Compumotor

AL-C Encoder User Guide

Compumotor Division
Parker Hannifin Corporation
p/n 88-012074-01 B

Parker

User Guide Change Summary

The following is a summary of the primary changes to this user guide since the last version was released. This user guide, version 88-012074-01**B**, supersedes version 88-012074-01**A**.

When a user guide is updated, the new or changed text is differentiated with a change bar in the right margin (this paragraph is an example). If an entire chapter is changed, the change bar is located to the right of the chapter title.

Technical changes to each chapter are synopsized below.

Chapter 1
(Introduction)

No changes

Chapter 2
(Installation)

- Pg. 6: Corrected Figure 2-1. Changed default DIP switch settings for switches #1 and #2 from ON to OFF. This accommodates off-the-shelf operation with the Model 500, Model 4000, and JSI controllers.
- Pg. 6: Corrected Table 2-3. Changed DIP switch settings for switches #1 and #2: both ON for SX and AX-A, both OFF (default) for Model 500, Model 4000, and JSI.
- Pg. 16: Corrected Figure 2-12. Changed Decoder-to-SX wiring as follows:

  TX- connects to **CHA+**
  TX+ connects to **CHA-**
  RX- connects to **CHB+**
  RX+ connects to **CHB-**

- Pg. 19: Edited *Troubleshooting* section to specify that if you operate the AL-C in the SX mode, the **STATUS** LED is always illuminated. If the AL-C travels to the end of its absolute range (256 inches), thus coming to a false zero position, the SX will send an error message via RS-232C.

Chapter 3
(Troubleshooting)

No changes

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How To Use This User Guide

This user guide is designed to help you install, develop, and maintain your system. Each chapter begins with a list of specific objectives that should be met after you have read the chapter. This section is intended to help you find and use the information in this user guide.

Assumptions

This user guide assumes that you have the skills or fundamental understanding of the following information.

- ❑ Basic electronics concepts (voltage, switches, current, etc.)
- ❑ Basic motion control concepts (torque, velocity, distance, force, etc.)

With this basic level of understanding, you will be able to effectively use this user guide to install, develop, and maintain your system.

Contents of This Manual

This user guide contains the following information.

Chapter 1: Introduction

The introduction chapter describes the product and its specific features. Included in this chapter is a description of how the product operates.

Chapter 2: Installation

This chapter contains a detailed list of items you should have received with your AL-C shipment. The installation chapter provides guidelines and instructions for you to properly mount the system and make all electrical connections. Included in this chapter is a table of system specifications. Upon completion of this chapter, your system should be completely installed, tested, and ready to perform basic operations.

Chapter 3: Troubleshooting

This chapter contains information on identifying and resolving system problems.

Installation Process Overview

To ensure trouble-free operation, pay special attention to the environment in which the AL-C equipment will operate, the layout and mounting, and the wiring and grounding practices used. These recommendations are intended to help you easily and safely integrate AL-C equipment into your manufacturing facility. Industrial environments often contain conditions that may adversely affect solid-state equipment. Electrical noise or atmospheric contamination, may also affect the AL-C System.

Developing Your Application

Before you attempt to develop and implement your application, there are several issues that you should consider and address.

① Recognize and clarify the requirements of your application. Clearly define what you expect the system to do.

② Assess your resources and limitations. This will help you find the most efficient and effective means of developing and implementing your application (hardware and software).

③ Follow the guidelines and instructions outlined in this user guide. **Do not skip any steps or procedures.** Proper installation and implementation can be ensured only if all procedures are completed in the proper sequence.

Installation Preparation

Before you attempt to install this product, you should complete the following steps. The successful completion of these steps will prevent subsequent performance problems and allow you to isolate and resolve any potential system difficulties before they affect your system's operation.

① Review this entire user guide. Become familiar with the user guide's contents so that you can quickly find the information you need.

② Review Chapter 1, *Introduction*, and the user documentation for the controller to develop a basic understanding of the system components, their functions, and interrelationships.

③ Review Chapter 2, *Installation*, to become familiar with the installation process.

④ After reading Chapter 2, begin the installation process. Do not deviate from the sequence or installation methods provided.

⑤ Perform as many basic functions as you can with the configuration established in Chapter 2. You can perform this task only if you have reviewed the entire user guide.

Conventions

To help you understand and use this user guide effectively, the conventions used throughout this user guide are explained in this section.

Warnings & Cautions

Warning and caution notes alert you to possible dangers that may occur if you do not follow instructions correctly. Situations that may cause bodily injury are presented as warnings. Situations that may cause system damage are presented as cautions. These notes appear in bold face and the word *warning* or *caution* will be centered and in all capital letters. Refer to the examples shown below.

WARNING

Do not touch the motor immediately after it has been in use for an extended period of time. The motor may be hot.

CAUTION

System damage will occur if you power up the system improperly.

Related Publications

- Current Parker Compumotor Motion Control Catalog
- Schram, Peter (editor), Quincy, MA. *The National Electric Code Handbook (Third Edition)*. To receive this publication, contact the National Fire Protection Association (Batterymarch Park, MA 02269).

Chapter 1. Introduction

Chapter Objective

The information in this chapter will enable you to understand the product's basic functions and features.

Product Description

The AL-C absolute linear encoder is an easy-to-use feedback device that provides digital position information corresponding to a mechanical location. As such, the AL-C does not lose position information in the event of a power outage. The AL-C also eliminates the need to find a home position or a reference point, since an absolute encoding system always knows its location.

The AL-C is essentially a rotary absolute encoder that has its shaft replaced by a pinion and rides on a rack, thereby measuring linear travel with a rotary measurement device.

The AL-C with the microprocessor-based decoder is designed for use with the following Compumotor controllers:

- ❑ SX Indexer/Drive
- ❑ Model 500 Indexer
- ❑ Model 4000 Indexer
- ❑ JSI Servo Controller
- ❑ AX-A Indexer/Drive

Product Features

The AL-C absolute linear encoder provides the following features:

- ❑ 12 standard lengths from 8 - 144 inches
- ❑ 21 feet of absolute travel possible
- ❑ Low friction and inertia
- ❑ No accumulative error
- ❑ Decoder with integral power supply
- ❑ Decoder contains microprocessor for decoding (eliminates user decoding)
- ❑ Four DIP switch selectable resolutions in discrete positions/inch (ppi):
  - 4,096 ppi
  - 8,192 ppi
  - 16,384 ppi
  - 32,768 ppi

Theory of Operation

The output data is obtained when light shines through a disk and is detected by a photo-transistor. Figure 1-1 is a top view of this disk (where the light sources are aimed). The disk is constructed of metal and is arranged in concentric tracks. Each track has an independent LED and photo-transistor parallel to the disk. This encoder disk has each track phased in a binary ratio to the next. The inside tracks are coarser, and the outside track has the finest resolution.

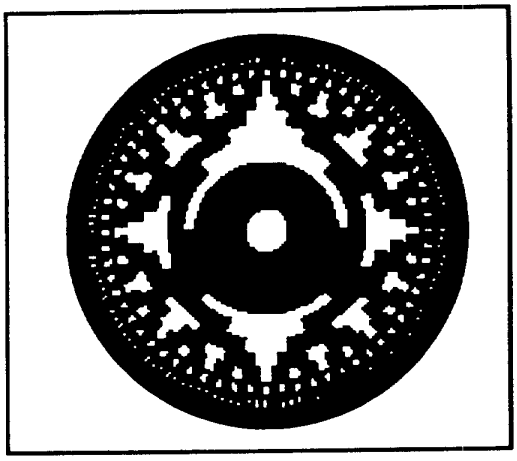


Figure 1-1. Absolute Encoding Disk

Figure 1-2 is a cross-sectional view of the LED and sensors in relation to the encoding disk. The only moving device is the disk, which is attached to the pinion shaft. As each LED passes an opening on the disk, it causes current to flow to the output circuit. The output circuit is then in a high state. The lights that are blocked by the track have no current flow to the output circuit, which causes a low state. The output circuit then assigns a number for these high and low states.

Most encoders use ten tracks on the encoding disk to obtain ten bits of positional data. With the AL-C, *redundancy encoding* is employed, which eliminates uncertainty between positions. In this case, only mechanical motion is allowed to change the position. This is commonly referred to as *redundant gray code*. This form of encoding has been developed by Compumotor using the disk shown in Figure 1-1.

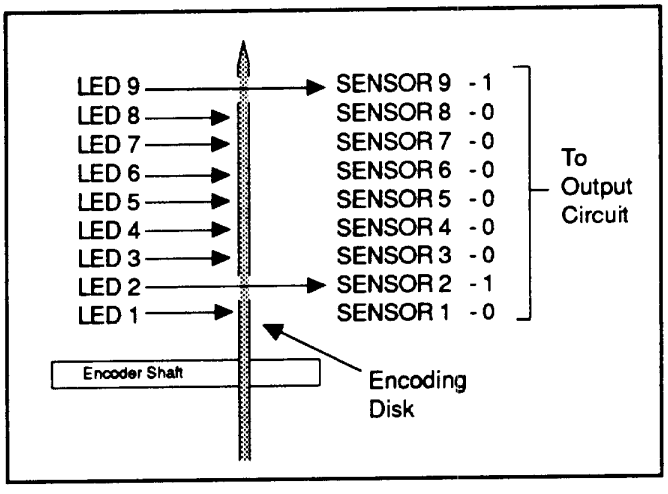


Figure 1-2. Cross-Section Sensing Circuit

The AL-C, a *multi-turn* absolute encoder, provides discrete position output for numerous pinion shaft revolutions. The AL-C's encoder head has three 8:1 (8 x 8 x 8) geared disks to provide an absolute travel of 512 turns of the pinion (256 inches of travel @ 2 pinion revs/inch). Each geared disk has its own concentric tracks for counting turns. With three tracks, LEDs, and photo detectors, a discrete count can be maintained for 0 - 7 revolutions of the gear. With 14 bits of resolution, the number of discrete positions increases to 8,388,608 over the total 512 turns.

Figure 1-3 depicts the AL-C encoder head and its multi-turn geared disks.

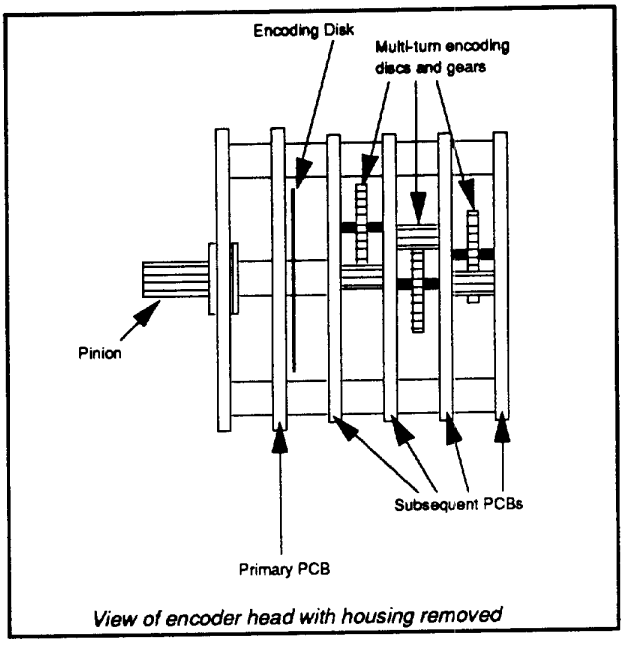


Figure 1-3. Internal View of Multi-Turn AL-C Encoder Head

The redundant gray code data from the AL-C encoder head, is transmitted to the AL-C's output electronics (decoder box) for interface to the user's control system. The decoder's microprocessor decodes this information and conforms the position output to the SX, 4000, 500, JSI, or AX-A. Figure 1-4 shows a block diagram of the encoder system.

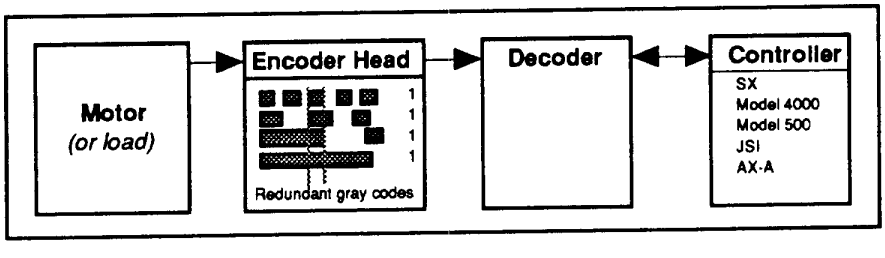


Figure 1-4. Encoder System Block Diagram

Chapter 2. Installation

Chapter Objectives

The information in this chapter will enable you to do the following:

- ❑ Verify that each component of your system has been delivered safely
- ❑ Configure the DIP switches and jumpers for your application
- ❑ Mount all system components
- ❑ Make all electrical system connections
- ❑ Ensure the complete system is installed properly and functions correctly

What You Should Have

Inspect the AL-C system upon receipt for obvious damage to its shipping container. Report any such damage to the shipping company. Parker Compumotor cannot be held responsible for damage incurred in shipment. The items in Table 2-1 should be present and in good condition.

Part	Part Number
AL-C Encoder Head with Cable	72-008178-10 (10-ft. cable for rack under 64") 72-008178-20 (20-ft. cable for rack over 64")
AL-C Linear Encoder Assembly	71-008073-XXX (XXX = inches of travel)
AL-C Decoder Box	71-008142-11
25-Pin Indexer Cable	71-011562-06
Power Cord	44-001609-01
AL-C Encoder User Guide	88-012074-01

Table 2-1. Ship Kit List

System Specifications

Use Table 2-2 as a quick reference for AL-C system specifications.

Parameter	Specification
Mechanical	
Resolution (DIP switch selectable)	4096, 8192, 16384, or 32768 positions per inch Absolute for 256 inches of travel
Accuracy	Approximately ±0.001 inch (dependent on thermal expansion of rack — rack is factory-calibrated at 68°F)
Repeatability	±0.0001 inch (2.5 µm)
Inertia	0.0005 oz-in^2 (0.9145 gm-cm^2)
Starting Force	8.0 oz (225 gm)
Maximum Speed	30 ips at full resolution
Update Rate	Approximately 1.4 ms (dependent on controller & is directly proportional to speed; faster speeds can lead to false stall detection if the controller is set up with a tight deadband)
Housing Material	Aluminum
Shaft Material	#303 stainless steel
Rack Material	416 stainless, hardened and ground
Electrical	
Input Power	Decoder box: 120VAC, ±10 %, 0.5 A, 50/60 Hz
Parallel Output (JSI, 500 & 4000)	TTL compatible; Max. cable length: 6 feet (*use 18AWG cable*)
Serial Output (SX & AX-A)	SX: RS-422; AX-A: RS-485; Max. cable length: 200 feet
Cable Length (encoder-to-decoder) AL-C8 through AL-C64 AL-C80 through AL-C144	 10 feet (3 meters) — armored cable available as -A option 20 feet (6 meters) — armored cable available as -A option
Environment	
Operating Temperature	Encoder: 32°F to 122°F (0°C to 50°C) Decoder Box: 32°F to 140°F (0°C to 60°C)
Storage Temperature	-22°F to 185°F(-30°C to 85°C)
Humidity	0 to 95% (non-condensing)

Table 2-2. AL-C Specifications

Configure the Decoder Box

To change the decoder box configuration you have to change DIP switch package S3. *(If you are using the AX-A Indexer/drive you must also remove jumpers JU3 and JU4.)* Use the procedure below to configure the decoder box for your application.

① DIP switch S3 and the jumpers are not accessible from the outside. Follow the steps below to open the decoder box.

a **Remove the power <u>before</u> opening the decoder box.**
b. Remove the four screws from the sides of the front panel (2 on each side).
c. Remove the two screws from the back of the unit.
d Gently pull the front panel and the attached boards from the encoder housing. Facing the front panel, the DIP switches are on the left and the jumpers are on the right (see Figure 2-1).

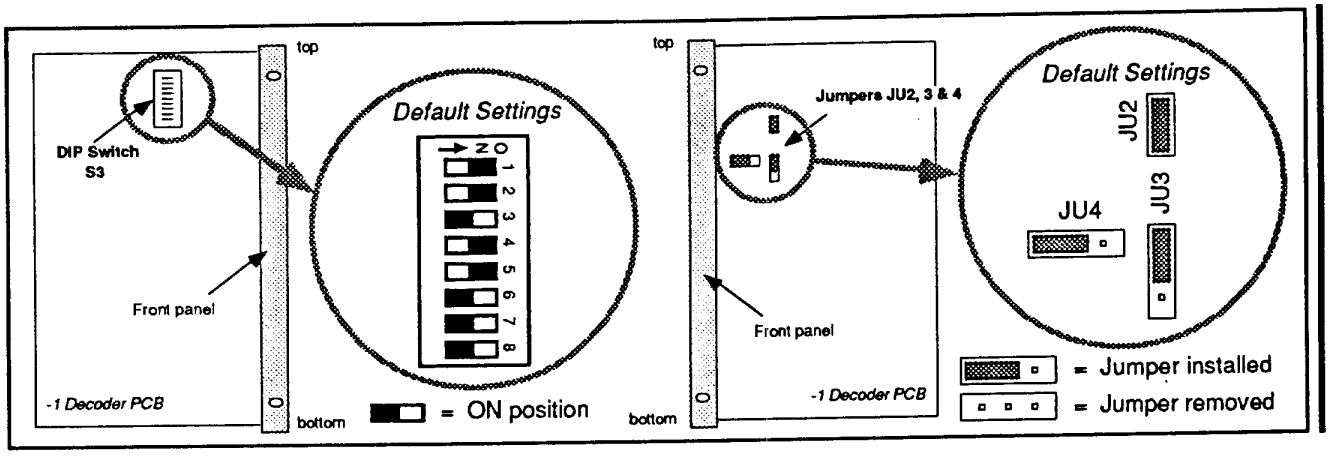


Figure 2-1. Decoder Box DIP Switch and Jumper Locations

② **<u>AX-A only</u>:** Remove jumpers JU3 and JU4 (leave jumper JU2 installed).

③ Use Table 2-3 as a guide to set DIP switch S3 according to the Compumotor controller you are using.

Switch #	Setting	Function for SX**	Function for 500, 4000 & JSI	Function for AX-A
#1	OFF* ON	Must be OFF ----------	Must be OFF ----------	---------- Must be ON (RS-422/485)
#2	OFF* ON	Must be OFF ----------	Must be OFF ----------	---------- Must be ON (Half-duplex)
#3	OFF ON*	CCW is increasing count CW is increasing count	CCW is increasing count CW is increasing count	Must be ON: CW is increasing count
#4 — #5	OFF — OFF* ON — OFF OFF — ON ON — ON	32,768 positions/inch 16,384 positions/inch 8,192 positions/inch 4,096 positions/inch	32,768 positions/inch 16,384 positions/inch 8,192 positions/inch 4,096 positions/inch	#4: *No function* #5 must be OFF: Selects hexadecimal reporting *AX-A resolution is set to 2,048 positions/inch*
#6	Must be ON*	*No function*	Multi-turn	Multi-turn
#7 — #8	ON — OFF ON — ON* OFF — ON	Selects SX *No function* *No function*	*No function* Selects 500, 4000, JSI *No function*	*No function* *No function* Selects AX-A

* Factory default settings
** The **STATUS** LED remains illuminated in the SX mode. If the AL-C travels to the end of its absolute

System Mounting

This section contains all AL-C encoder and decoder box mounting instructions and dimensional drawings.

Panel Layout Guidelines

The decoder's circuitry is microprocessor-based and fully digital (all voltages are within TTL levels). For this reason, the unit should be mounted with other control devices on a panel in a NEMA-approved enclosure. Figure 2-2 illustrates the minimum required clearances. Electrically noisy devices should be suppressed or housed in separate enclosures.

Do not mount large, heat-producing equipment directly beneath the decoder. *Logic devices may perform unpredictably if they become too hot.* The maximum allowable ambient temperature directly below the decoder is 122°F (50°C). Fan cooling may be necessary if adequate air flow is not provided.

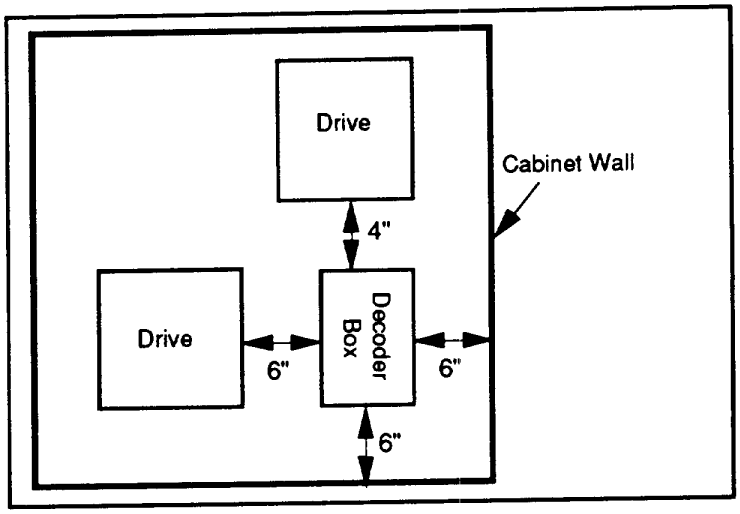


Figure 2-2. Panel Layout

Decoder Mounting Options

The decoder box is shipped with two mounting brackets. You can use these brackets to mount the box for minimum width or minimum depth. *Minimum-width* mounting allows more decoder boxes per panel. *Minimum-depth* mounting allows you to use a shallow enclosure. Figure 2-3 illustrates where to attach the brackets for the desired mounting configuration.

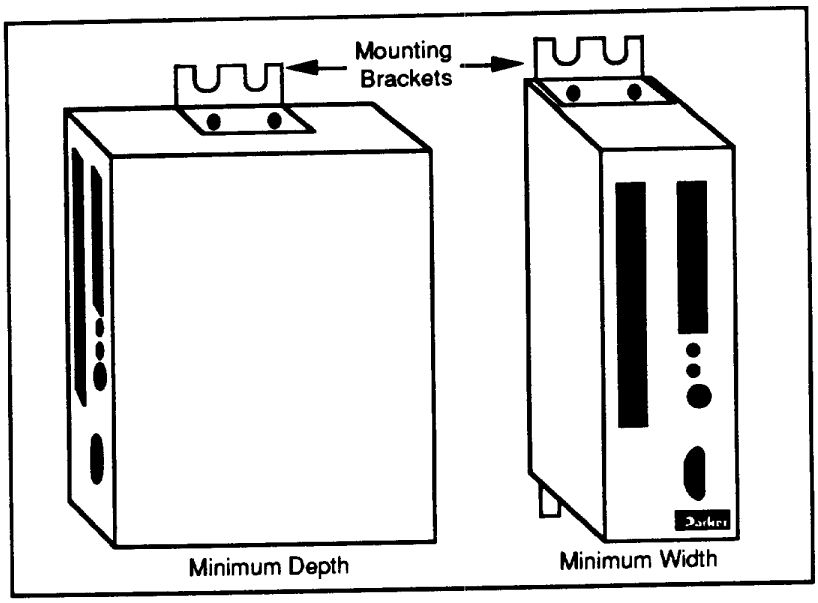


Figure 2-3. Minimum-Width and Minimum-Depth Mounting Options

Decoder Dimensions

Refer to Figure 2-4 for decoder box dimensions.

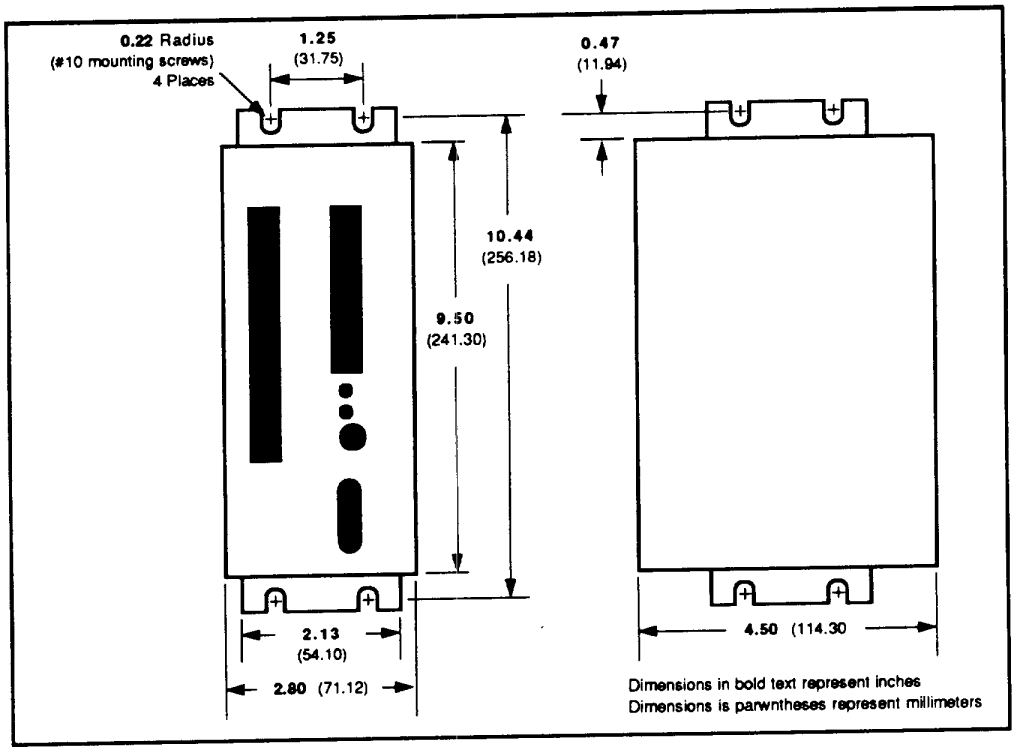


Figure 2-4. Decoder Box Dimensions

Encoder Mounting

This section contains a step-by-step procedure to mount the AL-C Encoder. **Do not proceed without reading each step carefully.**

The basic encoder system is shipped in two parts: the *rack assembly* and the *encoder assembly*. The rack assembly comprises the rack (toothed metal bar) and spar, protected by a six-piece aluminum cover assembly. The encoder assembly comprises an encoder head assembly and the cable block. **Do not attempt to disassemble the encoder assembly.**

Mounting Precautions

Note the following precautions before you mount your encoder.

- ❑ Review the entire mounting procedure prior to starting. **Do not disassemble the unit until the manual instructs you to do so.**
- ❑ Lay out the mounting arrangement.

  The layout must ensure that the axis of movement of the machine and the encoder are in line. If the layout does not achieve this, errors will be introduced. In severe cases, you may damage the encoder.
- ❑ Limit the travel of the encoder.

  The travel of the load to which the AL-C is attached cannot be allowed to exceed the encoder maximum travel or the encoder will be damaged. Travel must be limited in some fashion if the load can traverse further than the encoder can. The AL-C's *useable travel* values are provided in the table in Figure 2-6.
- ❑ Keep contaminates away from mounting location. Even though this encoder is well protected from liquids and dirt, additional steps should be taken to ensure trouble-free operation. Always mount the encoder seal so it is facing away from contaminants.
- ❑ Decide whether the encoder assembly or the rack assembly should be moving.

  The optimal combination is for the rack assembly to be attached to the machine's moving surface and the encoder assembly to be attached to the stationary portion. This allows the cable from the encoder assembly to be fixed.
- ❑ Check the two mounting surfaces for flatness and parallelism to one another.

  The two surfaces must be parallel (in yaw, pitch, and roll) to one another within ±0.004" (0.1 mm). You can measure this with a dial indicator. Figure 2-5 illustrates mounting surfaces that must meet tolerance. Surfaces that do not meet the recommended tolerance may jeopardize accuracy, speed, and product life.

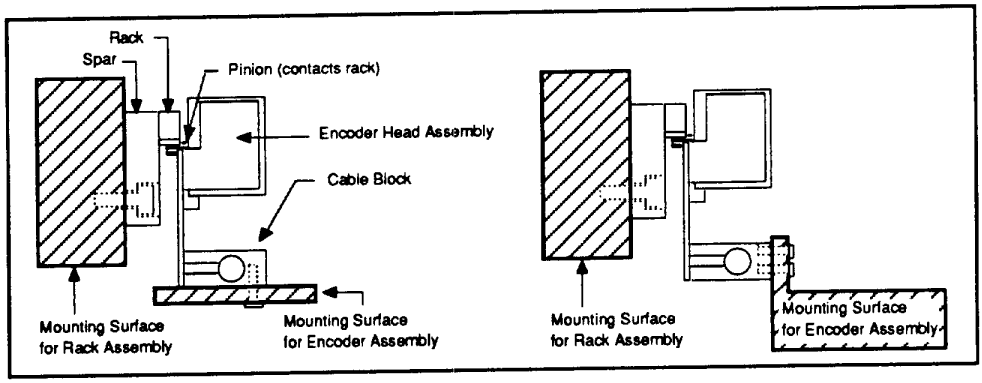


Figure 2-5. Typical Mounting Configurations

- ❑ If parallelism does not meet the tolerance requirement, you can create a new surface.

  Use a single piece of cold rolled steel that is equal to the entire length of the rack assembly, or use blocks or shims under each mounting hole to create a parallel surface. In either case, use a *set screw* arrangement in the material for calibration. This technique of creating a new parallel mounting surface is referred to as *leveling*.

- ❑ Determine where the encoder head will be mounted.

  If the two 8-32 threaded holes provided in the encoder base are not sufficient, you may need to manufacture a bracket to conform to the machine's geometry.

- ❑ Specify where the cable will be routed and determine if fluid will be present.

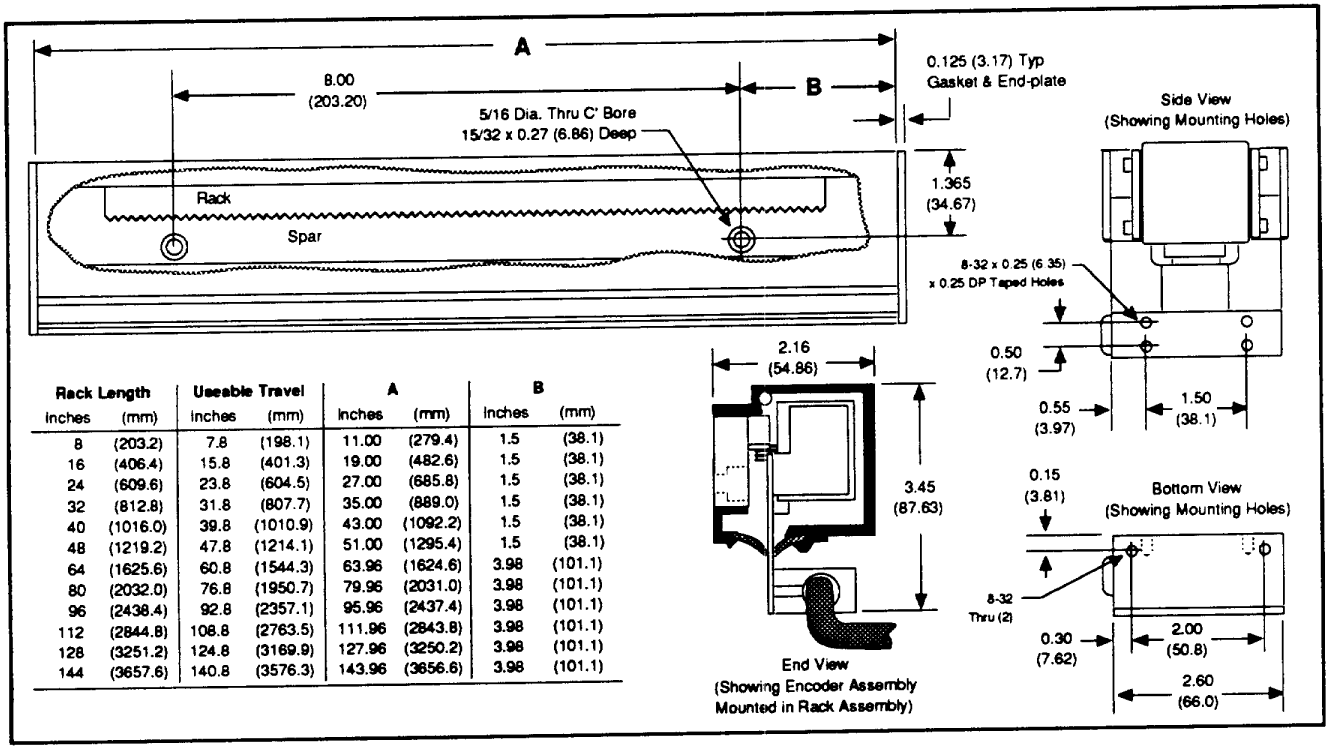
  Route the cable ***down*** from the encoder head so fluid flow will not damage the encoder head. Cable looping is a very effective means of preventing fluid flow to the encoder head (when excess cable is present).

- ❑ ***Do not adjust the bolts that are used to attach the rack to the spar.*** If you do, you will ruin the system's calibration and compromise system accuracy and performance. Use only the bolt holes shown in the spar to mount the rack assembly.

Mounting Procedure

After you address the above precautions and make necessary changes, you can begin to mount the unit. Below is the step-by-step process that you should follow to properly mount and test the rack and pinion encoder. This process assumes that two parallel surfaces exist for mounting.

Refer to Figure 2-6 for dimensional values.



Rack Length		Useable Travel		A		B	
Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
8	(203.2)	7.8	(198.1)	11.00	(279.4)	1.5	(38.1)
16	(406.4)	15.8	(401.3)	19.00	(482.6)	1.5	(38.1)
24	(609.6)	23.8	(604.5)	27.00	(685.8)	1.5	(38.1)
32	(812.8)	31.8	(807.7)	35.00	(889.0)	1.5	(38.1)
40	(1016.0)	39.8	(1010.9)	43.00	(1092.2)	1.5	(38.1)
48	(1219.2)	47.8	(1214.1)	51.00	(1295.4)	1.5	(38.1)
64	(1625.6)	60.8	(1544.3)	63.96	(1624.6)	3.98	(101.1)
80	(2032.0)	76.8	(1950.7)	79.96	(2031.0)	3.98	(101.1)
96	(2438.4)	92.8	(2357.1)	95.96	(2437.4)	3.98	(101.1)
112	(2844.8)	108.8	(2763.5)	111.96	(2843.8)	3.98	(101.1)
128	(3251.2)	124.8	(3169.9)	127.96	(3250.2)	3.98	(101.1)
144	(3657.6)	140.8	(3576.3)	143.96	(3656.6)	3.98	(101.1)

Figure 2-6. AL-C Dimensional Drawing

If you are mounting a rack assembly that is longer than 12 feet, use the special instructions (marked **For Rack Assemblies Longer than 12 Feet**). ***Special instructions for rack assemblies longer than 12 feet are provided for steps 2, 3, and 6.***

TOOLS REQUIRED

The AL-C comes with a small mounting kit that contains a 5/64" allen wrench and 1/4" spar mounting bolts. To minimize installation time, obtain the additional tools listed below prior to starting.

- ❑ Phillips-head screw driver
- ❑ Dial indicator

1. Remove Cover

Use the procedure below to remove the portions of the cover assembly to allow easy access for the mounting procedure (see Figure 2-7):

① Remove the three screws on each of the two end-plates.

② Remove the end-plates and seals. Try not to separate the seals from the corresponding end-plate.

③ Loosen, *but do not remove* the screws on the top of the extrusion. Once the screws are loose, remove the extrusion covering the rack assembly. *Do not remove the strip seal inside the cover.*

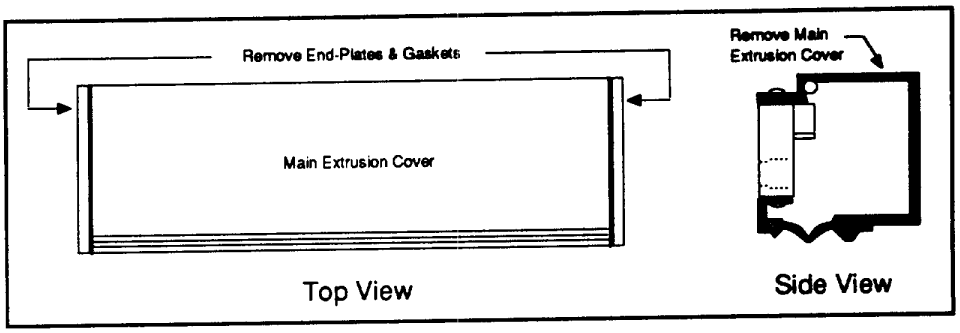


Figure 2-7. Removing the Cover

2. Align Rack Assembly & Drill Mounting Holes

Align the rack assembly on the mounting surface and mark the spar bolt location for the drilling and threading process (see Figure 2-6 for location of spar bolts and dimensions).

At this point, the top of the rack should be as parallel as possible to the encoder assembly's cable block (mounting surface). For the best mounting results, the mounting holes in the mounting surface should be machined (removing burrs or extrusions from holes) prior to mounting. Machining should be done for 1/4-20 screws.

For Rack Assemblies Longer than 12 Feet

① Align the two pieces of the rack assembly on the mounting surface. The adjoining ends are marked by either arrows or other ink marks. Match the ends together as shown in Figure 2-8.

② To correctly set the gap between the adjoining rack assemblies (this maintains accuracy when the pinion moves from one rack to the next), push the extra rack segment (supplied) so that its teeth mesh with the two adjoining racks (see Figure 2-8), clamp the rack assemblies into place, and then mark the mounting holes on the mounting surface as described above.

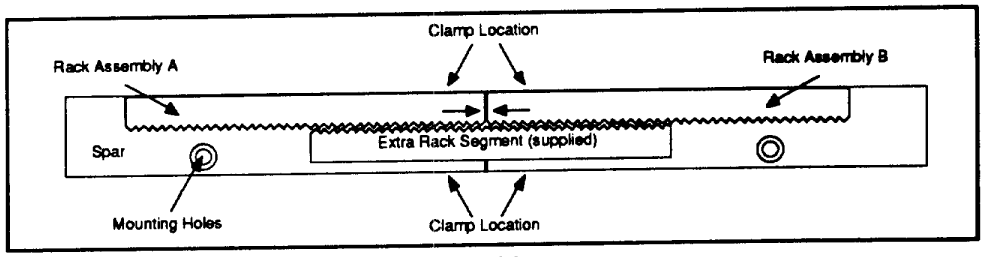


Figure 2-8. Aligning Multiple Rack Assemblies

3. Bolt Rack Assembly to Mounting Surface

① Using the supplied socket-head cap screws, bolt the rack assembly (spar) to the designated surface through the 5/16" holes starting from one end and going to the next location until all screws are installed. **Do not tighten any screws.** The clearance in the holes allows you to adjust the rack assembly for proper for parallelism.

> **For Rack Assemblies Longer than 12 Feet**
>
> Invert the extra rack segment (supplied) into the teeth of the rack assembly and clamp the pieces together. Keep the rack segment clamped together while you adjust the assembly for parallelism. Refer to Figure 2-8.

② Using a dial indicator as shown in Figure 2-9, adjust the rack assembly (starting from one end) so that the total indicated reading (TIR) on the rack (not the spar) is no more than 0.004 inches TIR (±0.002 inches). Read the indicator with reference to the mounting location of the encoder assembly. Once the measurement is within the above value, tighten the screw. Repeat this process for the remaining screw locations. **Never loosen the bolts that secure the rack to the spar, and avoid direct contact with the rack.**

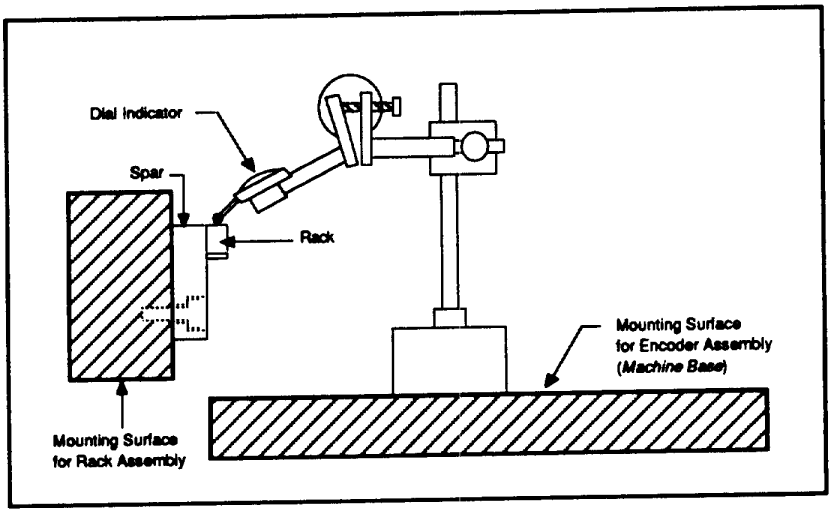


Figure 2-9. Dial Indicator Location

③ Once all screws are tightened, remeasure the straightness between the *machine base* and the rack to ensure it does not exceed 0.004 inches TIR.

4. Attach Encoder Assembly to Mounting Surface

Use the following procedure to mount the encoder assembly and align it with the rack (see Figure 2-6 for mounting details). The encoder's pinion must be parallel (yaw and roll) to the rack. Before fully mounting the encoder assembly in place, you must preload the spring-loaded encoder head to reduce backlash and optimize performance and product life. **If proper preload is not provided, the spring will eventually wear out and cause the unit to fail prematurely.**

① Place the encoder assembly in its final mounting position and press the pinion firmly against the rack (see Figure 2-10). *The applied pressure should be within the 1 to 2 lbs.*

② Install the mounting screws to the cable block, **but do not fully tighten them.**

③ Put your finger on top of the encoder housing and depress the spring to move the pinion away from the rack. If deflection can be felt and the spring has room to come back the same amount as deflected, then the preloaded pinion meets the required specification. If the preload is set properly, tighten the screws to the encoder bracket.

④ Move the encoder assembly so that the face of the pinion is 0.015" to 0.045" away from the spar surface (see Figure 2-10). If the pinion is touching the spar, the increased friction will reduce system speed and cause greater wear. Too little pinion contact on the rack will wear on the portion of the pinion that is in contact with the spar; consequently, the pinion may travel off the rack if it is not parallel.

⑤ With the encoder head preloaded and the pinion positioned properly, tighten the screws securing the encoder assembly's cable block to the mounting surface.

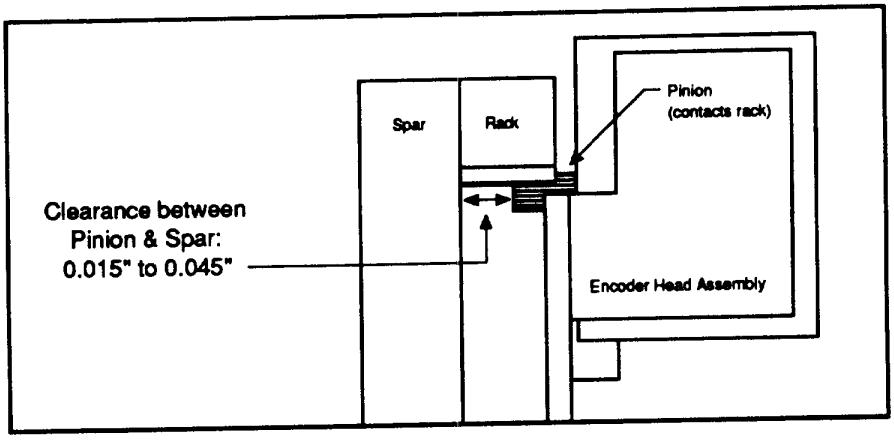


Figure 2-10. Pinion Clearance

5. Verify Travel Limit

To make sure the pinion rides smoothly and does not go off the rack, manually deflect the portion of the system that moves back and forth (slowly). If the unit travels off the rack, repeat Step 4.

6. Replace Cover

Replace the extrusion cover and then the end-plates. Be sure to tighten all screws.

For Rack Assemblies Longer than 12 Feet

Replace the extrusion covers and end-plates and tighten all of the screws. Seal the seams in the extrusion covers with aluminum tape (supplied). Apply the tape in such a way that it seals the entire extrusion cover (especially the small radius grooves on the cover).

7. Route Encoder Cable

Before you begin cable routing, you may have to disconnect the cable from the decoder box for ease in routing.

If the encoder assembly is mounted to the *stationary portion* of the machine, you may clip or pin the cable in a permanent position. If the encoder assembly is mounted to the *moving portion*, you will need a cable track or cable loop to avoid any problems. If cable tracks are required, contact Gortite at (414) 786-1500.

8. Check Repeatability & Accuracy

To check the system for repeatability and accuracy, place a dial indicator at the zero or home position and program the system to move out and then back to the zero position. Reset the indicator before starting. Repeat this process several times to make sure the system always comes back to the same point.

If the unit proves not to be repeatable within specifications (±0.0001"), recheck the system's alignments and tolerances. Misalignment or mounting the system outside of tolerance specifications are the most common reasons for repeatability problems. If problems persist, contact Compumotor's Applications Department at (800) 358-9070.

System Connections

This section contains step-by-step procedures to complete all of the AL-C's electrical connections.

Figure 2-11 illustrates the general system configuration you will achieve by the end of this chapter. Do not attempt to connect the components now; use the configuration procedures provided later in this chapter.

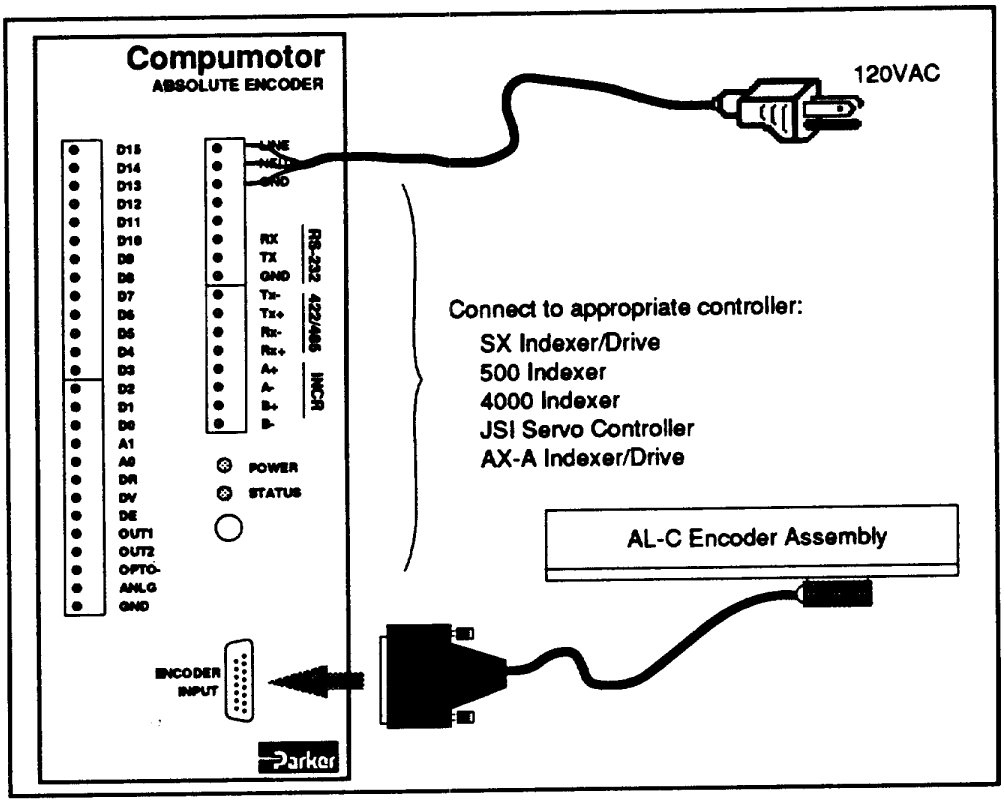


Figure 2-11. System Configuration

Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure the safety of personnel. You can reduce the effects of electrical noise due to electromagnetic interference (EMI) by grounding. All Compumotor equipment should be properly grounded. A good source of information on grounding requirements is the National Electrical Code published by the National Fire Protection Association of Boston, Massachusetts.

In general, all components and enclosures must be connected to earth ground through a grounding electrode conductor to provide a low impedance path for ground fault or noise-induced currents. All earth ground connections must be continuous and permanent. Compumotor recommends a single-point (one end only) grounding setup. Prepare components and mounting surfaces prior to installation so that good electrical contact is made between mounting surfaces of equipment and enclosure. Remove the paint from equipment surfaces where the ground contact will be bolted to a panel and use star washers to ensure solid bare metal contact.

For temporary installation, or when you cannot implement the grounding method described above, connect the **GND** terminal on the AC power connector to the earth ground. Whenever possible, route high-power signals (i.e., motor and power) away from logic signals (i.e., RS-232C, RS-422/485, parallel output) to prevent electrical noise problems.

Drive and Motor Wiring

Refer to the manuals provided with your drive and motor to properly wire these components. Ensure that you have performed this wiring step successfully by following any test routines or verification procedures that your motor/drive installation recommends.

Cabling

The cable from the encoder head to the decoder box is made of 15-conductor #26 gauge wire. These wires are not twisted, but they are shielded. The shield is terminated at the decoder box end and is not connected at the encoder end. The standard length is 10 feet for racks under 64 inches, and 20 feet for racks over 64 inches.

To minimize interface problems, mount the decoder as close as possible to the controller. Use shielded cables with the shield connected to the controller's earth ground only.

If you mount the AL-C in an environment that contains fluids, always route the cable down from the encoder. This prevents fluid flow on the cable from penetrating into the encoder housing. The same precaution should be used at the decoder box end.

CAUTION

Any modifications to the encoder-to-decoder cable will void the warranty! Please consult Compumotor prior to making any changes. Dial (800) 358-9070. Should it become necessary to remove the connector for routing purposes, order kit #74-010665-01 from Compumotor.

1. Connect the Encoder

Connect the encoder's 15-pin cable to the **ENCODER INPUT** connector on the decoder box (see Figure 2-11 above).

2. Connect the Controller

As described below, connect the AL-C to the Compumotor controller ordered with your system.

Refer only to the connection information relevant to the controller you are using.

Connecting the SX

Using a shielded cable with a **maximum length of 200 feet** (61 meters), connect the Decoder box to the indexer (see Figure 2-12).

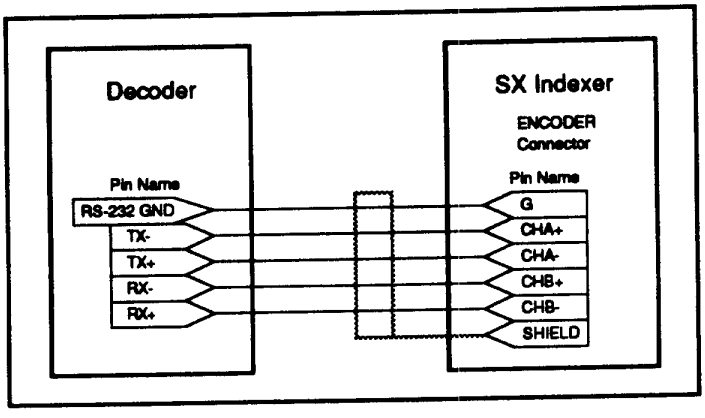


Figure 2-12. Connections to the SX

Connecting the Model 500 or Model 4000

Using the cable assembly provided in the AL-C ship kit, connect the decoder box to the indexer (see Figure 2-13). If you are using the Model 500 Indexer, be sure to connect the AL-C to the connector labeled **ABS/INC ENCODER**.

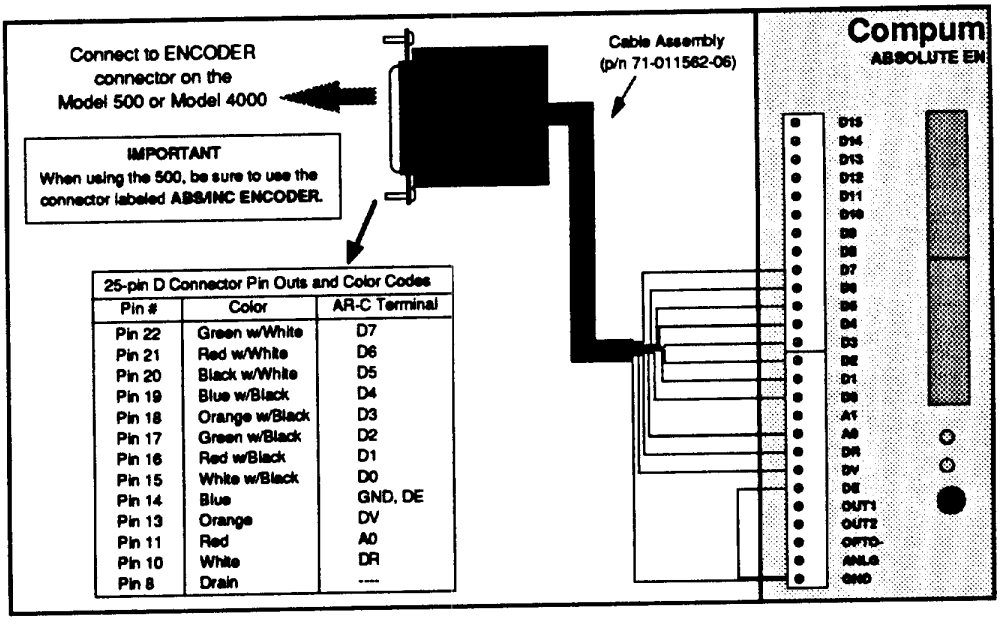


Figure 2-13. Connections to the Model 500 or the Model 4000

Connecting the JSI

Using a shielded cable with a **maximum length of 6 feet** (1.8 meters), connect the decoder box to the indexer (see Figure 2-14). If you use the D connector provided in the JSI ship kit, you will need to solder the wires to the connector terminals.

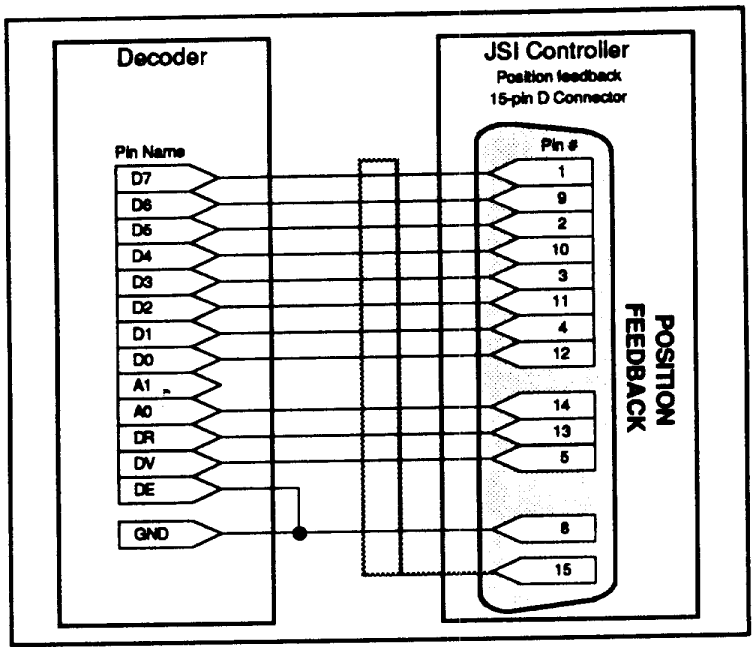


Figure 2-14. Connections to the JSI Servo Controller

Connecting the AX-A

Using a shielded cable with a **maximum length of 200 feet** (61 meters), connect the Decoder box to the AX-A (see Figure 2-15).

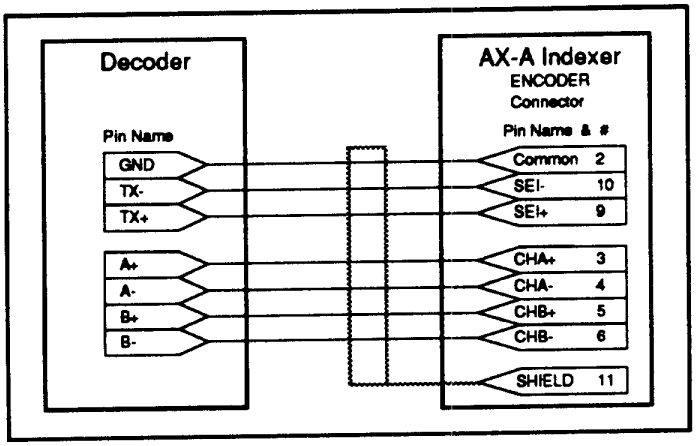


Figure 2-15. Connections to the AX-A

3. Connect the Power

Connect the supplied 120VAC input cable to the Decoder box first (see Figure 2-16). Then connect the cable's grounded plug into the 120VAC source. The green **POWER** LED should illuminate when power is applied.

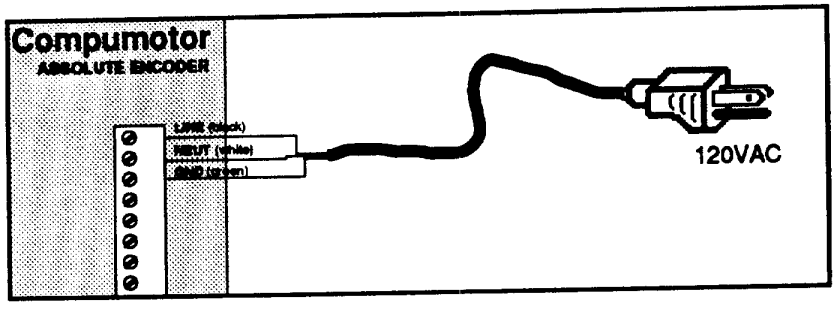


Figure 2-16. Power Connections to the Decoder Box

Installation Verification

To verify that the AL-C and the controller operate properly together, refer to absolute encoder verification procedures in the controller's user guide.

Chapter 3. Troubleshooting

Chapter Objective

The information in this chapter will enable you to isolate and resolve system hardware problems.

Troubleshooting

This section provides methods to identify and resolve possible encoder-related system problems. You should also refer to the indexer's user guide for troubleshooting procedures specific to the indexer you are using.

Dither

With position maintenance enabled and the absolute encoder resolution set to its highest resolution (32,768 positions/inch), the motor may *dither* — motor step to encoder step ratio is too small. To reduce or eliminate this problem, first lower the position maintenance gain values. If dither still occurs, increase the controller's deadband window (for instance, change **DWØ** to **DW1**). If dither still occurs, select a lower absolute encoder resolution via switches #4 and #5 on DIP switch S3*(does not apply to the AX-A)*.

LEDs

Except when operating in the SX mode, the **STATUS** LED on the decoder box front panel illuminates only when the encoder head is at the absolute zero position. In the SX mode, this LED is always illuminated. If the AL-C travels to the end of its absolute range (256 inches), thus coming to a false zero position, the SX will send an error message via RS-232C. This LED does not indicate any fault conditions.

The **POWER** LED illuminates only when 120VAC power is applied to the unit.

Reducing Electrical Noise

Try to eliminate sources of possible noise interference. Potential noise sources include inductive devices such as solenoids, relays, motors, and motor starters operated by a hard contact.

A technique for improving the AL-C's noise immunity is to connect the case of the motor/load (to which the encoder head is attached) to the **GND** input on the decoder box.

For more information on identifying and suppressing electrical noise, refer to the Technical Data section of the *Compumotor Programmable Motion Control Catalog*.

Returning the System

If you must return your AL-C system to affect repairs or upgrades, use the following steps:

① Get the serial number and the model number of the defective unit, and a purchase order number to cover repair costs in the event the unit is determined by the manufacturers to be out of warranty.

② Before you return the unit, have someone from your organization with a technical understanding of the AL-C system and its application include answers to the following questions:

- What is the extent of the failure/reason for return?
- How long did it operate?
- Did any other items fail at the same time?
- What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc)?
- How was the product configured (in detail)?
- What, if any, cables were modified and how?
- With what equipment is the unit interfaced?
- What was the application?
- What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
- What upgrades, if any, are required (hardware, software, user guide)?

③ In the USA, call Parker Compumotor for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number. The phone number for Parker Compumotor Applications Department is (800) 358-9070.

Ship the unit to:
Parker Hannifin Corporation
Compumotor Division
5500 Business Park Drive
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

④ In the UK, call Parker Digiplan for a GRA (Goods Returned Authorization) number. Returned products cannot be accepted without a GRA number. The phone number for Parker Digiplan Repair Department is 0202-690911. The phone number for Parker Digiplan Service/Applications Department is 0202-699000.

Ship the unit to:
Parker Digiplan Ltd.,
21, Balena Close,
Poole,
Dorset,
England.
BH17 7DX

⑤ Elsewhere: Contact the distributor who supplied the equipment.

Parity
An RS-232C error detection scheme which can detect an odd number of transmission errors.

Pulse Rate
The frequency of the step pulses applied to a motor driver. The pulse rate multiplied by the resolution of the motor/drive combination (in steps per revolution) yields the rotational speed in revolutions per second.

Relative Accuracy
Also referred to as *Step-to-Step Accuracy*, this specification tells how microsteps can change in size. In a perfect system, microsteps would all be exactly the same size, but drive characteristics and the absolute accuracy of the motor cause the steps to expand and contract by an amount up to the relative accuracy figure. The error in not cumulative.

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 required for a motor's shaft to rotate one complete revolution.

RS-232C
A data communications standard that encodes a string of information on a single line in a time sequential format. The standard specifies the proper voltage and timing requirements so that different manufacturers' devices are compatible.

Speed
Used to describe the linear or rotational velocity of a motor or other object in motion.

Stiffness
The ability to resist movement induced by an applied torque. Is often specified as a torque displacement curve, indicating the amount a motor shaft will rotate upon application of a known external force when stopped.

Text/Echo (Off/On)
This setup allows received characters to be re-transmitted back to the original sending device. Echoing characters can be used to verify or "close the loop" on a transmission.

TTL
Transistor-Transistor Logic. Describes a common digital logic device family that is used in most modern digital electronics. TTL signals have two distinct states that are described with a voltage—a logical *zero* or *low* is represented by a voltage of less than 0.8V and a logical *one* or *high* is represented by a voltage from 2.5V to 5V.

Appendices

Glossary

Absolute Positioning
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.

Absolute Programming
Refers to a motion control system employing position feedback devices (absolute encoders) to maintain a given mechanical location.

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.

Address
Multiple devices, each with a separate address or unit number, can be controlled on the same bus. The address allows the host to communicate individually to each device.

Ambient Temperature
The temperature of the cooling medium, usually air, immediately surrounding the motor or another device.

ASCII
American Standard Code for Information Interchange. This code assigns a number to each numeral and letter of the alphabet. In this manner, information can be transmitted between machines as a series of binary numbers.

Baud Rate
The number of bits transmitted per second. Typical rates include 300, 600,1200, 2400, 4800, 9600, 19,200. This means at 9600 baud, one character (-10 bits) can be sent nearly every millisecond.

BCD
Binary Coded Decimal is an encoding technique used to describe the numbers 0 through 9 with four digital (on or off) signal lines. Popular in machine tool equipment.

Block Diagram
A simplified schematic representing components and signal flow through a system.

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. Characters are stored as bytes.

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.

DCE
Data Communications Equipment transmits on pin three and receives on pin two of a 25-pin D connector.

DTE
Data Communications Equipment transmits characters on pin two and receives on pin three of a 25-pin D connector.

Efficiency
The ratio of power output to power input.

Encoder
A device which translates mechanical motion into electronic signals used for monitoring position or velocity.

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).

Full Duplex
The terminal will display only received or echoed characters.

Half Duplex
In half duplex mode, a terminal will display every character transmitted. It may also display the received character, resulting in double character displays.

Hand-Shaking Signals
RST: Request To Send
CTS: Clear To Send
DSR: Data Set Ready
DTR: Data Terminal Ready
IDB: Input Data Buffer
ODB: Output Data Buffer

Home
A reference position in a motion control system, usually derived from a mechanical datum. Often designated as the *zero* position.

Inertia
A measure of an object's resistance to a change in velocity. The larger an object's inertia, the larger the torque that is required to accelerate or decelerate it. Inertia is a function of an object's mass and its shape.

Inertial Match
For most efficient operation, the system coupling ratio should be selected so that the reflected inertia of the load is equal to the rotor inertia of the motor.

Logic Ground
An electrical potential to which all control signals in a particular system are referenced.

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.

Multiplexing
A method of linking several parallel output devices into a single unit and reading only one unit at a time. This mode of operation involves input/output handshaking. It allows the host to communicate with multiple units while requiring fewer inputs and outputs.

Null Modem
A simple device or set of connectors which switches the receive and transmit lines of a three wire RS-232C connector.

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
Refers to a motion control system where no external sensors are used to provide position or velocity correction signals.

OPTO-Isolated
A method of sending a signal from one piece of equipment to another without the usual requirement of common ground potentials. The signal is transmitted optically with a light source (usually a Light Emitting Diode) and a light sensor (usually a photosensitive transistor). These optical components provide electrical isolation.

Parallel
Refers to a data communication format wherein many signal lines are used to communicate more than one piece of data at the same time.

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