potential and the other end of the switch accessible.

Open-Loop System

A system where the command signal results in actuator movement but, because the movement is not sensed, there is no way to correct for error. Open loop means no feedback.

Operator Interface

A device that allows the operator to communicate with a machine. This device typically has a keyboard or thumbwheel to enter instructions into the machine. It also has a display device that allows the machine to display messages.

Optically Isolated

A system or circuit that transmits signals with no direct electrical connection. Used to protectively isolate electrically noisy machine signals from low level control logic.

Oscillation

An effect that varies periodically between two values.

Overshoot

The amount of the parameter being controlled exceeds the desired value for a step input.

Phase-Locked Servo System

A hybrid control system in which the output of an optical tachometer is compared to a reference square wave signal to generate a system error signal proportional to both shaft velocity and position errors.

Phase Margin

The difference between 180 degrees and the phase angle of a system at the frequency where the open loop gain is unity.

PID

Proportional-Integral-Derivative. An acronym that describes the compensation structure that can be used in a closed-loop system.

PLC

Programmable Logic Controller. An industrial control device that turns on and off outputs based upon responses to inputs.

PMDC Motor

A motor consisting of a permanent magnet stator and a wound iron-core rotor. These are brush type motors and are operated by application of DC current.

Point to Point Move

A multi-axis move from one point to another where each axis is controlled independently. (No coordination between axes is required.)

Pole

A frequency at which the transfer function of a system goes to infinity.

Pole Pair, Electromechanical

The number of cycles of magnetic flux distribution in the air gap of a rotary electromechanical device.

Position Error

The difference between the present actuator (feedback) value and the desired position command for a position loop.

Position Feedback

Present actuator position as measured by a position transducer.

Power

The rate at which work is done. In motion control, Power = Torque x Speed.

Process Control

A term used to describe the control of machine or manufacturing processes, especially in continuous production environments.

Pull-In Torque

The maximum torque at which an energized stepping motor or synchronous motor will start and run in synchronism.

Pull-Out Torque

The maximum torque that can be applied to a stepping motor or synchronous motor running at constant speed without causing a loss of synchronism.

Pulse Rate

The frequency of the step pulses applied to a stepper motor driver. The pulse rate divided by the resolution of the motor/drive combination (in steps per revolution) yields the rotational speed in revolutions per second.

PWM

Pulse Width Modulation. An acronym which describes a switch-mode control technique used in amplifiers and drivers to control motor voltage and current. This control technique is used in contrast to linear control and offers the advantages of greatly improved efficiency.

Quadrature

Refers to signal characteristics of interfaces to positioning devices such as encoders or resolvers. Specifically, that property of position

Ramping

The acceleration and deceleration of a motor. May also refer to the change in frequency of the applied step pulse train.

Rated Torque

The torque producing capacity of a motor at a given speed. This is the maximum continuous torque the motor can deliver to a load and is usually specified with a torque/speed curve.

Regeneration

The action during motor braking, in which the motor acts as a generator and takes kinetic energy from the load, converts it to electrical energy, and returns it to the amplifier.

Repeatability

The degree to which the positioning accuracy for a given move performed repetitively can be duplicated.

Resolution

The smallest positioning increment that can be achieved. Frequently defined as the number of steps or feedback units required for a motor's shaft to rotate one complete revolution.

Resolver

A position transducer utilizing magnetic coupling to measure absolute shaft position over one revolution.

Resonance

The effect of a periodic driving force that causes large amplitude increases at a particular frequency. (Resonance frequency.)

RFI

Radio Frequency Interference.

Ringing

Oscillation of a system following sudden change in state.

Rise Time

The time required for a signal to rise from 10% of its final value to 90% of its final value.

RMS Current

Root mean square current. In an intermittent duty cycle application, the RMS current is equal to the value of steady state current which would produce the equivalent resistive heating over a long period of time.

RMS Torque

Root Mean Square Torque. For an intermittent duty cycle application, the RMS torque is equal to the steady state torque which would produce the same amount of motor heating over long periods of time.

Robot

A reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

Robot Control

A computer-based motion control device to control the servo-axis motion of a robot.

Rotor

The rotating part of a magnetic structure. In a motor, the rotor is connected to the motor shaft.

Serial Port

A digital data communications port configured with a minimum number of signal lines. This is achieved by passing binary information signals as a time series of "1"s and "0"s on a single line.

Servo Amplifier/Servo Drive

An electronic device which produces the winding current for a servo motor. The amplifier converts a low level control signal into high voltage and current levels top produce torque in the motor.

Servo System

An automatic feedback control system for mechanical motion in which the controlled or output quantity is position, velocity, or acceleration. Servo systems are closed loop systems.

Settling Time

The time required for a step response of a system parameter to stop oscillating or ringing and reach its final value.

Shunt Resistor

A device located in a servoamplifier for controlling regenerative energy generated when braking a motor. This device dissipates or "dumps" the kinetic energy as heat.

Single Point Ground

The common connection point for signal grounds in a control wiring environment.

Slew

In motion control the portion of a move made at a constant non-zero velocity.

Slew Speed

The maximum velocity at which an encoder will be required to perform.

Speed

In motion control, the concept used to describe the linear or rotational velocity of a motor or other object in motion.

Speed Regulation

For a speed control system, speed regulation is the variation in actual speed expressed as a percentage of set speed.

SPS

Steps-Per-Second. A measure of velocity used with stepping motors.

Stall Torque

The torque available from a motor at stall or zero rpm.

Static Torque

The angle the shaft rotates upon receipt of a single step command.

Stator

The non-rotating part of a magnetic structure. In a motor the stator usually contains the mounting surface, bearings, and non-rotating windings or permanent magnets.

Stiffness

The ability to resist movement induced by an applied torque. It is often specified as a displacement curve, indicating the amount a motor shaft will rotate upon application of a known external force when stopped.

Synchronism

A motor rotating at a speed correctly corresponding to the applied step pulse frequency is said to be in synchronism. Load torques in excess of the motor's capacity (rated torque) will cause a loss of synchronism.

Tachometer

An electromagnetic feedback transducer which produces an analog voltage signal proportional to rotational velocity. Tachometers can be either brush or brushless.

Tachsyn

A brushless, electromagnetic feedback transducer which produces an analog velocity feedback signal and commutation signals for a brushless servo motor. The tachsyn is functionally equivalent to hall sensors and a tachometer.

Torque

The rotary equivalent to force. Equal to the product of the force perpendicular to the radius of motion and distance from the center of rotation to the point where the force is applied.

Torque Constant

A number representing the relationship between motor input current and motor output torque. Typically expressed in units of torque/amp.

Torque Ripple

The cyclical variation of generated torque given by the product of motor angular velocity and number of commutator segments.

Torque-to-Inertia Ratio

Defined as a motor's torque divided by the inertia of its rotor, the higher the ratio the higher the acceleration will be.

Transducer

Any device that translates a physical parameter into an electrical parameter. Tachometers and encoders are examples of transducers.

Transfer Function

The ratio of the Laplace transforms of system output signal and system input signal.

Trapezoidal Profile

A motion profile in which the velocity vs. time profile resembles a trapezoid. Characterized by constant acceleration, constant velocity, and constant deceleration.

TTL

Transistor-Transistor Logic.

Variable Frequency Drive

An electronic device used to control the speed of a standard AC induction motor. The device controls the speed by varying the frequency of the winding current used to drive the motor.

Vector Control

A method of obtaining servo type performance from an AC motor by controlling two components of motor current.

Velocity

The change in position as a function of time. Velocity has both a magnitude and a direction.

Voltage Constant (or Back EMF Constant)

A number representing the relationship between Back EMF voltage and angular velocity. Typically expressed as V/Krpm.

Zero

A frequency at which the transfer function of a system goes to zero.

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