03730

Linear Servo Amplifier

User Manual

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REQUESTING ASSISTANCE

If you have any difficulties with the 03730, please let us know by calling us at (408) 778-1127, Writing to us at the address shown on the cover, or emailing us at "info@seagullsolutions.net". When reporting a problem, Please have the serial number of your unit available and have a record of all circumstances and symptoms.

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TRADEMARKS

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Table of Contents

About This Manual

This manual is divided into the following sections:

SECTION 1 - GENERAL INFORMATION

> Contains a brief overview of the B3730, its operating modes, and features.

SECTION 2 - SPECIFICATIONS

> Includes the power and operating specifications for all modules.

SECTION 3 - INSTALLATION

> Provides information on installing the B3730 and basic checkout information.

SECTION 4 - OPERATION

> Details the various modes of operation by describing operating modes, front panel controls, rear panel connections, and software commands.

SECTION 5 - COMMAND SET

> Contains a complete list of the B3730's command set.

Manual Conventions

!! DANGER !!   Statement identifies any action or condition that could cause life-threatening harm.

!! WARNING !!   Statement identifies a condition or procedure that could result in personal injury.

!! CAUTION !!   Statement identifies a condition or procedure that could damage the equipment or result in data loss.

NOTE   Statement identifies helpful or useful information.

"XXXX"   Statement references a B3730 command, where **XXXX** is the command.

Safety Cautions

These safety notices should be read and complied with while operating or repairing this equipment. Failure to do so could result in damage to the equipment or result in personal injury or death.

GROUNDING

The B3730 is internally grounded through the power cord to Earth Ground. However, any spindle connected to the Linear Amplifier must also be grounded.

If this equipment is field installed, the installation instructions must be followed. Use the power cords and cables provided with the equipment; unauthorized substitutions may violate the safety of the equipment.

ENVIRONMENTAL

The Linear Amplifier must not be operated in the presence of flammable gases or fumes.

ELECTRICAL

Operating personnel must not remove equipment shields and covers. Replacement of assemblies or components and internal adjustments must be made by qualified personnel. Do not replace assemblies or components with AC or DC power applied.

SERVICE

Internal service on this equipment should not be performed alone. Another person capable of rendering first aid or of calling assistance should be present.

!! DANGER !!

VOLTAGES CAPABLE OF CAUSING DEATH OR SERIOUS INJURIES ARE PRESENT IN THIS EQUIPMENT AND AT THE MOTOR SUPPLY TERMINALS. USE EXTREME CAUTION WHEN SERVICING OR PERFORMING INTERNAL ADJUSTMENTS.

Section 1	General Information

1.1   GENERAL

This manual describes the B3730 Linear Amplifier and its operation. The B3730 is made up of four subassemblies:
- Front Panel Assembly
- Power Amplifier Assembly
- Pneumatics Assembly
- Main Electronics Assembly

1.2   INTRODUCTION

The B3730 Linear Servo Amplifier is an intelligent brushless DC spindle motor controller specifically designed for the Seagull® product line of Solutions air and ball bearing spindles. The B3730 is designed to provide reliable speed control, packaged for 19-inch rack mounting, and designed to enhance the testing capabilities for any media tester. It provides extremely accurate spindle speed control, a wide range of operating speeds, and low electrical noise operation.

Operation of the B3730 can be controlled by a host computer via a GPIB or a RS-232 communication interface (Factory Option). If a host computer is not available or necessary, the B3730 can be completely controlled by its front panel controls without any degradation of its performance. The B3730 contains the intelligence to monitor and control all functions related to spindle motor control once the parameters have been downloaded or input, and a run command initiated.

1.3   OVERVIEW

Ultimate speed control accuracy is one of the primary design goals, and is addressed by allowing customer-specific frequency inputs to be supplied to the B3730 via the rear panel connectors. Accuracy of one part per million is achievable with a stable frequency reference and a stable encoder feedback frequency.

1.4   STANDARD FEATURES

The B3730 Linear Servo Amplifier has the following features:

- Specifically designed and packaged for Seagull® spindles
- Speed stability of .001% of commanded RPM (stock configuration)
  Speed stability of .0001% achievable with system-spindle matching
- Internal and external RPM control
- Spin-up and Spin-down rate of 10-10000 RPM/sec^2 (dependent on loads)
- Three-phase sin wave motor drive
- Amplifier over-temperature shutdown
- Power loss controlled motor shutdown
- System isolated AC and DC power sources
- Operating Range of 0 to 18000 RPM
- GPIB or RS-232 communications to host computer
- Integral Pneumatics with auto-shutdown interlock

1.5   SUB-ASSEMBLIES

There are four sub-assemblies in the B3730. They are:
- Front Panel Assembly
- Power Amplifier Assembly
- Pneumatics Assembly
- Main Electronics Assembly

1.5.1 FRONT PANEL ASSEMBLY

Located on the front panel assembly is the LCD display controlled by the front panel
CPU. The front panel assembly contains all the intelligence for the B3730 to operate in
Local Mode. The front panel parses the GPIB communication and feeds it to the Main
Electronics Assembly, where the Motor Controller CPU performs the task. On the front
panel are the push button switches that allow the user to enter the values for speed and
acceleration/deceleration settings, Run/Stop, Clamp/Unclamp, CCW/CW, and
Local/Remote.

1.5.2 POWER AMPLIFIER ASSEMBLY

The power amplifier assembly supplies the power to the spindle motor. It takes a signal from the Main Electronics assembly and amplifiies it to the needed power to drive the spindle as commanded by either the front panel or the host computer.

1.5.3 PNEUMATICS ASSEMBLY

The pneumatics assembly feeds air to the spindle, and the clamp and spindle brake. Air for the Seagull® air bearing spindle is monitored via pressure sensing switches, and controlled via air regulators in this assembly.

1.5.4 MAIN ELECTRONICS ASSEMBLY

All motor controller intelligence is contained within this assembly. It communicates with an internal supervising CPU, generates a speed control signal based on the commanded speed in Local or Remote Mode, and controls spindle motor phase generation based on the spindle encoder signals.

Control and monitoring of the spindle's clamp and brake are done within this assembly. During operation, spindle Velocity Error and Tachometer values are monitored to determine when the spindle is at speed and stabilized. RPM is monitored using the spindle's commutation encoder outputs.

1.6 OPERATING MODES

The B3730 Linear Servo Amplifier has two major modes of operation: Local and Remote. Local Mode is usually used for maintenance, adjustments, and troubleshooting. Remote Mode is the normal operating mode when controlled by a host computer.

1.6.1 LOCAL MODE

Local Mode enables the user to operate the controller from the front panel. The spindle can be run in either the clockwise or counterclockwise direction; however, the spindle must be stopped before a direction change is recognized. The disk clamp can also be operated while in Local Mode, however, safety rules cannot be violated. A disk must be clamped before the spindle is allowed to rotate. If the Clamp/Unclamp function is selected while the spindle is rotating, the command will be ignored.

1.6.2 REMOTE MODE

Remote Mode is used when the B3730 is under the direction of a host computer. Parameters such as spindle RPM, direction, disk clamping, and run/stop commands are sent to the B3730 from a host computer via a GPIB or RS-232 communication interface. The B3730 ensures that all commands are correctly sequenced, safety requires that the clamp is in the clamped position before the spindle is allowed to rotate.

Regardless of the origination of the commands, the B3730 does not allow safe operation to be overridden. Safety checks ensure that the spindle's air bearing has sufficient air, that main line pressure is within the recommended range, and that the clamp has the minimum air pressure to unclamp the disk.

1.7   SOFTWARE

Software is required for each of the B3730's CPU's to operate. The operating program is resident in each CPU's EPROM when shipped from the factory. The software revision level can be verified by issuing the **"ID?"** command from the GPIB/RS-232 communication interface.

1.8   DIAGNOSTICS

The B3730's Front Panel CPU has built-in diagnostics that automatically perform system checks during power up.

Section 2	Specifications

2.1   GENERAL

Contained within this section are specifications for the B3730. Specifications included are power requirements and physical dimensions.

2.2   SYSTEM REQUIREMENTS

The B3730 requires the following AC input:

AC INPUT POWER REQUIREMENTS (FACTORY SET)			
Voltage	Frequency	Current	Fuse(5mmx20mm)
100 VAC	50 Hz	4.8 A	5 A Slo-Blo
120 VAC	50/60 Hz	4 A	5 A Slo-Blo
220 VAC	50/60 Hz	2.2 A	3 A Slo-Blo

NOTE The appropriate fuse must be installed for the AC power input.

MAXIMUM OUTPUT POWER	
Amperage	Wattage
10 Amps DC (Peak)	720 Watts

AIR SUPPLY REQUIREMENTS			
Input Air Line	Air Supply Input	Air Supply Dew Pt.	Filtration
1/4 Inch NPT Fitting	120 psi Max.	35° F (non-condensing)	5 micron

2.3   MACHINE PARAMETERS

PHYSICAL DIMENSIONS			
Height	Width	Depth	Weight
7 inches	17 inches	15.5 inches	36 pounds

MOTOR CONTROL SPECIFICATIONS

Speed Stability of .001% or better over full range (stock configuration)
.0001% or better over full range (custom factory component matching)
Programmable from 10 to 18000 RPM
Encoder Commutation
Local or Remote Operation
GPIB or RS-232 Communication Link (Factory Option)
Greater than -65 dB signal-to-noise ratio
Spin-Up and Spin-Down rates of 10-10000 RPM/sec^2 (Dependent on loads)

2.4   SAFETY FEATURES

Input air pressure switches (main air supply)
Spindle bearing pressure switches
Amplifier over-temperature interlock
Electronic spindle position locking

2.5   COMMUNICATIONS

GPIB Communications meeting the IEEE-488.2 standard are allowed for the GPIB
model.

RS-232C Communications (3-wire; Tx, Rx, Gnd) are allowed for the RS-232 model.
9600 BAUD, No parity, 8 Data bits, 1 Stop bit.
(N-8-1)

TX from host
computer on pin 3.

RX from host computer on pin 2.
GND from host computer on pin 5.

2.6   ENVIRONMENTAL   REQUIREMENTS

Operating Temperature: 73°F ± 10°F
Storage Temperature: -20°F to   120°F
Operating Humidity: 90% RH   Maximum
(noncondensing)
Storage Humidity: 0% to 90% RH   Maximum
(noncondensing)

Section 3   Installation

This section describes how to install   a B3730 Linear Servo
Amplifier and how to verify its   operation.

DISCLAIMER
This installation section is not a
procedure. Considerable
of personnel installing the
suggested that the installer be
have experience with similar test
any questions regarding
Seagull Solutions's Field Services
installation.

step-by-step installation
experience is required
equipment. It is
trained on the B3730 or
equipment. If there are
installation, please call
before beginning

Each assembly of the B3730 is   subjected to extensive
testing to ensure correct operation   and to ensure proper
installation. Should assistance be   required, please use the
following address and telephone   numbers for installation
and service assistance:

SEAGULL SOLUTIONS, INC.

Field Services Division
15105 Concord Circle
Morgan Hill, California 95037
Phone: (408) 778-1127
Fax: (408) 779-2806

3.2   INSPECTION

When this equipment is first received, thoroughly inspect the shipping container for any damage. If the container is damaged and it is apparent that the damage was incurred during shipping, notify the carrier **at once**. After unpacking the equipment, inspect for any obvious physical damage such as scratches, nicks, and dents.

Remove the packing list from the container and verify that all listed materials were received. Should a discrepancy be detected, contact Seagull's Field Services Division immediately.

3.3   RACK INSTALLATION

The B3730 installs in a standard 7-inch high rack slot. The unit's fan input vents and amplifier exhaust must be free of any obstructions, allowing air to flow through and around the unit, preventing overheating. Select a site that is free of excessive dust, vibration, condensation, and flammable materials. The ambient temperature should be within the ranges specified in the Specifications section (Section 2).

3.4   AIR CONNECTIONS

Connect clean, dry air to the "Air In" connection on the rear panel of the B3730.

!! CAUTION !!

Plant air must be conditioned, dehumidified, and filtered to prevent condensation at operating temperatures. Dew point of the supplied air must be less than 35° F. Input air pressure must not exceed 120 psi.

3.5   ELECTRICAL CONNECTIONS

AC power to the B3730 is determined by the factory. The AC power cable must have a ground wire and must connect the B3730 to the plant AC ground. Before connecting the AC power cable to the B3730, ensure that the power switch on the front panel is off.

NOTE

If intending to use the B3730 with any spindle other than the one supplied by Seagull Solutions, please   contact the Field Services Division before operating the B3730.

3.6   SPINDLE CONNECTIONS

Any spindle assembly supplied with the B3730 is correctly pre-wired. It should only be necessary to connect it using the supplied cables to place the system into operation. Contact Seagull's Field Services Division before using any spindle not supplied by Seagull.
A spindle contains not only the air bearing, but also a brushless DC motor and a commutation encoder. The motor and encoder are connected to the B3730 using appropriate cables.

1. Connect the spindle's air connector to the "Spindle Air" connector located on the rear panel of the B3730.
2. Connect the spindle's motor cable to the "Motor" connector located on the rear panel of the B3730.
3. Plug in the encoder from the spindle to the "Encoder" connector located on the rear panel of the B3730.

3.7   APPLYING POWER

Before AC power is connected to the B3730's input receptacle, ensure that the AC power switch on the front panel is **OFF.**

3.8   INITIAL CHECKOUT

This brief checkout only addresses Local Mode operation; Remote Mode operation is determined by the Host Computer. Refer to Section 5 for a list and description of the B3730's command set.

1. Turn on the B3730's AC power switch.
2. Press the ENTER button to begin local operation.
3. Press the MENU button to set the speed and acceleration. Use the "up" and "down" arrows to change the value in the selected field. Press the enter button to move to the next field.
4. Press the MENU button to return to the main display.
5. The cursor should be blinking on the "Enable" status field. Press the "Enter" button to toggle Run/Stop. After about 3 seconds, the spindle will appear to "jerk"; spin up to 1000 RPM; stop; then spin to the commanded speed. *This only occurs the first time the spindle is run after power up.*

6. Press the "Enter" button to stop the spindle.
7. Use the "up" and "down" arrow button to select the clamp function.
8. Press the "Enter" button to toggle the state of the clamp.
9. Use the "up" and "down" arrow button to select the brake function.
10. Press the "Enter" button to toggle the state of the brake.

Section 4	Operation

4.1   GENERAL

Contained within this section are instructions for operating the B3730, an explanation of its modes and sub-modes of operation, and an explanation of the safety interlocks. This section of the manual explains basic motor controller operation; other sections of this manual should be read to understand the how and why of operation.

NOTE
Should any of the B3730's assemblies not operate as stated, call Seagull Solutions's Field Services Division.

4.2   POWER-UP SEQUENCE

Startup Sequence for the B3730 requires two steps:
1. Applying Air.
2. Applying Power.

4.2.1   APPLYING AIR

Before proceeding, ensure that the following air gauges display the proper pressure levels necessary for safe air bearing operation. Actual values may vary based on the spindle used with the B3730. The front panel displays four air gauges.

!! CAUTION !!
Damage to the spindle can occur if the spindle is operated without minimum air requirements.

Assuming that all connections have been made as indicated in Section 3 (Installation) of this manual, the B3730 can now be safely operated.

4.2.2 APPLYING POWER

Apply power to the B3730 by turning the POWER switch on. This supplies AC and DC power to the unit. When the POWER switch is first turned on, the B3730 will perform internal system checks if the subsystems pass the diagnostic tests the cursor will blink in the lower right hand corner of the display.

NOTE
On power-up of the B3730, the first time a RUN command is issued, the spindle will go through the auto-initialization routine. This ensures proper motor commutation.

4.3   BASIC OPERATING MODES

The B3730 has two basic modes of operation: Local and Remote. Local Mode is usually reserved for maintenance, adjustments, and troubleshooting. Remote Mode is the normal operating mode; this mode must be used for operations requiring host computer control. The B3730 powers up in the remote mode by default.

Regardless of the origination of commands, the B3730 does not allow unsafe operation. Safety checks also ensure that the spindle has sufficient air for safe operation.

4.3.1 LOCAL MODE

The front panel allows the user to perform motor control functions without the need for a host computer. To initiate the "Local Mode" control the user must press the Enter button. The controller will flash a (+) sign signal in the lower right hand corner while it prepares the system for local operation. When the system is ready for local control a letter "L" will be displayed in the lower right hand corner and the cursor will be flashing over the enable status field. The system is now ready for local operation.

1. To select a Speed, Acceleration or Direction.

   Press the "Menu" button to view the Input Parameters menu. The cursor should be flashing over the speed entry field. Use the "up" and "down" arrows to change the value in the field. I.E. SPEED:02000. Then press the "Enter" button to accept the changed value. The cursor should now be flashing on the Accel entry field. Use the "up" and "down" arrows to change the value in the field. Press the "Enter" button accept the changed value. The cursor will now be flashing on the Direction field.

Local Mode Continued.

Use the right and left arrows to change the direction command.
Press the "Enter" button to accept the changed value.

Press the "Menu" button to return to the main display screen.

The cursor will be flashing on the enable status field.
Use the "down" arrow to move to the clamp status field.
Press "Enter" button to toggle the state of the clamp.
Use the "down" arrow to move to the brake status field.
Press "Enter" button to toggle the state of the brake.

The main display also shows the direction as sensed by the encoder and displays the speed in RPM.

4.3.2 REMOTE MODE

Remote Mode is used when the B3730 is under the direction of a host computer. This is usually the case in media testers. Parameters such as spindle RPM, revolution direction, disk clamping, and spindle run/stop commands are sent to the controller from a host computer. The controller ensures that all commands are correctly sequenced.
See Section 5 for a complete list and description of the B3730's command set.
The B3730 utilizes RS232 three wire communication. The commands must be terminated with the ascii character (13) - 0Dh. Commands that generate a response are return to the host computer terminated by the ascii character (13) - 0Dh.

4.3.3 GPIB ADDRESS SELECTION (4242) only

The GPIB device address is selected by configuring the address dip switch located on the upper left hand corner of the front panel PCB. To access the dip switch the user must remove the top cover of the controller. The dip switch "S7" must be changed with the controllers power off for the new address to take affect. The dip switch represents a binary code for addresses between 0 and 15. A switch in the UP or ON position represents a logic level "1". The first switch weighted by 1, the second by 2, the third by 4, the fourth by 8. Select a combination that adds up to the address you desire.
    I. E. The address (3) is selected by setting the switches 1 and 2 to the on position.
        The address (5) is selected by setting the switches 1 and 4 to the on position.

4.4   REAR PANEL CONNECTIONS

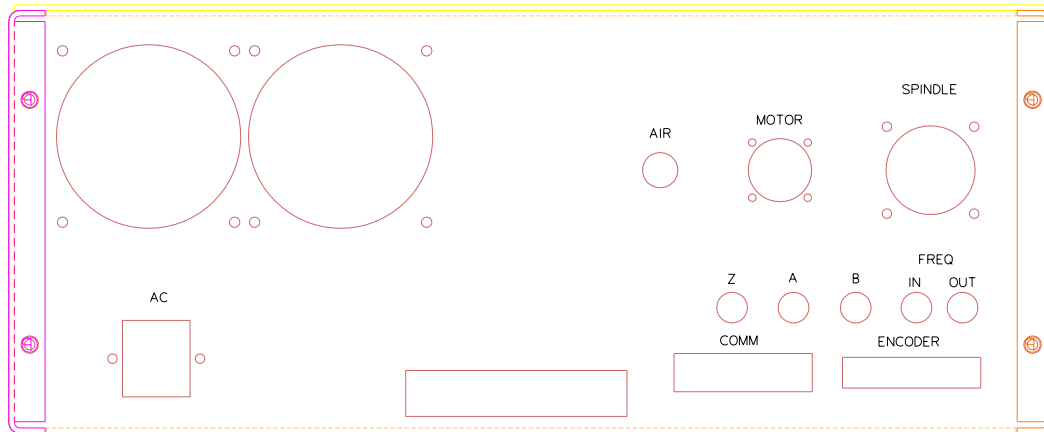A rear panel view is provided to show location of the rear panel connectors, inputs, and outputs.

Figure 4-2
Rear Panel Connections

4.5   ENCODER COMMUTATION

An encoder is installed below the spindle housing and is directly coupled to the spindle's shaft. This encoder provides three outputs: Index, Data A, and Data B, which are used by the Main Electronics Assembly to maintain the spindle's RPM.

The internal 1024 line count encoder is factory aligned to ensure that the spindle motor windings and the encoder's index track are correctly phased. If any adjustment is made to the encoder, the encoder must be realigned to the motor; otherwise, the spindle motor may not operate accurately or perhaps not at all.

!! CAUTION !!

Improper alignment of the spindle encoder can damage the B3730's power amplifier circuitry.

4.6   SAFETY INTERLOCKS

DC power, AC motor drive power, and the amplifier overtemperature thermistor are monitored to prevent spindle motor damage caused by excessive current or heat. The air bearing spindle pressure is monitored for a low pressure condition. The clamp air pressure is monitored to assure that the clamping mechanism is engaged.

Power supply voltages monitored are +5 Vdc, ±15 Vdc, and motor supply voltage (±V). Inputs are constantly monitored, and if any or all inputs deviate from their assigned value, spindle operation is disabled and a fault condition occurs.

4.7   FREQUENCY REFERENCE

The B3730 is shipped from the factory with an internal frequency reference. A BNC loopback cable must be connected from the "Frequency In" to the "Frequency Out" connectors on the back panel in order for the unit to run.

The B3730 can accept an external frequency reference, if the user wishes to synchronize with an external reference. The user must hook up their external reference to the "Frequency In" connector on the back of the B3730, and issue a speed command of 10 and an acceleration of 10000 from either the front panel or the host computer. The B3730 will then track the external reference after the user issues a run command. The B3730 will use maximum acceleration in tracking the reference. All other commands will operate normally.

Section 5   B3730 Command Set

5.1 COMMAND SET LISTING

The B3730's Command Set is case-sensitive.

Command	Definition
ACC:XXXXX	Defines the acceleration rate in RPM/sec^2. XXXXX is a 5-digit integer from 00001 to 10000. 00000 is invalid, and will default to 00005.
BRAKEOFF	Disables the spindle motor brake, if spindle is so equipped.
BRAKEON	Enables the spindle motor brake, if spindle is so equipped.
CLAMP	Activates the spindle disk clamp, if spindle is so equipped.
INIT	Initializes the spindle motor to establish commutation. This command MUST be issued prior to running the spindle.
RUN	Enables the spindle, and commands the spindle to run at the last entered speed, acceleration, and direction. NOTE: If no direction, speed, or acceleration has been commanded, spindle will attempt to maintain zero RPM.
SPD:XXXXX	Sets the requested speed to XXXXX RPM. XXXXX is an integer from 00010 to 18000.

STAT?	Returns the status of the controller as an ASCII value that represents bit fields set. The fields are decoded as follows: Bit 1, 0=Rotating, 1=Stopped Bit 2, 0=Clamped, 2=Not Clamped Bit 3, 0=Brake On, 4=Brake Off Bit 4, 0=No Fault, 8=Fault Bit 5, 0=At Speed, 16=Not At Speed Bit 6, 0=CCW, 32=CW Bit 7, RESERVED Bit 8, RESERVED
STOP	Disables the spindle motor, and applies the spindle motor brake, if spindle is so equipped. (See DIS command.)
UNCLAMP	Causes the disk clamp to unclamp, on spindles so equipped. NOTE: If an UNCLAMP is attempted while the spindle is rotating, the command will be ignored.

Index