Compumotor

Model 172 Indexer User Guide

Compumotor Division
Parker Hannifin Corporation
p/n 88-001023-03 Y

APPLICATION NOTE: Dealing With Electrical Noise

Compumotor Corporation®
June, 1986

Noise related difficulties can range in severity from minor positioning errors to damaged equipment from runaway motors crashing blindly through limit switches. In microprocessor controlled equipment, the processor is constantly fetching instructions from memory in a controlled sequence. If an electrical disturbance occurs, it could cause the processor to misinterpret an instruction, or fetch the wrong data. This is likely to be catastrophic to the program, requiring a processor reset. Later Compumotor indexers are designed with a watchdog timer that shuts down the system if the program is interrupted. This at least prevents the more catastrophic failures.

Sources of Noise

Being invisible, electrical noise can be very mysterious, but it invariably comes from the following sources:

- Power Line Disturbances
- Externally Conducted Noise
- Transmitted Noise
- Ground Loops

Certain widely used electrical devices are notorious for generating electrical noise conditions.

- Coil driven devices: Conducted and Power line noise
- SCR fired Heaters: Transmitted and Power line noise
- Motors and Motor Drives: Transmitted and Power line noise
- Welders (electric): Transmitted and Power line noise

Power line disturbances are generally easy to deal with due to the wide availability of line filtering equipment for the computer industry. Only the most severe situations call for an isolation transformer. Line filtering equipment is called for when other devices connected to the local power line are switching large amounts of current, especially if the switching takes place at high frequency. Corcom is one manufacturer of suitable power line filters.

Also, any device having coils is likely to upset the line when switched off. Surge suppressors such as MOV's (General Electric) are widely available to limit this kind of noise. A series RC network across the coil is also effective, (resistance; 500 to 1,000 Ω, capacitance; 0.1 to 0.2 µF). Coil driven devices include relays, solenoids, contactors, clutches and brakes.

Externally conducted noise is similar to power line noise, but the disturbances are created on signal and ground wires connected to the indexer. This kind of noise can get onto logic circuit ground or into the processor power supply and scramble the program. The problem here is that control equipment often shares a common DC ground which may run to several devices, such as a DC power supply, programmable controller, remote switches and the like. When some noisy device, particularly a relay or solenoid, is on the DC ground, it may wreak havoc with the indexer.

The solution for DC mechanical relays and solenoids involves connecting a diode backwards across the coil to clamp the induced voltage "kick" that the coil will produce. The diode should be rated at 4 times the coil voltage and 10 times the coil current. Using solid state relays eliminates this effect altogether.

Multiple devices on the same circuit should be grounded together at a single point.

Furthermore, power supplies and programmable controllers often have DC common tied to Earth (AC power ground). As a rule, it is preferable to have indexer signal ground floating with respect to Earth. This prevents noisy equipment which is grounded to Earth from sending noise into the indexer. When floating the signal ground is not possible, the Earth ground connection should be made at one point only as discussed in "Ground Loops" below.

In severe cases, optical isolation may be required to completely eliminate electrical contact between the indexer and a noisy environment. Solid state relays provide this isolation. Solid state relay manufacturers include Crydom, Potter-Brumfield and Opto-22 among others.

Transmitted Noise is picked up by external connections to the indexer, and in severe cases can attack an indexer with no external connections. The indexer enclosure will typically shield the electronics from this, but openings in the enclosure for connections and front panel controls may "leak". As with all electrical equipment, the indexer chassis should be scrupulously connected to Earth to minimize this effect.

When high current contacts open, they draw an "arc", producing a burst of broad spectrum radio frequency noise that can be picked up on indexer limit switch or other wiring. High current and high voltage wires have an electrical field around them, and may induce noise on signal wiring, especially when they are tied in the same wiring bundle or conduit.

When this kind of problem occurs, it is time to think about shielding signal cables or isolating the signals. A proper shield surrounds the signal wires to intercept electrical fields, but this shield must be tied to Earth to "drain" the induced voltages. At the very least wires should be run in "twisted pairs" to limit straight line antenna effects.

Most Compumotor cables have shields tied to Earth, but in some cases the shields must be grounded at installation time, as withthe 150 and 430 drive cables. Installing the indexer in a NEMA electrical enclosure insures protection from this kind of noise, unless noise producing equipment is also mounted inside the enclosure. Connections external to the enclosure must be shielded.

Even the worst noise problems, in environments near 600 amp welders and 25kW transmitters have been solved using enclosures, conduit, optical isolation, and single point ground techniques.

Ground Loops are the most mysterious noise problems. They seem to occur most often in systems where a control computer is using RS-232C communication. Symptoms like garbled transmissions and intermittent operation are typical.

The problem occurs in systems where multiple Earth ground connections exist, particularly when these connections are far apart.

Example: Suppose a model 2100 is controlling an axis, and the limit switches use an external power supply. The 2100 is controlled by a computer in another room. If the power supply Common is connected to Earth, the potential exists for ground loop problems. This is because most computers have their RS-232C signal common tied to Earth. The loop starts at 2100 limit switch ground, goes to Earth through the power supply to Earth at the computer. From there, the loop returns to the 2100 through RS-232C signal ground. If a voltage potential exists between power supply Earth and remote computer Earth, ground current will flow through the RS-232C ground creating unpredictable results.

The way to test for and ultimately eliminate a ground loop is to lift or "cheat" Earth ground connections in the system until the symptoms disappear.

Defeating Noise

The best time to handle electrical noise problems is before they occur. When a motion system is in the design process, the designer should consider the following set of guidelines for system wiring in order of importance:

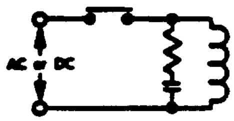
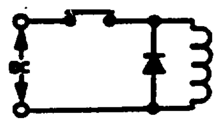
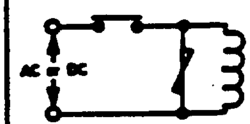
1. Put surge suppression components on all electrical coils: Resistor/capacitor filters, MOV's, Zener and clamping diodes.
2. Shield all remote connections, use twisted pairs. Shields should be tied to Earth at one end.
3. Put all microelectronic components in an enclosure. Keep noisy devices outside, watch internal temperature.
4. Ground signal common wiring at one point. Float this ground from Earth if possible.
5. Tie all mechanical grounds to Earth at one point. Run chassis and motor grounds to the frame, frame to Earth.
6. Isolate remote signals. Solid state relays or opto isolators are recommended
7. Filter the power line. Use common RF filters, Isolation transformer for worst case

A noise problem must be identified before it can be fixed. The obvious way to approach a problem situation is to eliminate potential noise sources until the symptoms disappear, as in the case of ground loops. When this is not practical, use the above guidelines to "shotgun" the installation. The odds are good that a general approach to good wiring will nail the problem.

References: Information about the equipment referred to in the article may be obtained by calling the numbers listed below.

Corcom line filters, (312) 680-7400
Opto-22 optically isolated relays, (714) 891-5861
Crydom optically isolated relays, (213) 322-4987
Potter Brumfield optically isolated relays, (812) 386-1000
General Electric MOV's, (315) 456-3266

COIL SUPPRESSION METHODS

RC	DIODE	VARISTOR (MOV)
		
1. Can be used for both AC and DC circuits. 2. Use 500–1000Ω for r and 0.1–0.2μF @ 200V for c in a general 12V load circuit.	For DC circuits only	Can be used for both AC and DC circuits.

172 INDEXER OPERATOR'S MANUAL
Compumotor Corporation
P/N 88-001023-03
June 13, 1986

Table of Contents

1. Description

The Compumotor Model 172 Preset Indexer is a single board programmable pulse generator for controlling stepping and microstepping motor translators. The 172 utilizes microprocessor architecture and large scale intergrated circuits to keep the parts count low for reliability, while allowing extraordinary flexibility in application.

Control inputs include thumbwheel switches for preset programming of motor output shaft acceleration, velocity, and position, as well as a fully parallel BCD computer interface. The Model 172 is offered in configurations for integration into OEM equipment.

2. Inspection

Carefully inspect the shipping carton for any evidence of physical abuse or damage. Report any such findings to your carrier immediately as well as to your receiving department. Compumotor Corporation cannot be held resonsible for in-transit damage.

Unpack the shipping carton and inspect the Model 172 Indexer and AC adapter for any damage, cracks, broken parts or damaged cables. Save the packing materials until the inspection and functional checks have been completed.

3. Initial Set-up

See Appendix A

4. Powering The Model 172

The Indexer Models 172D and 172A are supplied with instrument cases and a plug-in AC adaptor. The AC adaptor provides 10 VAC at 1500 mA to the on-board rectifiers and voltage regulators.

The circuit card version, Model 172X, requires 9-12 VAC or VDC between J6 Pin 4 and J6 Pin 1. When powering the 172X from DC supplies, J6 Pin 4 connects to +9-12 VDC and J6 Pin 1 connects to DC ground. The nominal current consumption is 1500 mA.

5. Functional Check

The following procedure presumes availability of a motor and a stepper or microstepping translator to test the response of the Model 172 Preset Indexer to various inputs.

Proper outputs from the Model 172 can be verified in the absence of a test motor and driver with a frequency counter, accumulating pulse counter, and oscilloscope.

Make the following setting on the Front Control Panel:

1. Preset/Cont to Preset
2. Abs/Inc to Inc
3. Accel to 10
4. Velocity to 1000
5. Steps to +0050000 (corresponding to 50,000 motor pulses with the factory set internal DIP switch values. See Appendix A.)

Connect oscilloscope ground to the 86-Pin rear connector (J1) GND, Pin #44 ("A" on AMP connector). Connect the oscilloscope input to Step, Pin #1 ("1" on AMP connector).

Pressing Start will initiate a nominal 5V pulse train which increases in frequency during acceleration. This is followed by an interval of constant frequency pulses corresponding to a constant velocity output, followed by decreasing frequency during deceleration. Note that the same pulse output will be observed (inverted) on the CW Step (J1 Pin 4) if there is an appropriate pullup resistor on this open-collector output.[1] The move takes about 2 seconds.

A constant velocity, obtainable by switching fron "Preset" to "Cont", can be measured with a frequency counter. The velocity setting (in revolutions per second) selects output frequencies (in KHz) which are equivalent to the motor resolution (in steps per revolution) multiplied by the velocity. For example, a frequency of 100 KHz is generated to rotate a 25,000 step per revolution Compumotor at a velocity of of 4 revolutions per second (25,000 PPR x 4 RPS = 100,000 PPS). In general, Velocity x motor resolution = output pulse frequency.

In the case of a 25,000 step per revolution Compumotor, the Model 172 Indexer will produce exactly 25,000 pulses for a 1 revolution movement, independent of velocity and acceleration settings. The number of pulses produced is equal to the front control panel step thumbwheel settings x the internal "number of pulses per least significant digit" DIP switch. In this case, a value of 1, the factory setting,

---

[1] This Pullup resistor (1K ohm for example) should be connected between the CW Step output and +5V (J1 Pin 10; "10" on AMP connector) for this test.

has been assigned to the LSD.

Verify that the Direction output (J1 Pin 2) changes from nominal +5V to nominal 0V if a move in the "+" direction is repeated in the "-" direction.

In the case of CW Step and CCW Step, pulse output should be active on CCW Step (J1 Pin 5) if "-" is selected. Conversely, if "+" is selected, the pulse ouput on CCW Step will cease and CW Step (J1 Pin 4) will be active. These two outputs are open-collector, and need pullup resistors in order to be seen on an oscilloscope.

The In Position output should be low (0V) while the Indexer is not producing output on any of the Step lines when in the Preset mode. Like the CW Step, CCW Step output. In Position is an open collector output.

In the Continuous and Preset Modes, the Constant V output is low (0V) during acceleration and deceleration, and goes high (+5V) when constant velocity or zero velocity is reached.

6. Installation and Operation

6.1. Introduction

The Model 172 has been designed with a special capability for those wishing to interface the indexer to a computer or programmable controller. While all Front Control Panel Command and Data inputs are available on the main rear connector (J1), only the functions you wish to control remotely or only the specific digits in those functions, need to be interfaced. Typically, Acceleration and Velocity are set on the Front Control Panel and Direction and the significant digits of Position are controlled remotely. All remote applications require Start, Stop and the extreme travel limits to be connected, of course. (Limits may not need to be connected for some rotary applications).

6.2. Getting Started

To get started, it is suggested that the Indexer be operated fron the Front Control Panel. If the motor being used for test is connected to a limited-travel mechanism, it is strongly recommended that the two extreme travel limit switches be connected prior to initiating any test.

6.3. Connecting Limits

Determine which end of the mechanism the load is to be moved when the motor shaft is rotating in the clockwise direction. Shaft direction is referenced by looking at the flange end of the motor. Mount a limit switch which will be actuated by the load at least 1/2" (12mm) from the mechanical end of travel. Wire the common line of the limit switch to J1 Pin 86 (AMP "Y"). Wire the normally open line to J1 Pin 85 (AMP "X").

In a similar fashion, mount and connect the counterclockwise limit switch, with common to J1 Pin 43 (AMP "43") and the normally open line to J1 Pin 42 (AMP "42"). CAUTION: NEVER connect frame ground (third wire ground) to logic ground. For example, it is frequently easier to ground limit switches to the frame of a machine than to run an extra wire from the limit switches to the indexer. This practice can cause erratic and unpredictable motor movement, and should be avoided at all costs.

The above limit connections are TTL compatible inputs with internal 1K ohm pullups. Switch closures, open collector pulldowns, or active loww TTL signals may be used to actuate either limit input. All limit cables should be shielded and that shield should connect to earth (case) ground - NOT logic ground.

6.4. Connecting The Motor

Stepping and microstepping translators are of two general types: those accepting TTL Step and Direction inputs and those using an open collector CW Step line and CCW Step line. The Model 172 nominally produces +4.5VDC pulses ("Logic 1") on the Step line with pulse widths and frequencies as specified in Appendix E (referenced to GND).

The Direction line is a TTL level: CW = logic "1" and CCW = logic "0". In the case of both Step and Direction, Logic "1" sources a maximum of 60mA and Logic "0" sinks a maximum of -60 mA (referenced to ground).

For the open collector CW and CCW outputs, the unit is capable of sinking up to -300 mA at up to 40 VDC (referenced to ground).

Before Proceeding: If a Compumotor Motor/Driver is not being used, check that the electrical specifications of the Model 172 and the translator are compatible. Compumotor Corporation cannot be responsible for damage due to mismatch.

The translator may be wired either to the main rear panel connector (J1) or to J4, a 9-Pin locking Ramp connector.

Refer to the information supplied with your translator and make the connections as follows:

		J1 Pin #	AMP #	J4 Pin #
Step and Dir Input	Step	1	1	9
	Direction	2	2	8
	GND	44	A	4
	GND	45	B	5

		J1 Pin #	AMP #	J4 Pin #
CW and CCW Input	CW Step	4	4	2
	CCW Step	5	5	1
	GND	47	D	4
	GND	48	E	5

To confirm proper connection operation of the Indexer, cranslator, motor and associated mechanism, proceed as follows:

1. Confirm that the proper settings for the desired number of Steps per LSD and for motor/translator resolution have been set. The settings on the number of pulses per LSD dipswitch (S1) determines the number of pulses produced for a given front panel or remote setting. The motor/translator resolution dipswitch (S2) must be matched to the translator being used to ensure acceleration and velocity calibration. (See Appendix A).

2. Set the Front Control Panel switches to

    a. Preset/Cont to Preset
    b. Abs/Inc to Inc
    c. Accel to 05
    d. Velocity to 0010
    e. Steps to +0000100 (assuming a 200 steps per revolution 1 step/LSD) or a value equal to 1/2 of a complete motor revolution.

3. Press Start

4. Observe the direction of motion of the motor shaft (it should be clockwise when viewed from the flange end of the motor) and observe the direction in which the mechanism moves. If the mechanism is of the limited travel variety, check that the load moves toward the CW

limit. It is very important that the limit switches be wired correctly. (See Appendix G).

5. Change only the direction digit on the Steps input to "-". Press Start again and confirm that the motor and mechanism actually reverses and that the CCW limit switch is being approached.

6. Change Preset/Cont to Cont. Press Start and let the mechanism slowly approach one of the limit switches. Be prepared to press Stop if the limit switch fails to stop the motor.

7. Confirm the proper operation of the opposite limit switch by changing direction and pressing Start.

After these tests have been performed, exercise the system over a wide range of acceleration, velocity and position commands. Check that the set-up parameters for resolution, pulses per LSD, Velocity range and Acceleration range all give the expected performance at the requisite load level for the settings on the Front Control Panel. Check that the open collector In Position output on J1 Pin 6 (AMP "6") goes low at the end of each move. Every time the motor reaches constant constant velocity in the continuous mode, the constant velocity output on J1 Pin 12 (AMP "12") goes high. This is an indication that a new acceleration and velocity may be programmed and Start may be pressed. The Start switch is ignored during acceleration and deceleration.

Select a location for the Home limit switch. The typical loacations are: center of travel or at either end of travel just inside the extreme end of travel limit switches. Mount the switch and connect common to J1 Pin 48 (AMP "E"). The normally open line is connected to J1 Pin 55 (AMP "N").

Before verifying the Go Home operation, set the Go Home velocity, acceleration and function in the desired manner. Refer to Appendix A, Section 5.

Select either Go Home + (CW) or Go Home - (CCW) depending on the direction sense established, and on the current position of the load relative to the Home Limit. It is important to note that an acceleration must be defined in order to execute a Go Home move.

It is important that limit switches be connected for this test, in case the wrong Go Home direction is selected. If the unit encounters a limit, the motor will reverse at the limit switch and continue to seek the Home position.

Check that the velocity in the Go Home mode is as expected and that the operation at the Home Limit is as programmed (Backoff, No Backoff, Backoff Direction). While the mechanism is going to the Home Position, the open collector GOING HOME output, J1 Pin 8 (AMP "8") should be low. When Home is reached, this line should go Open and the open collector AT HOME Output J1 Pin 9 (AMP "9"), should go low.

6.5. Remote Power Shutdown

If the motor and translator system being used is a Compumotor system, the Remote Power Shutdown (amplifier disable) function may be controlled through the Model 172. Asserting a Logic "0" (switch closure, TTL "low" lwvel, etc.) on J1 Pin 56 (AMP "P") will produce a nominal 5V (at 60 mA) level on J4 Pin 3 and J1 Pin 3 (AMP "3"). These two signals are known as SHUTDOWN IN and SHUTDOWN OUT respectively. A Logic "0" on SHUTDOWN IN will immediately disable a Compumotor motor/driver, and cause the shaft to free-wheel. Precise position of the shaft may be lost during a shutdown, and unpon re-enabling SHUTDOWN IN (Logic "1") the shaft may have moved if the frictional torque of the load is less than approximately 5% of the motor's rated torque. SHUTDOWN IN has a 1K ohm pullup resistor and will ensure that the motor is always enabled if this input is not utilized.

6.6. External or Computer Interface

There are two classes of inputs on the 172: Control and BCD Data. Since the 172 supports a mixed mode of operation, allowing some functions and/or values to be set on the Front Control Panel and others to be set by computer, specific front panel settings are required to allow computer control of a given function. These settings are listed below:

Control settings which allow External or Computer control:

1. Preset/Cont. to Preset
2. Abs/Inc to Inc
3. Direction to "-"

Data settings for external or computer control.

All BCD digits to be controlled must be set to "0".

Before proceeding, review the functions you wish to control ove the computer interface. The four decades of velocity and the seven decades of position data are probably excessive for many applications. In those cases, some of the least or most significant digits may not have to be connected. Any function not specifically controlled by the computer interface may be controlled manually. Appendix D shows a method for interfacing several digits to an 8 bit data bus.

<u>Control Inputs</u>

Start: This TTL level input initiates a pre-programmed move on a low level input. It must remain low for at least 10 microseconds to be recognized. The Indexer reads the Acceleration, Velocity, and Position data and executes the move. There is approximately a 30 msec delay between Start and move initiation. If the Acceleration or Velocity thumbwheels are set to zero in the Preset mode, no move will occur. The Start input also allows changing velocities when in the continuous mode. The Start command may be generated either by the Front Control Panel switch or by grounding J1 Pin 49 (AMP "F").

Stop: This TTL input initiates pre-programmed deceleration on a low level input. This input must remain low for at least 10 microseconds to be recognized. The rate of deceleration is determined exclusively by the Acceleration data present when the last Start command was received. It is possible to decelerate at a different rate only in the continuous mode, by setting velocity data to zero, setting the desired deceleration rate and initiating a Start. This data input is found on J1 Pin 50 (AMP "H").

CW Limit and CCW Limit: These two TTL active low inputs function as extreme travel limits. A low going edge on either of these inputs will stop pulse generation and terminate the move that was in progress. If either line remains low, the Indexer will accept only moves in the direction opposite the original direction of travel. This remains true until the limit is cleared, i.e., until the limit input goes high. CW Limit is J1 Pin 85 (AMP "X") and CCW Limit is J1 Pin 42 (AMP "42").

Note: Limit switches should be located ahead of the physical end of travel to allow for the deceleration time of the motor and load.

Preset/Cont: This input is paralleled by the Preset/Cont. switch and selects moves that are either a preset position (move distance x and then stop) or to a preset velocity (accelerate to a constant velocity and hold until stopped). This input is read by the indexer only when the Start command is received and only if the motor is not moving at the time. In Continuous mode, the position data lines are ignored and a Stop signal (or a start commanding a lower velocity) is require to initiate deceleration. Preset/Cont. is on J1 Pin 51 (AMP "J"). The mode will be Preset unless this line is grounded or the Front Control Panel mode switch is set to Cont. The front panel switch must be set to Preset for external control.

Direction: This thumbwheel input determines the direction of rotation of the motor output shaft. It is acknowledged only if the motor is stationary when the start command is received. The Indexer will ignore changes on the Direction input line before motor movement has been stopped. In the case where activation of a limit input has caused a stop, the Direction input must be reversed to back away from the limit. When J1 Pin 13 (AMP "13") is high, + or CW rotation is commanded. Holding this line low gives - or CCW rotation. The Front Control Panel Direction thumbwheel must be set to "-" for external control.

Inc/Abs: This command selects between the standard Incremental positioning and Absolute positioning. In incremental positioning, all distances are reference to the current position of the motor and the associated mechanism. The reference point for the absolute positioning is the Home position, which is defined to be zero. All CW moves from this position are arbitrarily labeled "+" and CCW moves "-". In other words, all CW moves cause the absolute position to increment, and all CCW absolute moves cause the absolute position counter to decrement. Inc/Abs is on J1 Pin 54 (AMP "K"). Note that the Indexer will execute incremental moves unless that line is grounded (setting the Front Control Panel Inc/Abs switch to Abs will also serve to ground this line). The front panel switch must be set to Inc for external control.

Note: The zero crossing inhibit function may only be used in absolute positioning mode.

GO HOME + or GO HOME -: These commands select the initial direction to be used in searching for the location of the Home Position. Both inputs are TTL Active Low which trigger the Indexer on the low-going edge of the input. GO HOME + is found on J1 Pin 53 (AMP "L") while GO HOME - is on J1 Pin 54 (AMP "M"). If the CW or CCW limits are encountered during a Go Home sequence, the motor will reverse direction once and attempt to seek the Home position.

NOTE: A Go Home move cannot be executed unless an acceleration has been defined.

HOME LIMIT: A switch closure to ground signals the location of the Home Position. This input is connected to J1 Pin 55 (AMP "N"). If you do not wish to use a Home limit switch in normal operation, this input may be grounded (activated) by turning Dip Switch S3 #7 ON.

With S3-7 ON, pressing HOME- or HOME+ will result in one of the following:

1. With S2-5 (Back off at Home limit) OFF, the motor does not move and home is redefined as the current position.

2. With S2-5 ON, the motor will search fruitlessly for a Home Limit transition until encountering in turn both CCW and CW limits. Therefore, DO NOT TURN ON BOTH S3-7 AND S2-5.

3. BCD Data Inputs

Each of the Control Panel 0-9 thumbwheels is connected in parallel with four data lines on J1. The coding of data is in the BDC (Binary Coded Decimal) format. The codes of the digits 0-9 are as follows:

BCD DATA LINES

	(2^0)	(2^1)	(2^2)	(2^3)
Value	1	2	3	4
0	Low	Low	Low	Low
1	High	Low	Low	Low
2	Low	High	Low	Low
3	High	High	Low	Low
4	Low	Low	High	Low
5	High	Low	High	Low
6	Low	High	High	Low
7	High	High	High	Low
8	Low	Low	Low	High
9	High	Low	Low	High

Combinations of data lines other than those shown here should not be used.

3. Driving the External Inputs

All inputs except Direction previously defined as Command inputs have "pull-up" resistors (1K ohms) and require grounding to change their status. This may be accomplished with standard TTL outputs, switches, relays, open-collector outputs or open collector transistors rated at 5 mA or more.

Data inputs and the direction input have "pull-down" resistors (4.7K ohms) and require switch closures to +5VDC (nominal 1 mA) to yield Logic "1". These inputs may be driven by buffered TTL outputs, switches, relays, or open emitter transistors. In practice, standard TTL outputs will drive the inputs; however, for reliable signal transmission over moderate to long cable lengths, buffered outputs consisting of 75174 (RS422 line drivers), or similar devices are recommended.

Sampled Command inputs (HOME LIMIT, GO HOME+, GO HOME-) must be held Low for at least 2 msec to be reliably received. Inputs which are read as a result of START being detected (Mode, Direction and BCD Data) must be stable for 2 msec from the leading edge of START.

Since data inputs must also be held constant for 2 msec from the leading edge of START, additional data latching circuitry may be required if the source computer cannot hold this data for that period. See Appendix D for a schematic example of a data latching interface.

7. Further Questions

Compumotor Corporation is dedicated to be a leader in digital motion control. We invite your problems, questions or comments.

Since all of our indexer products are microprocessor based, significant departures from the operating parameters outlined here are possible. If you have a volume requirement for our products (over 250 per year) we would like to discuss your specific needs.

Call or write:

Parker Compumotor
5500 Business Park Drive
Rohnert Park, CA 94928
(707) 584-7558 (800) 358-9068
RMA # ________________

In California call collect: (707) 778-1244
Outside California call toll free: (800) 358-9068

8. Specifications

Power Input

* 117 VAC, 50-60 Hz, 0.75A with supplied transformer
* 9-12 VAC, 50-400 Hz, 1.5A to edge connector J1
* 9-12 VDC unregulated 1.5A to edge connector J1

Command Inputs

Signal names: START, STOP, CW LIMIT, CCW LIMIT, RESET IN, GO HOME +, GO HOME -, HOME LIMIT

Electrical description: All are TTL compatible active low pulse inputs with 1K ohm pull ups and requires nominal 5mA closure to ground.

* Minimum Logic "0" input current = -5.0 mA
* Maximum Logic "0" input voltage = 0.75 VDC
* Minimum pulse width = 2 msec except START and STOP which require 10 microsec.

Direction, Mode and Position Programming Inputs

Signal names: DIRECTION, PRE/CONT, INCR/ABS

Electrical description: These TTL-compatible inputs have the electrical specifications shown above.
--Minimum DC signal duration is 2 msec following the leading edge of START.
--DIRECTION is clockwise (+) for Logic "1"; CCW (-) for Logic "0".
--PRE/CONT is CONTINUOUS for Logic "0"; PRESET for Logic "1".
--INCR/ABS is Absolute for Logic "0"; Incremental for Logic "1".

Data Inputs

Signal names: POSITION, ACCEL/DECEL, VELOCITY

Electrical description: There are 55 lines for parallel BCD data; each one has an input impedance of 4.7k ohm and each requires a nominal 1mA at 5 VDC for Logic "1".

* Minimal Logic "1" input current = 1mA
* Minimum Logic "1" input voltage = 2VDC
* Minimum data duration - 2 msec following the leading edge of START

POSITION[2]: 7 BCD Decades (28 lines)
Range = 1 to 9,999,999

VELOCITY[3]: 4 BCD Decades (16 lines)
Range = 1 to 9999

ACCELERATION: 2 BCD Decades (8 lines)
Range = 1 to 99

GO HOME VELOCITY: 8 selections (3 lines)
Range 0.1-20 rev.sec.

<u>Indexer Outputs</u>[4]

To Translator:

Signal names: STEP, DIRECTION, CW STEP, CCW STEP

Electrical description:
STEP: TTL Pulse Train (Nominal +3.5 VDC)
DIRECTION: TTL Level Output (Nominal +4.5 VDC)
"+" = CW = Logic "1"
"-" = CCW = Logic "0"

For STEP and DIRECTION Logic "1" = 60 mA maximum current source, Logic "0" = -60 mA maximum current sink

CW and CCW STEP: Open Collector, -300mA maximum at 40 VDC sink

To Computer or Programmable Controller:

Signal names: IN POSITION, CONSTANT V, GOING HOME, AT HOME, CANNOT MOVE

Electrical description:
All of the outputs to the computer except Constant V have these characteristics:

Open Collector: Logic "1", open circuit must be pulled up by external resistor.
Logic "0" Maximum current = -300mA max,

---

[2]See Appendix A for Scaling Information on Position Data Inputs.

[3]See Appendix F for ranges and precision.

[4]See Appendix E for pulse width and frequency.

max voltage 40 VDC.

CONSTANT V: TTl Output
Constant Velocity = Logic "1" (high) 3.5 VDC, +60mA minimum
Accellerating/Decelerating = Logic "0" (Low) 0.75 VDC Maximum, -60mA minimum

IN POSITION: Low = In Position or stopped
High = Moving to Position

CONSTANT V: High = at Constant V or stopped
Low = Accel or Decel

GOING HOME: Low = Searching for Home
High = Not Searching

AT HOME[5]: Low = At Home
High = Not at Home

CANNOT MOVE: Low = Cannot Move
High = Can Move

Physical Dimensions

Instrument Case (Model 172A or 172D)

Size:

	inches (centimeters)
width:	13.80 (35.0)
height:	2.25 (5.7)
depth:	10.00 (25.4)

Net Weight: 10 lbs. (4.5 kg) including AC Power Pak
Shipping Weight: 14 lbs. (6.4 kg) including AC PowerPak

Circuit Card Only (Model 172X)

Size:

	inches (centimeters)
width:	13.00 (33.0)
height:	1.75 (4.45)
depth:	7.30 (18.5)

Net Weight: 4lbs(1.8 kg) without AC Power Pak
Shipping Weight: 8 lbs. (3.6 kg) without AC Power Pak

---

[5]Valid only in the PRESET mode.

Appendix A: Switch Set-Up Parameters

1. Open the cover of the 172 and find the DIP switches marked S1, S2, and S3. Refer to the drawing in Appendix B for their locations.

2. S1: Setting the scale factor.

S1 determines the number of pulses sent to the translator for a "1" on the least significant Steps digit (LSD). The number of pulses sent to the motor drive is the product of the value set on this DIP switch and the front panel (or BCD interface). This DIP switch comes from the factory set for 1 step/LSD. Numbers up to 255 may be programmed to tailor the resolution of your stepping motor translator to the system resolution you desire.

For example, if a motor/driver combination has a resolution of 6400 steps per revolution, a setting of 1 step/LSD is will yield a system resolution of 6400. If 2 steps/LSD is selected, 3200 will be the system resolution. A system resolution of 640 positions per revolution will result from selecting 10 steps/LSD.

Table A-1A gives the system's resolution possibilities with common microstepping translators and table A-1B with Compumotors. The value represented by S1 is the sum of the values of the ON switches on S1, as shown in Appendix B.

Note: The velocity and acceleration are scaled only to the motor resolution selected. The number of steps per LSD has no effect on the set velocity and acceleration parameters.

3. S2 #1-4: Setting Motor Resolution

In order to properly scale the values of velocity and acceleration, the Model 172 needs to know the number of steps per revolution of the motor/translator combination. Determine the proper switch setting parameters from Table A-3 and program them on S2 #1-4.

4. S3 #4: Setting the Velocity Range

The four decades of velocity may be defined as follows:

S3 #4: OFF:	0.01-99.99 rev/sec. (0.60-5999.4 RPM)	High velocity range
S3 #4: ON:	0.001-9.999 rev/sec. (0.06-599.94 RPM)	Low velocity range

Note: Some combinations of velocity range and motor resolutions will vary these ranges. In particular, the high end of the velocity range will be lower for some motor resolutions. If the velocity setting is too large for the given motor resolution, the indexer will ignore the "Start" request. Refer to Appendix F.

5. S3 #5-6: Setting the Acceleration Range

The Model 172 is programmed to provide linear accelerations and decelerations.

Four ranges are available (units are revs/sec/sec):

	S3	
	5	6
0.01-0.99	ON	ON
0.1-9.9	ON	OFF
1-99	OFF	OFF
10-990	OFF	ON

6. S2 #5-7, S3 #1-3, S3 #7: Settings for GO HOME Functions

The Go Home velocity is selected by DIP switches 1-3 of S3 as described in Table A-4. The switches are read at the beginning of each Go Home move. Determine the proper Go Home velocity for your particular application, and enter the velocity code from Table A-4 in the appropriate DIP switches on S3.

The Go Home acceleration is read from the acceleration thumbwheels and range DIP switches at the beginning of each Go Home move, as in a normal move. If no value is set, the go home move is not executed.

The options for Home Limit actuation are described below:

6.1. S3 #5: OFF/ON, No Backoff/Backoff at Home Limit switch

Note: S3 #7 and S2 #5 must not be on at the same time.

6.1.1. NO BACKOFF: When this switch is OFF, the motor will begin deceleration as soon as the Home Limit input goes Low.

a. If the Home Limit is still low at the end of deceleration, that end position becomes Home.
b. If, however, the deceleration causes the motor to run

past the home Limit, the motor will reverse direction and move until the Home Limit goes Low again.

With no Backoff, the home position depends on the direction of approach, the velocity, the acceleration, and the Home Limit width, but is repeatable if these factors are unchanged. This allows finding the Home position in the shortest amount of time.

6.1.2. BACKOFF: Selecting the Backoff at Home Limit function by turning S2 #5 On will cause the motor to:

a. Stop upon finding Home.
b. Back off of Home in the direction specified by S2 #6.
c. Creep toward Home until the Home input just goes Low.

This method produces very repeatable results with accuracy, typically better than the hardware device providing the Home signal. Repeatability is independent of set acceleration, velocity, and distance parameters.

When S2 #5 in On (backoff on), S2 #6 determines the direction the motor backs off the Home position. This means that the motor will finally creep toward the Home limit in the direction <u>opposite</u> that selected by S2 #6.

6.2. S2 #7: OFF/ON: Enable/Inhibit Home Crossing

A dip switch (S2: #7) allows restriction of preset moves to those which result in an absolute position on the selected side of the home position, regardless of the current position. It does not restrict continuous moves.

The selected side of home position is defined by the absolute position at the end of the first preset move following power up or successful Go-Home. The selected side of home is determined regardless of the position of switch (S2: #7). The moves are restricted only if the switch is on.

6.3. GO HOME Summarized

The following examples and graphs summarize the 172 Indexer's Go Home function. All the graphs show the same Go Home direction, but a Go Home move started from the other side of home would look like a mirror image of the graphs. It is important to note that the different Go Home profiles do not depend on the Go Home direction or Backoff direction, but only on whether the directions are the same or different.

The graphs illustrate velocity on the vertical scale and distance and time on the horizontal scale. The scales are not precise, but are intended to illustrate the motion of the motor. The horizontal scale is linear with respect to time to illustrate the ramp and triangular acceleration. The solid lines represent forward motion of the motor, and the dashed lines represent backward motion. The vertical scale is offset for the dashed lines and exaggerated for the small velocities for clarity.

Selecting the Backoff function causes the controller to select one edge or the other of the Home Limit, as selected by the Backoff direction. GO HOME + causes a clockwise move, GO HOME - causes a counter- clockwise move. If the Go Home direction and the Backoff direction are the same, the far edge of the Home Limit is selected. If these directions are opposite, the near edge of the Home Limit is selected.

6.3.1 Home Backoff Description

6.3.1.1 If the Backoff function is not enabled the controller will move to the closest position to the end of the deceleration that is within the Home Limit.

a. If the deceleration runs through the Home Limit, the controller will move back to the closest edge. This is shown in Graph 1.
b. If the deceleration ends within the Home Limit, then this position will be the final position. This is shown in Graph 2.

6.3.1.2. If the Backoff function is enabled the controller will search for the approximate position of the desired edge at the Go Home velocity and stops. If the deceleration results in a position further than 0.1 rev from the desired edge, the motor will make a triangular move to a position 0.1 rev from the approximate edge position and then creep into the actual edge.

6.3.1.3. If the Backoff function is enabled and the selected home edge is on the far side of the Home Limit from the current position, the motor will continue through the Home Limit and begin deceleration at the rising edge of the Home input.

The motor moves 0.01 revolution after the detection of the falling edge before looking for the rising edge. This is to prevent the controller from interpreting a noisy or fuzzy falling edge as the entire Home Limit width (Graph 3).

a. If the falling edge of the Home input is wider than 0.01 revolution, the motor may begin deceleration on the falling edge instead of moving through the Home

Limit before deceleration (Graph 4).

b. If the entire Home Limit is narrower than 0.01 revolution, deceleration will begin 0.01 revolutions after the first edge (Graph 5).

6.3.1.4. If the Backoff function is enabled and the near edge is selected, the controller will begin deceleration when the Home Limit is first encountered. Regardless of where the deceleration ends, the motor will reverse and approach that edge as described above. This results in a longer Go Home sequence, but ensures repeatable edge approach from either side of Home, even with a large hysteresis.

6.3.2. The above examples have all referred to a Home Limit with no hysteresis. In Graph 6, some hysteresis is present. The dashed lines show the Home Limit shift due to hysteresis.

6.3.3 Two possibilities exist if the Home input is low when the Go-Home button is pushed:

a. If the Backoff function is not selected, no move will be made, but Home will be defined as the current position.

B. If the Backoff function is selected the motor will move to the selected edge, regardless of which GO HOME (+ or -) was pushed and begin deceleration on the rising edge of the Home input (Graph 7). Just as in any Go Home move, if the deceleration condition is met before Go Home velocity is attained, deceleration will begin.

6.4. Home Position Repeatability

6.4.1. Repeatability of Home searches was tested with the following apparatus. A 25,000 step/rev Compumotor was mounted to a 2-pitch lead screw which moved an x-stage along Thompson shafts. A 4,800 position encoder was mounted to the other end of the lead screw, giving an approximate resolution of 0.1 mil. A computer continuously read and displayed the encoder position values. Two different methods were used to generate Home Limit inputs.

1. a microswitch mounted along the path of travel was depressed when the table passed; and
2. an optical detector mounted along the path of travel was covered when the table passed.

6.4.2. Before Home position repeatability tests were performed, it was found that there was a region of approximately 2 mils in which the Home Limit signal generated by the optical detector was oscillating between High and Low. Home repeatability tests were performed at the extreme High and Low values of velocity and acceleration for both the microswitch and the optical detector. It was found that the repeatability was independent of velocity or acceleration for both the microswitch and the optical detector.

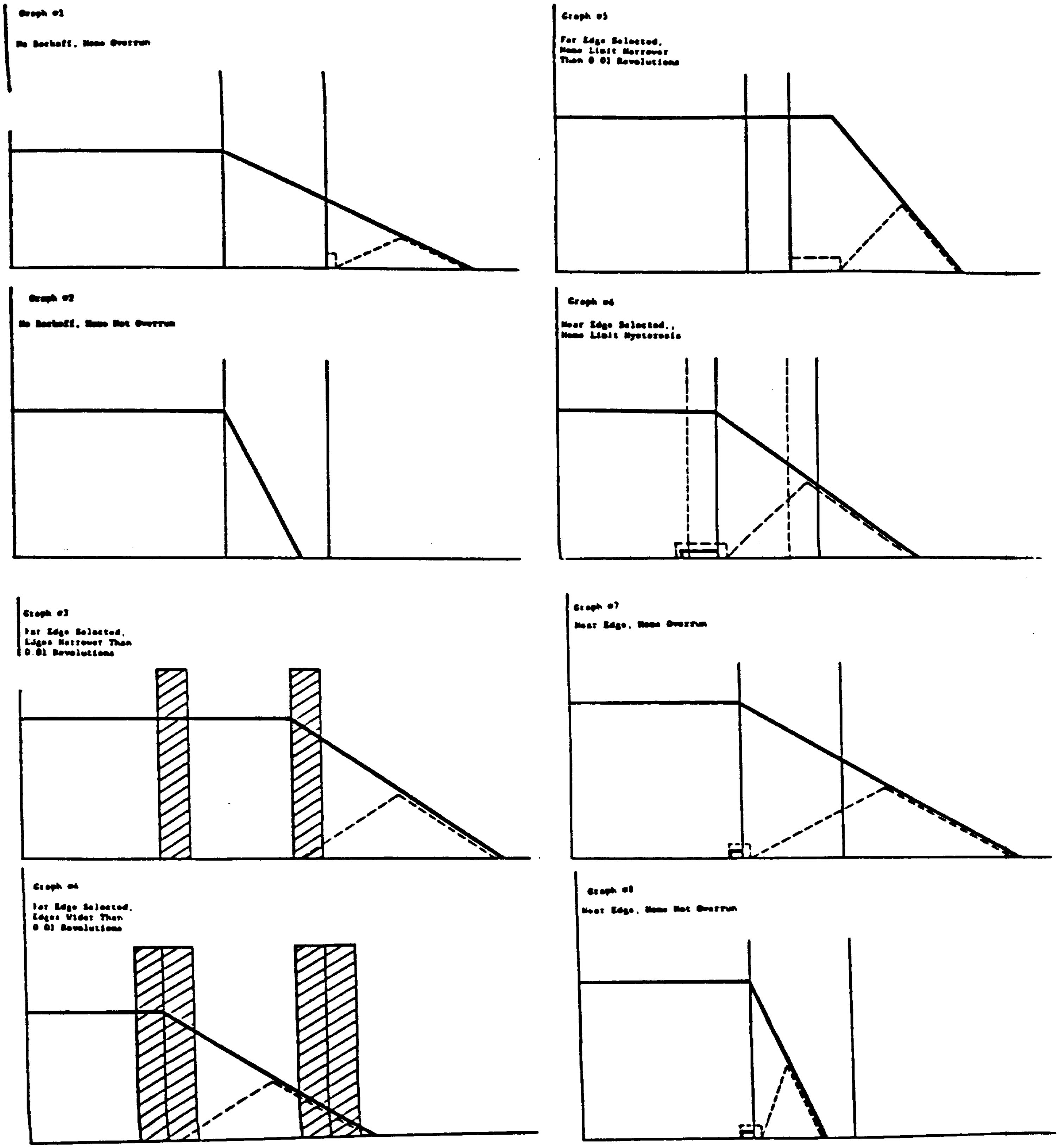
6.4.3. The optical detector readings were repeatable to about +/-0.5 mils. This range is narrower than might be expected from a 2 mil oscillation zone, but is reasonable because the motor approached the 2 mil oscillation zone from the same direction each time.

6.4.4. The microswitch readings were repeatable to about +/- 0.1 mil.

6.4.5. The above tests were repeated with a 200 PPR motor using the same apparatus. This gave a linear resolution of 2.5 mils/step. At velocities about 5 to 7 RPS the motor had a large amount of resonance which caused erroneous position readings. With relatively large accelerations these velocities were passed quickly and did not affect the accuracy of the position readings.

6.4.5. It was found that both the microswitch and the optical detector gave Home position repeatability to 0.1 mil, the resolution of the encoder. This was expected, because the variations in position noticed with the 25,000 PR motor were smaller than the resolution of the 200 PPR motor.

The controller has been designed to detect the Home input to the exact count for any motor resolution. It was concluded that the above repeatability reflects the mechanical limitations which can be expected from typical Home Limit generation techniques.


Graph #1
No Backoff, Home Overrun
Graph #5
Far Edge Selected,
Home Limit Narrower
Than 0.01 Revolutions
Graph #2
No Backoff, Home Not Overrun
Graph #6
Near Edge Selected,,
Home Limit Hysteresis
Graph #3
Far Edge Selected,
Edges Narrower Than
0.01 Revolutions
Graph #7
Near Edge, Home Overrun
Graph #4
Far Edge Selected,
Edges Wider Than
0.01 Revolutions
Graph #8
Near Edge, Home Not Overrun

7. Settings for Model 717 Display Option

If the Position Display Option is installed, S2 #8 determines whether the display is zeroed prior to each move. The display is always zeroed when the "At Home" output is activated (goes Low). If the accumulated position is to be displayed, set S2 #8 to ON. If single move distances are desired, set S2 #8 to OFF.

Refer to the Position Display Manual for internal switch settings and detailed counter operation.

TABLE A-1A

SYSTEM RESOLUTION POSSIBILITIES
USING NON-COMPUMOTOR MICROSTEPPING TRANSLATORS

Desired System Resolution (Steps Per Rev.)	Select this Motor/ Translator Resolution (Steps per Rev.)(S2)	Program This Number of Steps/LSD(S1)
640	6400	10
720	7200	10
1000	2000	2
1080	10800	10
1280	12800	10
1440	7200	5
1000	1000	1
1800	7200	4
2000	2000	1
2160	10800	5
2500	10000	4
2560	12800	5
3200	3200	1
3600	7200	2
5000	10000	2
6400	6400	1
7200	7200	1
10000	10000	1
10800	10800	1
12800	12800	1

TABLE A-1B

SYSTEM RESOLUTION POSSIBILITIES USING COMPUMOTOR MOTOR/DRIVERS

Desired System Resolution (Steps per Rev.)	Select This Motor/ Driver Resolution (Steps per Rev.)(S2)	Program This Number of Steps/LSD(S1)
900	21600	24
1000	25000	25
1016	25400	25
1080	21600	20
1200	21600	18
1250	25000	20
1270	25400	20
1350	21600	16
1440	21600	15
1500	36000	24
1800	36000	20
2000	36000	18
2160	21600	10
2250	36000	16
2400	21600	9
2500	25000	10
2540	25400	10
2700	21600	8
3000	36000	12
3125	25000	8
3175	25400	8
3600	36000	10
4000	36000	9

TABLE A-1B (Continued)

SYSTEM RESOLUTION POSSIBILITIES
USING COMPUMOTOR MOTOR/DRIVERS

Desired System Resolution (Steps per Rev.)	Select this Motor/ Driver Resolution (Steps per Rev.)(S1)	Program This Number of Steps/LSD(S1)
4320	21600	5
4500	36000	8
5000	25000	5
5080	25400	5
5400	21600	4
6000	36000	6
6250	25000	4
6350	25400	4
7200	21600	3
9000	36000	4
10000	50000	5
10800	21600	2
12500	25000	2
12700	25400	2
18000	36000	2
21600	21600	1
25000	25000	1
25400	25400	1
36000	36000	1
50000	50000	1

TABLE A-3

MOTOR/TRANSLATOR RESOLUTIONS

S2 # 1-4

Resolution (Steps per Rev)	S2 #1	#2	#3	#4	Resolution (Steps per Rev)	S2 #1	#2	#3	#4
200	OFF	OFF	OFF	OFF	12500	OFF	OFF	OFF	ON
400	ON	OFF	OFF	OFF	16384	ON	OFF	OFF	ON
800	OFF	ON	OFF	OFF	20000	OFF	ON	OFF	ON
1000	ON	ON	OFF	OFF	21600	ON	ON	OFF	ON
3200	OFF	OFF	ON	OFF	25000	OFF	OFF	ON	ON
4096	ON	OFF	ON	OFF	25400	ON	OFF	ON	ON
5000	OFF	ON	ON	OFF	36000	OFF	ON	ON	ON
10000	ON	ON	ON	OFF	50000	ON	ON	ON	ON

Note:
Above table refers to units at Revision E or higher (D for 172X).

TABLE A-4

"GO-HOME" VELOCITY

S3 # 1-3

Velocity (rev/sec)	Velocity (rpm)	S3 #1	#2	#3	Velocity (rev/sec)	Velocity (rpm)	S3 #1	#2	#3
0.10	6	OFF	OFF	OFF	2.5	150	OFF	OFF	ON
0.25	15	ON	OFF	OFF	5.0	300	ON	OFF	ON
0.50	30	OFF	ON	OFF	10.0	600	OFF	ON	ON
1.00	60	ON	ON	OFF	20.0	1200	ON	ON	ON

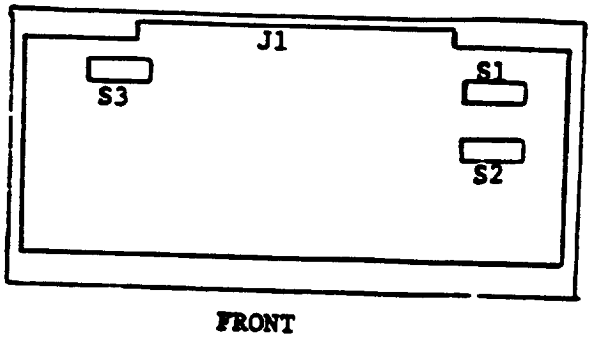


FIGURE B1

S1-1 1
S1-2 2
S1-3 4
S1-4 8
S1-5 16
S1-6 32
S1-7 64
S1-8 128
(S1-1 to S1-8) ______ Steps per LSD (ON=Value Shown) of distance (See page 13 and Tables A-1A, A-1B and B1)

S2-1
S2-2
S2-3
S2-4
(S2-1 to S2-4) ______ Steps per Revolution (See Page 13 and Table A-3)
S2-5 ______ Backoff at Home Limit (see page 16)
S2-6 ______ Backoff Direction CCW (see page 17)
S2-7 ______ Home Crossing Inhibit (see page 17)
S2-8 ______ Display Option Accumulative (see page 17)

S3-1
S3-2
S3-3
(S3-1 to S3-3) ______ Go Home Velocity (See Page 16 and Table A-4)
S3-4 ______ Velocity Range Low (see page 16)
S3-5
S3-6
(S3-5, S3-6) ______ Acceleration Range (see page 16)
S3-7 ______ Home Limit Bypass (see page 10)
S3-8 ______ Not used

TABLE B1

Common Binary Values for Pulses per Least Significant Digit

Binary	1	2	3	4	5	8	10	20	25	40	50	255
#1 2^0	ON	OFF	ON	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF	ON
#2 2^1	OFF	ON	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON	ON
#3 2^2	OFF	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	OFF	OFF	ON
#4 2^3	OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	ON	ON	OFF	ON
#5 2^4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	ON	ON
#6 2^5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
#7 2^6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
#8 2^7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON

Appendix C: Pin Out List

PCB PIN #	AMP PIN #	SIGNAL		INPUT/ OUTPUT
1	1	STEP		0
2	2	DIRECTION		0
3	3	SHUTDOWN		0
4	4	$\overline{\text{CW STEP}}$		0
5	5	$\overline{\text{CCW STEP}}$		0
6	6	$\overline{\text{IN POSITION}}$		0
7	7	$\overline{\text{CANNOT MOVE}}$		0
8	8	$\overline{\text{GOING HOME}}$		0
9	9	$\overline{\text{AT HOME}}$		0
10	10	+ 5 VDC		0
11	11	$\overline{\text{RESERVED IN}}$		I
12	12	CONSTANT VELOCITY		0
13	13	DIRECTION (CW/$\overline{\text{CCW}}$)		I
14	14	8	Position	
15	15	4	10^6	I
16	16	2	Digit	
17	17	1		
18	18	8	Position	
19	19	4	10^5	I
20	20	2	Digit	
21	21	1		

PCB PIN #	AMP PIN #	SIGNAL		INPUT/ OUTPUT
22	22	8	Position	
23	23	4	10^4	I
24	24	2	Digit	
25	25	1		
26	26	8	Position	
27	27	4	10^3	I
28	28	2	Digit	
29	29	1		
30	30	8	Position	
31	31	4	10^2	I
32	32	2	Digit	
33	33	1		
34	34	8	Position	
35	35	4	10^1	I
36	36	2	Digit	
37	37	1		
38	38	8	Position	
39	39	4	10^0	I
40	40	2	Digit	
41	41	1		
42	42	$\overline{\text{CCW LIMIT}}$		I

Notes: J1 is an AMP 86-Pin (Dual 43) 0.156 PC Edge Connector with Polarizing Slot and Solder Eyelets (AMP P/N 1-530654-3)

GND = Common DC Ground
PIN 44 Opposite PIN 1

PCB PIN #	AMP PIN #	SIGNAL	INPUT/ OUTPUT
43	43	GND (STEP RETURN)	I
44	A	GND (DIRECTION RETURN)	I
45	B	GND (SHUTDOWN RETURN)	I
46	C	GND (CW STEP RETURN)	I
47	D	GND (CCW STEP RETURN)	I
48	E	GND	
49	F	$\overline{\text{START}}$	I
50	H	$\overline{\text{STOP}}$	I
51	J	PRE/$\overline{\text{CONT}}$	I
52	K	INCR/$\overline{\text{ABS}}$	I
53	L	$\overline{\text{GO HOME +}}$	I
54	M	$\overline{\text{GO HOME -}}$	I
55	N	$\overline{\text{HOME LIMIT}}$	I
56	P	$\overline{\text{SHUTDOWN}}$	I
57	R	$\overline{\text{RESET IN}}$	I
58	S	4 GO HOME	
59	T	2 VELOCITY	I
60	U	1	
61	V	8	
62	W	4 ACCEL/DECEL	I
63	X	2 10^1 DIGIT	
64	Y	1	

PCB PIN #	AMP PIN #	SIGNAL	INPUT/ OUTPUT
65	z	8 ACCEL/DECEL	
66	a	4 10^0 DIGIT	I
67	b	2	
68	c	1	
69	d	8 VELOCTIY	
70	e	4 10^1	I
71	f	2 DIGIT	
72	h	1	
73	j	8 VELOCITY	
74	k	4 10^0	I
75	l	2 DIGIT	
76	m	1	
77	n	8 VELOCITY	
78	p	4 10^{-1}	I
79	r	2 DIGIT	
80	s	1	
81	t	8 VELOCITY	
82	u	4 10^{-2}	I
83	v	2 DIGIT	
84	w	1	
85	x	$\overline{\text{CW LIMIT}}$	I
86	y	GND	

NOTES: J1 is an AMP 86-pin (Dual 43) 0.156 PC Edge Connector with Polarizing Slot and Solder Eyelets (AMP P/N 1-530654-3)
GND = Common DC Ground
PIN 86 Opposite PIN 43
Compumotor Corporation

PIN-OUT LIST

MOTOR/DRIVER CONNECTOR J4

PIN #	SIGNAL	CORRESPONDING PIN # ON J1
9	STEP	1
8	DIRECTION	2
7	SHUTDOWN	3
6	SHIELD (AC GROUND)	None
5	GND	43
4	GND	44
3	GND	45
2	$\overline{\text{CW STEP}}$	4
1	$\overline{\text{CCW STEP}}$	5

Notes: J4 is a 9-Pin, 0.156" Spacing Locking Ramp Connector

J4 is wired in parallel with J1 for flexibility

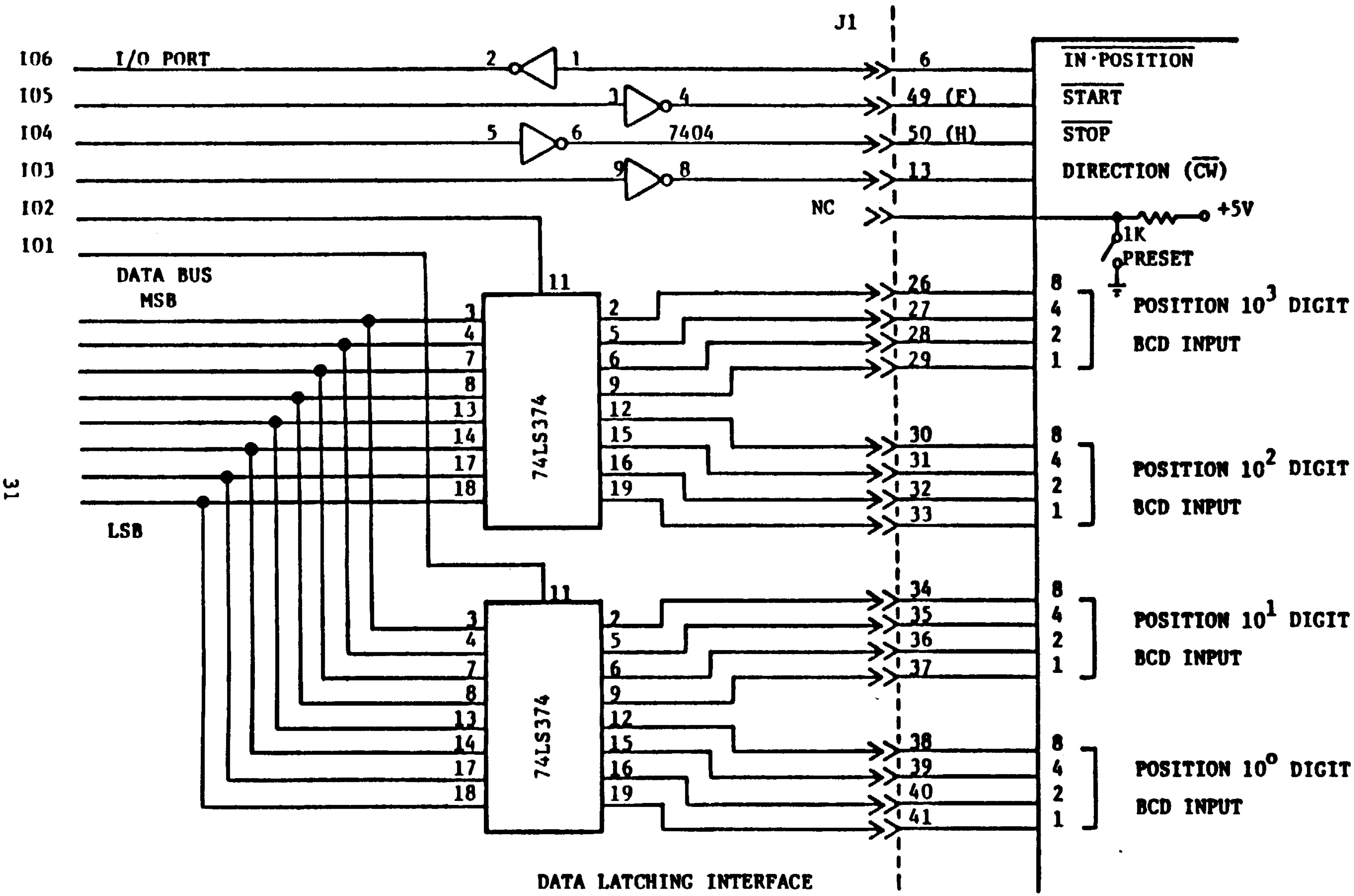
GND = Common DC Ground

AC POWER CONNECTOR J6

PIN #	SIGNAL
1	Transformer OUTPUT "A" (or unregulated 9-12V in)
2	AC Ground
3	AC Ground
4	Transformer OUTPUT "B" (or external supply GND)

Notes: J6 is a 4-Pin, 0.156" Spacing Locking Ramp Connector

Appendix D: Data Latching Interface



DATA LATCHING INTERFACE

Computer I/O Lines 1 and 2 (IO1 and IO2) are used to clock distance data from the Data Bus into the Data Latches. This particular configuration gives 1 digit resolution from 1 to 9999.

Appendix E: Pulse Output Ranges

TRANSLATOR RESOLUTION	STEP PULSE WIDTH
200-400	= 15 µsec
800-1000	= 7 µsec
2,000-12,800	= 1.5 µsec
21,600-50,000	= 1 µsec

Note: Maximum pulse frequency equals resolution in steps/rev times velocity in revs/sec. See Appendix F.

Appendix F: Velocity Range And Precision VS. Resolution

Motor/Driver Resolution (Steps/Rev.)	Low Velocity Range (Revs/Sec.)	Velocity Is Precise for Multiples of (Revs/Sec)	High Velocity Range (Revs/Sec)	Velocity Is Precise for Multiples of (Revs/Sec)
200	0.001-9.999	0.001	0.01-99.99	0.01
400	0.001-9.999	0.001	0.01-80.00	0.01
800	0.001-9.999	0.001	0.01-80.88	0.01
1000*	0.001-9.999	0.001	0.01-99.99	0.01
3200	0.001-9.999	0.001[C]	0.01-99.99	0.01[F]
4096	0.001-9.999	0.005	0.01-99.99	0.05
5000	0.001-9.999	0.001	0.01-99.99	0.01
10000	0.001-9.999	0.001	0.01-50.00	0.01
12500	0.001-9.999	0.001	0.01-40.00	0.01
16384	0.001-9.999	0.005[A]	0.01-30.00	0.05[D]
20000	0.001-9.999	0.001[A]	0.01-25.00	0.01
21600	0.001-3.000	0.005	0.01-25.00	0.25[D]
25000	0.001-9.999	0.001	0.01-20.00	0.01
25400	0.001-6.000	0.025[A]	0.01-20.00	0.25[D]
36000	0.001-9.000	0.005[B]	0.01-15.00	0.05[D]
50000	0.001-9.999	0.001	0.01-10.00	0.01

Note 1:

A Maximum Error ± .00010 revs/sec.

B Maximum Error ± .00013 revs/sec.

C Maximum Error ± .00025 revs/sec.

D Maximum Error ± .0004 revs/sec.

E Maximum Error ± .0007 revs/sec.

F Maximum Error ± .0013 revs/sec.

Note 2:
Above table refers to units
172A at Revision E or Higher
172D at Revision E or Higher
172X at Revision D or Higher

Appendix G: Limit Switch Connections

The Model 172 has two end of travel limit switch inputs each corresponding to one direction of motor rotation. These inputs are normally high, pulled up to the +5VDC supply of the indexer by 1 Kohm resistors.

The limit switches should be placed far enough before the end of travel of the load to insure that the load can be stopped in time by the motor. The response of the 172 to a limit input is an immediate halt of pulses to the motor.

Shielding is recommended on all remote wiring to the 172 to reduce the possibility of malfunction due to electrical interference. Any shielding must be connected to Earth, or the frame, and NOT to logic ground (GND).

Limit switches may take the form of a regular SPST switch, a magnetic vane or proximity switch, a Hall effect proximity sensor, an optical reflector or vane activated optical interruptor. Any device with open collector or TTL outputs that meets the electrical requirements below will serve to activate the inputs.

The limit switch approached by clockwise rotation of the motor should be connected to the CW input of J1 and the limit switch approached by counter clockwise rotation of the motor should be attached to the CCW input of J1. See connector pinout on following page.

Note: The limit switch specifications and recommended implementation techniques below apply to the input for the Home limit switch as well.

Input Requirements:

- -Active low TTL input requires a nominal 1mA current sinking switch closure to GND
- -Maximum logic low input voltage: 0.5 VDC
- -Minimum signal duration: 2 msec
- -Maximum logic high input voltage: 5.5 VDC

AMP connector pin location:

$\overline{\text{CW LIMIT}}$ (clockwise)	-	Pin "X"
GND	-	Pin "Y"
$\overline{\text{CCW LIMIT}}$	-	Pin "42"
GND	-	Pin "43"
$\overline{\text{HOME LIMIT}}$	-	Pin "N"
+5 VDC	-	Pin "10"

Typical Implementation:

1. Mechanical switch: the traveling load hits a spring loaded roller or lever actuated mechanical limit switch causing contact closure between the limit input and GND. The switch should be normally open, and suitable for small signals.

   Note: The spring loaded actuator is required to prevent load impact from damaging the switch or shortening its life. See Fig. 1.

2. Vane activated magnetic switch: the load has a sheet metal vane mounted to it which either passes into or out of the switch at the limit depending on switch output polarity. The output must be normally high (normally "sourcing"). The vane must be ferrous, (e.g., Microswitch 4AV1C-T1).

3. Vane activated optical interruptor: the load has a vane mounted to it which either passes into or out of the interruptor at the limit depending on interruptor output polarity. The output must be normally high (normally "sourcing"). (e.g., Spectronics SPX2002) See Fig. 2.

4. Magnet activated Hall effect proximity sensor: the load has a magnet mounted to it which is detected by the sensor when the load approaches. (e.g., Microswitch 205SR1A).

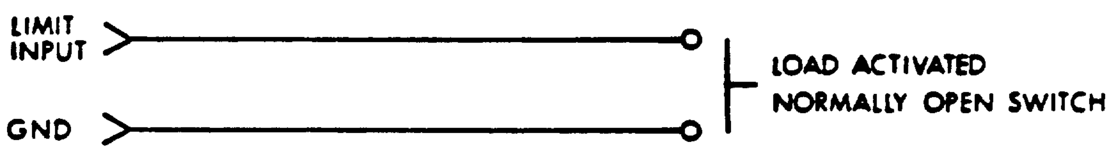


FIG 1.

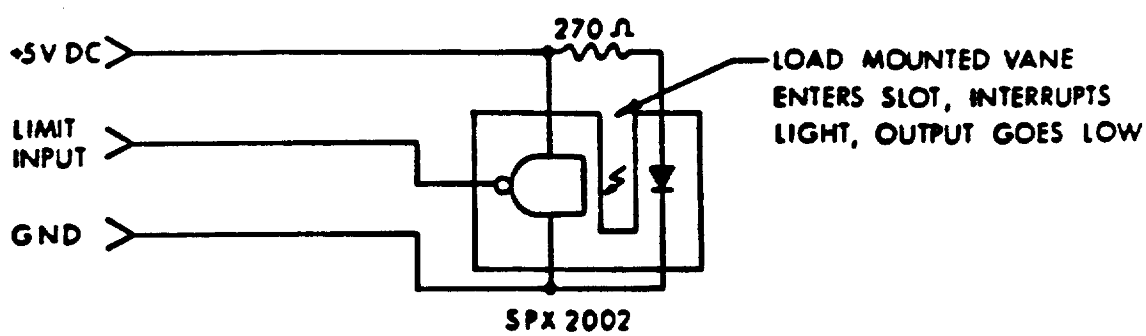


FIG 2.

Appendix H: Start Stop Velocities For Low Resolution Motors

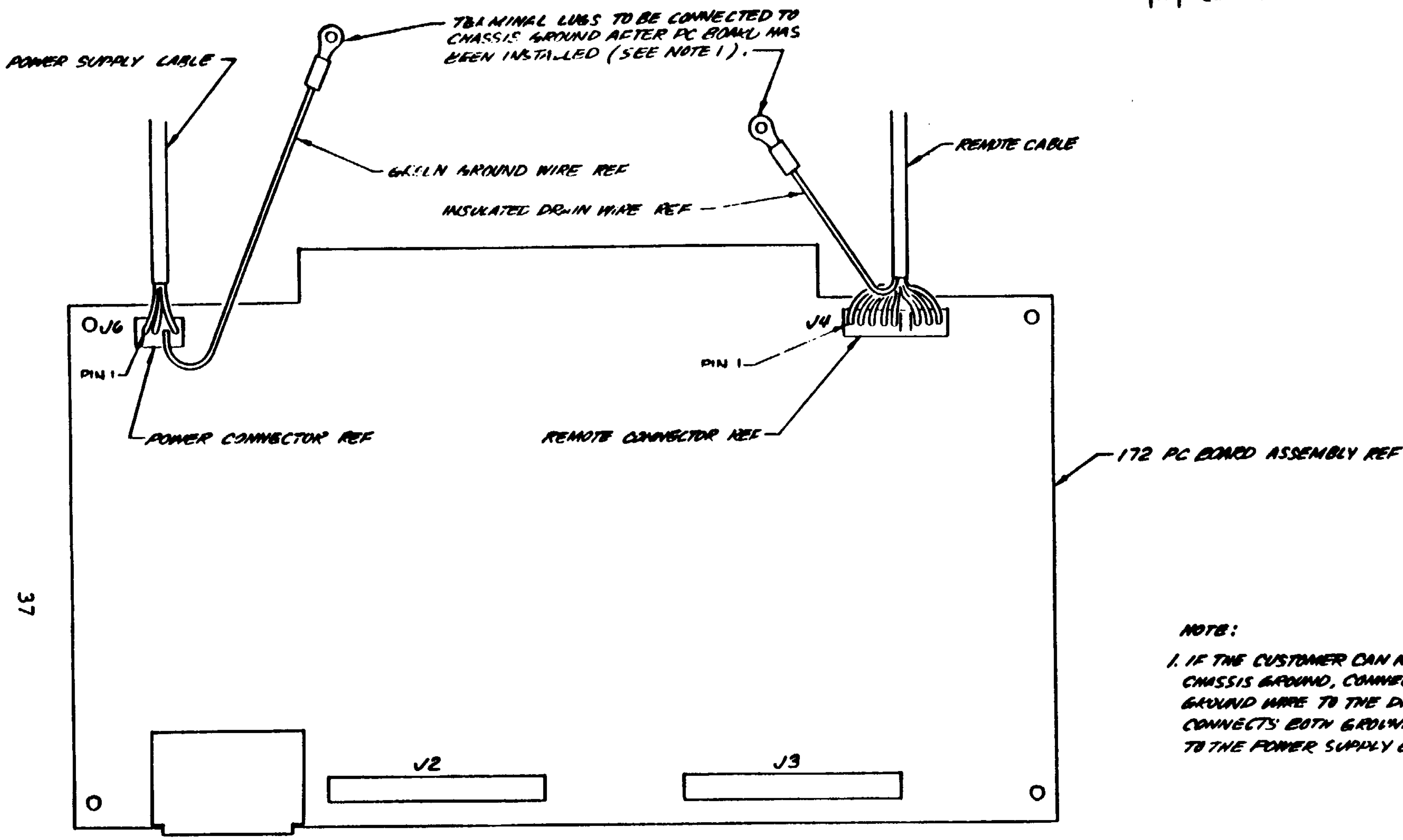
All Model 172 Indexers execute trapezoidal and triangular move profiles that ramp up from and down to zero velocity. This characteristic is acceptable for Compumotor motor/drives and other microstepped systems, but is unacceptable for low resolution stepper systems because of their low speed resonance characteristics. Low resolution systems typically require instantaneous accelerations/decelerations to/from some base speed that is above the fundamental base speed for that system.

All 172 Indexers at REVISION LEVEL C or higher have the capability to perform moves from a base speed. The base speed is 1 RPS and the correct frequency is automatically calculated from the Motor/Translator Resolution DIP switch S2. To command the 172 to use this base speed, apply a TTL "low" (or ground) on J1 Pin 11 (AMP "11") - the RESERVED IN input. When this input is low, all moves will begin and end at a 1 RPS base speed unless a lower velocity is commanded by the front control panel or external control. If a velocity lower than 1 RPS is selected, the 172 will use that value as its base speed and perform no acceleration or deceleration ramping.

The revision level of a unit may be determined by the label or the bottom of boxed versions or the part number and revision level stamped on 172X board only indexers.

APPENDIX I

LTR	DESCRIPTION	DATE	APPROVED
A	PROD. RLS. EK NO. 99		



NOTE:

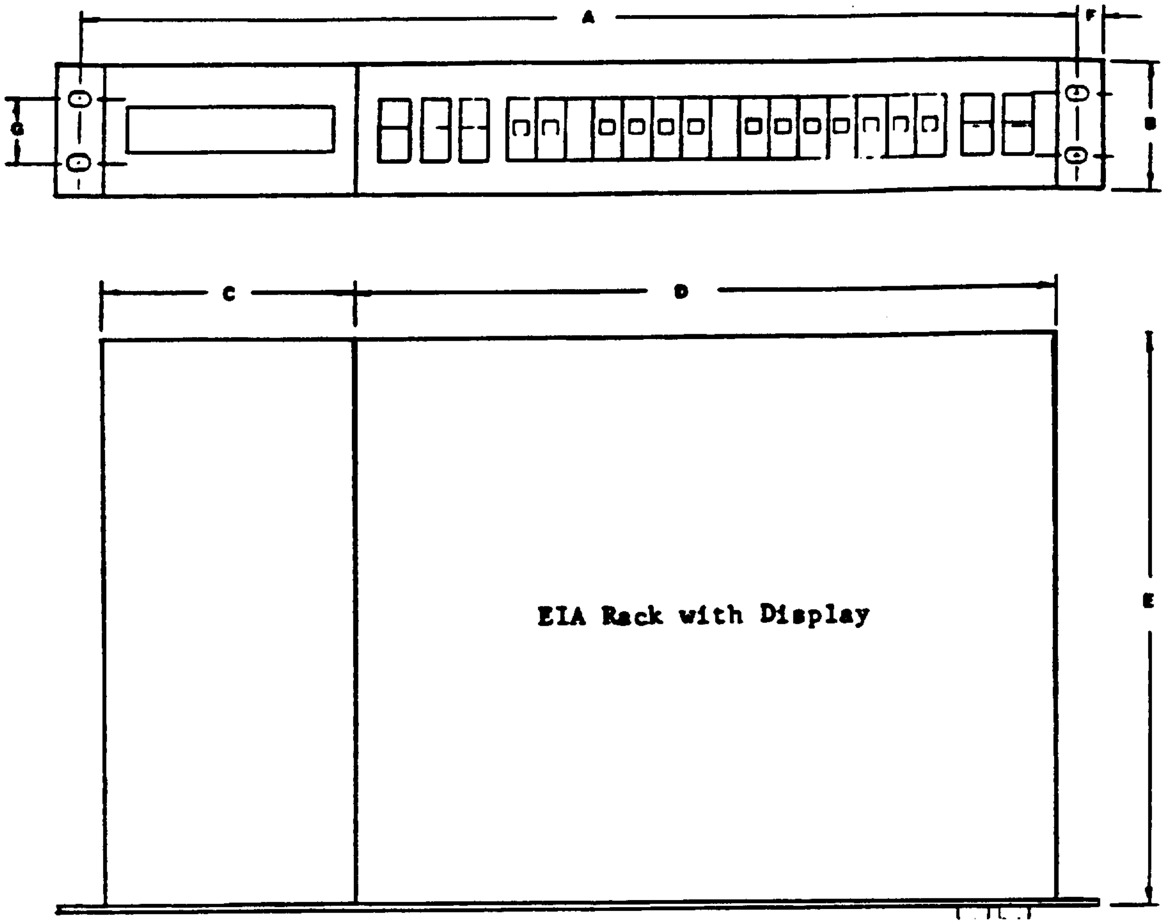
1. IF THE CUSTOMER CAN NOT PROVIDE FOR CHASSIS GROUND, CONNECT THE GREEN GROUND WIRE TO THE DRAIN WIRE. THIS CONNECTS BOTH GROUND WIRES TO THE POWER SUPPLY GROUND.

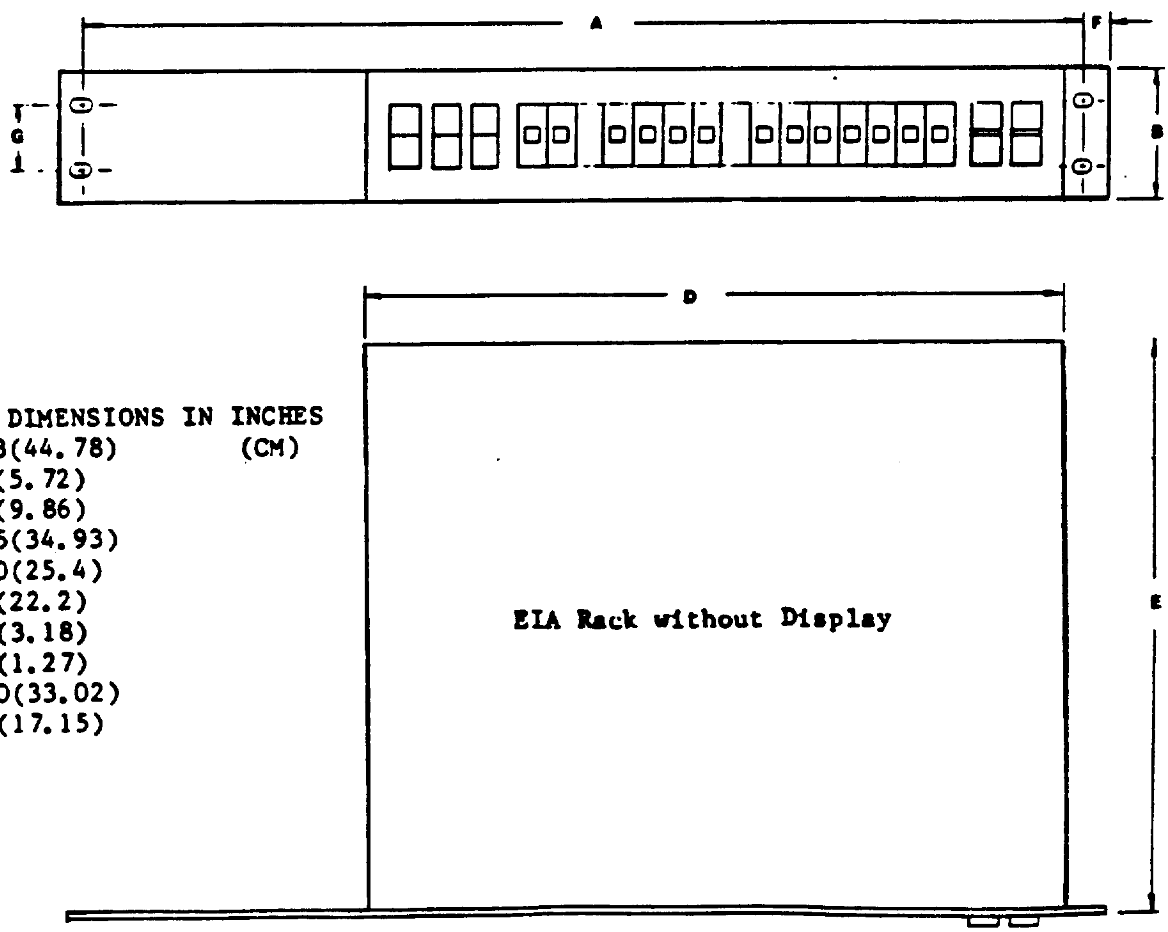
COMPUMOTOR CORP.

INSTALLATION INSTRUCTIONS
172 BOARD
ONLY GROUNDING

SCALE: FULL — SIZE: C — DRAWING NO: 88-002718-01

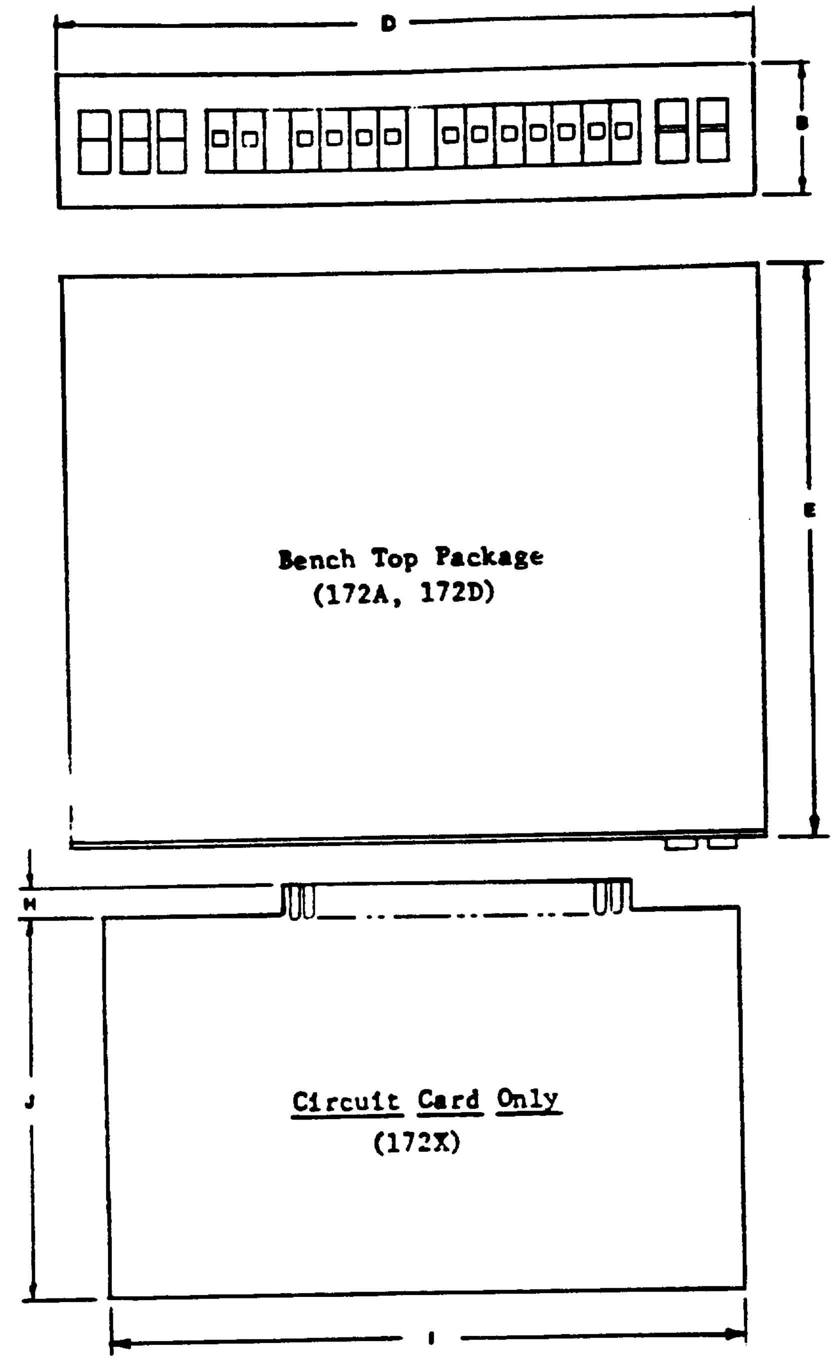
DO NOT SCALE DRAWING — SHEET 1 OF 1





PHYSICAL DIMENSIONS IN INCHES (CM)

A = 17.63(44.78)
B = 2.25(5.72)
C = 3.88(9.86)
D = 13.75(34.93)
E = 10.00(25.4)
F = 0.88(22.2)
G = 1.25(3.18)
H = 0.50(1.27)
I = 13.00(33.02)
J = 6.75(17.15)



WEIGHT IN POUNDS (KG)

	Without Display	Without Display	Circuit Card Only
Net	13(5.90)	10(4.5)	4(1.8)
Shipping	17(7.71)	14(6.4)	8(3.6)

Electrical Requirements
With AC Transformer: 90 to 130 VAC, 50/60 Hz, .2 A max.
Without AC Transformer: 9-12 VAC, 50 to 400 Hz, 1.5 A max.
9-12 VDC unregulated, 1.5 A max.

Environmental
Operating: 32 to 122°F (0 to 50 C)
10 to 90% Humidity, non-condensing
Storage: -25 to 185°F (-30 to 85 C)